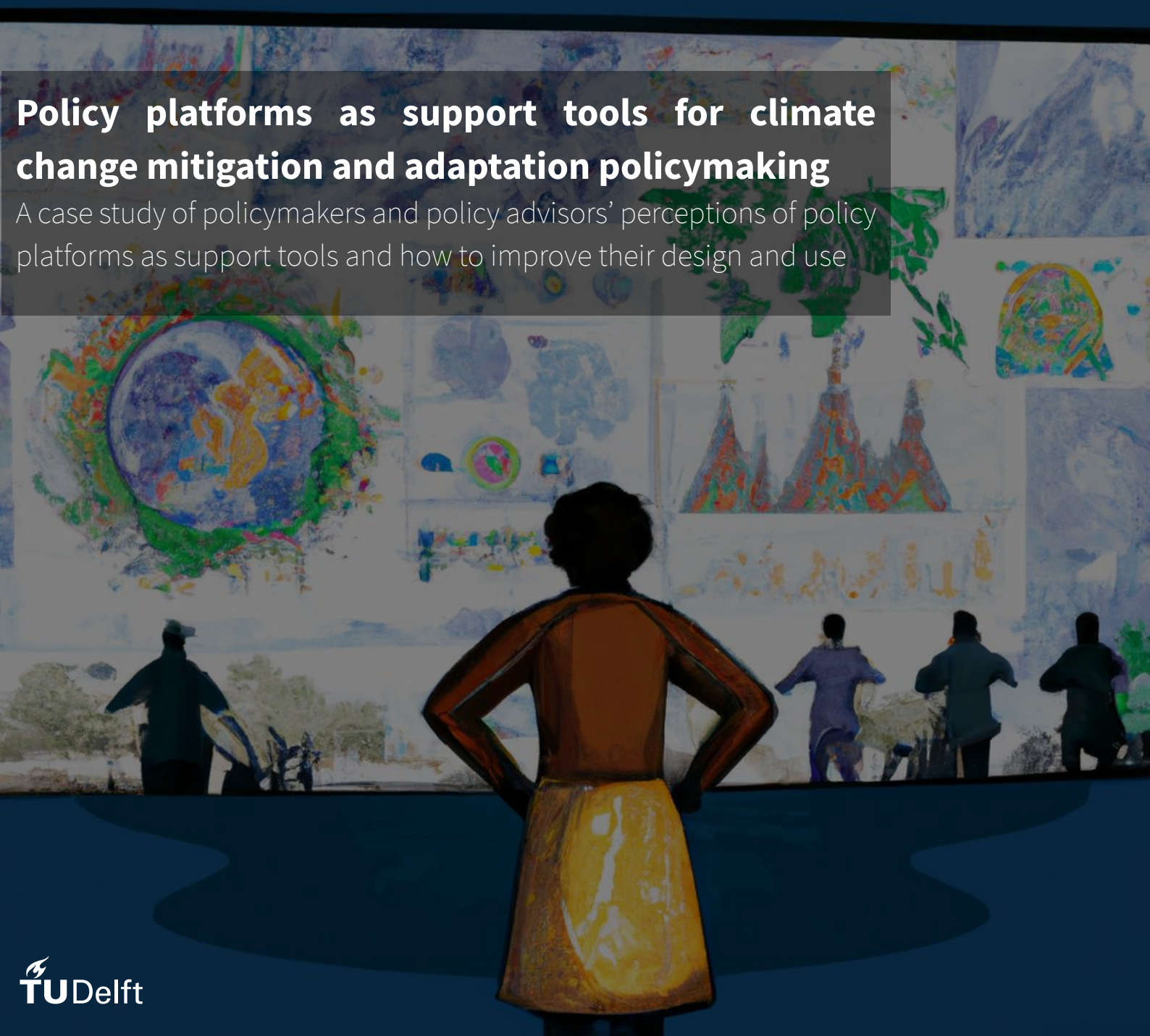
Policy platforms as support tools for climate change mitigation and adaptation policymaking

A case study of policymakers and policy advisors' perceptions of policy platforms as support tools and how to improve their design and use



TU Delft

POLICY PLATFORMS AS SUPPORT TOOLS FOR CLIMATE CHANGE MITIGATION AND ADAPTATION POLICYMAKING

A case study of policymakers and policy advisors' perceptions of policy platforms as support tools and how to improve their design and use

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by

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It's not about how to achieve your dreams. It's about how to lead your life. If you lead your life the right way, the karma will take care of itself. The dreams will come to you.

—Randy Pausch, The Last Lecture.

Contents

Abbreviations

CCMA	Climate change mitigation and adaptation
DPET	Reference to the Decarbonisation Policy Evaluation Tool (platform developed under the EU H2020 funded project INNOPATHS)
DSS	Decision support systems
DST	Decision support tools
EPA	Engineering and Policy Analysis (TU Delft MSc programme)
EU	European Union
EUCalc	Reference to the EUCalc Transition Pathways Explorer (platform developed under the EU H2020 funded project EU Calculator)
GHG	Greenhouse gases
H2020	Horizon 2020 (EU's research and innovation funding programme from 2014-2020)
MOOC	Massive Open Online Courses
MoSCoW	Prioritisation technique that splits requirements into the categories Must have, Should have, Could have and Won’t have.
MRQ	Main research question
SQ	Subquestion

Acknowledgements

Seven years ago, around this same time, I was writing the most important part of the most important text I had written up to that point: the acknowledgements of my bachelor's degree graduation project. At that time, I would never have imagined that I would be here today, writing the (updated) most important part of the most important text I've written up to this point: the acknowledgements of my master's thesis. I wonder what I will be writing as the most important text and who I'll be lucky to be able to thank seven years from now...

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though never expected (as it was only a courtesy), was frequently present and always greatly appreciated by me.

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Alexandre Curley

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Executive summary

CONTEXT

Climate change mitigation and adaptation (CCMA) represents a top priority in the global agenda. The adoption of the Paris Agreement at COP 21 in December 2015 was a significant step towards meaningful efforts to reduce global warming, especially with its ambitious goals of keeping the global average temperature "well below 2°C above pre-industrial levels, with efforts to limit the temperature increase to 1.5°C" (Paris Agreement, 2015). Despite increased global attention to climate-change mitigation and adaptation initiatives, human-caused climatic change is already affecting weather and climate extremes throughout the globe (IPCC, 2023), with the average global temperature reaching all-time high values in two consecutive days at the beginning of July 2023 (Paddison, 2023).

Multiple challenges affect the effectiveness of climate change mitigation and adaptation measures, such as accountability, intergenerational justice and developing countries' increased participation in greenhouse gas (GHG) emissions. The high complexity of information surrounding models' assumptions, results, and scenarios related to climate change also presents a challenge, especially when communicating with policymakers, since they are the ones negotiating essential policies.

In this context, support tools such as policy platforms can be helpful instruments in bridging the science-policy gap by allowing policymakers to understand scenarios and vailable policy levers better, enabling better understanding of concepts, terminology, and models or by serving as a hub for disseminating best practices and enabling users to learn from others. Although several examples of climate change mitigation and adaptation (CCMA) policy platforms are available, the literature does not provide a consensus on the conceptualisation of such support tools, and terms such as decision support tools, climate services, decision support systems and policy platforms have been used. Additionally, available literature often evaluates such support tools with regular citizens, leaving a knowledge gap as to how policymakers perceive such tools and how well they meet the needs of such end users.

ABOUT THIS THESIS

This thesis investigates policymakers' and policy advisors' perceptions of the usefulness of CCMA policy platforms, as well as the characteristics (in terms of functionalities or attributes) of such policy platforms they prefer in order to use them as support tools to help them deliver more effective policies or advice.

For this, this research proposes the following main research question and subquestions:

(MRQ) *What recommendations can be made for the design and use of CCMA policy platforms in order to improve their usefulness as support tools for policymakers and policy advisors?*

(SQ1) *What are the typical characteristics of climate-change mitigation and adaptation (CCMA) policy platforms?*

(SQ2) *What are the similarities and differences between existing CCMA policy platforms in the EU, considering the identified typical characteristics of policy platforms?*

(SQ3) *How do policymakers and policy advisors perceive the usefulness of CCMA policy platforms?*

(SQ3) *What characteristics do policymakers and policy advisors look for in CCMA policy platforms to be used as support tools for policymaking?*

SQ1 is addressed via a literature review in relevant scientific and grey literature regarding user needs and user requirements for decision support tools, decision support systems and similar terms. SQ1 provides as output a framework composed of 9 typical characteristics of policy platforms and 42 criteria embedded into the different groups. SQ2 is addressed via a systematic assessment of the EU-funded Horizon 2020 programme to identify relevant policy platforms and assess them using the proposed framework. SQ2 identifies and assesses 10 climate change mitigation and adaptation policy platforms using the proposed framework from SQ1. SQ3 and SQ4 are addressed by conducting interviews (11) with policymakers and policy advisors working on climate-change-related areas in the Netherlands and by conducting surveys (9) with policymakers in seven countries in the EU and North America. Policymakers and policy advisors provided feedback on the usefulness of two examples of CCMA policy platforms from the H2020 programme (EUCalc and DPET), as well as their

preferences for CCMA policy platform characteristics by assessing *what* characteristics they find most relevant (using a MoSCoW prioritisation technique) and *how* much they valued each characteristic (using a numerical ranking of the characteristics).

MAIN RESULTS

After investigating 17 scientific papers on user needs and user requirements related to climate-change-related decision support tools and decision support systems and 4 grey literature documents, 9 characteristics of policy platforms were identified. The characteristics include ***Transparency & Credibility of information***, ***Ease of use***, ***Flexibility of use***, ***Accessibility & Portability***, ***Education & Awareness***, ***Communication of complex information***, ***Data visualisation & interactivity***, ***Actively maintained and supported*****,** and ***Security & privacy***.

The assessment of 10 climate change mitigation and adaptation policy platforms within the Horizon 2020 programme using the proposed framework shows that ***Transparency & Credibility of Information*****,** ***Education & Awareness*****, and** ***Communication of Complex Information*** **are the characteristics in which the assessed platforms perform best**, with multiple examples of platforms achieving the maximum score in those characteristics. On the other hand, ***Actively maintained and supported*****,** ***Security & privacy*****, and** ***Accessibility & Portability*** **were the characteristics in which the assessed platforms performed worst**, with many not being updated or accessible anymore. Such findings show that currently available CCMA policy platforms are significantly lacking in relevant characteristics required for a support tool to be not even *useful* but *used* by policymakers.

Interviews and surveys with policymakers provided inputs into their perception of the usefulness of policy platforms and their preferences regarding the characteristics of policy platforms. In terms of the perception of the usefulness of CCMA policy platforms, the results of the interviews show that, although participants did perceive two examples of CCMA policy platforms assessed in interviews and surveys (EUCalc and DPET) as providing useful functionalities, **the overwhelming perception from the interviews was that both tools lacked applicability and relevance to participants' policymaking contexts**, leading to overall negative or mixed perceptions of usefulness of both tools. On the other hand, **survey results show that most respondents perceived tools such as EUCalc and DPET as "very useful"**. However, because survey results did not provide the level of detail obtained from interviews, a clear understanding of the difference in perceptions of both groups was not achieved, and future research is recommended to better understand this finding.

In general terms (beyond the two tools assessed), **accessibility, relevance, applicability, and credibility were identified as the primary factors driving the perception of the usefulness of CCMA policy platforms.** A useful policy platform is, therefore, one that assists policymakers and policy advisors in achieving their goals and delivering better policies (or advice) by providing information and functionalities relevant to their policymaking context, translating complex information into accessible and actionable insights, and being developed by credible sources while being transparent in terms of its capabilities and limitations.

Concerning the preferences for the characteristics of CCMA policy platforms, participants used the MoSCoW prioritisation technique to assign 14 characteristics to a must-have, should-have, could-have, or indifferent group. Participants also ranked each characteristic within each MoSCoW group according to their preferences. The combined results from the surveys and interviews paint a clear picture of how the majority of the participants perceived the different characteristics.

Characteristics related to the *communication of complex information in an easy-to-digest format (1st), free and open access to all functionalities of the tool (2nd), transparency regarding data sources, limitations, uncertainty, or assumptions associated with the tool (3rd) and high level of detail for spatial and temporal data (4th)* were all deemed as a **must-have**, signalling that those are *sine qua non* for policymakers to even consider to use a given policy platform.

Characteristics related to the *availability of training and learning functionalities (1st), availability of detailed documentation on concepts and models used in the tool (2nd), interactive and easy-to-navigate visual graphical elements (3rd) and all functionalities available via a web-based platform (4th)* were deemed as **should-have** characteristics, which suggests that the absence of these characteristics would not make the participants

completely lose interest in a given tool. However, a policy platform should ideally incorporate such characteristics in future updates in order to keep meeting user needs.

Characteristics related to the provision of *user stories from policymakers, communities, or organisations around the world (1st), availability of very recent ("last year") data (2nd), ability to import user data, export results, or integrate the tool with other platforms (3rd) and ability to modify parameters and run custom analyses based on user inputs (4th)* were deemed as **could-have** characteristics. These are essentially seen as 'nice to have' but not mandatory for policymakers.

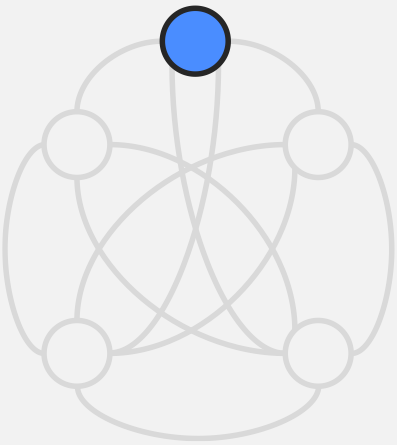
The final group includes characteristics that participants were **indifferent** to and included the *availability of the tool in languages beyond English* and the *ability to use the tool efficiently via mobile phones or tablets*. Indifferent characteristics do not affect the user positively (by their presence) or negatively (by their absence).

CONCLUSIONS

Based on the results of this thesis, the following recommendations are derived in order to improve the design and user of policy platforms (MRQ):

- **Incorporate systematic reviews of existing CCMA policy platforms into projects for new platform development.** Dozens of examples of CCMA support tools were identified in the context of this thesis. Since many of such tools are developed within projects and programmes such as the Horizon 2020 or Horizon Europe, having a clear understanding of how a new CCMA policy platform connects to the existing body of support tools could improve the understanding of how that new tool fills existing gaps and well as the policy relevance of projects that are developing such tools.
- **Involve boundary organisations in the development and use of CCMA policy platforms and information.** Despite some positive perceptions of the usefulness of the two assessed CCMA policy platforms in surveys and interviews, the findings point to a potential gap between many EU-level CCMA policy platforms and the context and policies that local policymakers can implement in their context. Boundary organisations such as PBL, KNMI, Potsdam Institute for Climate Impact Research (PIK), International Institute for Applied Systems Analysis (IIASA), and others can provide policymakers with more understandable and actionable climate information. Boundary organisations can help by directly participating in the development of support tools (as part of the project consortium), by developing guidelines or primers on how to better communicate climate science to policymakers (as recommended by literature), or by using models and CCMA policy platforms as tools to derive policy advice to be made available to policymakers across the EU.
- **Develop CCMA policy platforms that will be available in the long run.** Many policy platforms identified in this research did not allow for their assessment because their web pages were no longer accessible or pertained to completely different websites using the same domain. This happened to six H2020 projects that finished between 2018 and 2021 and were already unavailable. Additionally, some of the available webpages of H2020 platforms, while still accessible, lacked critical security credentials (such as valid SSL certificates that enable an encrypted connection). Not being able to reach a policy platform and not being able to use a policy platform safely are likely factors to reduce the interest of policymakers in experimenting with different tools that might be useful for them. Connecting completed projects with new projects is one method for ensuring that knowledge generated in EU projects is kept alive. Organisations that incentivise research and provide funding could also allocate specific budgets for the maintenance of developed policy platforms for longer periods.
- **Develop CCMA policy platforms that can accommodate the needs of different users.** Researchers and organisations creating CCMA policy platforms may choose to present information to users in layers or incrementally. Rather than providing the most detailed information up front and relying on users to find and filter what is relevant, a hypothetical CCMA policy platform could approach user interaction in layers. This can be achieved, for example, by first asking users to select what they want to accomplish with the tool (e.g., explore scenarios, learn topics, find user stories) and then presenting incrementally different options for further selection by the user based on the previous selection. This design is not

guaranteed to please everyone, but it may serve different needs better (more general versus more detailed information). Recent advances in technologies such as artificial intelligence can also play an important role in making information more adaptable to different needs and potentially helping make concepts, models and climate information more digestible and actionable.



Chapter 1
Introduction

Main topics

1. Contextualisation
2. Literature review
3. Research questions
4. Report organisation

1. Introduction

1.1 Contextualisation

Mitigation and adaptation to climate change are currently top priorities on the global agenda. The Paris Agreement was adopted at COP 21 in December 2015, marking a historic step towards concrete actions to limit global warming. The Paris Agreement entered into force on November 4, 2016, with the participation of 193 countries (plus the EU). Its most audacious goal is stated in Article 2 item (a) as pursuing a global average temperature increase of "well below 2°C above pre-industrial levels, with efforts to limit the temperature increase to 1.5°C" (Paris Agreement, 2015). As a result, many countries created frameworks and regulations to put the agreement's commitments into action. The European Commission, in particular, outlined its vision for a climate-neutral EU by 2050 in November 2018 (European Commission, 2018) and soon after unveiled the European Green Deal, which supports the implementation of the Paris Agreement and lays out the EU's roadmap to achieve carbon neutrality by 2050. The European Green Deal was then made law by the European Climate Law (European Commission, n.d.-b) and was considered "Europe's man on the moon' moment" by European Commission President Ursula von der Leyen (European Commission, 2019).

Despite increased global attention to climate-change mitigation and adaptation initiatives, human-caused climatic change is already affecting weather and climate extremes across the globe (IPCC, 2023). On July 2023, a few weeks before this thesis is due to be submitted, the average global temperature reached an all-time high of 17.01 degrees Celsius on Monday, July 3rd, 2023, only to be surpassed the next day, July 4th, with 17.18 degrees Celsius (Paddison, 2023). In a publication released by the end of July 2023 discussing such record events, Zachariah et al. (2023) claim that such events are no longer rare, and that what could be events that occurred once every 250 years for China and "virtually impossible to occur" (p.1) for the United States, Mexico region, and Southern Europe if it were not for human-induced climate change are now expected to occur once every five years (China), ten years (Southern Europe), and 15 years (for the United States and Mexico region). When commenting on such historic events, UN Secretary-General António Guterres was unequivocal, claiming that global warming's era has finished and that the "era of global boiling has arrived" (Guterres, 2023, p.1).

To be effective, climate change mitigation and adaptation measures require collective and coordinated action from a wide range of stakeholders, including scientists, policymakers, business leaders, and the general public. It is also regarded as the most pressing issue of our time in need of collective action (Brechin, 2016; Esty & Moffa, 2012). However, updated versions of national pledges made since the Glasgow COP26 in 2021 make no discernible difference in projected 2030 emissions, and the Paris Agreement goal remains far from met (United Nations Environment Programme, 2022). All of this contributes to the understanding of climate change as a super wicked problem with complex and uncertain causes, interrelationships, and potential solutions (Saab, 2019; World Bank Group, 2014). Numerous challenges are limiting the effectiveness of climate change mitigation and adaptation measures, and identifying such challenges is challenging in and of itself. Accountability, intergenerational justice, increased participation of developing countries in overall greenhouse gas (GHG) emissions, and the widespread presence of fossil fuel-intensive products and services in modern life are some of the major challenges for effective action (Wyns, 2023).

Another barrier to effective climate change action is the inherent complexity of communication - about model assumptions, results, scenarios, and interconnections, as well as a lack of applicability to users' context. This phenomenon is referred to as the climate information usability gap (Lemos et al., 2012), in which there is a mismatch between what producers of climate information expect to be useful and what users of such information see as applicable to their decision-making context. This is especially important when it comes to effective communication with policymakers about climate change-related science because they are the ones negotiating and implementing policies that will have a significant impact both now and thousands of years from now (IPCC, 2023). Although scientific input is critical, it is not the only factor considered by policymakers when making decisions. As a result, it is critical that the science underlying research and policy recommendations take into account the realities and challenges that policymakers face in their respective contexts. Due to time constraints, policymakers almost always rely on expert opinion to stay informed on such issues (Martin, 2021), particularly because scientific literature is typically written and consumed by scientists, making it difficult to engage broader stakeholders in the climate change debate (Martin, 2021).

Climate change scientific communication has traditionally relied on the science comprehension thesis (SCT). According to this, there is a gap in scientific literature comprehension that prevents the public from recognising the seriousness of climate change as scientists would want (Kahan et al., 2012). The deficit model also assumes that providing scientifically sound information will lead to people developing more positive attitudes towards climate change science and making better decisions (Rowan et al., 2021). This, however, has proven to be an overly simplistic understanding of human decision-making because information is only one factor that influences people's decisions and behaviours, and other factors, such as peer relationships and political and cultural worldviews, can also play a significant role in shaping one's opinion (Rowan et al., 2021). As a result, there is a growing demand for scientists to improve their communication skills in order to make scientific knowledge more accessible, inclusive, and effective (Suldovsky et al., 2022; World Health Organisation, 2021), with climate change and more recently, the Covid-19 pandemic serving as key examples.

(Decision) Support tools can be useful for bridging the gap between science and policy, particularly when simulation models are involved, because they can leverage learn-by-doing practises and facilitate understanding of concepts such as feedback, accumulation, delays, and others that are common in complex nonlinear systems such as those linked to climate change effects. Support tools can also allow different users to experiment with multiple assumptions and scenarios and receive near-instant feedback on their choices (Sterman, 2011). Such potential benefits have resulted in a significant increase in the number of decision support tools (DST) available for climate-related topics over the last few decades (Guivarch et al., 2022; Wong-Parodi et al., 2020). However, there does not appear to be a consensus in the literature on how to properly refer to such tools (Moss, 2015), with decision support tools and decision support systems being the most common terminology identified, but with multiple other names also being found in both the scientific literature and available online tools, such as support tools, decision aid, climate services, policy platforms (which is the preferred term defended in this thesis), tools, and a variety of other combinations.

For two reasons, this thesis aggregates several of the aforementioned possibilities using the term policy platforms. First of all, the term policy platform is broad enough to encompass a variety of tools, including tools for modelling and simulation, as well as policy databases and tools with a stronger emphasis on education and awareness. Second, it is an expression that may be applied

to a variety of study fields, including those that deal with the environment, healthcare, and transportation, among many others. Chapter 6 of this thesis discusses distinctions between policy platforms and conventional decision support tools (and related concepts) in light of the findings of this thesis.

Although no specific definition of a policy platform was found in the literature in the context of this thesis, policy platforms can be understood in a broader sense as tools for facilitating and supporting more effective policymaking. Policy platforms can achieve this by facilitating understanding of information, assumptions, limitations, and outcomes or by disseminating relevant knowledge and information on some topic. This may include, for instance, a policy platform that allows users to understand climate change models, learn about relevant concepts and factors influencing climate change, or explore best practices/success stories from around the world. In light of the findings from this thesis, Chapter 6 (Discussions and conclusions) gives a more refined conceptualisation of climate change mitigation and adaptation policy platforms.

The development of various types of platforms to improve model and scenario exploration and communication, enhance dialogue and collaboration, and disseminate best practices can already be seen and possibly traced to landmarks in the fight against climate change and the transition to renewable energy sources, such as the Paris Agreement. One such policy platform is the Senses Toolkit (https://climatescenarios.org/toolkit/), which gives users with modules to better understand and explore climate change scenarios, as well as more detailed policy and financial portals. Another platform that serves as a hub for collecting and sharing key climate mitigation research project insights is the CCM portal (https://climatechangemitigation.eu/). Furthermore, many other platforms under the Horizon 2020 EU-funded programme (H2020 programme), such as I2AM PARIS (https://www.i2am-paris.eu/), openENTRANCE (https://openentrance.eu/), and ENCLUDE (https://encludeproject.eu/interactive-policy-platform), aim to bridge the gap between scientific research and policy implementation.

Despite the growing number of such platforms developed in recent years, there is still debate about their effectiveness as non-expert support tools, with studies pointing to positive outcomes such as improved knowledge and more informed decisions as a result of using interactive platforms (Mayer et al., 2014;Volken et al., 2018), but also addressing challenges such as long-term retention of updated opinion (Xexakis & Trutnevyte, 2019).

The goal of this thesis is to add to the body of knowledge on climate change decision-making by shedding light on some of the challenges raised above. This study will investigate climate-change mitigation and adaptation (CCMA) policy platforms to learn about their main characteristics, how currently available policy platforms in the EU compare and contrast among themselves (taking into account the identified characteristics), and how policymakers and policy advisors perceive the usefulness of such tools, as well as what they prefer and look for in terms of functionalities or attributes when using such tools to support them in their work. This study is expected to contribute to a better understanding of how CCMA policy platforms can promote evidence-based policymaking, as well as important factors to consider when designing and using such a platform in policymaking contexts.

1.2. Literature review

This section contains a review of the literature to situate this research topic within the existing body of knowledge. The relationship between how policymakers or policy advisors perceive policy platforms does not appear to be fully established. From the simulation models related to

climate change mitigation and adaptation that emerge in the literature, many are either not easily accessible to the general public or are not necessarily interactive for non-experts. Furthermore, such simulation models frequently aim to provide answers or insights into possible futures, different pathways, or uncertainties that can improve policymaking but have not been tested with actual policy or decision-makers to assess how they are perceived or how the models affected policymakers in terms of understanding, confidence, or engagement with climate change-related topics.

This thesis aims to gain a comprehensive understanding of policy platforms and to explore policymakers' perspectives of them as support tools. As a result, a focus was placed on performing a literature assessment on the impacts or effects of different platforms on the decisions and perceptions of policy advisors and policymakers. Since a policy platform does not appear to be a well-defined term in the literature, the search criteria included numerous related terms to improve results. Scopus was chosen as the search database because of its extensive coverage of policy-related journals. The search criteria were divided into four sections, as shown in Table 1.1.

Table 1.1. Search terms and string used in literature review

Component	Search terms	Search query
Characteristics	"interactive" OR "responsive" OR "customi?able" OR "gamif*"	("interactive" OR "responsive" OR "customi?able" OR "gamif*") AND ("platform" OR "tool?" OR "application?" OR "app?" OR "web tool?" OR "digital tool?" OR "scenario?" OR "evidence based" OR "model based") AND ("energy transition" OR "decarboni?ation") AND ("decision support" OR "decision making" OR "engagement" OR "impact" OR "evaluation" OR "assessment" OR "polic*" OR "implement*" OR "percept*")
Platform	"platform" OR "tool?" OR "application?" OR "app?" OR "web tool?" OR "digital tool?" OR "scenario?" OR "evidence based" OR "model based"	
Area	"energy transition" OR "decarboni?ation"	
Impact	"decision support" OR "decision making" OR "engagement" OR "impact" OR "evaluation" OR "assessment" OR "polic*" OR "implement*" OR "percept*"	

Twenty-nine papers were found in the literature review. The titles and abstracts of all papers were read to assess their suitability for this research. Of the 29 original papers, 22 were excluded because they either discussed policy platforms in a different context (e.g., law or political science) or did not involve developing a policy platform or testing it with stakeholders like citizens or policymakers, even if they did involve simulation models related to climate or energy policies. The final list was expanded using backward snowballing from the original results, resulting in a total of 9 papers evaluated in the literature review. Given the research objectives, additional and more focused rounds of literature reviews were conducted to address SQ1 of this research.

1.2.1 Conflicting perceived effects on stakeholders' perceptions and decisions

Most of the papers obtained from the literature review evaluate interactive tools when used by ordinary citizens (Favrata et al., 2016; Michels et al., 2022; Volken et al., 2018; Xexakis & Trutnevyte, 2019). Favrata et al. (2016) developed a web platform to assess the impact of user choices on various indicators like population, GDP growth, energy efficiency, transportation, renewable energy in electricity supply, and costs. Users can interact with indicators, customise monthly average views and scenarios, and access Swiss energy transition MOOCs through the platform. Most users gave positive feedback on the tool. However, whenever something in the model contradicted users' convictions (for example, pro-nuclear and anti-wind power users), they expressed their dissatisfaction by challenging the tool, even though the model was simply representing government policies (in the case of nuclear power plants) or allowing users to configure options based on their own preferences (in the case of wind power). Michels et al. (2022) tested a serious game for energy transition in Baden-Württemberg, Germany, specifically focusing on wind power. The game was played with adults who were given background information on a hypothetical situation and non-technical information about renewable energy. During the game, users could face scenarios like protests against wind turbines and changes in regulations for minimum distance between turbines, which will require them to make appropriate decisions. Users managed factors in the game like budget, wind turbine yield and profits, household electricity supply, and reduced CO2 emissions. Interactive and gamified tools, such as the serious game, have the advantage of being customizable to users' existing knowledge of energy concepts. This makes them useful as educational tools for different stakeholders (Michels et al., 2022).

Volken et al. (2018) investigated the general public's preference for Switzerland's low-carbon and zero-carbon electricity generation portfolios using several questionnaires and a web-tool. Users completed questionnaires at three different moments: before a workshop session in which they interacted with the web-tool, during the workshop, and a few weeks later. The questionnaires contained user self-reported evaluations (such as knowledge of electricity supply topics, interest and willingness to act), a knowledge test on electricity technologies and their impacts (following receipt of a factsheet), and evaluations of the interactive tool, factsheet provided, and overall workshop. The tool allows users to interactively select different electricity supply portfolios to meet the country's demand in 2035 and view the results in a variety of visualisations. The experiment results show consistency in user preferences for topics such as solar cells and large hydropower dams as sources of electricity.

Furthermore, after being informed with the factsheet, interactive tool, and group discussions on topics such as run-of-river hydropower, users demonstrated learning effects, updating their preferences. While the tools used (fact sheet, group discussions, web-tool, and workshop) were perceived as useful and understood and liked by the participants, there was no difference in the factsheet's perception versus the interactive tool, which contradicts expectations that such tools would always lead to greater understanding and knowledge on the part of the users (Xexakis & Trutnevyte, 2019). This result is also consistent with the findings of a similar study conducted by Xexakis and Trutnevyte (2019), in which a group of non-experts used a very similar interactive tool, resulting in the lowest average scores in an energy-related quiz when compared to a similar group interacting with energy information using static scenario reports.

1.2.2 Limited testing with policymaking stakeholders

Only two papers evaluated decision-makers' engagement with interactive platforms directly, and both involved a small number of participants. Codrington et al. (2022) tested an interactive platform with three members of the Musqueam Indian Reserve community administration team in Canada to investigate whether solar panels can increase local communities' energy sovereignty. Users could assess the local community's greenhouse gas (GHG) emissions, costs, and energy independence associated with various energy system options using a platform. Users could create scenarios with multiple parameters for wind, solar, and storage capacity, as well as electricity demand and import and export prices, and then compare the results to a base-case scenario. Furthermore, participants evaluated the interactive tool's utility (i.e., its suitability to address community energy issues) and usability. The tool provided good flexibility and information to support the exploration of energy possibilities, according to the findings. Furthermore, the participants quickly figured out how to use the platform and discuss scenarios. The utility results, however, varied significantly due to the small number of participants. Nevertheless, community leaders felt that the tool improved their understanding of potential energy system costs and sources, as well as GHG emissions and that it supported community decisions to install solar panels. Despite the fact that the findings of Codrington et al. (2022) were obtained through interactions with a few decision-makers, they are consistent with Michels et al. (2022) observations of the benefits of interactive platforms.

Hewitt et al. (2020) used two interactive tools to evaluate energy spatial planning options with stakeholders (policymakers and landscape planners) from a municipal level in the Netherlands and a regional level in Spain. The two tools took very different approaches, with the first (COLLAGE) tested in the Dutch municipality of Dalfsen having strong interactive characteristics and touch-screen capability, which facilitated stakeholder discussions and immediate identification of changes when users made different selections. The tool evaluated in Spain (APoLUS), on the other hand, was more robust and focused on long-term scenarios for renewable energy (RE) and land use. Stakeholders perceived the highly interactive tool tested in the Netherlands to meet their needs and facilitate fruitful discussions about RE targets during the workshop, according to the findings. The APoLUS tool, on the other hand, was perceived as too complex and difficult to disseminate its information, which did not quickly lead to participants perceiving the tool's benefits. Furthermore, the COLLAGE tool engaged participants through more gamified and modern technology, whereas APoLUS was primarily a traditional simulation tool with a simple graphical user interface running to provide some level of interactiveness. Hewitt et al. (2020) concluded that tools like COLLAGE are more likely to engage stakeholders because they are more modern, user-friendly, highly visual, and interactive, whereas tools like APoLUS are less likely to find natural end-users other than research groups, which can impose an additional burden on the platform and facilitators to translate the inherent complexity of simulations and engage decision-makers. Highly interactive tools like COLLAGE may also have relevant trade-offs, as their analyses and outcomes may be more superficial, lacking the robust exploration of various scenarios provided by tools like APoLUS.

1.2.3 Government-related tools

The literature search yielded papers on national and supranational climate change mitigation and adaptation policy platforms. For example, the RISKMETER platform was developed in collaboration with the Swiss National Science Foundation (SNSF) to investigate alternative electricity portfolios for Switzerland in 2035 and their implications for public health, safety, and

the environment (Renewable Energy Systems group - University of Geneva, n.d.). Furthermore, the literature search turned up additional EU policy platforms related to climate change mitigation and adaptation policies, such as I2AM PARIS, ENCLUDE, and PANTERA (part of the EU-funded Horizon 2020 programme). Despite focusing on different aspects of climate change mitigation and adaptation measures, all of these tools aim to provide useful and comprehensive information to various stakeholders while also facilitating the exploration of various possible scenarios, models, or policy options (Xexakis et al., 2022; Papadimitriou et al., 2019; Nikas et al., 2021). Table 1.2 provides an overview of the literature reviewed.

Table 1.2. Overview of analysed literature

ID	Authors	Audience	Assessment method	Policy platforms perceived effects on stakeholders
1	(Xexakis et al., 2022)	Horizon 2020 platform	N/A	N/A
2	(Codrington et al., 2022)	Community member leaders	Questionnaires and workshop	Mostly positive
3	(Favrata et al., 2016)	General public	Feedback from users	Mostly positive. Negative comments usually due to conflict with users convictions
4	(Michels et al., 2022)	General public	Workshop	Positive, although not mentioned specific feedback techniques
5	(Hewitt et al., 2020)	Municipal and regional decision-makers	Workshop	Conflicting. COLLAGE platform mostly associated with positive feedback and engagement. APoLUS platform mostly associated with complexity to understand and use and harder to perceive value.
6	(Volken et al., 2018)	General public	Questionnaires and workshop	Conflicting. Interactive platform effective in enhancing knowledge on energy transition. However, a longer period after interacting with the platform, stakeholders tended to revert back to original preferences.
7	(Papadimitriou et al., 2019)	Horizon 2020 platform	N/A	N/A
8	(Nikas et al., 2021)	Horizon 2020 platform	N/A	N/A
9	(Xexakis & Trutnevyte, 2019)	General public	Questionnaires and workshop	Conflicting. Participants in general performed better in tested understanding when using static reports with scenarios and contextualisation than when using interactive platform. For self-reported evaluations from user, interactive tool performed as well as static reports.

Although the reviewed literature suggests an interest in support platforms to address complex challenges such as climate change mitigation and adaptation, particularly at the EU level (many of such tools are being developed under the H2020 or Horizon Europe programmes), few studies

investigate how policymakers and advisors of policymakers perceive such tools and what characteristics they consider important for a policy platform to be used as a support tool. This represents an important knowledge gap, as various policy platforms have already been developed or are in the process of being developed as part of major international programmes to address climate change mitigation and adaptation. However, it is still unclear whether such platforms meet the needs of policymakers when it comes to climate change mitigation and adaptation.

1.3. Research questions

Policy platforms (DST, DSS, decision aid, or similar tools) can have both positive and negative perceived impacts, depending on factors such as relevance to user needs, level of complexity, ease of communication, cognitive load associated with interacting with the platform, past experience, and other factors, according to the conducted literature review. As a result, the literature does not appear to agree that (interactive) support tools are necessarily better for improving user understanding or engagement.

This study aims to fill the knowledge gap mentioned above by investigating what recommendations can be made to improve the usefulness of policy platforms as support tools, as well as how policymakers and advisors to policymakers in the EU perceive the usefulness of such platforms and what qualities or characteristics of a policy platform are valued by these users. The study also seeks to improve understanding of what constitutes a policy platform in the context of climate change mitigation and adaptation in the EU, based on key characteristics of such platforms, as well as how existing CCMA EU platforms compare and contrast when these identified characteristics are applied. The main research question and subquestions for this study are derived further below.

1.3.1 Main research question and subquestions

(MRQ) *What recommendations can be made for the design and use of CCMA policy platforms in order to improve their usefulness as support tools for policymakers and policy advisors?*

By responding to the research question above, the following objectives will be met:

1. Contribute to the advancement of knowledge about CCMA policy platforms and how they can help policymakers make climate change adaptation and mitigation decisions.

2. Draw lessons for future CCMA policy platform developments with a clearer understanding of end-user requirements and preferences.

To respond to the previous main research question, the following subquestions must be addressed. First, it is critical to understand what the literature suggests as typical policy platform characteristics, requirements or features:

(SQ1) *What are the typical characteristics of climate-change mitigation and adaptation (CCMA) policy platforms?*

The first question will generate a list of typical characteristics of CCMA policy platforms. Following an initial understanding of these main characteristics, it is critical to comprehend the current playing field of platforms that have already been developed for use by policymakers in the context of climate change mitigation and adaptation in the EU, as well as how they compare to one another based on the previously identified characteristics, which leads to the second subquestion of this thesis:

(SQ2) *What are the similarities and differences between existing CCMA policy platforms in the EU, considering the identified typical characteristics of policy platforms?*

Finally, since the primary goal of this research is to make recommendations for improving the design and use of policy platforms for policymakers and policy advisors, it is critical to understand how this group of users perceives the usefulness of such platforms as well as their preferences regarding such platforms' characteristics:

(SQ3) *How do policymakers and policy advisors perceive the usefulness of CCMA policy platforms?*

(SQ4) *What characteristics do policymakers and policy advisors look for in CCMA policy platforms to be used as support tools for policymaking?*

SQ3 and SQ4 are expected to improve the current understanding of how policymakers perceive the usefulness of policy platforms and what they look for in such tools to help them make policy decisions. Based on this and the previous subquestions, recommendations for developing future policy platforms to better meet the needs of policymakers can be made.

1.4. Report organisation

Chapter 1 (Introduction) provided a broad overview of the thesis, contextualising the importance of climate change mitigation and adaptation, as well as the potential role policy platforms can play as support tools for policymakers and policy advisors. In order to situate this thesis within the existing body of knowledge, Chapter 1 also provided an overview of the relevant literature. A knowledge gap was identified regarding how policymakers and policymakers' advisors perceive policy platforms in terms of their usefulness and the characteristics they prefer most in such platforms, which led to the formulation of this thesis's main research question and subquestions.

The **second chapter (Research approach**) discusses the research approach used in this thesis, which included a collective case study of CCMA policy platforms within the context of the EU-funded Horizon 2020 programme, as well as interviews (N = 11) and surveys (N = 9) with policymakers and policymakers' advisors. Interviews and surveys were conducted to assess policymakers' and advisors' perceptions of the usefulness of two examples of H2020 policy platforms, as well as their preferences in terms of priorities (must-have, should-have, could-have, or indifferent) and ranking (1st, 2nd, 3rd, and so on) of relevant characteristics of policy platforms identified in this thesis. Chapter 2 concludes with a research flow diagram illustrating how the thesis is organised and linked in order to answer the various subquestions as well as the main research question.

Chapter 3 (Characteristics of policy platforms) focuses on SQ1 of this thesis: *What are the typical characteristics of climate-change mitigation and adaptation (CCMA) policy platforms?* A systematic search of the scientific and grey literature yielded a list of nine typical characteristics of policy platforms: *Transparency & Credibility of information, Ease of use, Flexibility of use, Accessibility & Portability, Education & Awareness, Communication of complex information, Data visualisation & interactivity, Actively maintained and supported, and Security & privacy*. Chapter 1 concludes by proposing a framework combining these characteristics and 42 criteria (questions) divided within the identified characteristics to be used to assess policy platforms.

Chapter 4 (Assessment of Horizon 2020 CCMA policy platforms) focuses on SQ2 of this thesis: *What are the similarities and differences between existing CCMA policy platforms in the EU, considering the identified typical characteristics of policy platforms?* Following a systematic search in the repository of projects from the H2020 programme, ten CCMA policy platforms were identified

within the context of the H2020 programme and assessed using the proposed framework. As a result, chapter 4 builds on the findings of Chapter 3 by employing the proposed framework to evaluate relevant CCMA policy platforms developed recently as part of H2020 projects.

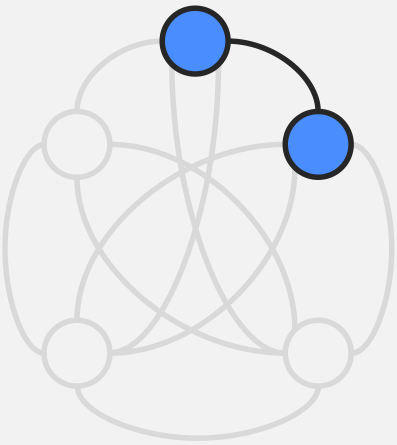
Chapter 5 (Usefulness and preferred characteristics: the voice of policymakers and policy advisors about CCMA policy platforms) focuses on SQ3 (*How do policymakers and policy advisors perceive the usefulness of CCMA policy platforms?*) and SQ4 (*What characteristics do policymakers and policy advisors look for in CCMA policy platforms to be used as support tools for policymaking?*) of this thesis. Insights were derived from 11 interviews with Dutch policymakers and policy advisors, as well as nine survey responses from policymakers and advisors from other countries. In order to become acquainted with the types of platforms currently being developed in the context of the H2020 programme, interview participants and survey respondents were asked to investigate two examples of CCMA policy platforms identified in Chapter 4.

The findings reveal a mixed perception of the usefulness of CCMA policy platforms among interview participants and survey respondents. Positive perceptions of available information, such as scenarios, pathways, and policy levers (for the EU Calc platform), and benchmarks and best practices that inspire policy transfer (for the DPET platform), were identified. Participants and respondents, however, expressed strong reservations about both platforms' level of abstraction, complexity, and lack of applicability to their respective policymaking contexts.

Through interviews and surveys, a clear overall perception emerged regarding the characteristics of policy platforms. Transparency, communication of complex information, high granularity, and free and open access were all perceived as fundamental characteristics (must-have in a policy platform). Additionally, characteristics such as training and learning functionalities, ease of navigation, availability via a web-based platform, and comprehensive documentation on models and concepts were perceived as highly important but not mandatory (should-have). On the other hand, attributes such as user stories from around the world, availability of very recent data, ability to modify parameters and conduct custom analyses, and data import/export were perceived overall as ‘nice to have’ (could-have characteristics). Participants and respondents were also overall indifferent to being able to interact with a policy platform via tablets or mobile phones or having a policy platform available in languages other than English.

This thesis concludes with **Chapter 6 (Discussions and Conclusions)**. Based on the research findings, it revisits and updates the conceptualisation of policy platforms, which was briefly discussed in Chapter 1. The chapter discusses the overall usefulness and characteristics of CCMA policy platforms, going beyond the two examples examined by interview participants and survey respondents. The usefulness of policy platforms is evaluated using concepts found in scientific literature, such as credibility, salience, and legitimacy. Furthermore, the most preferred characteristics of policy platforms are compared and contrasted with recent literature.

Chapter 6 discusses the thesis' limitations and formally answers the thesis' four subquestions and the main research question. Incorporating systematic reviews of already existing policy platforms, leveraging on boundary organisations (such as PBL, KNMI, and others beyond the Netherlands), and improving the maintenance and life expectancy of developed policy platforms represent some of the main recommendations for improving the design and use of CCMA policy platforms. The sixth chapter concludes with a discussion of the research's academic, societal, and EPA relevance, as well as recommendations for future research.



Chapter 2
Research approach

Main topics

1. Research approach and design
2. Research methods, data and tools used

2. Research approach

This chapter describes the research structure used in this thesis, which includes the research design, research methods, data, and tools used to answer the various subquestions and the main research question. A research flow diagram is also presented to show how the thesis is structured in terms of which chapter each subquestion is investigated in.

2.1 Research approach and design

According to Creswell and Creswell (2018), research approaches are broadly classified as quantitative, qualitative, or mixed methods, depending on the specific aims of the research and its characteristics, such as research questions and research methods. In turn, the research design refers to the different types of inquiry within the research approach that provide specific directions for the study (Creswell & Creswell, 2018). Surveys or experiments (on the quantitative approach), grounded theory or case studies (on the qualitative approach), and convergent, explanatory sequential mixed methods (on the mixed methods approach) are some examples of research design (Creswell & Creswell, 2018).

Since the main research question and subquestions focus on understanding broad issues such as the usefulness of climate-change mitigation and adaptation policy platforms for policymakers and policymakers' advisors in their practical work, a qualitative collective case study was chosen as the best research design for this study. A case study, according to Crowe et al. (2011), is a suitable research approach when the researcher wants an in-depth and multi-faceted understanding of a complex phenomenon while taking its practical context in real life into account. Climate-change mitigation and adaptation (CCMA) policy platforms in the EU serve as the 'case' of this case study because other policy platforms in the EU that are not related to climate-change mitigation and adaptation (e.g., health-related policy platforms) and climate-change mitigation and adaptation policy platforms outside the EU also exist. To gain a more nuanced understanding of the various characteristics of CCMA policy platforms, ten policy platforms were investigated.

The exploratory nature of this research, as well as the research design and methods used, place this thesis more on the qualitative side of research approaches, as described by Creswell and Creswell (2018), even though quantitative analysis in the form of statistical analyses was also performed to support the investigation of SQ2 and SQ4.

2.2 Research methods, data and tools used

Document analysis, literature review, surveys and interviews are some examples of research methods suitable for a qualitative research approach (Creswell & Creswell, 2018), all of which have been used in this thesis to address the different subquestions.

This research is divided into four phases, with phases one through three addressing the four subquestions of this research and phase four providing discussions and conclusions to this thesis. The first stage involved conducting desk research in the form of a literature review to address SQ1, which involved conducting a qualitative systematic review to identify common features, requirements, or characteristics of policy platforms (interactive tools and similar terms) in the available literature (both scientific and grey literature). According to Snyder (2019), qualitative systematic reviews entail conducting a systematic review process to identify and collect sources of information, followed by a qualitative approach to evaluating that information. The first phase concluded with the development of a proposed framework for assessing policy

platforms based on the findings of the literature review on the main characteristics of policy platforms. The research method, data collection and analysis procedures, and tools used to address SQ1 are described in Chapter 3.

The second phase also involved desk research as a research method, but in the form of document analysis by investigating the current state of the EU's climate-change mitigation and adaptation policy platforms. The analysis focused on existing policy platforms in the Horizon 2020 programme. The emphasis on EU policy platforms is justified because the EU has made public commitments to become the first climate-neutral continent by 2050, which is the overarching goal of the European Green Deal. More specifically for the EU, the H2020 Programme was the EU's primary research and innovation programme from 2014 to 2020, covering the Paris Agreement and the European Green Deal period and providing nearly €80 billion for research and innovations (European Commission, 2013), making it an appropriate source for identifying relevant policy platforms. The second phase builds on the output of the first phase by performing an assessment of ten policy platforms within the H2020 programme (the cases in the collective case study design) using the proposed framework. In the context of this research, the findings of phases 1 and 2 also allowed for a revised conceptualisation of policy platforms (addressed in the fourth phase). Chapter 4 explains in detail the research method, data collection and analysis procedures and tools used to address SQ2.

SQ3 and SQ4 were addressed in the third phase, which included semi-structured interviews (N = 11) and surveys (N = 9) with policymakers and policy advisors. The findings of the first two phases, which investigated typical policy platform characteristics and relevant CCMA policy platforms in the context of the H2020 programme, were used as input for the design of the interviews and surveys. The interviews and surveys were designed to produce meaningful and informative results in cases where participants were both familiar and unfamiliar with policy platforms. Participants were asked to freely explore two examples of policy platforms identified in the H2020 project dataset (and assessed in phase 2), following a think-aloud protocol, in order to provide insights regarding their preferences and perception of the usefulness of such platforms (in order to address SQ3). Participants were also asked to prioritise (using the options must-have, should-have, could-have, or indifferent) and rank (1st, 2nd, 3rd, and so on) a set of policy platform characteristics based on how important they perceived such characteristics to be available in a policy platform, providing more objective and quantitative insights to address SQ4 and the MRQ. The research method, data collection and analysis procedures, and tools used to address SQ3 and SQ4 are described in Chapter 5.

Finally, the fourth phase of this research compiles all previous phases' findings, compares and contrasts them, and provides discussions in light of relevant literature. Phase 4 outputs include a revised conceptualisation of policy platforms (in light of this research findings) as well as answers to the research subquestions and main question.

Figure 2.1 summarises the data requirements, research methods, and tools used to answer each question in this thesis, and Figure 2.2 depicts the research structure of this thesis using a research flow diagram.

Legend:	Data	Research method	Tools

SQ1	**What are the typical characteristics of climate-change mitigation and adaptation (CCMA) policy platforms?**
	Scientific literature and grey literature
	Desk research (literature review)
	Scientific databases and search engines
SQ2	**What are the similarities and differences between existing CCMA policy platforms in the EU, considering the identified typical characteristics of policy platforms?**
	Horizon 2020 repository of projects and available information on the websites of respective policy platforms.
	Desk research (document analysis)
	Excel and Python for systematic filtering of the H2020 projects dataset and information consolidation.
SQ3	**How do policymakers and policy advisors perceive the usefulness of CCMA policy platforms?**
SQ4	**What characteristics do policymakers and policy advisors look for in CCMA policy platforms to be used as support tools for policymaking?**
	Output of SQ1 and SQ2
	Empirical research (semi-structured interview and survey)
	ATLAS.ti for coding and thematic analysis

Figure 2.1. Overview of research subquestions, data, research methods and research tools used.

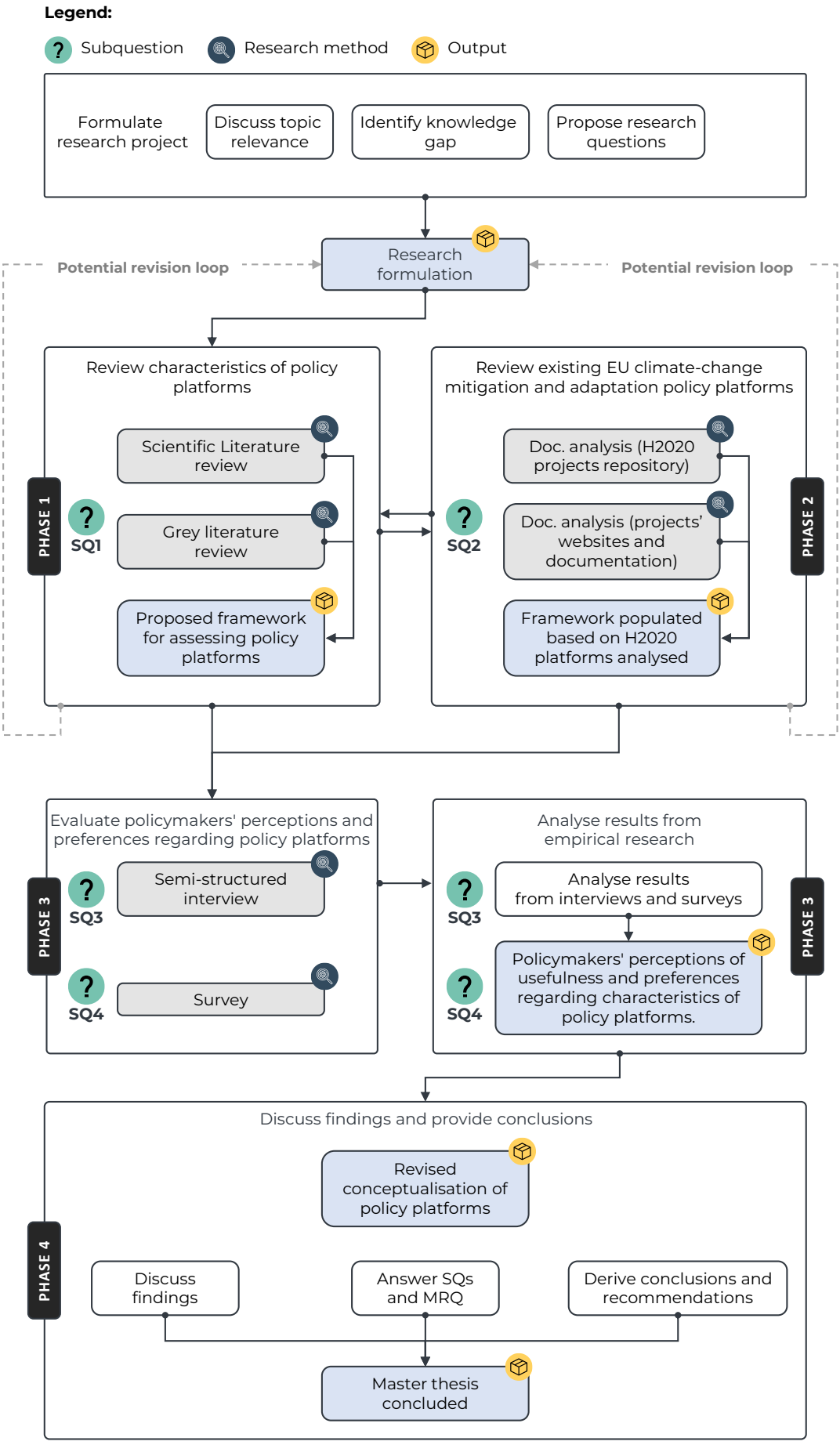
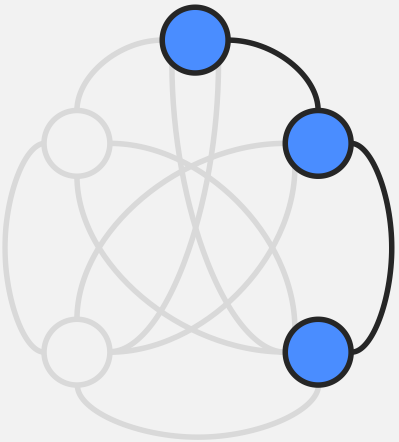


Figure 2.2. Research flow diagram .



Chapter 3
Typical characteristics of CCMA policy platforms

Main topics

1. Literature review of user needs and requirements
2. Analysis of user needs and requirements
3. Proposed framework for assessing CCMA policy platforms
4. Conclusions of chapter 3

3. Typical characteristics of CCMA policy platforms

This chapter addresses the first subquestion of this research: *What are the typical characteristics of climate-change mitigation and adaptation (CCMA) policy platforms?* A systematic review of the scientific literature was conducted to better understand the characteristics that a policy platform may have. In addition, an analysis of relevant grey literature was carried out. In both cases, since this research focuses on the use of policy platforms by policymakers (or advisors to policymakers), a specific focus on user requirements and user needs was placed in the scientific and grey literature search. This chapter begins with a systematic review of the literature, followed by an analysis of the findings and how themes of policy platform characteristics were derived from the consulted literature. Finally, this chapter presents a framework - comprised of a list of policy platform characteristics and a set of criteria (i.e., questions) to be used within each characteristic - to assess each identified policy platform, which will be addressed in Chapter 4.

3.1 Literature review of user needs and requirements

3.1.1 Systematic search in scientific literature

To better understand the typical characteristics of policy platforms, a systematic search was carried out using Scopus as the search database. Because this research aims to investigate what recommendations can be made to improve the usefulness of policy platforms as decision-support tools, the search was focused on user requirements, features, or needs. The search also included decision support tools (and similar) addressing environmental or climate change-related issues. Although non-climate-change-related decision support tools such as decision support tools for medicine and healthcare or logistics and operations management - two additional prominent areas besides climate or environment - could potentially provide valuable insights into relevant user requirements, not limiting the search query to climate or environmental areas resulted in an unfeasibly large number of papers (over 600 results) to assess given the length of this MSc thesis project. As a result, the final query used for step 1 considered a search within the title, abstract, and keywords of papers using the string ("user* feature*" OR "user* requirement*" OR "user* need*") AND ("decision support tool*" OR "decision support system*") AND (environmental OR "climate change*"), yielding 83 papers.

Step 2 involved reading the abstracts of all 83 results to determine their suitability for this study. Fifty-one (51) papers were excluded from this analysis, primarily because they were not relevant to this research purpose (e.g., by only vaguely mentioning user needs or requirements, with no actual relevance in those papers), leaving 32 papers for further analysis in step 3. Step 3 involved screening the remaining 32 papers in order to better understand the topics covered. Nineteen (19) papers were excluded because they were irrelevant to the purpose of this study. This included papers that evaluated the accessibility of travel decision support systems for people with disabilities, papers that used the Quality function deployment (QFD) method - a systematic approach to understanding customer needs and translating them into design requirements (Quality Function Deployment Institute, n.d.) - but in completely unrelated areas such as food packaging, or, most commonly and similarly to step 2, mentioned user needs or requirements without in-depth discussions about them. The systematic literature review resulted in 13 papers from the original 83 for in-depth analysis, and four additional articles were added based on snowballing from the 13 papers, resulting in a list of 17 articles.

Figure 3.1 depicts the systematic literature review process, and Table 3.1 provides an overview of the scientific literature examined.

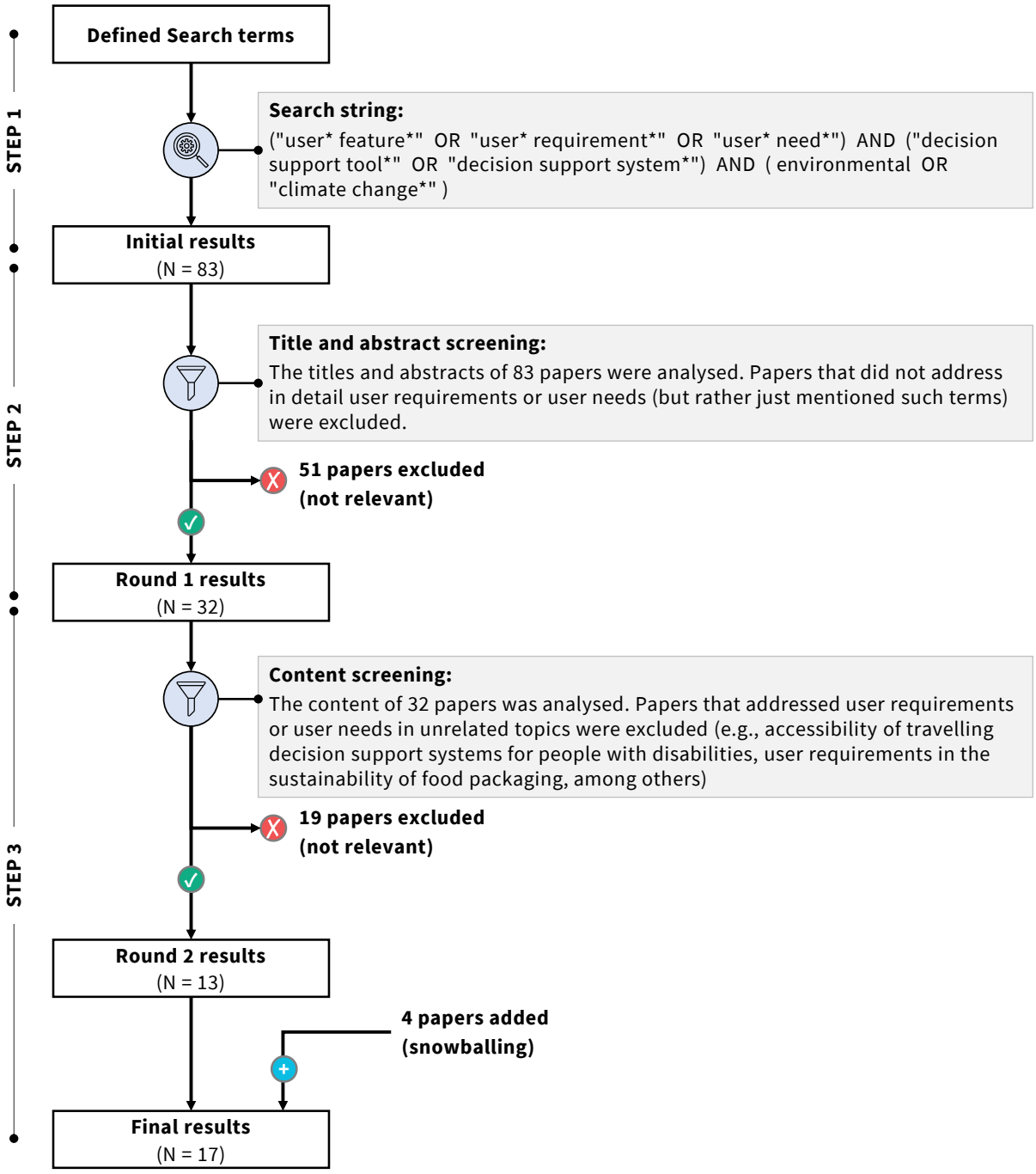


Figure 3.1. Systematic literature review process to identify requirements and user needs

Table 3.1. Overview of analysed scientific literature for user requirements and needs

ID	Title	Reference	Context	Location	Requirements or recommendations derived from
1	How to Support Forest Management in a World of Change: Results of Some Regional Studies.	Fürst et al. (2010)	Forest management support tools.	Multiple (Middle, Eastern and Southeastern Europe)	• Delphi study with experts from forest, nature protection, water management and regional planning
2	Environmental decision support systems (EDSS) development – Challenges and best practices.	McIntosh et al. (2011)	General (Environmental Decision Support Systems)	General (literature review)	• Scientific literature
3	Vision and Requirements of Scenario-Driven Environmental Decision Support Systems Supporting Automation for End Users.	Schlobinski et al. (2011)	General (Environmental Decision Support Systems)	European Union (EU)	• Interviews with people involved in pilot applications of the EDSS
4	Web-based decision support to set up cost effective programs of measures for multiple water aspects	Broekx et al. (2012)	Water policy decision-making	Belgium	• Interviews with expert groups (responsible for programs of measures for specific water aspects) and river basin managers (responsible for management plans on local and regional levels)
5	No perfect tools: Trade-offs of sustainability principles and user requirements in designing support tools for land-use decisions between greenfields and brownfields	Bartke and Schwarze (2015)	Land use decisions (greenfield and brownfield sites)	European Union (EU)	• Workshop with representatives of local and state authorities, property holders and developers, the general public, technical experts and academics
6	What Do Users Really Need? Participatory Development of Decision Support Tools for Environmental Management Based on Outcomes.	Hewitt and Macleod (2017)	Land and freshwater management.	Scotland	• Participatory Workshop with representatives from the Cairngorm National Park Authority, Scottish Natural Heritage and Scottish Environmental Protection Agency and experts in land and water management

Table 3.1. Overview of analysed scientific literature for user requirements and needs (cont.)

ID	Title	Reference	Context	Location	Requirements or recommendations derived from
7	A Decision Support Tool for the Strategic Assessment of Transport Policies – Structure of the Tool and Key Features.	Szimba et al. (2017)	Transport policies.	European Union (EU)	• Survey with specialists of the European Commission (Directorate-General Mobility and Transport) • Scientific literature • Research projects
8	User-driven design of decision support systems for polycentric environmental resources management	Zulkafli et al. (2017)	General (Environmental Decision Support Systems)	Peu	• Observations, interviews, focus group discussions, and social network mapping
9	Why popular support tools on climate change adaptation have difficulties in reaching local policy-makers: Qualitative insights from the UK and Germany.	Clar and Steurer (2018)	General (Adaptation Support Tools)	United Kingdom and Germany	• Interviews with representatives of each tool provider (Adaptation Wizard – UK; Klimalotse - Germany) not directly involved in the development of the tools, as well as with experts involved in the development of the tools. • Interviews with regional adaptation experts and local actors responsible for climate change adaptation from distinct communities.
10	Updating an existing online adaptation support tool: insights from an evaluation.	Haße and Kind (2019)	General (Adaptation Support Tools)	Germany	• Benchmark based on risk communication literature • Workshop with representatives from local authorities in Germany working with climate change-related topics • Usability test of the Klimalotse tool • Interviews with users and potential users • Analysis of webpage views
11	Overcoming knowledge barriers to adaptation using a decision support framework.	Palutikof et al. (2019)	Coastal adaptation.	Australia	• Online survey and workshop with representatives of government, private sector, community groups and NGOs

Table 3.1. Overview of analysed scientific literature for user requirements and needs (cont.)

ID	Title	Reference	Context	Location	Requirements or recommendations derived from
12	Co-designing adaptation decision support: meeting common and differentiated needs.	Webb et al. (2019)	General (adaptation decision support strategies)	Australia	• Interviews with representatives of federal, state and local governments, regional bodies, NGOs, researchers and the private sector.
13	Participatory development of digital support tools for local-scale energy transitions: Lessons from two European case studies.	Hewitt et al. (2020)	Renewable Energy development	Spain and the Netherlands	• Workshop sessions with cooperatives, environmental groups, policymakers and planners in the Netherlands and Spain
14	Bridging the Science-Policy Gap – Toward Better Integration of Decision Support Tools in Coastal and Marine Policy Implementation	Schumacher et al. (2020)	Coastal and marine policies.	Baltic countries.	• Survey with representatives of public administration, research institutes, universities, NGOs and private sector
15	Users' Cognitive Load: A Key Aspect to Successfully Communicate Visual Climate Information.	Calvo et al. (2021)	Wind energy Decision Support Tool	Spain	• Workshop to target expert user needs. • Interviews with target users (climate experts, operators and managers of wind power plants) • Experiment with nonexperts to compare two versions of a decision support tool
16	Utilizing an End-User Driven Process to Identify and Address Climate-Resilience Tool Needs in the U.S. Gulf of Mexico.	Collini et al. (2022)	General (Climate-Resilience Tool Needs)	Mexico	• Workshop sessions with representatives of national, state, and local organisations from the built and natural environment in the Gulf of Mexico
17	Developing a renewable energy planning decision-support tool: Stakeholder input guiding strategic decisions.	González and Connell (2022)	Renewable energy planning.	Ireland	• Workshops with public and private sector organisations.

3.1.2 Grey literature analysis

In addition to scientific literature, grey literature was searched for relevant information about user needs and requirements for climate change mitigation and adaptation (CCMA) policy platforms (or decision support tools). The Google search engine was used to investigate results related to user needs (or requirements) and decision support tools, similar to the Scopus search described in the previous section. Relevant literature identified includes a report based on an MSc thesis (Roth et al., 2014) encompassing a case study of the decision support tool BalticClimate Toolkit, the ISO/IEC 25010:2011 standard (related to Systems and software Quality Requirements and Evaluation (SQuaRE)), and user needs deliverables of the H2020 project ICARUS, which is focused on improving air quality and reducing the carbon footprint in European cities. Table 3.2 summarises each grey literature document consulted.

Table 3.2. Overview of analysed grey literature for user requirements and needs

ID	Title	Reference	Description
1	Decision Support Tools as Instruments to facilitate Climate Change Adaptation: The case of the BalticClimate Toolkit for adaptation in the German Baltic Sea region	Roth et al. (2014)	The study looked into the use of decision-making tools to assist decision-makers in climate change adaptation. The authors also looked into the criteria that decision support systems should meet in order to be effective. The authors conducted a case study of the BalticClimate Toolkit, a web-based tool designed to assist Baltic Sea region decision-makers with climate-change-related issues. Based on the results of 30 interviews with people working on climate change mitigation or adaptation in the Baltic Sea region, a set of success criteria for decision support tools was proposed.
2	ISO/IEC 25010:2011 Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — System and software quality models	International Organization for Standardization (2011)	The International Organisation for Standardisation (ISO) developed an international standard for software quality requirements and evaluation. The standard is divided into two sections: (i) Quality in Use characteristics and sub-characteristics (used to evaluate software products from the user's perspective, i.e., when used in a specific context of use) and (ii) Product quality model, which defines a set of characteristics and sub-characteristics that can be used to assess the quality of software. The current version of the standards, ISO/IEC 25010, has been reviewed and confirmed in 2017.

Table 3.2. Overview of analysed grey literature for user requirements and needs (cont.)

ID	Title	Reference	Description
3	Report on requirements for user-centric tools (D.7.3)	Aristotle University of Thessaloniki et al. (2018)	ICARUS H2020 project deliverable. The findings of the investigation of functional and non-functional requirements conducted as part of the ICARUS project are presented. A list of functional and non-functional requirements was developed based on interviews with citizens in ICARUS participating cities. The MoSCoW Analysis [1] (Must have, Should have, Could have, and Won't have have requirements) was used to prioritise requirements. User stories were then used to define the tool's functional specifications based on the prioritised user requirements.
4	MS10: Validated requirements for the ICARUS DSS	MS10: Validated Requirements for the ICARUS DSS (2016)	Milestone of ICARUS H2020 project. Provides a summary of requirements derived from stakeholder feedback. The document was used for drafting additional ICARUS H2020 project deliverables.

[1] According to Brennan (2009), the MoSCoW Analysis is a prioritisation technique that splits requirements into categories: Must (requirements that must be satisfied), Should (requirements that should be satisfied if possible), Could (requirements that are desirable but not necessary), and Won't (requirements that will not be implemented). The MoSCoW Analysis was also used in the context of the survey and interview questions used in this research (addressed in detail in Chapter 5).

3.2 Analysis of user needs and requirements

Each information source from the previous section's systematic review of scientific literature and grey literature was individually examined to identify requirements or user needs relevant to this research. This analysis was inspired by the technique of thematic synthesis. Cruzes and Dyb (2011) define thematic synthesis as a research methodology that combines thematic analysis principles with other qualitative research techniques. The analysis aims to develop analytical themes via a descriptive synthesis and identify relevant explanations for a review question (Cruzes and Dybå, 2011). Thematic synthesis entails systematically coding data to produce descriptive and analytical themes grounded in the data (Nicholson et al., 2016), typically proceeding in an iterative fashion, beginning with an initial review of each document, followed by the identification of relevant segments, labelling of segments, and finally translating the codes derived from these segments into meaningful themes (Cruzes and Dybå, 2011). The thematic synthesis technique was used in this thesis with the goal of identifying user requirements or needs rather than identifying patterns and themes for multiple purposes.

The Lateral web platform (https://www.lateral.io/) was used to facilitate the identification of requirements, features, or characteristics in scientific and grey literature due to its capabilities of facilitating the organisation, reading, and identification of concepts in source materials. The Lateral platform allows the user to read PDF documents within the platform and designate concepts (or codes) that are relevant to the user. In this research, the concept "requirement/feature" was developed and used to identify potential relevant requirements for a more detailed analysis when reading the materials presented in tables 3.1 and 3.2. The Lateral

platform supports tabular visualisation of all information sources and assigned concepts, making it easier to determine which source of information each concept was identified in and which passages of the documents the concepts were identified in.

Following the completion of the literature reading, the Lateral tabular view was exported to Excel, and a second stage of analysis was initiated to identify themes that encompassed the requirement/feature codes (concepts) identified in the literature. This second stage was iterative in nature, with the goal of identifying requirements themes that encompassed identified groups of concepts that were internally coherent while remaining comprehensive enough to reduce the number of groups. The groups identified through the review of scientific and grey literature are depicted in Figure 3.2. Appendix 1 contains the references (as identified in the materials read) that were used to identify and designate the "requirement/feature" concept in the Lateral platform and, later, the composition of the groups shown in Figure 3.2.

An important consideration must be made regarding the terminology used. The concept of requirements and features in systems development literature sometimes presents subtle differences, particularly because requirements can be discussed in terms of business requirements, system requirements, user requirements, and solution requirements (Wiegers & Hokanson, 2023). In general, requirements can be viewed as a specification of what should be implemented, providing a description of how properties, attributes, or systems should behave (Sommerville & Sawyer, 1997, as cited in Wiegers & Hokanson, 2023), or as a condition or capability demanded by stakeholders in order to achieve some goal or solve some problem (Brennan, 2009). Brennan (2009) defines features as a logically related set of requirements (functional or non-functional) that should form a cohesive bundle of functionalities aligned with objectives and business goals. Aside from requirements and features, attributes, functionalities, and qualities are also frequently used terms when referring to user needs or capabilities of a software or system, indicating a high level of interchangeability. For instance, Wiegers and Hokanson (2023) use the generic term requirements to refer to various types of information (business requirements, solution requirements, data requirements, and so on), regardless of whether "local terminology focuses on features, use cases, user stories, or anything else" (Wiegers & Hokanson, 2023, Requirements Defined section). A detailed discussion of software features, requirements, and others is beyond the scope of this research. Therefore, to avoid confusion, the generic term "characteristics" of decision-support tools (decision-support systems, policy platforms, and so on) will be used from now on. The generic term "characteristic" was also identified in the consulted literature from Tables 3.1 and 3.2.

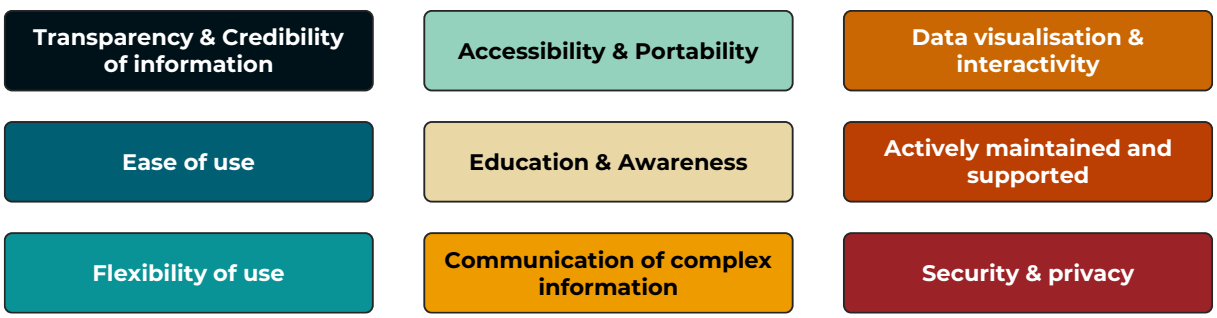


Figure 3.2. Characteristics of policy platforms and decision-support tools identified in the literature (see Appendix 1 for detailed references of literature excerpts related to each of the characteristics)

3.2.1 Transparency & Credibility of information

Transparency and credibility of information refers to characteristics of policy platforms that are related to how open they are about the limitations and assumptions of their data sources and models (if available), if they are associated with credible organisations and partners (e.g., the consortium responsible for the tool's development), and how well they communicate their intended purposes and targeted user groups. Transparency and credibility of information concepts were identified in 8 of the articles reviewed. In a review of the available literature on Environmental decision support systems (EDSS), McIntosh et al. (2011) identified that the representation of uncertainty related to results obtained was one of the success criteria for EDSS to support science and engineering analysis successfully. According to the authors, being honest and open about model assumptions and uncertainties is a best practice if one wants to improve user perception of credibility and trust (McIntosh et al., 2011). Similar findings were also observed by Hewitt and Macleod (2017) in a study of EDSS for land and freshwater management in Scotland. The authors identified 12 principles for developing tools to support environmental decision-making related to land and freshwater management as a result of a workshop engagement involving stakeholders with expertise in outcomes-based environmental management. Workshop participants emphasised the importance of dealing honestly with uncertainty about the tool's outputs in order to trust the information provided by the decision-support tool, as well as the tool being transparent and upfront about its intended purpose and what it can and cannot do (Hewitt & Macleod, 2017).

The credibility of the tool's data sources and the organisation(s) or people who created it was also emphasised in the literature. One of the critical requirements derived from interviews with expert groups and river basin managers in Belgium, according to Broekx et al. (2012), is the need for the available data on the decision-support tool to be detailed and include both the source of the information and uncertainty levels. The need for a tool to be authoritative was identified by Palutikof et al. (2019) as the most common survey answer for the question asking about the key features that would make a climate risk management tool useful for coastal decision-makers, where the concept of authoritative involved being developed, assessed, and approved by experts. Additional references to the theme of information transparency and credibility were found in Schumacher et al. (2020), Bartke and Schwarze (2015), Collini et al. (2022), and the International Organisation for Standardisation (2011), and are detailed in Appendix 1.

3.2.2 Ease of use

In a broader sense, *ease of use* refers to how intuitive a tool is for users who are unfamiliar with it. Six scientific and three grey literature sources were used to identify concepts related to usability. Clar and Steurer (2018) found that in a review of two online support tools (Adaptation Wizard in the UK and Klimalotse in Germany), both tools were simple to use and produced outputs that were usually simple to apply. They also emphasise that Klimalotse does not target users with specific knowledge of adaptation policies, instead offering modules ranging from basic understanding to advanced support. According to the results of the authors' interviews, this characteristic of Klimalotse was perceived as a benefit because users who are unfamiliar with it but interested in learning more about it can find value in the tool's provided step-by-step introduction (Clar & Steurer, 2018). McIntosh et al. (2011) highlight as a best practice recommendation for the development of DSS that one action to improve the adoption of decision-support tools is to present the tool to the user in a simple fashion in order to minimise complexity and having a design for ease of use of a tool (e.g., by having a user interface (UI) adaptable to different user types and with

adequate help functionalities available). Fürst et al. (2010) also identified self-explanatory UI as a critical condition for users accepting and using the tool. The availability of "help features (tutorials on how to use the tool, help boxes)" (Collini et al., 2022, p. 206) was also one of the main recommended features derived from workshop sessions with representatives from various levels of government and organisations in the Gulf of Mexico. The International Organisation for Standardisation also specifies error protection (the level at which users are prevented from making errors while using a tool) and operability (the level at which a system has attributes that make it easy to use) as sub-characteristics of a software product's usability (International Organisation for Standardisation, 2011). Still on the grey literature, a user-friendly tool was designated as a must-have requirement in deliverable D 7.3 ("Report on requirements for user-centric tools") of the H2020 ICARUS project (MS10: Validated Requirements for the ICARUS DSS, 2016).

3.2.3 Flexibility of use

Flexibility of use refers to a tool that offers users a variety of options. This could include allowing users to learn about topics or concepts, run custom simulations and scenarios, and receive recommendations. Flexibility of use concepts were discovered in 12 sources (9 scientific, 3 grey literature). According to Schumacher et al. (2020), respondents to an end-user survey suggested enhanced flexibility of Decision-Support Tools (DST), such as providing customised outputs based on user needs, to maximise DST's practical relevance. Schlobinski et al. (2011) identified several user requirements of analysts (decision-makers or people supporting decision-makers) of a climate change adaptation tool for city planners and managers, some of which relate to having the flexibility to use a decision-support tool in a variety of ways. Being able to export model results and visualisations for use with external applications and manipulate system elements such as input parameters, boundary conditions and input models for scenarios were all considered to be requirements for the analysts (Schlobinski et al., 2011). Edit and extending model logic, as well as being able to import data sources, were also suggested as relevant criteria to assess DSS by Hewitt and Macleod (2017), while McIntosh et al. (2011) recommended developing a DSS that "can be used to solve multiple environmental problems" (p.1400).

From the consulted grey literature, flexibility (the extent to which a system can be used for contexts beyond the initial specifications) was identified in the ISO/IEC 25010 quality-in-use model (International Organisation for Standardisation, 2011), and the ability to perform 'what-if' and 'scenario' analyses was suggested by Roth et al. (2014) as a relevant factor to alleviate perceptions that a DSS does not take into account local specificities or does not meet the needs of users.

3.2.4 Accessibility and portability

Accessibility and portability refer to how easy and portable the policy platform is to use on mobile phones and tablets, whether the tool is open-access and web-based, freely accessible from all over the world, and how accessible it is for people with various disabilities. Accessibility and portability references were found in 9 examples of consulted literature (6 scientific and 3 grey literature). The International Organisation for Standardisation identifies three accessibility and portability-related characteristics or sub-characteristics of the ISO/IEC 25010 product quality model: portability, availability, and accessibility. The ability of a system or product to be transferred from one environment to another (software or hardware) while maintaining the same effectiveness and efficiency is referred to as portability. Availability, on the other hand, refers to the degree to which a system or product is accessible and operational whenever it is needed (International Organisation for Standardisation, 2011). Accessibility refers to the level at which a system can be

used by users with the widest range of capabilities and particularities to achieve specific goals in specific contexts of use (International Organisation for Standardisation, 2011). Alternatively, as Calvo et al. (2021) put it, accessibility refers to guidelines that ensure that websites and other technologies are "designed and developed so that people with disabilities can use them independently from their capability limitations: auditory, visual, cognitive, physical, or neurological" (p.12).

Portability was also mentioned by Hewitt and Macleod (2017) as one of the criteria for EDSS, as well as a must-have requirement for the user-centric tools for the ICARUS H2020 project (Aristotle University of Thessaloniki et al., 2018). Fürst et al. (2010) identified availability as a relevant characteristic when stating that users identified "broad accessibility for users at any time and any place" (p. 946) as one of the most important attributes of support tools. Being easily accessible via a web-based platform was also mentioned as a relevant feature of decision-support tools in several studies (Aristotle University of Thessaloniki et al., 2018; Collini et al., 2022; Fürst et al., 2010; Hewitt & Macleod, 2017), usually in conjunction with the desire for a free and open access tool.

3.2.5 Education and awareness

Education and awareness refers to aspects of policy platforms that improve understanding of topics or concepts, provide access to additional resources or recommendations of additional tools or sources of information, and provide functionalities that support networking or the discovery of success stories from policymakers and organisations in other locations. Schumacher et al. (2020) identified the need for policy platforms to provide resources to improve users' knowledge (e.g., video, courses, tutorials, webinars, and similar) when discussing how a lack of experience with decision-support tools may make users less interested in using the tools, so providing training functionalities would be of interest. Clar and Steurer (2018) also discuss how one of the critical features of the UK climate tool Adaptation Wizard is that it provides accompanying services that facilitate adaptation measures, which the authors found in only six of the 88 tools evaluated. McIntosh et al. (2011) highlight educational benefits when they highlight that the literature mentions that the use of EDSS may support changes in mental conceptualisations of world-systems and improved learning and adaptability to environmental changes (Kolkman, 2005; McCown, 2002; as cited in McIntosh et al., 2011), but they also mention other findings suggesting that improved learning by users may not lead to changes in actual behaviour (Matthews et al., 2011, as cited in McIntosh et al., 2011).

Discovering and accessing real-world case studies or success stories from policymakers or organisations in other locations is another important aspect of education and awareness. These needs were mentioned several times in the literature. According to Haße and Kind (2019), one of the updates made to the German Klimalotse online tool in response to user feedback was the availability of "real-world case studies illustrating how other municipalities dealt with the tasks, as well as exemplar documents from municipalities and template documents" (p.566). Roth et al. (2014) found similar results, with participants interviewed favoured seeing examples of how others solved similar problems. The authors also state that sharing best practices and lessons learned can assist users in determining which climate change adaptation option is best suited to their specific situation (Roth et al., 2014). Some of the local policymakers interviewed by Clar and Steurer (2018) pointed out that they expect knowledge exchange not only from researchers to policymakers but also between policymakers and that sharing best practices can be an interesting way to achieve this.

3.2.6 Communication of complex information

Communication of complex information refers to a policy platform's ability to produce understandable results that can be applied in more practical ways. This trait is consistent with the BellagioSTAMP's sixth principle: effective communication. The BellagioSTAMP is made up of eight guiding principles for measuring and assessing progress towards sustainability (Pintér et al., 2012). Bartke and Schwarze (2015) proposed a criterion called practicality based on requirements identified by users of sustainability assessment tools (SATs), which includes aspects such as how quickly and easily methods in the tool can be used and understood, whether detailed documentation is required to use a specific tool; and whether the results produced by the platform are easy to assess and understand. Roth et al. (2014) discovered that policymakers, in particular, perceived the BalticClimate Toolkit as too detailed and expressed a preference for more concise information, suggesting that it may be necessary to provide them with succinct documentation containing only the most essential information, such as policy briefs or key takeaways. Similar findings involving the importance of presenting information in a more condensed, attractive, or easy-to-digest manner were discovered in various sources (Aristotle University of Thessaloniki et al., 2018; Clar & Steurer, 2018; Hewitt & Macleod, 2017; Hewitt et al., 2020; McIntosh et al., 2011).

3.2.7 Data visualisation & interactivity

Data visualisation and interactivity refers to the availability of visual graphical elements (e.g., different types of charts, maps, tables and other visualisations) as well as how the information is presented (e.g., choice of colour, angles, brightness, gradients and similar) and how interactive the available elements are (e.g., if users can zoom in and out, visualise data labels, filter selections, and so on). Hewitt et al. (2020) found that the COLLAGE tool's interactive functionalities, including the real-time presentation of renewable energy targets through charts, introduced a gamification element that stimulated user engagement with the tool. This interactivity was deemed crucial in capturing the interest of stakeholders and inspiring them to experiment with the platform. This finding contrasts the limited interactivity offered by the APoLUS tool, which only features a basic graphic interface operating within the R environment and a few command-line operations (Hewitt et al., 2020). Calvo et al. (2021) identified the inclusion of interactive elements that allow users to filter out non-relevant information or emphasise particular details for decision-making as a significant factor in enhancing user experience and decreasing cognitive load associated with climate data visualisations. Similar observations were also found in Schlobinski et al. (2011) when discussing that to analyse outcomes from multiple scenarios in a model effectively, the capability to visually represent model results is required and in Roth et al. (2014) when arguing that an "overall text-heavy representation acts as repellent and does not help to arise interest and concern as has been found in the case of the BCT [BalticClimate Toolkit]" (p.62).

3.2.8 Actively maintained and supported

The condition of decision-support tools being *actively maintained and supported* with the most recent scientific findings and updated functionalities, as well as having an active community of users, was mentioned as important in the consulted literature to keep users interested in a particular tool and ensure information is still seen as trustworthy. According to Roth et al. (2014), due to the dynamic nature of climate-change-related scientific knowledge, it is critical to consistently incorporate and update the most recent scientific discoveries into decision-support tools or risk losing users' interest or trust in the information presented. This is also consistent with the findings of Fürst et al. (2010), who found that the availability of real-world conditions and the most up-to-date knowledge was a feature that participants valued in an optimal support tool.

Similar references were found in Hewitt and Macleod (2017), where the authors propose that active maintenance, preferably through a large and open user community, is an important criterion for an EDSS. The authors add that this is important for distinguishing between projects that are still being maintained and those that are not, and they also recommend that a tool be designed to be updateable with new information as it becomes available as a general principle for application development (Hewitt & Macleod, 2017). Broekx et al. (2012), Palutikof et al. (2019), Schumacher et al. (2020), and Webb et al. (2019) also identified requirements or user needs related to ongoing support, continuous improvement, long-term access, or availability of very recent data.

3.2.9 Security & privacy

A final characteristic group identified in the consulted literature refers to *security and privacy* and was mostly derived from recommendations from the ISO/IEC 25010 System and software quality models from the International Organization for Standardization. The international standard defined under the Product quality model is the security and confidentiality sub-characteristic relevant to this research. Security refers to the extent to which a system safeguards information and data, whereas confidentiality is related to the extent to which a system restricts data to be accessible solely by those authorised (International Organization for Standardization, 2011). Security and privacy requirements or user needs were not explicitly identified in other sources of information. However, this characteristic group was included due to the topic's relevance to the EU. On May 25, 2018, the General Data Protection Regulation (GDPR), the "strongest privacy and security law in the world" (European Council & Council of the European Union, 2022), was put into effect. The GDPR law increased protection for personal data by imposing that websites, for example, obtain clear consent to process personal data, making it available for users the "right to be forgotten" (European Council & Council of the European Union, 2022), among several other measures. A detailed discussion of the GDPR or security and privacy requirements is beyond the scope of this thesis. However, criteria related to how policy platforms handle cookies and security checks of the websites of the different policies have been included to incorporate the topic's relevance in the European Union.

3.2.10 Technical and user perception-dependent characteristics

Two distinct groups of characteristics were identified in the literature, but they are not explicitly assessed in Chapter 4 when evaluating the identified policy platforms. The first group includes characteristics that rely on users' perception and judgement (see Table A1.2 on Appendix 1 for details). The International Organisation for Standardisation (2011) provides examples of this characteristic group, which include appropriateness recognisability (i.e., the extent to which users perceive a system as suitable for their needs), functional completeness (i.e., the extent to which a collection of functions fulfils all specified tasks and user objectives), and similar items. These characteristics are addressed (directly or indirectly) in the survey and interviews with policymakers or policy advisors (Chapter 5). The second category is for characteristics that are inherently technical (see Table A1.3 on Appendix 1 for details). The International Organisation for Standardisation (2011) gives examples of these characteristics, such as accountability (i.e., the extent to which an entity's actions can be uniquely traced back to that same entity) and co-existence (e.g., the extent to which a system can efficiently perform its required functions while sharing resources and the environment with other systems, without negatively impacting them). Technical characteristics, while important for software and decision support tool evaluation, are beyond the scope of this research. Table 3.3 presents an overview of all references to characteristics of policy platforms identified per source of information.

Table 3.3. Overview of references of policy platform characteristics identified in the literature (✓ indicates that one or more references for that characteristic were identified in that source)

Source	Transparency & Credibility of information	Ease of use	Flexibility of use	Accessibility & Portability	Education & Awareness	Communication of complex information	Data visualisation & interactivity	Actively maintained and supported	Security & privacy	Total references identified
Fürst et al. (2010)		✓		✓				✓		3
McIntosh et al. (2011)	✓	✓	✓		✓	✓				13
Schlobinski et al. (2011)			✓				✓			5
Broekx et al. (2012)	✓		✓					✓		3
Bartke and Schwarze (2015)	✓		✓			✓				3
Hewitt and Macleod (2017)	✓		✓	✓	✓	✓		✓		16
Szimba et al. (2017)			✓	✓						2
Clar and Steurer (2018)		✓			✓	✓				9
Haße and Kind (2019)					✓	✓				2
Palutikof et al. (2019)	✓							✓		2
Webb et al. (2019)					✓			✓		2
Hewitt et al. (2020)				✓		✓	✓			3
Schumacher et al. (2020)	✓		✓		✓			✓		5
Calvo et al. (2021)				✓			✓			4
Collini et al. (2022)	✓	✓	✓	✓						4
González and Connell (2022)		✓	✓							2
Roth et al. (2014)			✓		✓	✓	✓	✓		6
International Organization for Standardization (2011)	✓	✓	✓	✓	✓		✓		✓	12
Aristotle University of Thessaloniki et al. (2018)		✓		✓		✓				5
MS10: Validated Requirements for the ICARUS DSS (2016)		✓	✓	✓			✓			5
Total references identified	**15**	**12**	**20**	**15**	**12**	**12**	**9**	**9**	**2**	

3.3 Proposed framework for assessing CCMA policy platforms

A set of criteria (i.e., questions) were derived from the scientific and grey literature evaluated and discussed in the previous section to support each characteristic's assessment. The proposed criteria aimed to address as many aspects of each characteristic group (e.g., transparency and credibility of information, accessibility and portability, and so on) as identified in the relevant literature consulted. Furthermore, each criterion was proposed to support the objective assessment of different policy platforms in the EU H2020 programme, which is why characteristics judged to be dependent on individual perceptions were not considered (as discussed in the previous section).

For each criterion, a given policy platform can successfully meet that criterion (receiving a "✓" mark, equivalent to a 1), not meet that criterion (receiving a "✗" mark, equivalent to a 0), or that specific criterion may not apply to one or more policy platforms (for which cases a "**N/A**" mark is assigned). Non-applicable marks are reserved for situations such as when a policy platform, for example, is not designed with the intention of providing interactive visualisations. In such cases, a "**N/A**" mark is assigned to avoid penalising a policy platform in those criteria (by assigning a "✗" mark).

Different automated tests were chosen for some criteria to help evaluate how well the policy platforms meet those criteria. Among the automated tests are:

- **Google Lighthouse accessibility test.** This test can be found in Chrome's DevTools (a collection of web developer tools built directly into the Chrome browser). It provides an accessibility score (0 - 100), with a good (green) score above 90 being considered good. Google Lighthouse compares web content to the Web Content Accessibility Guidelines (WCAG), which are widely regarded as the industry standard for digital accessibility. Because no automated test can guarantee WCAG compliance, a policy platform's Lighthouse accessibility score should not be considered the only measure of accessibility. It can, however, be helpful in identifying common accessibility issues (Bureau of Internet Accessibility, 2021).
- **Uptrends website availability test**. The ability of users to access and use a website or web service is referred to as website availability (Uptrends, n.d.-b). For the purposes of this study, it is critical to determine whether the websites of the various policy platforms are available and accessible from various locations. The Uptrends uptime free test (https://www.uptrends.com/tools/uptime) was used as a proxy for this criterion because it can send requests to a specified website and check each response from over 40 checkpoints worldwide (Uptrends, n.d.-a).
- **Cookies and data transfer for GDPR compliance test**. To determine how well each policy platform complies with EU GDPR requirements, the 2GDPR tool (https://2gdpr.com/) was used.
- **SSL Trust website safety & security check.** The SSL Trust website safety & security check (https://www.ssltrust.com.au/ssl-tools/website-security-check) was used to assess the safety and security of each policy platform website. This option was chosen because it allows users to see how a given URL performs when checked by over 60 databases from companies like Google, Comodo, Opera, and Securi, assisting users in determining whether a website is safe to visit.

The Uptime, GDPR, and Safety & Security tests, like Lighthouse accessibility, are not meant to be the only and final test for availability, privacy, and security topics, but rather preliminary tests that users can perform themselves to get a better idea of how different policy platform websites perform in terms of availability, security, and privacy. As a result, unless there is a clear conclusion (e.g., websites lacking valid certificates, not using encrypted connections, and so on), no definitive conclusions about how policy platforms perform in such tests will be drawn in this thesis. Despite the above remarks, it is still important to have a better understanding of such characteristics for the assessed policy platforms, so each of the aforementioned tests will be performed for each identified policy platform in Chapter 4.

Chapter 4 will discuss the list of policy platforms identified in the H2020 repository and the results obtained from assessing all the identified platforms using the proposed framework. Table 3.4 depicts the entire framework, including all nine characteristics as well as the criteria list that will be used to evaluate each identified policy platform.

An expert researcher in the field of decision support tools related to climate change mitigation and adaptation (CCMA) provided feedback on the characteristics and criteria listed in Table 3.4. Feedback was gathered and incorporated into the development of the various characteristics and criteria. Two specific pieces of feedback stand out and deserve special mention. One of the points raised by the expert researcher is the speed with which policy platforms can provide users with relevant information. This proved to be an important point because it was explicitly mentioned by one survey participant and perceived by the researcher as relevant to policymakers during the interviews (see Chapter 5 for the detailed discussion on surveys and interviews). However, speed would be related to a technical characteristic of a policy platform (e.g., how quickly it can make database requests to populate the front end for users or how quickly it can run different what-if scenarios and generate charts). As stated by the International Organisation for Standardisation (2011), capacity (i.e., the degree to which the maximum limits of a product or system parameter meet requirements) and performance efficiency (i.e., performance relative to the amount of resources used under stated conditions) could be suitable requirements to assess this type of user need, but this is beyond the scope of this research. Another critical feedback mentioned by the researcher during feedback collection was about platforms being tailored to specific target groups. This feedback, while partially beyond the scope of this research (because it would entail investigating how potential user groups were involved in the development of each policy platform and how much each platform was customised for the needs of such groups, how conflicts and potential trade-offs were handled, and so on), is also partially covered by criteria such as “high level of detail for spatial and granular data”, since a policy platform with data available on a high level of granularity could potentially fit better the needs of different policymakers, that would be able to select the desired level of detail.

Table 3.4, therefore, presents the framework already considering the feedback collected.

Table 3.4. List of characteristics and criteria for the assessment of policy platforms. Using the criteria below, each policy platform will be evaluated on Chapter 4 and assigned either a "✓" mark (if it successfully meets the criterion), a "✗" mark (if the policy platform does not meet the criterion) or a "N/A" mark (if that criterion does not apply to that policy platform)

Transparency & Credibility of information
TC.1 Does the tool clearly specify its intended objective or purpose (e.g., using a statement of objectives, purpose or mission)?
TC.2 Does the tool clearly specify who its intended users are?
TC.3 Is the tool developed by or affiliated with credible sources (e.g., research organisations and researchers), and is this clearly stated on the tool?
TC.4 Does the tool clearly communicate the data source (quantitative data, models, policies etc) used for analyses or recommendations?
TC.5 Does the tool openly communicate limitations associated with its models/functionalities allowing users to understand what can and cannot be concluded from the tool?
TC.6 Does the tool openly communicate uncertainty and assumptions that its models may have (e.g., value ranges, confidence intervals, probability distributions, etc.)?
Ease of use
EU.1 Does the tool clearly display available options so that users can easily understand what to do next to navigate it (e.g., are "back" and "next" types of buttons easily visible on the screens; are filters, range, or scroll buttons easily visible in the screens where users interact with visualisations, does the tool state in which menu/submenu the user is etc.)?
EU.2 Does the tool have a section where the user can learn how to use it and what functionalities are available (e.g., a "start here" section, a web tour, an introduction, an about section etc.)?
EU.3 Does the tool produce outputs or provide brief, clear, or simple functionalities to understand and use (e.g., brief reports, takeaways, summaries, etc.)?
EU.4 Are the tool's screens free of excessive visual clutter, which can make it difficult for users to understand the information being presented (e.g., no multiple visualisations of different measures or scales on the same screen; various types of visualisations such as charts, tables, maps, and others on the same screen; screens that require excessive scrolling to understand or cover the analyses, etc.)?
EU.5 Does the tool provide clear explanations or visible help for users to understand visualisations/functionalities that may require prior knowledge (e.g., abbreviations, units of measure, axes, or similar)?
EU.6 Does the tool provide visualisations (charts, tables, maps, pictures, etc.) that include all the information necessary to understand what that visualisation depicts (e.g., correctly labelled axes, legends visible, supporting text boxes, or other resources)?
EU.7 Does the tool validate user input before running models, analyses, or producing any output (e.g., validate selections, numbers entered, units, thousands/millions separator, etc.)?
Flexibility of use
FU.1 Does the tool allow users to use it for various needs or preferences (e.g., learn more about a particular topic, better understand a model, get recommendations, perform custom analyses, etc.)?
FU.2 Does the tool enable users to modify the models' underlying logic (e.g., modify ranges, probabilities, or threshold values, perform analyses for various time horizons, perform sensitivity or what-if analyses, etc.)?
FU.3 Is the tool capable of generating personalised or tailored outputs/recommendations based on user inputs (e.g., based on location, constraints, needs, or other characteristics provided by the user)?
FU.4 Does the tool provide a high level of detail for spatial and/or temporal data (e.g., can the user select different levels of spatial regions (world, continents, countries, cities etc.) and/or other levels of temporal scales (decades, specific years, quarters etc) for analysis)?
FU.5 Does the tool allow users to continue their work in the future or integrate the results obtained in other forms (e.g., allow users to save, share or export scenarios/analyses or results by providing clear instructions on how to connect to and use the tool, having GitHub or other repositories available)?
FU.6 Does the tool allow users to access past analyses (e.g., access to saved history, imported files, imported scenarios, or similar)?
Accessibility & Portability
AP.1 Does the tool provide intuitive and easy navigation when accessed via mobile phones or tablets (e.g., users can clearly see menus, options, and filters when accessing the tool via a mobile phone)?
AP.2 Does the tool offer free and open access to all of its functionalities?
AP.3 Is the tool at least partially natively accessible in languages other than English (e.g., by allowing the user to select the language without needing third-party web extensions)?
AP.4 Does the tool provide access to all its features only through a website (i.e., without the need to download software or other packages)?
AP.5 Does the tool pass accessibility tests? [1] *[1] Assessed by running Lighthouse accessibility scoring tests (should be good: 90-100)*
AP.6 Does the tool pass availability tests? [2] *[2] Assessed by evaluating availability from different locations (https://www.uptrends.com/tools/uptime)*
Education & Awareness
EA.1 Does the tool offer explanations or resources to help users understand the topic that the tool aims to address (e.g., energy transition, energy citizenship, decarbonisation pathways etc)?
EA.2 Does the tool provide additional resources to enhance learning or awareness of the topic(s) it addresses (e.g., video resources, courses, workshops, articles, interviews, talks or other events, training sessions etc)?
EA.3 Does the tool provide recommendations of similar tools, platforms, websites or projects that the user can also benefit from?
EA.4 Does the tool offer examples of successful policies or best practices from other places that can help promote policy transfer and evidence-based policymaking (e.g., articles, press releases, interviews, videos, events, or other resources)?
EA.5 Does the tool offer suggestions or potential choices without being normative about what is the "right thing to do"?
Communication of complex information
CI.1 Does the tool provide brief resources (e.g., key takeaways, summaries) to synthesise complex information in a more easily digestible format?
CI.2 Does the tool provide resources for users to help them understand information or reduce complexity (e.g., tooltips in charts, explanations of units used, explanations of scenarios or similar resources)?
CI.3 Does the tool provide resources to help users understand the results of analyses (e.g., ranges, intervals, concept descriptions, explanations of what can be concluded/not concluded, and so on)?
Data visualisation & interactivity
DV.1 Does the tool provide visual graphical elements (e.g., charts, tables, maps, infographics or others)?
DV.2 Does the tool offer graphical visualisations (charts, maps, images) with easily distinguishable elements (e.g., colours, angles, brightness, gradients, opacity, etc.) without requiring users to reference legends or additional explanations constantly?
DV.3 Does the tool offer interactive visual graphical elements (e.g., charts, tables, maps, or others that users can select, zoom in on, apply filters or otherwise interact with)?
Actively maintained and supported
AM.1 Is there evidence that the tool is currently in use (e.g., recent posts, version updates, or social media activity)?
AM.2 Is there a menu or option for users to contact someone in case of a bug, question, suggestion or request for additional information?
AM.3 Does the tool indicate that it has been recently updated (e.g., does it display recent data/information/policies/projects from the past three years as it becomes available)?
Security & privacy
SP.1 Does the tool allow users to interact with it without having to create accounts, fill out forms or provide personal data?
SP.2 Does the tool pass cookies and data transfer for GDPR compliance tests? [3] *[3] Assessed using an online EU cookie law checker (https://2gdpr.com/)*
SP.3 Does the tool pass Website Safety & Security Checks? [4] *[4] Assessed by using the comprehensive safety and security check by SSLTrust (https://www.ssltrust.com.au/ssl-tools/website-security-check)*

3.4 Conclusions of chapter 3

This chapter addressed the first subquestion of this thesis:

(SQ1) *What are the typical characteristics of climate-change mitigation and adaptation (CCMA) policy platforms?*

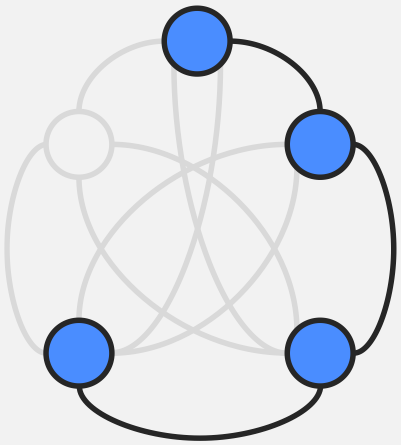
As policy platform is not a term as widely used, a systematic search into the literature was performed using decision support tool(s) and decision support system(s) as starting points, given their more frequent use. The search for scientific and grey literature focused on user requirements and needs in order to identify policymakers' needs regarding support tools. To identify relevant features or requirements, scientific and grey literature were used. Given the broad meaning of some relevant terms in the literature, the literature search included a broad range of relevant terms to improve results. The review of the literature included 17 scientific papers and four grey literature documents. To aid in the identification of common themes that characterise CCMA policy platforms, a systematic analysis based on the thematic synthesis technique was used.

From this chapter on, the term *characteristics* was deliberately chosen over *requirements* or *features* when describing relevant functionalities or attributes of policy platforms. This decision was motivated by the fact that requirements or features in the literature on systems development occasionally present subtle but potentially significant differences. To avoid ambiguity, the generic term *characteristics* was chosen for use throughout the thesis.

The themes identified in the literature investigated resulted in the identification of nine characteristics. These were *Transparency and Credibility of Information*, *Ease of Use*, *Flexibility of Use*, *Accessibility and Portability*, *Education and Awareness*, *Communication of Complex Information*, *Data Visualisation & Interactivity*, *Actively maintained and supported*, and *Security & Privacy*.

When evaluating policy platforms, two identified characteristic groups in the literature were not explicitly examined. The first category includes characteristics that are intrinsically dependent on user perception and judgment (e.g., whether users perceive a system as being suitable for their needs, whether a set of functions fulfils all specified tasks and user objectives, and so on). Because of their subjective nature, these were not considered in the proposed framework for assessing H2020 CCMA policy platforms (but were addressed in interviews and surveys with policymakers and advisors). The second group consists of technical characteristics, which include aspects such as how well a system can perform its tasks while sharing resources and an environment with other systems without affecting them. Technical characteristics are important in evaluating software and decision support tools, but they are beyond the scope of this study.

This first subquestion resulted in a practical assessment framework composed of the nine identified characteristics of policy platforms and a set of criteria to be used when assessing the various platforms, which was used to answer the second subquestion of this research.



Chapter 4

Assessment of Horizon 2020 CCMA policy platforms

Main topics

1. The EU Horizon 2020 programme
2. Identification of policy platforms within the H2020 programme
3. Overview of the policy platforms identified within the H2020 programme
4. Assessment of CCMA policy platforms identified within the H2020 programme
5. Conclusions of chapter 4

4. Assessment of Horizon 2020 CCMA policy platforms

This chapter addresses the second subquestion of this research: *What are the similarities and differences between existing CCMA policy platforms in the EU, considering the identified typical characteristics of policy platforms?* To identify climate-change mitigation and adaptation (CCMA) policy platforms, a systematic search in the Horizon 2020 (H2020) project repository was conducted. Each policy platform was then evaluated individually based on the characteristics described in Chapter 3 (shown in Table 3.4). This chapter concludes with a discussion of the findings from evaluating all platforms using the proposed framework.

4.1 The EU Horizon 2020 programme

Horizon 2020 (H2020) was the EU's primary research and innovation programme that ran from 2014 to 2020 and had a funding budget of nearly €80 billion, making it the largest EU research and innovation programme of its time (European Commission, 2014). Horizon Europe, the successor programme, will provide funding for European research and innovation from 2021 to 2027 with a budget of €95.5 billion (European Commission, n.d.-c). The H2020 programme was chosen as the focal point for this research because of its relevance, the time span it covered (which included the signing of the Paris Agreement in 2015 and the adoption of the European Green Deal in 2019), and the fact that most of the projects funded by the H2020 programme are already completed or nearing completion, which makes it more likely to identify policy platforms already fully developed in the H2020 programme than in its successor Horizon Europe.

The H2020 programme had Excellent Science, Industrial Leadership and Societal Challenges as its three key focus areas (European Commission, 2014), which split into several sub-areas, as depicted in Table 4.1. An official assessment of the H2020 programme as a whole is scheduled to be released by December 2023, with the publication of the Horizon 2020 ex-post evaluation report (European Commission, n.d.-d). However, according to data from the European Commission Horizon 2020 dashboard[1] (accessed on 20/05/2023), 37,265 grants were signed (including suspended, terminated and closed grants) in the H2020 programme, summing up to €68.32 billion of net EU contribution (European Commission, 2023). The pillar Societal Challenges included 7,811 grants and had the largest funding (€26.39 billion), followed by Excellent Science (€25.02 billion and 20,686 grants) and Industrial Leadership (€13.8 billion and 7,682 grants). Table 4.1 provides an overview of the H2020 programme structure with all its pillars and sub-areas.

[1] The Horizon Dashboard offers public access to statistics and data on EU research and innovation projects. Data on programme, countries, pillars, priorities and others can be found on the Key Figures sheet of the dashboard (https://webgate.ec.europa.eu/dashboard/sense/app/98dcd94d-ca66-4ce0-865b-48ffe7f19f35/sheet/KVdtQ/state/analysis)

Table 4.1. Overview of H2020 programme structure (source: Horizon 2020 sections)

Excellent Science
European Research Council
Future and Emerging Technologies
FET Proactive
FET Flagships
FET open
Marie Sklodowska-Curie actions
Research Infrastructures, including e-Infrastructures
e-infrastructures
Industrial Leadership
Leadership in Enabling and Industrial Technologies
Nanotechnologies, Advanced Materials, Advanced Manufacturing and Processing, and Biotechnology
Nanotechnologies
Information and Communication Technologies
Photonics
Micro- and Nanoelectronics
Content Technologies and Information Management
A new generation of components and systems
Advanced Computing
Robotics
Future Internet
Space
Access to risk finance
Innovation in SMEs
The Eurostars programme
Societal Challenges
Health, Demographic Change and Wellbeing
Scientific Panel for Health (SPH)
Food Security, Sustainable Agriculture and Forestry, Marine, Maritime and Inland Water Research and the Bioeconomy
Bioeconomy
Secure, Clean and Efficient Energy
Smart, Green and Integrated Transport
Climate Action, Environment, Resource Efficiency and Raw Materials
Waste
Water innovation
Fighting and adapting to climate change
Europe in a changing world - Inclusive, innovative and reflective societies
Secure societies - Protecting freedom and security of Europe and its citizens
Spreading Excellence and Widening Participation
Teaming
Twinning
Era Chairs
Enhanced European Innovation Council (EIC) pilot
EIC Accelerator Pilot
Fast Track to Innovation
Future and Emerging Technologies (FET) Open
Horizon Prizes
Focus areas
European Institute of Innovation and Technology (EIT)
Euratom
Nuclear fusion
Science with and for Society
Science Education
Promoting Gender Equality in Research and Innovation
Public Engagement and responsible research and innovation
Responsible research & innovation
Ethics
Open Science (Open Access)

4.2 Identification of policy platforms within the H2020 programme

The EU Commission's Community Research and Development Information Service (CORDIS) was investigated in order to identify relevant climate change mitigation and adaptation policy platforms related to the H2020 programme. The CORDIS is the European Commission's primary source of information on projects funded by the EU's innovation and research programmes (European Commission, n.d.-a). Based on official CORDIS data for the H2020 programme, a systematic search and analysis of H2020-funded projects were performed to identify the final list of policy platforms for assessment (section 4.4), as described in the following subsections.

4.2.1 Identification of H2020 projects

The first step in conducting a systematic analysis to identify climate change mitigation and adaptation policy platforms was to identify all projects funded under the H2020 programme. Users can search for projects and results on the CORDIS platform (https://cordis.europa.eu/projects) in a variety of ways, including by framework programme, latest results, exploring the previously mentioned Horizon Dashboard, and downloading datasets. Because the goal of this analysis was to conduct a systematic search in the entire dataset of H2020 projects using relevant filters (e.g., priorities, sub-areas, keywords, and others), the entire dataset of H2020 projects was downloaded on 26/03/23 as an Excel file from the CORDIS platform (Publications Office, 2015). The dataset is freely accessible at https://doi.org/10.2906/112117098108/12.

The dataset includes 34,398 projects from the previously mentioned priorities (Excellent Science, Industrial Leadership, and Societal Challenges) as well as additional sections. The Excellent Science priority has the most projects (19,578 projects with Excellent Science as the main programme), followed by the Societal Challenges (6,424) and Industrial Leadership (6,185) priorities. In addition to the three priorities, the H2020 programme funded research projects under other sections such as Spreading Excellence and Widening Participation (477 projects with Spreading Excellence and Widening Participation as the main programme), Science with and for Society (233 projects), and Euratom (complementary research programme for nuclear research and training, with 89 projects). There were 215 research projects with the Horizon 2020 Framework Programme listed as the main programme and 1,197 research projects in the H2020 projects dataset that did not have a main programme associated with them.

Table 4.2 summarises all of the programmes and subprogrammes, as well as the number of projects associated with them, as specified in the H2020 dataset downloaded from the CORDIS platform's legal basis column. Table 4.3, in turn, describes all of the attributes available in the H2020 projects dataset. It is important to note that a project can be associated with one or more H2020 programmes or subprogrammes; however, projects typically have one main programme and several secondary programmes, so the numbers in Table 4.2 refer to the main programme as depicted in the official dataset available. Another important point to note is that projects that do not have an official main programme (1,197 projects) may be associated with one or more programmes (if the official CORDIS page of those projects is consulted); however, the H2020 projects dataset did not mention any main programme under the legal basis attribute for these projects (i.e., the column was blank in the dataset), so these projects were considered to be without a main programme for the purposes of this research.

Table 4.2. Number of projects per priority or section in the H2020 programme (source: own analysis based on the legal basis attribute of the H2020 projects dataset (Publications Office, 2015))

Priority and sub-areas	Number of projects
1. PRIORITY: Excellent science	**19,578**
1.1. The European Research Council (ERC)	7,404
1.2. Future and emerging technologies (FET)	547
1.3. Marie Skłodowska-Curie actions	11,360
1.4. Research infrastructures	267
2. PRIORITY: Industrial leadership	**6,185**
2. PRIORITY: Industrial leadership	1
2.1. Leadership in enabling and industrial technologies	3,028
2.2. Access to risk finance	12
2.3. Innovation In SMEs	3,144
3. PRIORITY: Societal challenges	**6,424**
3. PRIORITY: Societal challenges	65
3.1. Health, demographic change and well-being	1,119
3.2. Food security, sustainable agriculture and forestry, marine, maritime and inland water research, and the bioeconomy	799
3.3. Secure, clean and efficient energy	1,324
3.4. Smart, green and integrated transport	1,660
3.5. Climate action, environment, resource efficiency and raw materials	663
3.6. Europe in a changing world - Inclusive, innovative and reflective societies	416
3.7. Secure societies - Protecting freedom and security of Europe and its citizens	378
4. SPREADING EXCELLENCE AND WIDENING PARTICIPATION	**477**
4. SPREADING EXCELLENCE AND WIDENING PARTICIPATION	128
4.a. Teaming of excellent research institutions and low performing RDI regions	83
4.b. Twinning of research institutions	201
4.c. Establishing ‚ERA Chairs'	58
4.e. Supporting access to international networks for excellent researchers and innovators who lack sufficient involvement in European and international networks	2
4.f. Strengthening the administrative and operational capacity of transnational networks of National Contact Points	5
5. SCIENCE WITH AND FOR SOCIETY	**233**
5. SCIENCE WITH AND FOR SOCIETY	67
5a. Make scientific and technological careers attractive to young students, and foster sustainable interaction between schools, research institutions, industry and civil society organisations	47
5b. Promote gender equality in particular by supporting structural changes in the organisation of research institutions and in the content and design of research activities	27
5c. Integrate society in science and innovation issues, policies and activities in order to integrate citizens' interests and values and to increase the quality, relevance, social acceptability and sustainability of research and innovation outcomes in various fields of activity from social innovation to areas such as biotechnology and nanotechnology;	37
5d. Encourage citizens to engage in science through formal and informal science education, and promote the diffusion of science-based activities, namely in science centres and through other appropriate channels;	13
5e. Develop the accessibility and the use of the results of publicly-funded research;	3
5f. Develop the governance for the advancement of responsible research and innovation by all stakeholders (researchers, public authorities, industry and civil society organisations), which is sensitive to society needs and demands, and promote an ethics framework for research and innovation;	31
5g. Take due and proportional precautions in research and innovation activities by anticipating and assessing potential environmental, health and safety impacts;	1
5h. Improve knowledge on science communication in order to improve the quality and effectiveness of interactions between scientists, general media and the public.	7
Euratom	**89**
Euratom	89
Horizon 2020 Framework Programme	**215**
Horizon 2020 Framework Programme	215
Not specified	**1,197**
Not specified	1,197
Grand Total	**34,398**

Table 4.3. Attributes and description of attributes available in the H2020 projects dataset (Publications Office, 2015). Particularly important attributes for further steps of the analyses are highlighted.

Attribute	Description
ID	Project ID
Acronym	Project acronym
Status	Project status (closed, signed, terminated)
Title	Project title
Startdate	Project start date
Enddate	**Project end date**
Totalcost	Project total cost
Ecmaxcontribution	EU contribution
Legalbasis	**Project main programme (according to H2020 structure)**
Topics	Project topic (according to H2020 structure)
Ecsignaturedate	Date of signature by European Commission
Frameworkprogramme	H2020
Mastercall	MasterCall for proposal
Subcall	Subcall for proposal
Fundingscheme	Funding scheme of the project (e.g., Research and Innovation Action (RIA))
Nature	Mostly blank but some with detaisl such as crisis recovery, crisis preparedness or crisis response
Objective	**Description of the project's objective (as available on the official CORDIS page). This attribute was used to filter the dataset based on keywords (section 4.2.2).**
Contentupdatedate	Content update date
RCN	Record Control Number of project
Grantdoi	Grant DIGITAL OBJECT IDENTIFIER (DOI)

4.2.2 Systematic analysis of the H2020 projects dataset

A systematic analysis was performed on a dataset of 34,398 projects from the H2020 programme to identify relevant policy platforms that would meet the scope of this research (i.e., CCMA policy platforms). This analysis was carried out in three steps, beginning with querying the dataset using various parameters and ending with reading the objective description of the projects, which was

available as one of the attributes in the dataset, as shown in Table 4.3. The subsections that follow explain each step of the systematic analysis.

4.2.2.1 Filtering dataset based on programmes and subprogrammes

The first step in conducting a systematic analysis to reduce the number of projects to evaluate using the framework proposed in Table 3.4 was to identify the most relevant programmes and subprogrammes. This was accomplished using an initial list of relevant policy platforms obtained from my thesis's first supervisor and another researcher working with my thesis's first supervisor in the H2020 ENCLUDE project, who is knowledgeable about decision-support tools and has provided feedback on the proposed framework. The initial list of policy platforms included platforms developed (or in the process of development) within and outside of H2020 projects. Table 4.4 depicts the platforms associated with H2020 projects.

Table 4.4. Overview of the initial list of policy platforms identified.

Platform	Corresponding H2020 project*	Legal basis
Senses Toolkit	ERA4CS (Grant agreement 690462)	3.5. Climate action, environment, resource efficiency and raw materials
EUCalc	EUCalc (Grant agreement 730459)	
I^2AM PARIS	PARIS REINFORCE (Grant agreement 820846)	
Climate Change Mitigation (CCM)	CARISMA (Grant agreement 642242), then handed to DEEDS (Grant agreement 776646), then handed to LANDMARC (Grant Agreement 869367), then handed to MAIA (Horizon Europe project)	
SET-Nav	SET-Nav (Grant agreement 691843)	3.3. Secure, clean and efficient energy
SENTINEL	SENTINEL (Grant agreement 837089)	
OpenENTRANCE	OpenENTRANCE (Grant agreement 835896)	
ENCLUDE	ENCLUDE (Grant agreement 101022791)	
ENTRUST	ENTRUST (Grant agreement 657998)	
AR6 Scenario Explorer and Scenarios Database	ENGAGE (Grant agreement 821471)	Not specified

**Includes projects fully or partially funded by the H2020 programme*

Table 4.4 shows that almost the entire initial list of projects developing policy platforms is funded under priority 3. (Societal challenges) on subprogrammes 3.3. (Secure, clean and efficient energy) or 3.5. (Climate action, environment, resource efficiency and raw materials). As a result, the H2020 projects dataset was filtered to include only projects related to subprogrammes 3.3, 3.5, or not specified, reducing the total number of projects from 34,398 to 3,184 (9.3% of the original dataset).

4.2.2.2 Filtering dataset based on the project end date and keywords

Filtering by the end date of projects

Because the variety and number of projects in the reduced dataset of 3,184 projects were still too large to evaluate, the project list was filtered based on the project end date. This was chosen to ensure that the policy platforms evaluated in this research were fully developed as the projects to which they belonged were already completed. The motivation was to reduce the risk of starting to evaluate platforms based on the proposed framework when they were still too early in development, resulting in no platform being available for assessment. Based on this criterion, 2,414 projects (7% of the original dataset) with an end date between 2014 and 2022 were identified (770 projects with an end date between 2023 and 2027 were excluded from consideration).

Filtering based on keywords

The platform list was then filtered based on keywords relevant to this research. The filtering was performed on the column containing the description of the objectives of each H2020 project, and it was accomplished with the help of three sets of keywords, as shown in Table 4.5. The first set of keywords included terms related to the project's *purpose*, such as "platform", "tool", and "decision support tool". The first set sought H2020 projects that mentioned the goal of delivering some sort of support tool, platform, or similar terms. The second set of keywords was related to the H2020 project's *theme* and included terms like "transition," "pathways," "adaptation," "mitigation," and others. The second set sought to identify H2020 projects addressing climate change mitigation and adaptation issues, as this is the focus of this research. The final set of keywords was related to the H2020 project's *target group* and included terms like "policy makers," "decision makers," "policymaking," and multiple variants of these terms. The third set of keywords sought to identify H2020 projects that explicitly mentioned policymaking, policymakers, or other decision-making-related terms in their objectives, as this is also the goal of this research.

Table 4.5. Keywords used in the Systematic analysis of the H2020 projects dataset.

Keywords set	Search string
1. Purpose	"platform" OR "platforms" OR "tool" OR "tools" OR "decision support tool" OR "decision support tools" OR "policy tool" OR "policy tools" OR "web" OR "online"
2. Theme	"climate change" OR "climate-change" OR "energy transition" OR "transition" OR "pathway" OR "pathways" OR "decarbonization" OR "decarbonisation" OR "adaptation" OR "mitigation"
3. Target group	"policymaker" OR "policymakers" OR "policy-maker" OR "policy-makers" OR "policy maker" OR "policy analyst" OR "policy-analysts" OR "policy advisor" OR "policy advisors" OR "policy makers" OR "decision maker" OR "decision makers" OR "decision-maker" OR "decision-makers" OR "policymaking" OR "policy making" OR "policy-making" OR "decision making" OR "decision-making"

Python was used to help with keyword filtering. The entire Excel dataset of H2020 projects (34,398 records) was imported as a pandas dataframe and filtered by project end year (2022 or before) and corresponding programme (3.3, 3.5 or not specified) as mentioned above. The re library was used to perform the search based on the keywords using regular expressions, and three columns were added to the pandas dataframe to indicate the keywords identified (one column for each keyword set). The purpose keywords column identified all (if any) keywords from the purpose keywords set identified in the H2020 project objective description, and similarly for the theme keywords column and target group keywords columns.

As a result of the keywords filtering step, from the 2,414 projects that emerged from the previous step (project end year before 2023), 882 projects had at least one matching keyword from the purpose set, 380 projects had at least one matching keyword from the theme set, and 296 projects had at least one matching keyword from the target group set (keywords queries were performed independently). The resulting pandas dataframe was then exported to an updated Excel H2020 projects dataset for further analysis. Based on the newly created matching keywords per set, the dataset was filtered to include only H2020 projects with at least one matching keyword from the theme keywords set (e.g., mitigation, decarbonisation or transition) and at least one matching keyword from the target group keywords set (e.g., policymaking, policymakers or decision-making). The purpose keywords set was not used as a mandatory filter because some projects that match the target group and theme keywords might have policy platforms being developed but not necessarily mention any of the terms included in the purpose keywords set in the project's objective. This is the case of the ENCLUDE project (not included in the analyses of further sections because the project is still ongoing), for example, which will be developing a policy platform to support policymakers, citizens, and other stakeholders with insights about energy citizenship. The ENCLUDE project mentions keywords from the theme set ("decarbonization", "transition") and the target group set ("policymaking") but no words from the purpose set. Therefore, in order to minimise the risk of eliminating potentially relevant projects based on the purpose keywords set, this filter was not applied, and the purpose keywords column was used only to support the next phase of the analysis of H2020 projects, which involved reading the description of the project's objectives in order to identify relevant projects to assess using the criteria stated in Table 3.4.

Table 4.6 shows the steps taken to filter the H2020 project dataset systematically. The theme and target group keyword sets were used as mandatory filters (projects had to present at least one matching word from each keyword set in order to be selected), whereas the purpose keywords set was only used as a supporting column for further analyses.

Table 4.6. Steps taken in the systematic filtering of the H2020 projects dataset.

<table>
<tr><th>H2020 dataset</th><th>Legal Basis</th><th>End year</th><th>Matching keywords (independent)</th><th>Matching keywords (combined)</th></tr>
<tr><td rowspan="5">H2020 projects dataset (34,398)</td><td rowspan="4">H2020-EU.3.3., H2020-EU.3.5. or Not specified (3,184)</td><td rowspan="3">Before 2023 (2,414)</td><td>At least one matching word from purpose set (882)</td><td rowspan="4">At least one matching word from theme set AND at least one matching word from target group set (79)</td></tr>
<tr><td>OR
At least one matching word from theme set (380)</td></tr>
<tr><td>OR
At least one matching word from target group set (296)</td></tr>
<tr><td>=
Unique projects (1,179)</td></tr>
<tr><td>2023 or later (770)</td><td></td><td></td></tr>
<tr><td>Others (31,214)</td><td></td><td></td><td></td></tr>
</table>

Project's objectives assessment

Following the completion of the steps outlined in Table 4.6 for the systematic filtering of the H2020 project dataset, 79 projects passed all steps and had their objectives descriptions read in detail in

order to identify their fit for this research. After reading each of the 79 projects, 54 were determined to be unsuitable for this research, while 25 were determined to be relevant. Projects eliminated after reading the corresponding project's objective include ones that mentioned at least one keyword from the theme and target group sets but either in different contexts (such as the CARE project, which aims to develop a health-related decision-making support tool to assist in the fight against HIV, tuberculosis (TB) and viral hepatitis C (HCV) and define pathways of drug-resistant HIV), or only as contextualisation (such as the UrBAN-WASTE project, which aims to support policymakers in answering challenges associated with waste production in tourist cities).

Relevant projects were those whose objective descriptions explicitly mentioned policymaking or decision-making objectives related to climate change mitigation and adaptation contexts and which addressed, directly or indirectly, the development of scenarios, support tools, platforms, frameworks, or similar terms. One platform (Senses Toolkit) did not mention keywords from the target group set by its parent project (ERA4CS), but it was manually added to the list because it was part of the initial list of recommended policy platforms (Table 4.4) and is well suited to the purpose of this study.

The final list of projects to be assessed using the proposed framework from Table 3.4 was then composed of 26 projects, as mentioned in Table 4.7. The websites of all platforms were investigated to determine their suitability for this study. As shown in Table 4.7, 13 of the 26 final projects were not prioritised for assessment for a variety of reasons (explained in Table 4.7). Figure 4.1 depicts the entire process of conducting a systematic analysis of the dataset of H2020 projects.

Table 4.7. Final list of policy platforms for assessment using the proposed framework

Project	Duration	Matching keywords	Comments
PARIS REINFORCE	2018 - 2021	**Purpose set:** "platform", "tools" **Theme set:** "decarbonisation" **Target group set:** "policymaking", "policymakers"	Assessed
EUCalc	2018 - 2021	**Purpose set:** "Online", "tool", "tools" **Theme set:** "Pathways", "decarbonisation", "Transition", "transition", "pathways" **Target group set:** "decision makers", "decision-makers", "decision making"	Assessed
COACCH	2017 - 2021	**Purpose set:** "platform" **Theme set:** "adaptation", "climate change", "mitigation" **Target group set:** "policy making", "decision making"	Assessed
CD-LINKS	2015 - 2018	**Purpose set:** "platform" **Theme set:** "pathways", "adaptation", "climate change", "mitigation" **Target group set:** "policy makers"	Assessed
ERA4CS	2016 - 2021	**Purpose set:** "tools" **Theme set:** "adaptation", "mitigation" **Target group set:**	Assessed
SOCLIMPACT	2018 - 2021	**Purpose set:** **Theme set:** "Climate Change", "adaptation", "decarbonisation", "pathways", "mitigation" **Target group set:** "policy makers", "Policy makers", "decision making"	Assessed
INNOPATHS	2018 - 2021	**Purpose set:** "tools", "online" **Theme set:** "decarbonisation", "pathways" **Target group set:** "policy makers"	Assessed
SENTINEL	2018 - 2021	**Purpose set:** "platform", "online" **Theme set:** "transition" **Target group set:** "policy-analysts"	Assessed
PLACARD	2018 - 2021	**Purpose set:** "platform", "platforms", "online" **Theme set:** "Climate Change", "Adaptation" **Target group set:** "policymakers"	Assessed
EnerMaps	2020 - 2022	**Purpose set:** "tool", "tools" **Theme set:** "energy transition" **Target group set:** "decision makers"	Assessed
MAGIC	2018 - 2021	**Purpose set:** **Theme set:** "climate change" **Target group set:** "decision makers", "decision making"	Due to the time constraints imposed by this thesis, this project was not evaluated.
X-tendo	2019 - 2022	**Purpose set:** "tools", "online" **Theme set:** "transition" **Target group set:** "policy makers", "policy making"	Due to the time constraints imposed by this thesis, this project was not evaluated.
ARCH	2019 - 2022	**Purpose set:** "platform", "tools" **Theme set:** "pathway", "climate change" **Target group set:** "decision-making", "policy makers"	Due to the time constraints imposed by this thesis, this project was not evaluated.
HEAT-SHIELD	2018 - 2021	**Purpose set:** "online" **Theme set:** "climate change" **Target group set:** "policy makers"	Not assessed. HEAT-SHIELD weather platform not available when tested.
CARISMA	2015 - 2018	**Purpose set:** "platform", "online" **Theme set:** "climate change", "mitigation" **Target group set:** "policymakers"	Not assessed. CARISMA project website not accessible
CIRCULAR IMPACTS	2016 - 2018	**Purpose set:** "web", "tool" **Theme set:** "pathway", "transition" **Target group set:** "policy makers"	Not assessed. CIRCULAR IMPACTS project website not accessible
CRESCENDO	2015 - 2019	**Purpose set:** "tool" **Theme set:** "adaptation", "climate change", "pathways", "mitigation" **Target group set:** "policymakers"	Not assessed. CRESCENDO project website not accessible

Table 4.7. Final list of policy platforms for assessment (cont.)

Project	Duration	Matching keywords	Comments
DEEDS	2015 - 2019	**Purpose set:** **Theme set:** "Pathways", "Decarbonisation", "decarbonisation", "pathways", "decarbonization" **Target group set:** "policy makers"	Not assessed. DEEDS project website not accessible
HERON	2018 - 2021	**Purpose set:** "decision support tool" **Theme set:** "pathways" **Target group set:** "decision makers", "policy makers"	Not assessed. HERON project website not accessible
GREEN-WIN	2018 - 2021	**Purpose set:** **Theme set:** "adaptation", "mitigation" **Target group set:** "policy makers"	Not assessed. No online platform or support tool identified on the project's website.
MEDEAS	2018 - 2021	**Purpose set:** "tool", "tools" **Theme set:** "transition" **Target group set:** "policy-makers"	Not assessed. No online tool (Python library).
CICERONE	2015 - 2018	**Purpose set:** "platform" **Theme set:** "pathways" **Target group set:** "policy-makers"	Not assessed. Project mentions the design of a platform ("EU Circular Cooperation Hub" specifically for programme owners (i.e. public institutions that fund and design circular economy relate programmes) to co-design programmes with a variety of countries, regions and cities across Europe."). However, this was not found to be available on the project website
COMETS	2015 - 2019	**Purpose set:** "Platform", "tools" **Theme set:** "energy transition", "transition" **Target group set:** "decision makers"	Not assessed. Project mentions the objective to "provide tools and recommendations for improving the start-up, steering, and up-scaling of CAI (Collective Action Initiatives) activities. COMETS will co-design the tools with practitioners, enabling changes in the current situation and generating blueprints for future initiatives.". However, no platform was identified in the website of the project.
LANDSENSE	2018 - 2021	**Purpose set:** "Platform", "online", "tools" **Theme set:** "pathways" **Target group set:** "decision-making"	Not assessed. Project's objective to "build a far reaching citizen observatory for Land Use and Land Cover (LULC) monitoring that will also function as a technology innovation marketplace" is beyond the scope of this research.
CLARITY	2016 - 2018	**Purpose set:** **Theme set:** "adaptation", "climate change" **Target group set:** "Decision makers"	Not assessed. The Climate Services Information System platform delivered was found to contain some case studies and showcases, but not on the same level as other platforms investigated in this research.
TRANSrisk	2015 - 2018	**Purpose set:** "decision support tool" **Theme set:** "transition", "climate change", "pathways", "mitigation" **Target group set:** "policy makers"	Not assessed. TRANSrisk project website not accessible

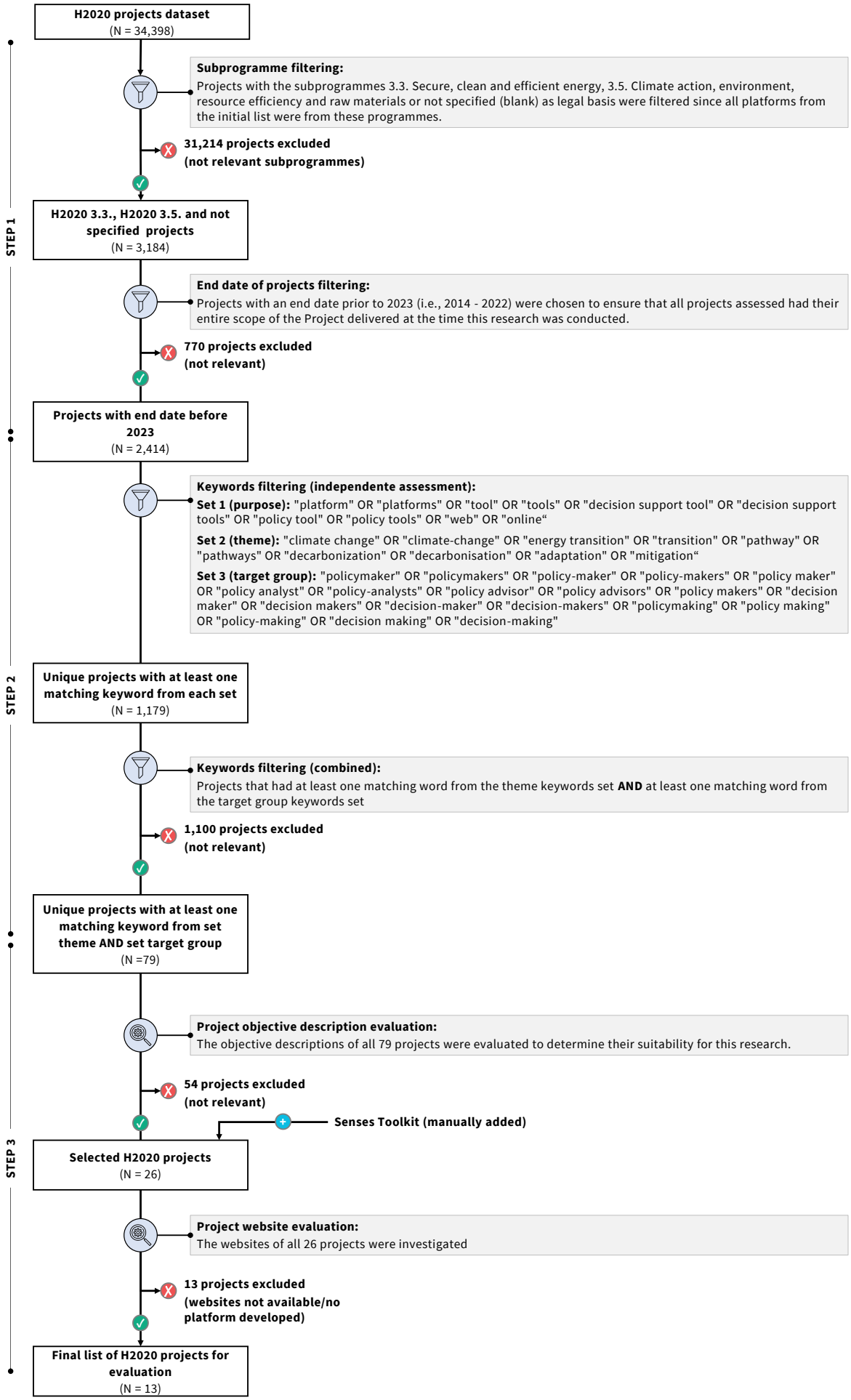


Figure 4.1. Systematic analysis of the H2020 projects dataset

4.3 Overview of the policy platforms identified within the H2020 programme

The final list of platforms investigated included ten policy H2020 projects. The SENTINEL project (https://sentinel.energy/) aimed to accelerate the energy transition and achieve total decarbonisation of the energy sector through the Sustainable Energy Transitions Laboratory (SENTINEL), featuring modular models for low-carbon energy systems. The platform offers diverse resources, including case studies, e-learning materials, and descriptions of 14 energy system models. The COACCH project (https://www.scenarioxplorer.coacch.eu/) aimed to assess climate change costs in Europe through a downscaled approach, providing Policy Briefs and a Climate Change Impact Scenario Explorer for users to visualize economic costs at different scales and scenarios.

The SOCLIMPACT project (https://soclimpact.net/) modelled climate change effects on European islands and archipelagos, offering a knowledge library and Regional Exchange Information System (REIS) platform for stakeholders to interact. It also produced an Adaptation Support Tool to guide climate change adaptation for policymakers. The EUCalc project (http://tool.european-calculator.eu/intro), aimed to map emission and sustainable transformation pathways at the European and Member State levels, offering an open-source Transition Pathways Explorer platform for policymakers and stakeholders to explore various emission scenarios and pathways to a net-zero carbon future. The INNOPATHS (DPET) project (https://dpet.innopaths.eu/#/) developed a research summary of low-carbon energy transition policies that provides different performance indicators to assess policy impacts from literature reviews.

The CD-LINKS (Climate Policy Database) (https://climatepolicydatabase.org/) collects information on currently implemented climate change mitigation policies from countries worldwide, providing a collaborative platform to access policies and best practices quickly. The Era4CS (Senses Toolkit) (https://climatescenarios.org/toolkit/) project provides accessible climate change scenarios and practical guidelines for stakeholders, including a policy portal for policymakers and a finance portal for financial decision-makers. The Paris Reinforce (I^2AM Paris) (https://www.i2am-paris.eu/) project facilitates communication among stakeholders and provides detailed model documentation, interactive views, and model comparisons for understanding decarbonisation pathways and policy options. The PLACARD (http://connectivity-hub.placard-network.eu/) project fosters collaboration and knowledge sharing between Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) groups. It offers tools, guidelines, and policy briefings to engage policymakers and decision-makers in climate-proof and disaster-resilient practices. Finally, the EnerMaps (https://lab.idiap.ch/enermaps/) project developed a user-friendly digital platform for centralizing over 30 energy datasets, facilitating data accessibility for academics and policymakers in the renewable energy sector.

Both the EUCalc Transition Pathways Explorer and the INNOPATHS DPET were chosen as policy platforms for interviews and surveys, in which participants interacted with these tools to assess their usefulness in assisting them in providing better policies or advice. Chapter 5 discusses the reasons for choosing the EUCalc and DPET platforms, as well as some print screens of relevant functionalities available in each platform and detailed insights into participants' opinions on both tools.

Appendix 2.1 contains a more detailed description of all of the above-mentioned policy platforms.

4.4 Assessment of CCMA policy platforms identified within the H2020 programme

All projects mentioned in the previous section and their corresponding tools were assessed using the characteristics proposed in the framework depicted in Table 3.4 (*Transparency & Credibility of information, Ease of use, Flexibility of use, Accessibility & Portability, Education & Awareness, Communication of complex information, Data visualisation & interactivity, Actively maintained and supported, and Security & privacy*) and the proposed criteria within each characteristic group. The detailed assessment of each policy platform is provided as supplementary data in 4TU.ResearchData Repository, in which comments regarding the attributed mark ("✓" if successfully meet the criterion, "✗" not met the criteria or "**N/A**" if the criterion is not applicable) are provided to support the scores derived for each characteristic.

Figures 4.2, 4.3, and 4.4 provide visualisations of the scores obtained for each policy platform and characteristic. Each characteristic is then discussed in greater depth in order to compare and contrast each platform in terms of each characteristic. The percentages shown in Figure 4.2 for each policy platform and characteristic are calculated by comparing how many criteria are successfully met within each characteristic group to the total number of criteria applicable to that group. The Sentinel platform score of 66.7% for *Transparency & credibility of information*, for example, refers to the four criteria it successfully meets out of six applicable criteria for that characteristic group (i.e., 66.7% is equal to 4/6). Similarly, the COACHH score of 83.3% for *Flexibility of use* indicates that the COACCH policy platform successfully met five of six criteria for that group.

A specific criterion may not always apply to a given policy platform. In such cases, a "N/A" mark is assigned, which has no effect on the platform's score for that specific characteristic. For example, the INNOPATHS DPET has a "N/A" for one criterion under Flexibility of use (FU. 2) because it is not a scenario-building or simulation tool, and thus that criterion does not apply to it. In that case, the score of 60% for INNOPATHS DPET Flexibility of use refers to three criteria being successfully met out of five applicable criteria (rather than six because one was understood to be "N/A").

This approach of assigning "N/A" when not applicable and adjusting the calculation was introduced to avoid penalising some platforms for not providing functionality that was never intended to be provided (for example, modelling and simulation functionalities for tools that were not built for that). If more than half of the criteria for a characteristic group were assigned a "N/A" mark, the entire group received a "N/A" mark. This was the case, for example, with the PLACARD platform for Communication of Complex Information, which was implemented to reduce the risk of generating inconsistent scores due to a large number of "N/A" marks that would not be considered in the calculations.

Figure 4.5 provides an in-depth view of how each policy platform performs against each characteristic and the full evaluation of each policy platform, including comments supporting each score can be found in the 4TU.ResearchData Repository under DOI 10.4121/09b4c00a-3f69-4bff-aa6c-09aed6dbdb23.

	SENTINEL	COACCH	SOCLIMPACT	EUCalc	INNOPATHS (DPET)	CD-LINKS (Clim. Polic. DB)	ERA4CS (Senses)	PARIS REINFORCE) (I2AM PARIS)	PLACARD	EnerMaps
Transparency & Credibility of information	66.7%	83.3%	100.0%	100.0%	100.0%	80.0%	100.0%	83.3%	100.0%	100.0%
Ease of use	71.4%	85.7%	71.4%	85.7%	80.0%	80.0%	71.4%	100.0%	100.0%	71.4%
Flexibility of use	16.7%	83.3%	75.0%	83.3%	60.0%	100.0%	100.0%	80.0%	80.0%	83.3%
Accessibility & Portability	66.7%	50.0%	83.3%	66.7%	50.0%	66.7%	50.0%	50.0%	66.7%	33.3%
Education & Awareness	60.0%	80.0%	100.0%	100.0%	100.0%	80.0%	100.0%	100.0%	100.0%	60.0%
Communication of complex information	33.3%	66.7%	50.0%	100.0%	100.0%	100.0%	100.0%	100.0%	N/A	100.0%
Data visualisation & interactivity	0.0%	100.0%	66.7%	66.7%	50.0%	100.0%	66.7%	100.0%	100.0%	100.0%
Actively maintained and supported	33.3%	50.0%	33.3%	33.3%	33.3%	100.0%	33.3%	100.0%	33.3%	33.3%
Security & privacy	100.0%	66.7%	33.3%	33.3%	66.7%	100.0%	100.0%	66.7%	33.3%	66.7%

Figure 4.2. Overview of assessment of policy platforms and characteristics (heatmap view).

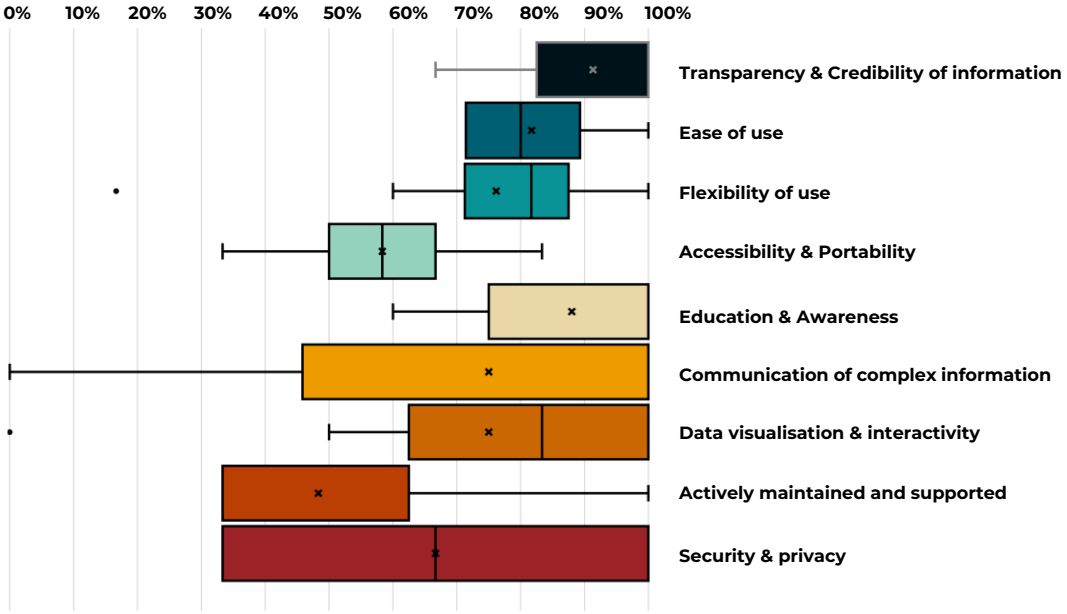


Figure 4.3. Overview of assessment of policy platforms and characteristics (boxplot view)

	Min	25%	50%	75%	Max	IQR [1]	Range [2]
Transparency & Credibility of information	66.7%	83.3%	100.0%	100.0%	100.0%	16.7%	33.3%
Ease of use	71.4%	71.4%	80.0%	85.7%	100.0%	14.3%	28.6%
Flexibility of use	16.7%	76.3%	81.7%	83.3%	100.0%	7.1%	83.3%
Accessibility & Portability	33.3%	50.0%	58.3%	66.7%	83.3%	16.7%	50.0%
Education & Awareness	60.0%	80.0%	100.0%	100.0%	100.0%	20.0%	40.0%
Communication of complex information	33.3%	66.7%	100.0%	100.0%	100.0%	33.3%	66.7%
Data visualisation & interactivity	0.0%	66.7%	83.3%	100.0%	100.0%	33.3%	100.0%
Actively maintained and supported	33.3%	33.3%	33.3%	45.8%	100.0%	12.5%	66.7%
Security & privacy	33.3%	41.7%	66.7%	91.7%	100.0%	50.0%	66.7%

Legend:

- Best score for that metric
- Intermediate score for that metric
- Worst score for that metric

[1] Interquartile range (IQR) is a measure of statistical dispersion and refers to the difference between Q3 (75%) and Q1 (25%),

[2] Range provides an indication of the statistical dispersion of a dataset and refers to the difference between the largest and smallest values.

Figure 4.4. Descriptive statistics of the different characteristics of policy platforms

4.4.1 Analysis of the assessment of H2020 CCMA policy platforms

Based on the minimum and range metrics, the *Transparency and Credibility of Information* characteristic ranked second in performance among the tested policy platforms. SOCLIMPACT, EUCalc, INNOPATHS (DPET), ERA4CS (Senses Toolkit), PLACARD, and EnerMaps all received perfect scores. The Sentinel platform received the lowest score (66.7%) , mostly due to an inaccessible GitHub page. Following the same metrics, *Ease of Use* emerged as the best performer. PARIS REINFORCE (I2AM PARIS) and PLACARD both received 100% for *ease of use*. Other platforms had issues with option visibility, tool use guidance, cluttered screens, and unclear visualisation explanations. Sentinel, SOCLIMPACT, Senses Toolkit, and EnerMaps received the lowest percentage (71.4%). Sentinel ranked last in terms of *Flexibility of Use* (16.7%), given that when the project's modelling tool was accessed, it was inaccessible, so many criteria could not be evaluated. Except for Sentinel, all platforms scored above 75% in terms of *flexibility of use*.

Accessibility & Portability had the lowest maximum score (83.3% for SOCLIMPACT), with nearly all platforms scoring 50% to 66%. This was primarily due to multiple platforms failing the Lighthouse accessibility tests and not being at least partially accessible in other languages. Only Sentinel and the Climate Policy Database passed all of the accessibility tests, and only SOCLIMPACT and PLACARD were partially available in other languages. *Education and awareness* received the third-lowest range metric score, indicating that platforms performed similarly in this area. Sentinel and EnerMaps received the lowest Education and awareness score (60%) because they did not recommend similar tools or projects, which was a common theme across platforms. The IQR and range metrics for *Communication of complex information* were among the highest, indicating that platform performance varied greatly. Sentinel received a score of 33.3% because its modelling tool was unavailable for this study. Because the PLACARD platform's simple legend, filters, and other features do not necessitate the careful handling of complex data, this characteristic did not apply to PLACARD.

Five platforms received perfect scores for *Data visualisation and interactivity*. Platforms that did not receive a perfect score in this category frequently did not provide users with interactive visual graphical elements that allowed them to zoom, apply filters, or otherwise interact with, as well as clear and concise legends on charts and other visual graphical elements. *Actively maintained and supported* had a low IQR, indicating that most platforms performed similarly; however, all with poor scores for this characteristic – with the lowest overall values appearing in Q1 (25%), Median (75%), and Q3 (75%). Only Climate Policy Database and I2AM Paris received the highest score in this category because they are still in operation, either independently or in collaboration with other projects, such as I2AM PARIS, which is linked to other H2020 and Horizon Europe projects. There was no evidence that the platform was still being used or that it had recently received any updates for the majority of the platforms. *Security and privacy* data demonstrates widely dispersed behaviour. The highest IQR of any characteristic was for *security and privacy*. Three platforms scored highest for this characteristic, three scored lowest, and three others scored in the middle, indicating balanced but widely distributed behaviour. On the plus side, nearly all platforms allowed users to fully interact with them without requiring accounts or personal information. However, many platforms failed the cookies test, and two platforms (EUCalc and PLACARD) failed the security and safety tests, indicating that the platforms may become obsolete and no longer be supported in the near future.

	SENTINEL	COACCH	SOCLIMPACT	EUCalc	INNOPATHS (DPFT)	CD-LINKS (Clim. Polic. DB)	ERA4CS (Senses)	PARIS REINFORCE) (I2AM PARIS)	PLACARD	EnerMaps
Transparency & Credibility of information	66.7%	83.3%	100.0%	100.0%	100.0%	80.0%	100.0%	83.3%	100.0%	100.0%
TC.1 Does the tool clearly specify its intended objective or purpose (e.g., using a statement of objectives, purpose or mission)?	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
TC.2 Does the tool clearly specify who its intended users are?	✓	✓	✓	✓	✓	✗	✓	✗	✓	✓
TC.3 Is the tool developed by or affiliated with credible sources (e.g., research organisations and researchers), and is this clearly stated on the tool?	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
TC.4 Does the tool clearly communicate the data source (quantitative data, models, policies etc) used for analyses or recommendations?	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
TC.5 Does the tool openly communicate limitations associated with its models/functionalities allowing users to understand what can and cannot be concluded from the tool?	✗	✗	✓	✓	✓	✓	✓	✓	N/A	✓
TC.6 Does the tool openly communicate uncertainty and assumptions that its models may have (e.g., value ranges, confidence intervals, probability distributions, etc.)?	✗	✓	N/A	✓	N/A	N/A	✓	✓	N/A	✓
Ease of use	71.4%	85.7%	71.4%	85.7%	80.0%	80.0%	71.4%	100.0%	100.0%	71.4%
EU.1 Does the tool clearly display available options so that users can easily understand what to do next to navigate it (e.g., are "back" and "next" types of buttons easily visible on the screens; are filters, range, or scroll buttons easily visible in the screens where users interact with visualisations, does the tool state in which menu/submenu the user is etc.)?	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓
EU.2 Does the tool have a section where the user can learn how to use it and what functionalities are available (e.g., a "start here" section, a web tour, an introduction, an about section etc.)?	✓	✓	✓	✓	✓	✗	✓	✓	✓	✗
EU.3 Does the tool produce outputs or provide brief, clear, or simple functionalities to understand and use (e.g., brief reports, takeaways, summaries, etc.)?	✓	✗	✓	✗	✓	✓	✓	✓	✓	✗
EU.4 Are the tool's screens free of excessive visual clutter, which can make it difficult for users to understand the information being presented (e.g., no multiple visualisations of different measures or scales on the same screen; various types of visualisations such as charts, tables, maps, and others on the same screen; screens that require excessive scrolling to understand or cover the analyses, etc.)?	✗	✓	✓	✓	✗	✓	✗	✓	✓	✓
EU.5 Does the tool provide clear explanations or visible help for users to understand visualisations/functionalities that may require prior knowledge (e.g., abbreviations, units of measure, axes, or similar)?	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓
EU.6 Does the tool provide visualisations (charts, tables, maps, pictures, etc.) that include all the information necessary to understand what that visualisation depicts (e.g., correctly labelled axes, legends visible, supporting text boxes, or other resources)?	✓	✓	✗	✓	N/A	N/A	✓	✓	N/A	✓
EU.7 Does the tool validate user input before running models, analyses, or producing any output (e.g., validate selections, numbers entered, units, thousands/millions separator, etc.)?	✗	✓	✓	✓	N/A	N/A	✓	✓	N/A	✓
Flexibility of use	16.7%	83.3%	75.0%	83.3%	60.0%	100.0%	100.0%	80.0%	80.0%	83.3%
FU.1 Does the tool allow users to use it for various needs or preferences (e.g., learn more about a particular topic, better understand a model, get recommendations, perform custom analyses, etc.)?	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
FU.2 Does the tool enable users to modify the models' underlying logic (e.g., modify ranges, probabilities, or threshold values, perform analyses for various time horizons, perform sensitivity or what-if analyses, etc.)?	✗	✓	✗	✗	N/A	N/A	✓	N/A	N/A	✓
FU.3 Is the tool capable of generating personalised or tailored outputs/recommendations based on user inputs (e.g., based on location, constraints, needs, or other characteristics provided by the user)?	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓
FU.4 Does the tool provide a high level of detail for spatial and/or temporal data (e.g., can the user select different levels of spatial regions (world, continents, countries, cities etc.) and/or other levels of temporal scales (decades, specific years, quarters etc) for analysis)?	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓
FU.5 Does the tool allow users to continue their work in the future or integrate the results obtained in other forms (e.g., allow users to save, share or export scenarios/analyses or results by providing clear instructions on how to connect to and use the tool, having GitHub or other repositories available)?	✗	✓	N/A	✓	✗	✓	✓	✓	✗	✓
FU.6 Does the tool allow users to access past analyses (e.g., access to saved history, imported files, imported scenarios, or similar)?	✗	✗	N/A	✓	✗	✓	✓	✗	✓	✗
Accessibility & Portability	66.7%	50.0%	83.3%	66.7%	50.0%	66.7%	50.0%	50.0%	66.7%	33.3%
AP.1 Does the tool provide intuitive and easy navigation when accessed via mobile phones or tablets (e.g., users can clearly see menus, options, and filters when accessing the tool via a mobile phone)?	✓	✗	✓	✓	✗	✗	✗	✗	✗	✗
AP.2 Does the tool offer free and open access to all of its functionalities?	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
AP.3 Is the tool at least partially natively accessible in languages other than English (e.g., by allowing the user to select the language without needing third-party web extensions)?	✗	✗	✓	✗	✗	✗	✗	✗	✓	✗
AP.4 Does the tool provide access to all its features only through a website (i.e., without the need to download software or other packages)?	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓
AP.5 Does the tool pass accessibility tests? [1] [1] Assessed by running Lighthouse accessibility scoring tests (should be good: 90-100)	✓	✗	✗	✗	✗	✓	✗	✗	✗	✗
AP.6 Does the tool pass availability tests? [2] [2] Assessed by evaluating availability from different locations (https://www.uptrends.com/tools/uptime)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗

Figure 4.5. Detailed view of the performance of the assessed policy platforms.

	SENTINEL	COACCH	SOCLIMPACT	EUCalc	INNOPATHS (DPET)	CD-LINKS (Clim. Polic. DB)	ERA4CS (Senses)	PARIS REINFORCE) (I2AM PARIS)	PLACARD	EneMaps
Education & Awareness	60.0%	80.0%	100.0%	100.0%	100.0%	80.0%	100.0%	100.0%	100.0%	60.0%
EA.1 Does the tool offer explanations or resources to help users understand the topic that the tool aims to address (e.g., energy transition, energy citizenship, decarbonisation pathways etc)?	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
EA.2 Does the tool provide additional resources to enhance learning or awareness of the topic(s) it addresses (e.g., video resources, courses, workshops, articles, interviews, talks or other events, training sessions etc)?	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓
EA.3 Does the tool provide recommendations of similar tools, platforms, websites or projects that the user can also benefit from?	✗	✓	✓	✓	✓	✓	✓	✓	✓	✗
EA.4 Does the tool offer examples of successful policies or best practices from other places that can help promote policy transfer and evidence-based policymaking (e.g., articles, press releases, interviews, videos, events, or other resources)?	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗
EA.5 Does the tool offer suggestions or potential choices without being normative about what is the "right thing to do"?	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓
Communication of complex information	33.3%	66.7%	50.0%	100.0%	100.0%	100.0%	100.0%	100.0%	N/A	100.0%
CI.1 Does the tool provide brief resources (e.g., key takeaways, summaries) to synthesise complex information in a more easily digestible format?	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CI.2 Does the tool provide resources for users to help them understand information or reduce complexity (e.g., tooltips in charts, explanations of units used, explanations of scenarios or similar resources)?	✗	✓	✗	✓	✓	✓	✓	✓	N/A	✓
CI.3 Does the tool provide resources to help users understand the results of analyses (e.g., ranges, intervals, concept descriptions, explanations of what can be concluded/not concluded, and so on)?	✗	✗	N/A	✓	N/A	N/A	✓	✓	N/A	✓
Data visualisation & interactivity	0.0%	100.0%	66.7%	66.7%	50.0%	100.0%	66.7%	100.0%	100.0%	100.0%
DV.1 Does the tool provide visual graphical elements (e.g., charts, tables, maps, infographics or others)?	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓
DV.2 Does the tool offer graphical visualisations (charts, maps, images) with easily distinguishable elements (e.g., colours, angles, brightness, gradients, opacity, etc.) without requiring users to reference legends or additional explanations constantly?	✗	✓	✓	✓	✗	✓	✗	✓	✓	✓
DV.3 Does the tool offer interactive visual graphical elements (e.g., charts, tables, maps, or others that users can select, zoom in on, apply filters or otherwise interact with)?	✗	✓	✗	✗	N/A	N/A	✓	✓	✓	✓
Actively maintained and supported	33.3%	50.0%	33.3%	33.3%	33.3%	100.0%	33.3%	100.0%	33.3%	33.3%
AM.1 Is there evidence that the tool is currently in use (e.g., recent posts, version updates, or social media activity)?	✓	✗	✗	✗	✗	✓	✗	✓	✗	✗
AM.2 Is there a menu or option for users to contact someone in case of a bug, question, suggestion or request for additional information?	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓
AM.3 Does the tool indicate that it has been recently updated (e.g., does it display recent data/information/policies/projects from the past three years as it becomes available)?	✗	N/A	✗	✗	✗	✓	✗	✓	✗	✗
Security & privacy	100.0%	66.7%	33.3%	33.3%	66.7%	100.0%	100.0%	66.7%	33.3%	66.7%
SP.1 Does the tool allow users to interact with it without having to create accounts, fill out forms or provide personal data?	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓
SP.2 Does the tool pass cookies and data transfer for GDPR compliance tests? [3] [3] Assessed using an online EU cookie law checker (https://2gdpr.com/)	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗
SP.3 Does the tool pass Website Safety & Security Checks? [4] [4] Assessed by using the comprehensive safety and security check by SSLTrust (https://www.ssltrust.com.au/ssl-tools/website-security-check)	✓	✓	✓	✗	✓	✓	✓	✓	✗	✓

Figure 4.5. Detailed view of the performance of the assessed policy platforms (cont.)

4.5 Conclusions of chapter 4

This chapter addressed the second subquestion of this thesis:

(SQ2) *What are the similarities and differences between existing CCMA policy platforms in the EU, considering the identified typical characteristics of policy platforms?*

The EU-funded Horizon 2020 programme was chosen as the source for the policy platforms assessed in this study. The programme was chosen for its relevance and duration, which included the signing of the Paris Agreement in 2015 and the adoption of the European Green Deal in 2019. A systematic investigation was conducted in the Community Research and Development

Information Service (CORDIS), the EU Commission's primary repository of projects funded by the EU's innovation and research initiatives, to identify relevant projects developing CCMA policy platforms within the H2020 programme. The official H2020 projects dataset (downloaded from the CORDIS website on March 26th, 2023) identified 34,398 projects across the program's priorities and other sections. The dataset was filtered in three stages: by relevant programmes and subprograms (3.3. Secure, clean, and efficient energy, 3.5. Climate action, environment, resource efficiency, raw materials, and not specified), project end date (before 2023), and three keyword sets. The keywords were divided into three categories: project purpose (e.g., "platform", "tool", and "decision support tool"), theme (e.g., "transition", "pathways", "adaptation", and "mitigation"), and target group (e.g., "policymakers", "decision makers", and "policymaking"). Twenty—six projects were identified for detailed evaluation; however, upon closer inspection of the project websites, many of the webpages were no longer accessible, or the projects were determined to be irrelevant to this research, resulting in the assessment of ten CCMA policy platforms using the proposed framework.

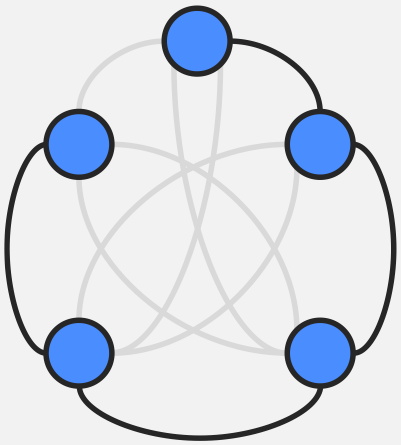
Some of the characteristics evaluated using the proposed framework revealed that the investigated policy platforms performed very well. Six of the ten evaluated platforms received 100% for *Transparency & Credibility of Information*, *Communication of Complex Information*, and *Education & Awareness*, with only Sentinel receiving less than 50% for *Communication of Complex Information*. *Data visualisation & interactivity* was another characteristic that received 100% from 50% of the platforms and less than 50% from one (Sentinel). Multiple criteria were deemed non-applicable due to the inaccessibility of the modelling tool when the Sentinel platform was evaluated in this study, so it did not perform well in many of the characteristics.

Despite overall positive aspects such as *Transparency & Credibility of Information*, *Communication of Complex Information*, *Education & Awareness*, and *Data Visualisation & Interactivity*, the evaluated platforms consistently underperformed in some areas. *Actively maintained and supported* is a key example, with only 20% (2 platforms) receiving 100% and the remaining 80% receiving no more than 50%. Only three (30%) of the ten platforms investigated showed signs of being used or updated (e.g., recent posts, version updates, social media activity, or others). For all other platforms (70%), all available news, activities, posts, and other content that would demonstrate platform use are at least one and a half years old. Only two platforms (20%) showed signs of having been recently updated with new data, projects, or policies (I2AM PARIS and Climate Policy Database). *Security and privacy* is another example of a characteristic in which policy platforms performed poorly, despite being better overall than *Actively maintained and supported*. Only three policy platforms (30%) received the maximum score of 100% for this characteristic, while the remaining seven platforms (70%) received up to 67% for *Security and privacy*. Compliance with GDPR regulations regarding cookies and data transfer was the criteria within security and privacy in which the assessed platforms performed the worst (70% failed), followed by website safety and security checks (20%).

Some platforms clearly outperformed others in terms of some of the evaluated characteristics. The **I2AM PARIS** platform was one of these cases, as it provided the most detailed documentation on the models used in the tool of any of the platforms examined. The **Senses Toolkit** also excelled at education and awareness, providing very user-friendly and engaging learning paths for users to follow in order to better understand the policy and financial aspects of decarbonisation and the energy system. By providing an interactive and engaging tool users can use to investigate climate change effects across many EU islands and archipelagos (including different economic and social impacts, as well as different sectors and industries studied), the **SOCLIMPACT** platform provided

excellent user-friendliness and communication of complex information. **EnerMaps** also excelled in flexibility of use, allowing users to access dozens of energy-related datasets and customise different input parameters at multiple levels of detail in order to run custom analyses. The **INNOPATHS DPET** had an excellent user interface, with a very unique "one-page" platform that provided users with access to several filters, scales, dropdown menus, and options, all on one screen. **EUCalc Transition Pathways Explorer** also demonstrated excellent ease of use and communication of complex information, allowing users to select from a variety of pathways, key-behaviour levers, and ambition levels while also providing detailed but appealing information to enhance users' understanding while exploring scenarios.

As far as the proposed framework can assess, the findings above highlight areas in which projects involved in the development of policy platforms consistently deliver on high standards (such as transparency, flexibility of use, education and awareness, and communication of complex information). However, the findings also highlight important warnings that future policy platforms should be aware of, as they can jeopardise policymakers' perceptions of the usefulness and added value of a support tool. The findings indicate that CCMA policy platforms should improve their handling of security and privacy issues, as well as their accessibility to users with various types of disabilities.



Chapter 5

Usefulness and preferred characteristics: the voice of policymakers and policy advisors about CCMA policy platforms

Main topics

1. Interview design
2. Survey design
3. Interview results
4. Survey results
5. Consolidated analysis of the MoSCoW's prioritisation of policy platforms characteristics
5. Conclusions of chapter 5

5. Usefulness and preferred characteristics: the voice of policymakers and policy advisors about CCMA policy platforms

SQ3 (*How do policymakers and policy advisors perceive the usefulness of CCMA policy platforms?*) and SQ4 (*What characteristics do policymakers and policy advisors look for in CCMA policy platforms to be used as support tools for policymaking?*) are addressed in this chapter. In the Netherlands, 11 interviews were conducted with policymakers and policy advisors to determine their perceptions of the usefulness of two examples of policy platforms evaluated in Chapter 4 (INNOPATHS Decarbonisation Policy Evaluation Tool and EUCalc Transition Pathways Explorer), as well as their preferences regarding the priority of different characteristics of policy platforms (derived from the proposed framework in Table 3.4). To broaden the range of insights gathered, a survey was developed and distributed to policymakers and policy advisors in countries other than the Netherlands, with nine responses being collected. This chapter first describes the interview and survey design, including participant selection, approaches to developing questions, and methods for analysing interview and survey data. The results of the interviews and surveys are then presented and discussed. The following chapter (Chapter 6) then discusses the findings from Chapters 3, 4, and 5 in order to answer all research questions and provide the research's conclusions, recommendations, and limitations.

5.1 Interview design

This section describes how the interviews in this thesis were designed, including the selection of participants, the design of interview questions, and the methods used to analyse the results. Table 5.1 provides an overview of the interview design, following the recommendations from Tong et al. (2007).

Table 5.1. Overview of interview design (based on recommendations from Tong et al. (2007))

No	Item	Description	Application to this study
Domain 1: Research team and ref ɛxivity			
Personal Characteristics			
1	Interviewer/facilitator	Which author/s conducted the interview or focus group?	The only author of this thesis.
2	Credentials	What were the researcher's credentials? E.g. PhD, MD	MSc student at TU Delft
3	Occupation	What was their occupation at the time of the study?	MSc student at TU Delft
4	Gender	Was the researcher male or female?	Male.
5	Experience and training	What experience or training did the researcher have?	4+ years of experience with Management and Technology consulting in which professional interviews were frequently part of job description. First time conducting interviews in a post-graduate academic context in this research.
Relationship with participants			
6	Relationship established	Was a relationship established prior to study commencement?	Potential interview candidates were contacted by e-mail or LinkedIn to assess their interest in participating in the study. One participant (out of eleven) was already known from a previous TU Delft course project.
7	Participant knowledge of the interviewer	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	When approached by the researcher, candidates were given only a brief summary of the thesis project, along with its research questions and objectives. If participants requested it, personal objectives, motivations for conducting the research, and other topics were discussed during the introduction portion of the interviews.
8	Interviewer characteristics	What characteristics were reported about the interviewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	During the initial approach, the researcher's overall interest in the research topic was presented to the candidates (e.g., investigate the gap between research and implementation in the field of climate change mitigation and adaptation; research how decision support tools can improve evidence-based policymaking).

Table 5.1. Overview of interview design (based on recommendations from Tong et al. (2007)) (cont.)

No	Item	Description	Application to this study
Domain 2: study design			
Theoretical framework			
9	Methodological orientation and Theory	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	Thematic analysis. The selection of this technique was based on the greater degree of flexibility it provides to the researcher, as it does not require the same level of theoretical commitments as alternative qualitative analysis techniques. Furthermore, as Braun and Clarke (2006) discussed, using thematic analysis to provide a rich description of the data set can be especially useful in studies where participants' opinions on a topic are unknown. This approach is well-suited to the current investigation, which seeks to examine policymakers' and policymakers' advisors' perceptions of policy platforms related to climate change mitigation and adaptation.
Participant selection			
10	Sampling	How were participants selected? e.g. purposive, convenience, consecutive, snowball	Purposive (policymakers and advisors of policymakers involved in the areas of climate change mitigation and adaptation in the Netherlands).
11	Method of approach	How were participants approached? e.g. face-to-face, telephone, mail, email	Participants were mostly contacted through LinkedIn messages. Participants were chosen based on their current positions and organisations. Some participants were suggested by my thesis committee, other researchers, or candidates who had previously been approached. In the case of suggested participants, they were contacted further via e-mail to assess their willingness to participate in the study.
12	Sample size	How many participants were in the study?	The study included 11 policymakers or policymakers' advisors. All interviews were conducted individually (11 interviews).
13	Non-participation	How many people refused to participate or dropped out? Reasons?	31 candidates were contacted. 11 candidates agreed to participate and were interviewed. Due to a lack of availability on May 23, two candidates declined to participate. 18 candidates did not respond to the initial contact.
Setting			
14	Setting of data collection	Where was the data collected? e.g. home, clinic, workplace	Data was collected via interviews conducted using Microsoft Teams.
15	Presence of non-participants	Was anyone else present besides the participants and researchers?	No, only the researcher and the participants. All interviews were conducted individually (e.g., with only one participant and the researcher present).
16	Description of sample	What are the important characteristics of the sample? e.g. demographic data, date	All participants live in the Netherlands and work on climate change mitigation and adaptation issues at the municipal, provincial, or national levels. Age, gender, ethnicity, and other demographic data on participants were not collected because they were not relevant to this study.
Data collection			
17	Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	Prior to the interviews, an interview guide was created, and feedback was gathered from my thesis committee and two additional EPA Programme professors. Two testing interviews were conducted with EPA colleagues to validate question comprehension and adherence to the expected length of the interview (1 hour). The interview questions were not given to the participants ahead of time, and the researcher asked all of them verbally during the interviews.
18	Repeat interviews	Were repeat interviews carried out? If yes, how many?	No repeated interviews were carried out.
19	Audio/visual recording	Did the research use audio or visual recording to collect the data?	All interviews were recorded, and the audio was transcribed automatically by Microsoft Teams. The transcriptions were then summarised by the researcher before moving on to the qualitative analysis of the interviews.
20	Field notes	Were field notes made during and/or after the interview or focus group?	No field notes were taken during or after the interviews. The transcripts, which were summarised and anonymised, were the researcher's source of information. The recoding of the interviews was rewatched if necessary to clarify potential points of confusion.
21	Duration	What was the duration of the interviews or focus group?	Interviews typically lasted 50 to 60 minutes, with one interview being shorter (41 minutes) due to the participant's time constraints.
22	Data saturation	Was data saturation discussed?	Data saturation refers to participants being recruited until no additional relevant knowledge is obtained from new participants. This was not the case in this study. Additional interviews would have been conducted if more time and people had been available in order to gain additional insights.
23	Transcripts returned	Were transcripts returned to participants for comment and/or correction?	Participants were informed in the interview consent form (which they had to fill out prior to the interviews) that they could request the anonymous summary of the interviews and provide feedback if they deemed it appropriate. Only one participant requested to receive the interview summary.

Table 5.1. Overview of interview design (based on recommendations from Tong et al. (2007)) (cont.)

No	Item	Description	Application to this study
Domain 3: analysis and f ndings			
Data analysis			
24	Number of data coders	How many data coders coded the data?	One, the author of this thesis project.
25	Description of the coding tree	Did authors provide a description of the coding tree?	The section on interview results presents the themes, subthemes, and codes used in this study.
26	Derivation of themes	Were themes identified in advance or derived from the data?	Both. Some themes were identified in advance (for example, perceptions about the EUCalc or DPET policy platforms, preferences regarding characteristics of policy platforms such as transparency, flexibility, and so on). While performing line-by-line coding, additional themes were discovered (e.g., useful tools mentioned by participants).
27	Software	What software, if applicable, was used to manage the data?	ATLAS.ti was used throughout the qualitative coding process and to generate themes. For the prioritisation and ranking questions, Microsoft Excel was used.
28	Participant checking	Did participants provide feedback on the findings?	No. The final thesis document will be distributed to all participants as they have expressed an interest in seeing the findings. Participants will be encouraged to provide feedback if desired, but the thesis will be completed at that point.
Reporting			
29	Quotations presented	Were participant quotations presented to illustrate the themes / findings? Was each quotation identified? e.g. participant number	See discussions in the interview results section.
30	Data and findings consistent	Was there consistency between the data presented and the findings?	See discussions in the interview results section.
31	Clarity of major themes	Were major themes clearly presented in the findings?	See discussions in the interview results section.
32	Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	See discussions in the interview results section.

5.1.1. Selection of participants

The interviewees were chosen using a purposeful sampling technique, in which one is interested in selecting information-rich cases for in-depth evaluation (Patton, 2014). In this approach, the researcher deliberately seeks individuals who will best assist in answering the research questions (Creswell & Creswell, 2018). Since this study focuses on how policymakers and advisors to policymakers perceive the usefulness of CCMA policy platforms and their preferences for the characteristics of such platforms, the target group for the interviews were policymakers or advisors to policymakers working on climate change-related issues such as energy transition, climate adaptation, and urban resilience. Due to the study being conducted in the Netherlands, participants working in the country were given preference for ease of arrangement. As a result, all 11 interviews were conducted with participants working on CCMA topics in the Netherlands.

Participants were contacted through LinkedIn and email to gauge their interest in participating in the study. Recommendations for potential participants were also obtained from my thesis committee, other researchers, and other interviewees. Fifty-five (55) potential interview candidates were identified, and 31 were approached for participation via LinkedIn messages or email. Twenty-four (24) people were not approached because the expected number of interviews had been reached or because their role descriptions did not align with the study's focus on climate change mitigation and adaptation policymaking. Out of 31 candidates approached, two declined due to scheduling conflicts during the month the interviews were scheduled to take place (May 2023), and 18 did not respond, leading to a final number of 11 candidates that accepted to be

interviewed for this research. After accepting the invitation, participants were emailed to provide more details about the study and to request their availability for scheduling interviews.

Policymakers and policy advisors from the municipal level (The Hague, Delft, Rotterdam, and Utrecht), provincial level (North Holland), and national level (Ministries and Governmental Agencies) were interviewed. Table 5.2 displays the interview numbers, interviewee roles, and reference IDs for each interview. When relevant quotes are presented in the following sections, the interview reference ID is used as a reference.

Table 5.2. Details of interviewees

Interview number	Participant role	Reference ID
1	Energy Transition Policymaker	ETP1
2	Energy Policy Officer	EPO1
3	Sustainability Advisor	SA1
4	Energy Transition Policymaker	ETP2
5	Climate Policy Advisor	CPA1
6	Energy Transition Policymaker	ETP3
7	Climate Policy Advisor	CPA2
8	Resilience Officer	RO1
9	Climate Adaptation Policy Officer	CAPO1
10	Climate Adaptation Policy Advisor	CAPA1
11	Resilience Officer	RO2

5.1.2 Interview setting

All interviews were conducted through online Teams meetings and were video and audio recorded, with automatic transcripts generated for each interview. All interviews were conducted individually (with only the researcher and one participant present) and lasted up to one hour (usually between 55 minutes and one hour). Candidates received an e-mail at least one week before each interview with the interview consent form and an explanation of how the interview would take place, the types of questions involved, and how and for how long the data would be stored at TU Delft. Each participant's formal consent was obtained prior to the start of each interview. The interviews conducted in this research were approved by the Human Research Ethics Committee (HREC) of TU Delft on March 24, 2023 (application ID 2897).

5.1.3 Interview questions design

The interviews were semi-structured, with an interview guide providing the overall structure, but the researcher was free to ask additional follow-up questions based on how insightful previous answers had been or ask questions not previously thought of based on the answers of the participants regarding their current role and challenges they faced. The interview was divided into four sections: introduction (2 questions), perception of the usefulness of climate-change mitigation and adaptation policy platforms (4 questions), preferences regarding characteristics of policy platforms (2 questions), and final questions (2 questions). Table 5.3 lists the interview questions used during the interviews.

Table 5.3. Overview of interview questions

Section	Question	Comments
Introduction	**1)** Tell me a little bit about your current role and how it is connected to climate change mitigation and adaptation challenges.	N/A
	2) How many years of experience do you have in this role?	N/A
Perception of the usefulness of climate-change mitigation and adaptation policy platforms	**3)** In your opinion, how well does a tool like the Transition Pathways Explorer (EUCalc) meet your needs?	Depending on the interview, a combination of questions 3 and 5 and 4 and 5 were asked as opposed to separate questions. Additional follow-up questions were asked whenever relevant.
	4) In your opinion, how well does a tool like the Decarbonisation Policy Evaluation Tool (DPET) meet your needs?	
	5) How would you evaluate the usefulness of policy platforms such as EUCalc and DPET in assisting you in delivering more effective advice or policies?	
	6) Before this interview, had you ever interacted with a climate-change-related Policy Platform, such as the ones you just interacted with or similar ones? ***(If yes)*** *Can you tell me more about the context in which you used such tool(s)?* ***(If no)*** *Do you see any particular reason why you haven't used any tool like that before?*	
Preferences regarding characteristics of policy platforms	**7)** If you were to choose an online tool such as the ones you interacted with or a similar one to support you in your work, what would be the most important factors/criteria in your choice?	Not asked in 2 interviews due to time restrictions.
	8) Please put the below characteristics into each priority group (Must have, Should have, Could have, Indifferent) and ranking (1,2,3 and so on) according to your preferences.	See Figure 5. for an illustrative example.
Final questions	**9)** Is there anything else related to climate change mitigation and adaptation or your current role that I haven't addressed and that you would like to talk about?	Depending on the interview, these questions were merged as one final interview questions due to time restrictions.
	10) Do you have any questions you would to ask or feedback you would like to provide me?	

The introduction section consisted of questions about the participants' current roles and how they related to climate change mitigation and adaptation challenges (from their perspectives), as well as how many years of experience each participant had in that role. The section on participants' perceptions of the usefulness of climate change mitigation and adaptation policy platforms (INNOPATHS DPET and EUCalc Transition Pathways Explorer) consisted of open exploration of two examples of two policy platforms (INNOPATHS DPET and EUCalc Transition Pathways Explorer), in which participants were encouraged to freely explore each platform for about 10 minutes each based on their preferences, curiosity, and perception of what appeared to be most appealing when considering the challenges they face. After exploring each tool, participants were asked how they perceived each tool's usefulness in assisting them in providing more effective advice or policies and if they had previously interacted with similar tools. The section addressing the participants' preferences for policy platform characteristics included an open-ended question asking what the participants thought were the most important characteristics, features, or capabilities that a support tool should have if they had to choose a tool to help them with their work. This question was left open-ended in order to avoid bias in the participant's responses, so they were free to mention what they thought was most important in a support tool without any guidance. The following question in that section asked participants to rank (1,2,3, etc.) different characteristics of policy platforms identified in this research (taken from Table 3.4) in different priority groups (Must-have, Should-have, Could-have, Indifferent). Finally, the final questions in the section were designed to allow participants to ask the researcher questions and provide feedback on the interview if they had any.

The interview sections “Perception of the usefulness of climate-change mitigation and adaptation policy platforms” and “Preferences regarding characteristics of policy platforms” had a central role in answering SQ3 and SQ4 and providing insights to answer the main request question of this thesis, so they are discussed in greater depth in the subsections below.

5.1.3.1 Assessment of the perception of the usefulness of climate-change mitigation and adaptation policy platforms

Selection of the EUCalc Transition Pathways Explorer

The EUCalc policy platform was chosen to be used as a tool for free exploration during the interviews in order to gather insights from participants about how useful they believe a platform like that could be in assisting them with the challenges they face at work, as well as their overall perception of the tool. EUCalc explicitly states that it is intended for policymakers and advisors of policymakers, and it includes a number of features that could be useful to this group of users, such as multiple videos explaining relevant aspects of the tool, policy briefs summarising key findings of the project in a policy-oriented language, a repository of events and media stories, and the EUCalc Transition Pathways Explorer itself, where users can explore emission scenarios using different policy levers and ambition levels. The EUCalc Transition Pathways Explorer also includes a number of pop-up windows, tooltips, and other information that were found to be useful for assessing users' perceptions while interacting with the tool. Supplementary Data on 4TU Research contains the full evaluation of the EUCalc tool based on the criteria listed in Table 3.4.

Selection of the INNOPATHS Decarbonisation Policy Evaluation Tool (DPET)

The Decarbonisation Policy Evaluation Tool (DPET) from the INNOPATHS project, similar to the EUCalc platform, explicitly states that it is intended to be a reference for policymakers (among other target users) regarding scientific evidence on decarbonisation policy. As a result, it was

interesting to investigate how policymakers and policymakers' advisors would perceive the usefulness of such a platform. The DPET was also chosen as a tool to be assessed via free exploration by the interviewees due to its very different ambition compared to the EUCalc tool. The DPET aims to systematically synthesise what is known (or unknown) about climate change mitigation policies and make it available to users for exploration through a variety of functionalities (policy type, jurisdiction level, sector, and evidence type, to name a few). The DPET also categorizes the evaluated literature into seven categories: "Environmental effectiveness," "Technological effectiveness," "Cost effectiveness," "Innovation incentives," "Competitiveness," "Distributional impacts," and "Other socio-political impacts." DPET was evaluated as providing a valuable contrasting experience to a more scenario-based tool (EUCalc) and, thus, relevant to ask policymakers and policy advisors to explore during the interviews, given users' high level of flexibility when selecting policy types and investigating the available literature. Supplementary Data on 4TU Research contains the full evaluation of the EUCalc tool based on the criteria listed in Table 3.4.

Methodology used in the exploration of the EUCalc and DPET platforms

Participants were asked to interact with the EUCalc and DPET platforms during the interviews. In each interview, the participant interacted with the EUCalc platform first, followed by the DPET platform. Each platform was used by the participants for about 10 minutes. However, in some cases, this time was either cut short (due to interview time constraints) or extended (depending on how insightful the conversation was at the time). The corresponding link for each policy platform was shared with the participants during the interview for the exploration of each policy platform. When asked if they would share their screens while interacting with each platform, all participants agreed to share their screens while interacting with the platforms. Each participant was informed that there was no specific goal for them to achieve while interacting with each policy platform and that they could explore each platform based on what seemed more interesting to them and the challenges they faced in their roles. The participants were only asked to be curious while exploring the many functionalities available in each platform and to think aloud while exploring each tool.

The thinking aloud protocol asks participants to verbalise their thoughts while performing an activity (Ericsson and Simon, 1993, as cited in Güss, 2018), and it has already been used in several disciplines such as education, software engineering, sport psychology, and business management (Güss, 2018). It is a protocol used to observe what users are thinking and can help identify areas of an application that users struggle with and why (Olmsted-Hawala et al., 2010). The think-aloud protocol allows the person conducting the test to see not only what actions users take but also why those actions are taken and how they feel about their interaction with the application of interest (Barnum, 2020). Participants were asked to freely share what they were trying to do or achieve with the tools during the think-aloud moments of the interview (one for EUCalc and one for DPET), and the researcher did not keep asking frequent questions to the participants unless participants remained silent for an extended period of time or appeared confused. In such cases, questions such as "what are you trying to do now?", "what do you think of this tool so far?", "are you looking for a particular thing now?", "is there anything that you particularly like or dislike so far?" and similar were asked to encourage participants to share additional information.

Prior to the interviews, the participants were not informed about the support tools with which they would interact, nor were they given any prior material about the EUCalc or DPET. This was chosen for a variety of reasons. First, even if the platforms were shared with the participants

ahead of time, there was no guarantee that they would have familiarised themselves with them in order to conduct more detailed or comprehensive investigations during the actual interview. Second, by sharing the policy platforms ahead of time, there was a risk that some participants would not find them useful or interesting for their work and would drop out of the interview, resulting in only participants who were truly interested in the tools participating in this study's interviews, potentially resulting in an unbalanced result. Finally, the platforms were not previously shared with the participants to reduce the risk that participants would focus too much on the details of each tool (e.g., why those are the models available in EUCalc, or why there are limited resulting papers for a given policy in the DPET platform) rather than thinking more broadly about how policy platforms such as those (but not necessarily exactly those two since there were many others found in this research, as discussed in Chapter 4) could be useful in their work and challenges and what they liked or didn't like about them.

Due to time constraints, participants were not directly encouraged to view videos explaining how to use each tool or additional resources available on each platform. Participants were encouraged to read the initial instructions in each tool before interacting with it. The initial instructions for EUCalc involved setting the initial input of the simulation (warming limit they would like to comply with - either 1.5 or 2 degrees Celsius - and the European share of the resulting global greenhouse gas budget - either Capability or Per Capita). The EUCal tool's initial instructions (see Fig 5.1 (3) for details) explain that users should choose whether everyone should be allowed to emit the same amount of greenhouse gases ("Per capita"), or if Europeans should have a lower limit due to their higher-than-average GDP ("Capability"). The initial instructions for DPET were a series of modal windows that explained the steps users should take to find the results they were looking for. Because of time constraints, participants interacted only with the "interactive platform" part of each policy platform, which meant that the main website of each platform (where users could see project deliverables, policy briefs, videos, media releases, and so on) was not shared with the participants, only the supporting websites where they could use the interactive platforms. During the interviews, participants were told that each policy platform (EUCalc and DPET) had more functionalities than the websites provided, and they were encouraged to explore the main websites of each platform after the interview if they were interested.

Figure 5.1 provides a mosaic view of some relevant menus and functionalities available in the EUCalc tool, including: **(1)** Policy briefs menu (from EUCalc main website), with key findings of the EUCalc H2020 project intended for policymakers; **(2)** Videos menu (from EUCalc main website), providing a list of useful resources for users to better understand concepts and the Transition Pathways Explorer tool; **(3)** Initial input (warming limit and European share of greenhouse gas budget) users had to provide before starting exploring scenarios in the Transition Pathways Explorer; **(4)** EUCalc Massive Open Online Course (MOOC) menu (from EUCalc main website), with reference to a TU Delft course in the edx platform; **(5)** Pathways description modal window from the Transition Pathways Explorer (opened if users selected the information button next to the pathways dropdown list); **(6)** Main screen of the Transition Pathways Explorer, showing different menus at the top (e.g., Emissions, Energy etc) and levers and ambition levels on the left (e.g., passenger distance, living space per person etc); and **(7)** example of lever modal window with additional explanations on the ambition levels for that lever (opened if users clicked on the name of the lever – in the case of this picture "mode of transport"). Participants did not interact during the interviews with items (1), (2) and (4) in Figure 5.1 for EUCalc because they are menus available on the main website of the EUCalc tool.

Figure 5.2 provides a mosaic view of some relevant menus and functionalities available in the DPET, including: **(1)** Main screen of the DPET (where users could select different policies, filters and explore the resulting papers using the table at the centre); **(2)** example of some of the many information tooltips available for users to better understand the different filters available; **(3)** example of a full screen detailed view of a paper (users can see what is the corresponding policy instrument, impacts on the different criteria available in DPET, methodology and other details of the paper, highlights of the paper and the reference to the paper at the bottom); **(4)** About section of the INNOPATHS DPET (accessed if users selected the "about" button at the top of the DPET screen); **(5)** Glossary section of the INNOPATHS DPET with additional explanations on each policy instrument and criteria (accessed if users selected the "glossary" button at the top of the DPET screen); **(6)** Policy briefs menu (from INNOPATHS main website), with key findings of the INNOPATHS H2020 project; and **(7)** News and blogs menu (from INNOPATHS main website), containing access to articles addressing relevant topics related to the INNOPATHS project. Participants did not interact during the interviews with items (6) and (7) in Figure 5.2 for DPET because they are menus available on the main website of the DPET.

Figure 5.1 and Figure 5.2 present miniaturised print screens of some of the menus available in each tool, but all pictures are in high definition, so they should be readable when zoomed in.

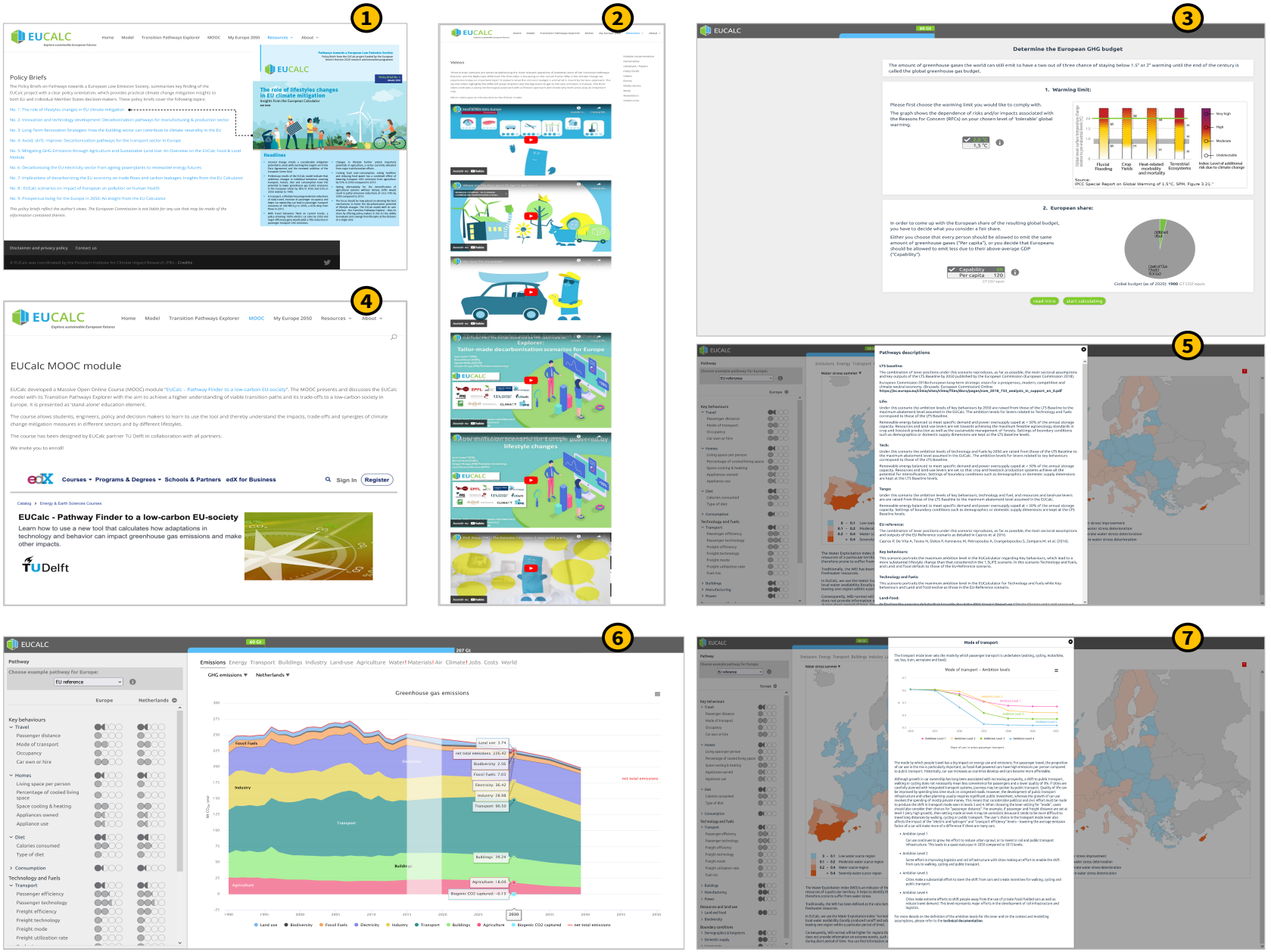


Figure 5.1. Overview of menus and functionalities available in the EUCalc policy platform. Items (1), (2), and (4) are screenshots from the main website of the platform (EUCalc project), while items (3), (5), (6) and (7) are screenshots from the interactive platform (EUCalc Transition Pathways Explorer)

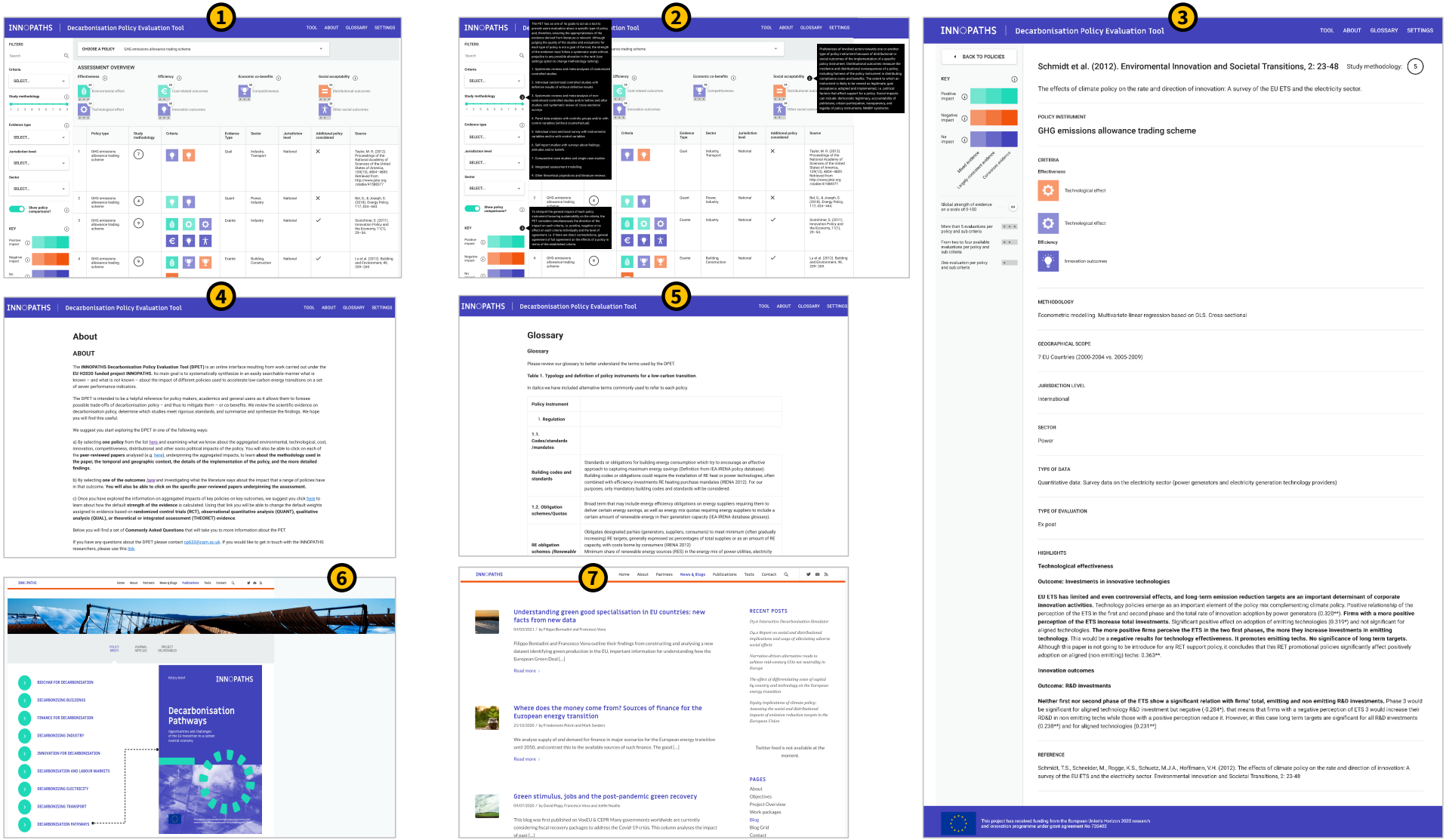


Figure 5.2. Overview of menus and functionalities available in the DPET policy platform. Items (6) and (7) are screenshots from the main website of the platform (INNOPATHS project), while items (1), (2), (3), (4) and (5) are screenshots from the interactive platform (INNOPATHS Decarbonisation Policy Evaluation Tool)

5.1.3.2 Assessment of the preferences regarding characteristics of policy platforms

During the interview, two questions were asked to assess the participants' preferences for policy platform characteristics. The first question (number 7 in Table 5.3) was designed to elicit open-ended insights into the most important factors in the participants' decision to use a support tool in their work. This was followed by a prioritisation and ranking question based on some of the policy platform characteristics listed in Table 3.4 (Chapter 3). Participants were asked in an open-ended fashion first to refrain from biasing their opinions with the characteristics they would be asked to prioritise and rank in the following question.

For the prioritisation and ranking of characteristics of policy platforms, a combination of two techniques typically used for the prioritisation of software requirements was used: the MoSCoW technique and the Rank ordering technique. In software development practices, different techniques have been proposed to help answer the general question of what should be done next and what is most important. As discussed by Wiegers and Hokanson (2023, The Prioritization Challenge section), although all software product requirements are "called requirements, some are more required than others". A thorough discussion on prioritisation techniques for software requirements is beyond this thesis project's scope, so a focus will be given to the two techniques used in this research.

The acronym MoSCoW stands for **M**ust-have, **S**hould-have, **C**ould-have, and **W**on't-have requirements. In this technique, requirements should be classified based on the intrinsic value of each requirement, which means that all requirements perceived as "must-have", for instance, can be prioritised in this manner (Miranda, 2022). However, due to typical time or financial constraints that can arise in software development projects, it is recommended that at most 60% of requirements be assigned as must-have, 20% as should-have, and 20% as could-have (Agile Business Consortium, 2014). For the proposed solution to be considered a success (Wiegers & Hokanson, 2023), must-have requirements must be satisfied, or, similarly, a viable solution cannot be delivered without those requirements (Agile Business Consortium, 2014). Should-have requirements, in turn, are important but not critical (Agile Business Consortium, 2014). It may be painful to not deliver them in the proposed solution, but it is still viable (i.e., not having them does not configure a failure). Should-have requirements are typically regarded as highly desirable functionalities, and they should be revisited if possible, given time, financial, and other constraints, in order to deliver a solution with greater value added. Could-have requirements are still desirable but not as important as should-have requirements. They are frequently referred to as 'nice to have' because their full delivery is contingent on a best-case scenario (Agile Business Consortium, 2014). Finally, will not have requirements are those that are considered to be outside the scope of that solution, at least for that time being (Wiegers & Hokanson, 2023).

Rank ordering techniques, on the other hand, refer to methods that arrange the requirements list in a numerical sequence that dictates the order of preference from least important to most important (Wiegers & Hokanson, 2023). Unlike the MoSCoW technique, as Wiegers and Hokanson (2023) pointed out, multiple requirements cannot be assigned the same rank (i.e., two or more requirements cannot be the first most important requirement concurrently).

One way to combine prioritisation techniques, as discussed by Wiegers and Hokanson (2023), is first to use the MoSCoW technique to prioritise requirements and identify the most relevant features of the solutions and then make use of a rank order technique to differentiate the items within each priority group. This study modified this proposed technique combination. Since this research does not aim to develop a new policy platform for which the participants interviewed would be the end users, the MoSCoW technique was modified to better address one of its goals,

which is to identify which characteristics policymakers and advisors of policymakers find most relevant in a policy platform to increase their willingness to use such platforms to support their work. Thus, the won't-have category was changed to an indifferent category, where participants do not really have a preference for an indifferent requirement. The following explanation of must-have, should-have, could-have, and indifferent characteristics was used to elicit participants' priorities and rankings during interviews.

- **Must-have:** refers to characteristics that, in your opinion, are mandatory for a policy platform to be useful to you and add value to your work.

- **Should-have**: refers to characteristics that, in your opinion, are much desired in a policy platform but are not mandatory for it to be useful to you and to add value to your work (e.g., you could wait for it to be released (maybe) in future versions of the tool).

- **Could-have**: refers to characteristics that, in your opinion, are 'nice to have', but their absence would not negatively impact your perception of usefulness and value added by a policy platform (e.g., the tool could never provide this functionality, and you would still use it and find it valuable).

- **Indifferent**: refers to characteristics that you don't have a particular preference or opinion about.

Based on the above explanation, participants were asked to rank a list of 14 policy platform characteristics (derived from the characteristics and criteria listed in Table 3.4) in terms of priority (Must-have, Should-have, Could-have, Indifferent) and preference ranking (1st, 2nd, 3rd, and so on). A characteristic assigned by a participant with the highest rank represents the most important characteristic in that group (Must-have, Should-have, Could-have) in that participant's opinion. A feature with a rank of second represents the second most important feature, and so on. Indifferent characteristics were not ranked because, by definition, participants are indifferent to them.

Table 5.4 shows the list of characteristics used in the interview prioritisation question, as well as the relevant references to the original criteria from the proposed framework in Table 3.4. The list of 14 characteristics shown in Table 5.4 was created by evaluating all nine characteristics of policy platforms as well as all of the criteria provided in the framework in Table 3.4 and following two guidelines. First, with the exception of security and privacy, the list of characteristics that interview participants would use for the prioritisation exercise should include at least one criterion from each of the nine characteristics. Security and privacy did not have any characteristics for participants to prioritise and rank because it was assumed that no participant would prioritise security, safety, or privacy characteristics other than as a must-have (resulting in less insightful results) or that they would find them too technical to assess. Second, the researcher evaluated the available criteria depicted in the framework in Table 3.4 in order to select characteristics that would be more meaningful and easy for participants to understand. For example, having three characteristics for participants to prioritise and rank (one for transparency, one for limitations, and one for uncertainty related to the tool) was deemed potentially too confusing, so they were combined into a single item. Similarly, the rest of the framework was evaluated to generate the list of characteristics shown in Table 5.4.

Table 5.4. List of characteristics participants were asked to assign a priority (Must-have, Should-have, Could-have, Indifferent) and a ranking (1st, 2nd, 3rd and so on)

ID	Characteristic	Reference (Table 3.4)
1	Transparency regarding data sources, limitations, uncertainty or assumptions associated with the tool *(e.g., tool provides menu or section in which these items are at least briefly explained)*	Transparency & Credibility of information (TC.4, TC.5, TC.6)
2	Communication of complex information in an easy-to-digest format *(e.g., tooltips explaining concepts or measures; infographics; policy briefs; key takeaways and similar)*	Communication of complex information (CI.1, CI.2); Ease of use (EU.3)
3	High level of detail for spatial and temporal data *(e.g., world, continents, countries, cities etc (spatial) and decades, years, quarters etc (temporal))*	Flexibility of use (FU.4)
4	Free and open access to all functionalities of the tool *(i.e., no subscription or 'price tag)*	Accessibility & Portability (AP.2)
5	Availability of detailed documentation on concepts and models used in the tool *(e.g., specific model documentation menu; link to a repository or GitHub page etc)*	Transparency & Credibility of information (TC.4)
6	Ability to modify parameters and run custom analyses based on user inputs *(e.g., scenarios, what-if, sensitivity analyses etc)*	Flexibility of use (FU.2, FU.3)
7	Availability of very recent ("last year") data *(e.g., estimations and calculations available as soon as they become published)*	Actively maintained and supported (AM.3)
8	Availability of training and learning functionalities *(e.g., video resources, Massive Open Online Course (MOOC) modules, workshops, training sessions etc)*	Education & Awareness (EA.2)
9	Interactive and easy to navigate visual graphical elements *(e.g., tool allow users to read/select data points, zoom in/out in visualisations, filter etc)*	Data visualisation & interactivity (DV.2, DV.3)
10	All functionalities available via a web-based platform *(i.e., users don't need to download software or other packages)*	Accessibility & Portability (AP.4)
11	User stories from policymakers, communities or organisations around the world *(e.g., interviews, videos, articles or other forms of sharing best practices ('not only scientific knowledge'))*	Education & Awareness (EA.4)
12	Ability to import user data, export results, or integrate the tool with other platforms *(e.g., import CSV or other files from users, export scenarios results, connect with the tool via APIs etc)*	Flexibility of use (FU.5, FU.6)
13	Availability of the tool in languages other than English *(e.g., the tool is at least partially available in other languages without the need of browser extensions or similar)*	Accessibility & Portability (AP.3)
14	Ability to use the tool efficiently and effectively via mobile phones or tablets *(e.g., tool provides intuitive and easy navigation when accessed via mobile phones or tablets)*	Accessibility & Portability (AP.1)

To operationalise the prioritisation and ranking process, participants were given a link to a one-question Qualtrics survey during each interview. As before, participants shared their screens while prioritising. Participants were asked to drag and drop the characteristics depicted in Table 5.4 to the priority group of their choice. After dragging a characteristic to a priority group, a ranking number for that specific characteristic within that specific priority group emerged. Before submitting their answers, participants were allowed to reorganise the characteristics within the priority groups as well as the ranking within each group as needed. Participants were asked to briefly discuss why they placed those characteristics in that group and with that ranking after classifying each characteristic into a priority group and a ranking number.

A completed and illustrative prioritisation exercise is depicted in Figure 5.3. Due to the inability to remove the ranking functionality only for that group without removing it for all the other groups, ranking numbers appeared in the prioritisation question in Qualtrics. As a result, eventual ranking numbers in the indifferent group were ignored in the analysis of the results. Furthermore, the additional explanations provided in brackets in Table 5.4 were presented as tooltips that appeared when the participant hovered the mouse over the "details" text for each characteristic.

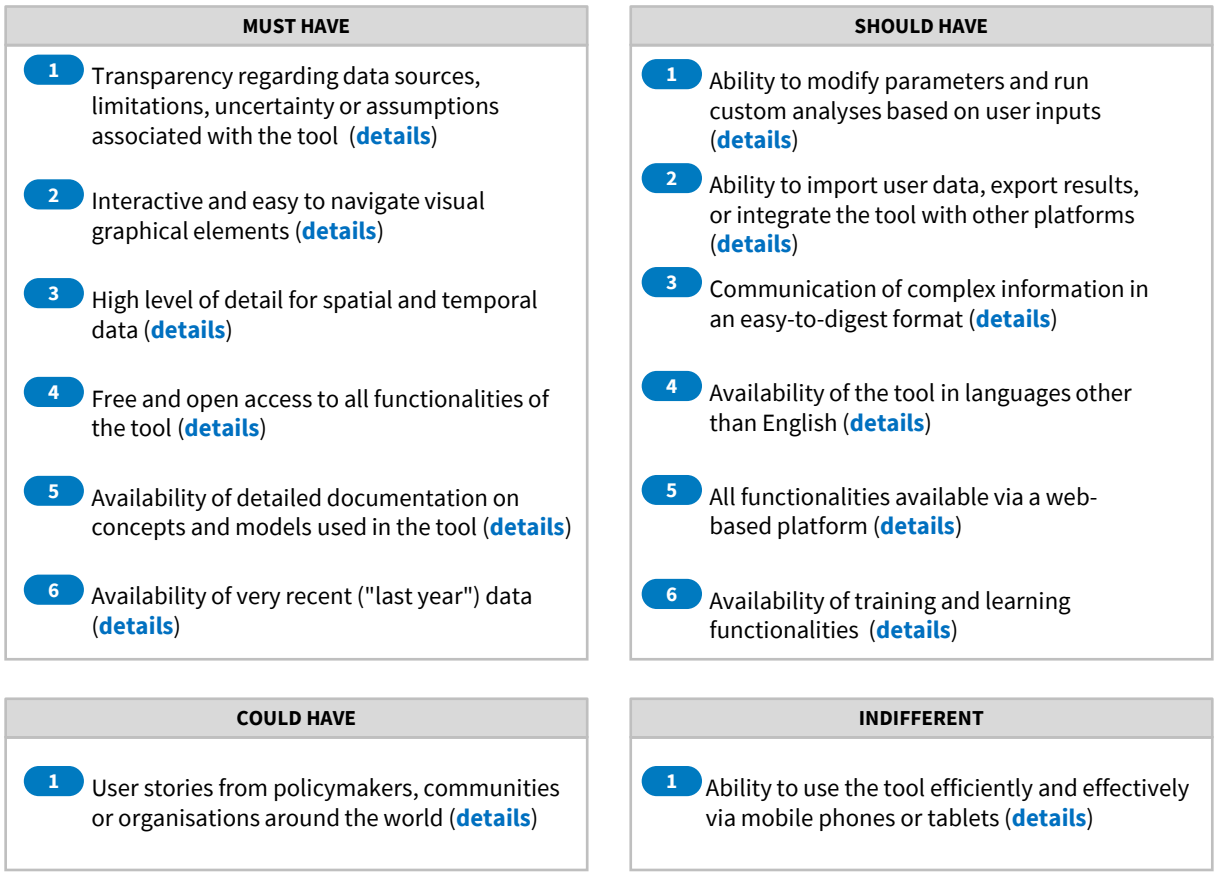


Figure 5.3. Illustrative example of a completed prioritisation question from the interviews

5.1.4 Methods used for the analysis of interviews

To systematically analyse the interview results, all interviews were subjected to a qualitative content analysis. The qualitative analysis of the interviews was aided by the use of the ATLAS.ti software, which facilitates the assignment of codes to interview excerpts as well as the management of the generated codes, allowing the available data, codes, and themes to be merged, grouped, and visualised in various forms. In qualitative research, a code is an aspect of data that

appeals to the researcher (Braun & Clarke, 2006). A code assigns prominent and relevant meaning to portions of data and is usually formed by one word or a reduced sentence (Saldaña, 2009).

Thematic analysis was used in this study to derive higher-order meaning from coded data. The choice for thematic analysis was based on two factors, as discussed in Braun and Clarke (2006). First, the authors state that when using thematic analysis, researchers are not constrained by specific theoretical commitments, as is the case with other qualitative analysis methods such as grounded theory, which allows for greater flexibility while still allowing for detailed data analysis. Second, and as a direct result of the first, because thematic analysis does not require the researcher to have detailed theoretical knowledge in order to use it, it can be a more accessible technique for performing qualitative analysis (Braun & Clarke, 2006). Thematic analysis is a technique that focuses on identifying and reporting patterns within the analysed data, which are referred to as the different themes (Braun & Clarke, 2006). Themes, according to DeSantis and Ugarriza (2000), are conceptual elements that give meaning to repeating occurrences. According to Braun and Clarke (2006), a theme should capture important data characteristics relevant to the research questions. The main themes of this thesis are **(i)** participants' perceptions of the usefulness of climate change mitigation and adaptation policy platforms when considering their role and the challenges they face and **(ii)** participants' preferences for the characteristics that policy platforms can have (as detailed in Table 5.4) in terms of priority and ranking. To better represent the findings of the interviews, the above main themes were subdivided into subthemes. Additional themes refer to what participants (openly) consider most important in a policy platform in order to (consider) using it for their work, as well as what they find most useful in similar tools they are already familiar with and may use.

Braun and Clarke's (2006) six phases guided the thematic analysis in this thesis. The researcher should first become acquainted with the data, which in this case were the 11 automatic transcripts of the interviews. All interview transcripts and video recordings were analysed in order to generate summaries (one for each interview) for the second phase (generating initial codes). The summarised version of each interview was kept as close to the original as possible, with the answers as mentioned by the participants, but was edited for grammar and to remove potentially identifiable data. In the second phase, all interview summaries were coded using line-by-line (open) coding, resulting in the creation of several codes. This initial coding phase aims to keep the data open to multiple directions (Charmaz, 2006, as cited in Saldaña, 2009). Braun and Clarke (2006, p.89) emphasise this by advising researchers to code for multiple potential themes according to available time because "you never know what might be interesting later." Braun and Clarke (2006) propose searching for themes as the third phase. During this stage, the researcher should begin investigating how different codes can be combined to form a theme. In this stage of the process, focus coding is typically used to identify the most frequent or important codes in order to develop salient categories in the data (Saldaña, 2009). Positive and negative codes related to the policy platforms evaluated in the interviews (EUCalc and DPET) were merged into positive and negative subcategories in this study. In phase four, themes were reviewed to ensure consistency between extracts and datasets. In phase five (defining and naming themes), theme names were iteratively refined to best reflect their extracts. Braun and Clarke (2006) conclude phase six (producing the report) by selecting compelling excerpts from each theme to tell the research's story. This stage is covered in depth in the section on interview results.

5.2 Survey design

The interview served as the foundation for the survey. The goal of using a survey was to reach out to a larger number of respondents than were already participating in the interviews, as well as to

gather insights from policymakers and policymakers' advisors outside of the Netherlands. The sections that follow describe how the survey was designed, how data was collected, and how the results were analysed. Appendix 3 contains the complete list of questions as they appeared in the survey.

5.2.1 Survey dissemination

The survey's target audience was the same as the interview's: policymakers and advisors to policymakers working on climate change mitigation or adaptation issues. Unlike the interviews, however, the survey respondents were not restricted to the Netherlands. The survey was then distributed via LinkedIn and the network of other researchers known to my thesis committee. These connections disseminated the survey link to policymakers they knew who were working on climate change mitigation and adaptation in the Mediterranean region, particularly Greece.

Table 5.5 presents the list of survey responses, the country in which the respondents work and the organisation level of the respondents. Survey ID references are used later in this chapter for quote references whenever applicable.

Table 5.5. Overview of survey responses

Survey ID	Respondent's country of employment.	Respondent's current position and sector
1	Spain	Other (International organisation)
2	United States of America	Other (Private sector)
3	Greece	Policy Advisor/Policy Officer (National Government)
4	Cyprus	Other (Regional Government)
5	Belgium	Other (Non-Governmental Organisation)
6	Greece	Policy Advisor/Policy Officer (National Government)
7	France	Policy Advisor/Policy Officer (International organisation)
8	Greece	Policy Advisor/Policy Officer (Private sector)
9	Mexico	Policy Advisor/Policy Officer (Private sector)

5.2.2 Survey setting

The survey was created with Qualtrics and made available for response collection on May 10th, 2023. On June 1st, 2023, a cut-off point was established, and all available responses up to that point were collected from Qualtrics for analysis. There were 17 responses, with nine (53%) completed entirely. Eight (47%) responses were incomplete, indicating that respondents dropped the survey shortly after agreeing to the consent question (first question). Only the nine fully completed surveys were considered for analysis and will be discussed in the survey results section.

On April 21, 2023, the TU Delft Human Research Ethics Committee (HREC) approved the survey process for this research (application ID 3055). Respondents were only allowed to continue with the survey if they answered 'yes' to the first question ("Please indicate if you agree to the terms of consent provided"). This was done to ensure that respondents had given their consent for the collection and analysis of the data they provided as answers in the survey. The Qualtrics 'Anonymize responses' feature was enabled in the survey. Since the survey was only available

through an anonymous link, no e-mail, location data, or IP addresses were collected from respondents.

5.2.3 Survey questions design

The majority of the survey questions were based on the interview questions shown in Table 5.3. However, some modifications were required because the responses were gathered through an anonymous survey rather than a conversational interview. The survey questions began with background information questions. Respondents were asked in the first two survey questions if they agreed to the terms of consent provided in the initial message and if they currently work as a policymaker or advisor to policymakers on climate-change-related issues. Respondents were not permitted to proceed with the remaining questions if they answered 'no' to either of the first two questions. Respondents could use the back button to return to the previous question if they accidentally selected 'no' in each of the first two questions. The remaining questions in the background information section asked respondents about their current position, their years of experience, and the sector and country in which they work.

The second part of the survey, like the interviews, was made up of questions about the usefulness of climate-change mitigation and adaptation policy platforms. Respondents were asked to interact with the same policy platforms that were used during the interviews (EUCalc Transition Pathways Explorer and INNOPATHS Decarbonisation Policy Evaluation Tool). Since respondents would not be able to ask questions to the researcher (as was the case in the interviews), respondents were asked to follow a simple exercise for each platform to provide some guidance on the available functionalities in each platform. Respondents were asked to investigate some key behaviours available (e.g., 'passenger distance' within the 'travel' lever) and the available information provided, as well as to increase the ambition level of some key behaviours (e.g., wind power) to see how that affected the available visualisations for the EUCalc platform. For the DPET platform, respondents were asked to select one of the available policies (e.g., 'GHG emissions allowance trading scheme') and explore different filters (e.g., jurisdiction level). Respondents were also asked to analyse one paper on DPET based on the options they chose. There was a chance that no paper would be found, depending on the filters used. This was communicated to the respondents, who were encouraged to consider alternative options if this was the case. By asking respondents to perform simple exercises in the policy platforms before asking their perceptions, respondents could provide more specific responses regarding how easy (or hard) it was to perform those tasks or what they thought of the usability of each platform. As addressed by Barnum (2020, p.19), “without a common set of scenarios, users will go their own way in an interface, which makes it difficult to see patterns of usage and recurrence of problems among and between users”. Since the respondents could work in many different areas within climate change mitigation and adaptation, the requested tasks were not too limiting as to encourage respondents to select menus and options they found interesting to investigate (as was also done during the interviews). Before proceeding with the survey, respondents were asked to spend at least two minutes interacting with each policy platform. They were also encouraged to interact for as long as they wanted, but two minutes was set as the minimum time before the next questions in Qualtrics became available. After interacting with the two platforms, respondents were asked in separate open-ended questions how they perceived the usability of each platform. Respondents were also asked if they had previously used similar tools before that interview. If they said 'yes', they were asked in what contexts they had used those tools and if they could provide any additional information, such as their names. If they answered 'no,' they were asked if they saw any particular reason for this, given that many of the H2020 policy platforms were aimed at policymakers. The section's

final question asked respondents to rate the usefulness of policy platforms like EUCalc and DPET in assisting them to deliver more effective advice or policies (on a scale of not at all useful to extremely useful).

The third section of questions was essentially the same as the interview questions and asked respondents about their preferences for policy platform characteristics. In an open-ended question, respondents were asked what aspects (in terms of a tool's functionalities or capabilities) they would prioritise if they were to use a decision-support tool to help them with their work. This was followed by a prioritisation and ranking exercise identical to the one used in the interviews (see Table 5.4 and Figure 5.3). In an open-ended question, respondents were asked to elaborate on the reasons for their preferences (MoSCoW) and ranking after the prioritisation and ranking question. The survey concluded with a final open-ended question in which respondents could provide the researcher with any feedback they deemed appropriate. The list of survey questions is presented in Table 5.6.

Table 5.6. Overview of survey questions. Some questions have had their text reduced for presentation reasons.

Question (answer options)	Mandatory
1) Please indicate if you agree to the terms of consent provided. *(Yes | No)* *If answered no, respondents were presented with an explanation that they were required to agree to the terms of consent in order to proceed with the survey. Respondents were able to go back to previous question if they wanted to change answer.*	Yes
2) Do you currently work as a policymaker or advisor of policymakers on climate-change mitigation and adaptation-related areas? *(Yes | No)* *If answered no, respondents were presented with an explanation that they were not part of the target group of that survey. Respondents were able to go back to previous question if they wanted to change answer.*	Yes
3) What is your current position? *(Policy Advisor/Policy Officer | Politician | Researcher | Other)*	Yes
4) How many years of experience do you have in your current position? *(Less than one year | 1 - 2 years | 3 - 5 years | 6 - 9 years | 10 or more years)*	Yes
5) Which sector do you work in? *(National Government | Regional Government | Local Government | University or Research Institution | Non-Governmental Organisation | Private Sector | International organisation)*	Yes
6) From which country is the organisation you work for? *(dropdown list)*	Yes
7) Task-based exercise for EUCalc policy platform *Participants were instructed to complete a simple exercise in order to investigate the menus and features of EUCalc. A timer counted down from 2 minutes until respondents could continue the survey.*	Yes
8) what are your opinions about the usability of the EUCalc tool? *(open-ended question)*	No
9) Task-based exercise for DPET policy platform *Participants were instructed to complete a simple exercise in order to investigate the menus and features of DPET. A timer counted down from 2 minutes until respondents could continue the survey.*	Yes

Table 5.6. Survey questions (cont.) Some questions have had their text reduced for presentation reasons.

Question (answer options)	Mandatory
10) what are your opinions about the usability of the DPET tool? *(open-ended question)*	No
11) Before completing this survey, had you ever interacted with a climate-change-related Policy Platform, such as the ones mentioned above or others? *(Yes | No)* *If answered 'yes', respondents were asked a non-mandatory open-ended question: "Can you elaborate more about the context in which you used such tool(s) (e.g., name of tool(s), reason for using etc)?"* *If answered 'no', respondents were asked a non-mandatory open-ended question: "Many of these Policy Platforms are developed with policymakers in mind as one of the intended users. Do you see any particular reason why you haven't used any tool like that before?"*	Yes
12) Having interacted with both the EUCalc and the Decarbonisation Policy Evaluation Tool (DPET), how would you evaluate the usefulness of policy platforms such as these in assisting you in delivering more effective advice or policies? *(Extremely useful | Very useful | Indifferent | Barely useful | Not at all useful)*	Yes
13) Can you elaborate on the reasons behind your previous answer? *(open-ended question)*	Yes
14) If you were to choose an online tool such as the ones provided as examples or a similar one to support you in your work, what aspects (in terms of characteristics, functionalities or capabilities of the tool) would be the most important in your decision to use a given tool? *(open-ended question)*	Yes
15) Prioritisation and ranking of characteristics of policy platforms *(drag-and-drop question in which respondents could designate the MoSCoW priority and rank to each characteristic)*	Yes
16) Can you elaborate on the reasons behind your choices above? *(open-ended question)*	No
17) Final question intended to collect optional feedback *(open-ended question)*	No

5.2.4 Methods used for the analysis of survey responses

For the survey response analysis, each of the nine responses had their answers entered question by question into an Excel spreadsheet to be analysed. No qualitative coding was done on the open-ended questions because the majority of responses were short, and there was no need to code the answers. Relevant survey extracts were collected and are presented in the section devoted to survey results. Because the same exact question was used in both cases, the prioritisation and ranking of characteristics of policy platforms question was analysed the same way for surveys and interviews.

5.3 Interview results

This section presents the interview results following the thematic structure presented in Table 5.7. Supplementary data related to the interviews can be found in the 4TU.ResearchData Repository under DOI 10.4121/15b0ab98-0cd6-4325-a9df-e639316c66bd.

Table 5.7. Thematic framework

Theme/Subtheme/Code	How many times it was mentioned (across all interviews)	How many participants mentioned it
◿ **Participants' perceptions on the EUCalc Transition Pathways Explorer**		
◿ **Positive perceptions**	19	7
Allows you to test scenarios, policies and ambitions and see how that af ects the system	6	5
Clear user interface and visualisation capabilities	5	4
Provides detailed pathways and levers for exploration	8	2
◿ **Negative perceptions**	96	11
Does not allow simulation of the ef ects of custom policies on the system	4	3
Does not enhance comprehension of how to realise desired futures	17	7
Excessive detail and complex information with a high cognitive load	14	4
Insuf cient contextualisation of purpose, concepts and functionalities available	35	7
Not connected to policymaking level in which the system can be influenced	21	8
Outdated information	3	2
Poor language choice when communicating climate change-related information.	2	1
◿ **Mixed perceptions**	21	9
Could be useful in dif erent contexts or policymaking levels	15	6
Assumptions need to be clear and understood in order to be useful	2	1
Could potentially be useful for references or comparisons	4	3
◿ **Participants' perceptions on the Decarbonisation Policy Evaluation Tool (DPET)**		
◿ **Positive perceptions**	25	7
Allows access to detailed literature references on various policies	9	5
Allows you to be more specific about the policies you wish to investigate or quantify	4	2
Allows you to benchmark and draw inspirations from policies that have been tested in other locations	10	5
Clearly conveys its purpose and is simple to use	2	1
◿ **Negative perceptions**	21	8
Excessive detail and scientific information with a high cognitive load	5	4
Not connected to the challenges faced in policymaking context	10	5
Not intuitive and easy to use	6	3
◿ **Mixed perceptions**	21	8
Could be useful in dif erent contexts or policymaking levels	4	3
Unsure about the usefulness of scientific papers for policymaking challenges	5	3
Unsure about the usefulness of the explored papers within your policymaking context	12	5
◿ **Comparisons between EUCalc and DPET**		
◿ **Both platforms perceived with a positively**	4	3
Both DPET and EUCalc provide a good user experience	2	1
DPET and EUCalc complement each other well	2	2
◿ **Both platforms perceived negatively**	2	1
Both DPET and EUCalc are too theoretical and disconnected from real-world challenges of policymakers	2	1
◿ **Preferences for EUCalc**	1	1
EUCalc provides scenario-building capabilities	1	1
◿ **Preferences for DPET**	5	3
DPET provides a better user experience	2	1
DPET provides more useful and tangible information	3	3
◿ **Useful functionalities identified in similar tools mentioned by participants**		
◿ **Ability to export data**	1	1
AR 6 Scenario Database	1	1
◿ **Ability to see climate change-related data and scenarios in useful granularity level**	18	8
Climate Adaptation Signal Map	1	1
Climate Damage Estimator	2	1
Climate Impact Atlas	2	1
Data Supply Energy Transition Built Environment (DEGO)	1	1
Digital Twin	3	1
Regional Climate Monitor	5	1
Tailored-made tools	4	3
◿ **Access to relevant climate policies**	2	1
Climate Policy Database	2	1
◿ **Provision of relevant information for dif erent countries**	2	2
Climate Action Tracker	1	1
Climate Pledge NDC tool	1	1
◿ **Most important factors participants look for in a policy platform**		
Ability to customise visualisations	1	1
Being able to perform various analyses and monitor your situation	3	2
Being developed in collaboration with policymakers and other stakeholders	4	1
Help to address challenges and function as a means of communication with stakeholders.	2	2
Provide a collection of tested policies to serve as a benchmark and source of inspiration	5	2
Provide functionalities and information at the appropriate level of granularity	3	2
Provide trustworthy and transparent information	4	3
Should fit your policymaking language	2	1
User friendly	4	3
Visually appealing	4	3

Table 5.7. Thematic framework (cont.)

Theme/Subtheme/Code	How many times it was mentioned (across all interviews)	How many participants mentioned it
◿ **Prioritisation of characteristics of policy platforms**		
◿ **Ability to import user data, export results, or integrate the tool with other platforms**	11	10
Must-have	1	1
Should-have	3	2
Could-have	5	5
Indif ɛrent	2	2
◿ **Ability to modify parameters and run custom analyses based on user inputs**	11	9
Must-have	2	2
Should-have	5	4
Could-have	4	3
Indif ɛrent	N/A	N/A
◿ **Ability to use the tool ef ficiently and ef ɛctively via mobile phones or tablets**	10	10
Must-have	N/A	N/A
Should-have	N/A	N/A
Could-have	3	3
Indif ɛrent	7	7
◿ **All functionalities available via a web-based platform**	11	10
Must-have	3	3
Should-have	6	5
Could-have	1	1
Indif ɛrent	1	1
◿ **Availability of detailed documentation on concepts and models used in the tool**	13	9
Must-have	2	1
Should-have	6	5
Could-have	4	2
Indif ɛrent	1	1
◿ **Availability of the tool in languages other than English**	8	7
Must-have	1	1
Should-have	N/A	N/A
Could-have	6	5
Indif ɛrent	1	1
◿ **Availability of training and learning functionalities**	13	10
Must-have	N/A	N/A
Should-have	7	5
Could-have	4	3
Indif ɛrent	2	2
◿ **Availability of very recent ("last year") data**	13	11
Must-have	2	2
Should-have	6	5
Could-have	5	4
Indif ɛrent	N/A	N/A
◿ **Communication of complex information in an easy-to-digest format**	12	9
Must-have	8	6
Should-have	3	2
Could-have	1	1
Indif ɛrent	N/A	N/A
◿ **Free and open access to all functionalities of the tool**	10	8
Must-have	2	2
Should-have	5	3
Could-have	1	1
Indif ɛrent	2	2
◿ **High level of detail for spatial and temporal data**	12	9
Must-have	7	5
Should-have	5	4
Could-have	N/A	N/A
Indif ɛrent	N/A	N/A
◿ **Interactive and easy to navigate visual graphical elements**	10	9
Must-have	6	5
Should-have	4	4
Could-have	N/A	N/A
Indif ɛrent	N/A	N/A
◿ **Transparency regarding data sources, limitations, uncertainty or assumptions associated with the tool**	16	11
Must-have	16	11
Should-have	N/A	N/A
Could-have	N/A	N/A
Indif ɛrent	N/A	N/A
◿ **User stories from policymakers, communities or organisations around the world**	21	11
Must-have	N/A	N/A
Should-have	1	1
Could-have	18	9
Indif ɛrent	2	1

5.3.1 Background information of working experience and challenges faced by participants

Participants interviewed were policymakers or advisors to policymakers working on climate change mitigation or adaptation issues in the Netherlands at the municipal, provincial, or national levels. Background information on the current role, years of experience, and challenges faced by participants were coded during the process described in section 5.1.4 Methods used for the analysis of interviews) in order to generate a better understanding of the available dataset and as part of the line-by-line coding approach. To reduce the risk of re-identification of participants, quotes about background information in this section will be used without directly referring to the source.

Energy transition participants develop and implement sustainable energy projects, including district heating and cooling solutions, to make buildings gas-free. By advising and streamlining, they incentivise the reduction of energy consumption. Others work on energy transition from a broader sustainability perspective, including biodiversity and sustainable waste management. Some investigate how people, processes, and organisations affect critical infrastructures from an adaptation and resilience perspective, preparing for climate crises and advising political actors on climate adaptation and resilience policies. Collaboration with organisations to improve their climate change resilience and future-proofing the built environment were also mentioned. Other participants monitor international climate policies and decarbonisation commitments to describe better and assess the global energy and climate system. Participants had between one and five years of experience in their current role, with some having more experience in related fields like water management or performing the same role but in other European countries, bringing the total working experience to around ten years in climate-change mitigation and adaptation. However, the number of years in their current role was not seen to have a clear impact on the results, so it is only reported as contextual information.

When asked about their challenges, some examples mentioned by participants include making policy advisors' jobs more data-driven and having to make difficult trade-offs because energy transition is not their organisations' only priority. As one participant noted, there are many dependencies on higher levels, such as the national or EU level, making it difficult to achieve goals like climate neutrality.

> The biggest hurdle coming from a local government is that we are held responsible for achieving this goal [of climate neutrality], but I think maybe somewhere between 10% and 20% of the transition is what we can actually influence. (Energy transition policymaker)

Additionally, the way decisions and policies are implemented on a local level was mentioned as being sometimes widely different between municipalities, with some being much stricter on building and construction regulations ('if companies want to build in our city, then they have to live up to the rules we describe'), while others being much more flexible to attract investments and constructions ('if we want companies to build in our city, then we have to make it as easy as possible'). Another significant challenge, as mentioned by one of the policymakers, is the perceived inherent complexity of working with climate-change-related data and concepts in order to make them more actionable for various organisations and businesses, to which regular climate information may not mean much in practical terms for their operations.

> It is a challenge to identify what kind of information companies need to assess their risk and take action. These general climate change scenarios, even though they are more specific at the moment, are still rather broad and are not always the information organisations actually need. (Adaptation policymaker)

5.3.2 Participants' perceptions of the EUCalc Transition Pathways Explorer

This section explores the perspectives of the participants on the EUCalc platform. Participants shared their impressions of the EUCalc platform in terms of usability-related aspects and how useful they thought a support tool like this would be in assisting them in providing more effective advice or policies. The perceptions of the participants were gathered while they interacted with the platform for approximately 10 minutes and are related to interview questions 3 and 5 from Table 5.3. The perceptions are discussed in accordance with the structure outlined in the thematic framework shown in Table 5.7.

5.3.2.1 Positive perceptions

Regarding positive perceptions of the EUCalc Transition Pathways Explorer (19 instances, 7 participants), the interviews revealed that the provision of **detailed pathways and levers for exploration** was the positive aspect most mentioned in the interviews (8 instances, 2 participants). The large number of pathways (16 options), levers (13 options), and sub-levers (over 50 sub-levers that users can explore with varying levels of ambition) were deemed highly beneficial, with participants appreciating the fact that 'you can have different pathways to look at' (CPA1) and that EUCalc 'has a lot of preset pathways that you can explore, and it allows you to do your own analysis' (CPA2). The way EUCalc presented the information as modal windows that participants could open and close for more detailed information without leaving the main screen was also mentioned as a positive aspect. Figure 5.1 (5), (6), and (7) illustrates some of the references made by participants.

> This is great [referring to the "pathways description" window]. You have a list of scenarios here, and you can get the basic information about the scenarios right next to it. Not many models, reports or online tools have this readily available. (CPA2)

> Even if you work with energy modelling, you do not necessarily know a lot about all models. This [EUCalc], for example, gives a lot of help to someone who's just looking at it for the first time or who doesn't know much about how these models work. (CPA2)

The ability for users to **test scenarios, policies, and ambitions and see how that affects the system** was also mentioned as a highlight of the EUCalc platform (6 instances, 5 participants). Depending on how they explored the tool, participants were occasionally asked how they evaluated the information provided in the platform while interacting with it (in terms of being practical or theoretical). One participant stated that a 'tool like this [EUCalc] would not be too theoretical, and it would actually be interesting to make certain analyses' (SA1). Other positive feedback includes the ability to use the EUCalc tool to facilitate more meaningful discussions and potentially improve policymakers' actions, as well as quickly test hypotheses or potential scenarios.

> if I am someone that needs to convince decision-makers, then I would use the past trends [pathway] to show as example that if we continue what we are doing, this will happen [referring to a flat kind of behaviour in which no significant reduction in emissions is observed]. And then I would start making choices to show them what they can do regarding building and homes, insulation, energy or adding more green. (ETP2)

> This tool is very nice if you want to do a quick check, like what if the diet only changes in terms of calories? So you could check what that would mean for Europe's emissions by just changing the calories consumed by people. (CPA2)

During the interviews, the **clear user interface and visualisation capabilities** of the EUCalc was also emphasised (5 instances, 4 participants). This was not always the case for every menu or functionality available in the tool. Participants generally stated that the tool initially has a lot of information and that 'you need some time to figure out how it works, and then it looks easy to use'

(EPO1). The tool's clear and well-communicated visualisations were viewed positively by some participants, mentioning that 'What I like about it is that it's very clean, so you [can] easily have an overview' (CPA1). The initial warming limit chart was also mentioned positively by a participant (see Figure 5.1 (3)).

> Here [Global mean surface temperature change chart], you can definitely tell that with 1.5 degrees, we are more in a moderate range [of additional risk due to climate change], and if we go to 2 degrees, we'll have more fluvial flooding and also get into the red [risk level] on the terrestrial ecosystems. So I think this graph clearly shows that 1.5 degrees of warming is much less devastating than 2 degrees. (SA1)

5.3.2.2 Negative perceptions

The interviews revealed that participants mentioned negative perceptions of the EUCalc platform far more frequently than positive perceptions (96 instances, 11 participants). It is interesting to note that even participants who had positive perceptions of the EUCalc tool also had negative perceptions, even if they were specific to certain menus or functionalities or how the tool communicated specific messages. One such instance was the description of the "European share" of the available greenhouse gas budget (see Figure 5.1 (3) for details), in which one participant pointed out that the way the text was written was not conveying the information in the best way possible, and that in such a polarised field as climate change, it is critical not to leave room for misinterpretation.

> I believe this phrase is not right here. It is not phrased correctly because here it says that "Europeans should be allowed to emit less due to their above-average GDP". It shouldn't say "allowed to emit less"; it should say "not be allowed to emit more" because of their above-average GDP. As it is now, this seems to me that it has a more positive connotation, but if we want to connect it to equity principles, it should be that Europeans, Americans and all other high-income countries should not be allowed to emit more because of their above-average GDP. (CPA2)

The most frequently mentioned negative perceptions of the EUCalc tool by participants were related to **insufficient contextualisation of purpose, concepts, and functionalities available** (35 instances, 7 participants). In several situations, participants were unsure what the available levers or ambitions meant and how they could use that information, stating that 'it does not really tell me what is exactly happening, how often, and what the impact is' (EPO1) and that the names provided for the pathways do not 'sound like a pathway, it sounds like certain topics, for example, homes and buildings, past trends, middle of the road' (CAPO1). Participants thought the way information was communicated in the EUCalc tool was not clear enough and that it would be helpful if the tool provided comparisons on more practical terms such as 'Ok, normally you have maybe twice a year heat events, and this would increase the likelihood by five times, then you'll have a clearer picture' (EPO1). Furthermore, many participants did not perceive the provision of modal windows that expanded with additional explanations as sufficient contextualisation, at least while briefly interacting with the tool during the interviews.

> It was not clear to me that the section on the left *[referring to key behaviours]* is where you set your ambitions because it doesn't say "ambitions" anywhere. (SA1)

> I would expect there to be information such as "You can design your own mix, what do you find more important?". (CAPO1)

> This cooled living space *[key behaviour lever]*, what does that mean? Cooling in what way? Air conditioning or just curtains on windows? So, I'm not sure how I would use this [tool]. (CAPA1)

Additional relevant themes mentioned by participants were that they felt the EUCalc tool **did not enhance comprehension of how to realise desired futures** (17 instances, 7 participants) and that it is **not connected to the policymaking level in which the system can be influenced** (21 instances, 8 participants). This was primarily due to the disparity between the levers and ambition

levels available for exploration in the EUCalc tool and the local level decisions over which those policymakers actually have influence or policies they can implement.

> I think this *[EUCalc]* is interesting for us because it shows you the levers you can pull, but it doesn't really provide us with the means to reach our own goals (ETP1)

> We are at the local level, so I have to focus on our citizens and companies, and this is just way too high [level] to make a decision on what I think our politicians would be eager to adopt. (RO2)

> There are a lot of options [available], and I expected that something like this would happen where it presupposes that we have much more to decide for ourselves [than what we actually have]. (ETP1)

> You want to make sure that whatever you choose here as your ambition level, I would say it should not only be your ambition level, but you should actually be able to influence the indicator. If you're not able to influence it, if you're just setting an ambition, it's kind of an empty shell. (SA1)

5.3.2.3 Mixed perceptions

Mixed perceptions of the EUCalc platform (21 instances, 9 participants) were primarily associated with the opinion that the tool "Could be useful in different contexts or policymaking levels" but was not directly related to their work or challenges. Given the large number of available levers and sub-levers, the tool was deemed potentially very useful in certain situations, such as 'if you already have expert knowledge, this is probably amazingly useful when writing reports' (RO1). Some participants thought the tool was overly focused on the European level, making it 'probably useful at the European level' (RO1) but not immediately applicable to lower levels of policymaking.

> If this [EUCalc] sticks to a national level, then we might see improved policy. We might see improved laws, which we are very grateful for because we're very dependent on the national government and the quality of their policy for us to do our work correctly. (ETP1)

> I think this tool could be useful, but for us, the scale of the Netherlands is too big. This would be more useful, for example, at the ministry level, since we would want to know also then the specified provincial data. (CAPA1)

> I would use it [tool that had been developed for that municipality] for that [seeing emissions scenarios for 2030 and 2050 and the progress of the city's goals], but it was tailor-made. I wouldn't use this [EUCalc] as a European [tool], I think that's more for our national institutions, like PBL. (ETP2)

5.3.3 Participants' perceptions of the Decarbonisation Policy Evaluation Tool (DPET)

5.3.3.1 Positive perceptions

In terms of positive perceptions of the DPET (25 instances, 7 participants), the interviews revealed a more balanced distribution of perceptions (positive, negative, and mixed) when compared to the EUCalc platform. The highest perceived benefit of the DPET was its provision of **benchmarks and inspirations from policies that have been tested in other locations** (10 instances, 5 participants). Participants mentioned that such a tool opens up new possibilities and that they could benefit from some policy benchmarks because 'now we are very reliant on the expertise of in-house members that look something up or have this knowledge' (ETP1) and that a tool such as DPET 'gives you information that you could use to build policies rather than just give you information [saying] that things are bad'. (RO1). Access to tried-and-true policies was seen as appealing for improving how policymakers address common challenges and also the speed with which they can do so.

> If someone says, "We give you 10 million euros now, what are you going to do with it?" We didn't expect 10 million euros, we don't have projects for 10 million euros laying around. We would want to have something like a proposal already, something like a tested policy that works. (ETP1)

> This could lead to an interesting best practice for us where we can see that, for instance, in other parts of the world they've proven that a certain measure is effective because there's a positive environmental effect and there's a positive cost related outcome. (SA1)

The **vast literature available on various policies** was also identified as a positive aspect of the DPET (9 instances, 5 participants). The large number of policies available for selection at the platform (20 policies), filters (7 filters, including toggles, scales, search field, and others), and criteria (7 criteria) allow users to conduct custom searches based on what they are currently working with or interested in learning more about (see Figure 5.2 (1) and (2) for an overview of the available filters and options).

> With this tool you can actually reason backwards: I know what I want, and I will look inside the tool for what I want to have rather than having a big broad tool that has everything in it. (RO1)

> I'm not going into a university website to see if there are any [scientific] updates, so then something like this tool that collects all of them would be interesting, though I would want it for the Dutch context. (CAPA1)

> We quantify policies as well; we do that every year. If we have to start again, we might have a look here to see if there's literature that we can use, and that is really useful, I think. (CPA1)

5.3.3.2 Negative perceptions

Concerning the DPET's negative aspects (21 instances, 8 participants), they were primarily related to the tool "**not being perceived as intuitive and easy to use"** (6 instances, 3 participants), "**not being connected to challenges the participants face in their context of work"** (10 instances, 5 participants), or being "**excessively detailed on the literature"** (5 instances, 4 participants). Some participants found the DPET's one-page-only design, in which you perform your searches, to be overwhelming, stating that the tool is not '100% clear, and it has too much stuff on the screen. So you have to spend time to get into it' (CPA2) and that once you start using it it seems like you are 'already at the detailed page, and then you can get even more details, and that's it' (EPO1), which supports the perception that the DPET platform's functionalities are not clearly communicated.

Some participants also found that the available scientific results in the DPET were difficult to connect to actual policymaking challenges and that, while having access to inspiration and potential benchmarks is beneficial for policymaking, the DPET 'addresses this a little bit, but not on a practical level (ETP3)'. The same disconnect from their policymaking context that was perceived with the EUCalc was also perceived with the DPET, with one participant stating, 'again we run into the problem of the municipality being different from the national government, we cannot do everything' (ETP1). As a result, some policymakers perceived the information provided as interesting but not very applicable.

> In the municipality I work for, we have a couple of issues, big issues. Will these issues be represented in these solutions, or will there be a solution here [DPET] that is tailored to our issues? Probably not, it simply is not big enough yet, I think. (ETP1)

> I filtered building codes and standards, because we actually want to have higher building standards, we want them to be more sustainable. But then, if you filter local [jurisdiction level], you see there are only two papers left, so that sort of already proves my point that it is difficult to regulate building codes and standards at a local level because most of it is done at a national level. (SA1)

> I don't know how a tool like this would supply me with additional information I can actually use in my work because it's very scientific. (CAPO1)

> You have to look at a society and types of policy that are similar to the way we organise things in Europe, which would make it more applicable. (CAPO1)

Another negative perception of the DPET, somewhat similar to the previous one, is related to the DPET's excessive detail and cognitive load. Some participants mentioned that while interacting

with the tool, they encountered situations in which the same paper mentioned both positive and negative outcomes for the same criteria or papers with multiple criteria affected, resulting in a difficult-to-understand overview that would potentially require them to invest significant time to understand, which could have been improved if the tool provided a 'levelled storyline, so you have less information on top, and then you need to click through and get more and more details' (EPO1)

> I wonder If we would actually use a platform like this to get inspiration from because it's takes a little bit of thinking, effort and time to dig into this (SA1)

> I think that people want to tell a lot at the same time, and they want to be complete, so they don't want to lose any information. But then it is also a bit of an overload. I would prefer it to answer in an easy way,"We would recommend you to use this kind of R&D funding and not this kind of R&D funding because we have looked at the different studies, and we see that this one scores way better on average than the focus of these R&D studies". (EPO1)

5.3.3.3 Mixed perceptions

Mixed perceptions about the DPET (21 instances, 8 participants), like the EUCalc tool, were mostly related to situations in which the participants perceived a potential benefit of such a tool but it was not directly related to their work or challenges. Due to different political or cultural contexts, different energy systems, weather, or other factors, some participants were **sceptical about being able to replicate policies** (12 instances, 5 participants) addressed in the scientific or grey literature available in the DPET:

> All of our buildings are on the gas network. In other countries, they have changed from coal to gas because gas is better than coal. But we want to get off gas, so I don't know if it helps to read on the international level or international papers on that. (ETP3)

> There is also a difference between policymaking and implementing policy. This tool is good for the idea, but the exact implementation is not a copy-and-paste scenario, it will never be (ETP1)

> When you have something in one place, and you want to replicate it, you can never replicate it in another city because it's geographically different, it's financially different, there are different policies, different laws, everything is different. You can maybe use some technical things which you can replicate, but the rest is all different.(ETP2)

> This tool is interesting, there are examples you can read, but then I know that there are experts in this kind of sector that say, "OK, but that's different, we have already tried this 20 years ago, and it doesn't work". So I need a certain expert opinion that is also related to the great geographic area or the economy we live. (CAPO1)

Some mixed perceptions also came from participants reflecting on the **interface between science and policy** (5 instances, 3 participants), with participants wondering if 'all academic research is immediately applicable to the work that I do' (SA1) or mentioning that DPET makes it easier to prove something, which 'goes back to the question whether or not you need scientific proof to prove something is useful' (RO1). Other participants, similarly to what happened with the EUCalc, saw the DPET as potentially useful for 'someone who actually has time and has to advise, he or she can probably look at all the criteria and why it is important for a given policy' (ETP2), or for more specialised workers in industries such as financial services which might 'do analyses based on these kinds of studies' (CAPO1).

5.3.4 Comparisons between the EUCalc and DPET platforms

In some interviews, participants voluntarily compared both DPET and EUCalc platforms to illustrate some points they wanted to make, and some participants were also asked how they would compare both tools, depending on how the participants were exploring the tools. When participants provided input on how they perceived the tools compared to each other, they were

either perceived positively (4 instances, 3 participants), negatively (2 instances, 1 participant), or preferences were given to one tool over the other.

Participants that perceived both tools positively mentioned the potential synergies between the tools, with EUCalc providing scenario-building and policy testing capabilities while DPET could provide benchmarks and inspirations. Both tools were also perceived as complementing each other well by a participant, that added that 'they both look very good visually and I think they're both pretty user friendly and self-explanatory' (SA1). On the other hand, both tools were also perceived as too theoretical and disconnected from the challenges policymakers face in their actual work, with one participant stating that with both EUCalc and DPET 'it's all theoretical, and what we actually need is how policy eventually works out in the operation *[*level*]*, in practice' (RO2).

The simulation capabilities of EUCalc was preferred over the repository of scientific information of DPET by one participant because 'you can see the graph and the actual emissions, and you can modify and base scenarios off of this tool by your own input' (SA1). However, DPET was perceived as providing more tangible and useful information by other participants, which stated that 'summarising scientific literature in such a platform for the things that do work and how well they work is more useful than necessarily planning very far ahead to see how we're doing' (ETP1) and that DPET 'gives you information that you could use to build policies rather than just give you information [saying] that things are bad' (RO1).

5.3.5 Additional tools perceived as useful by the participants

During the interviews, participants were asked if they had previously interacted with similar policy platforms or decision-support tools, and if so, what the context of use was and what they liked best about these tools. Many participants chose to share their screens in order to demonstrate how they use other tools and what they liked about them. A detailed discussion of each of the tools mentioned by participants is beyond the scope of this research, but Table 5.8 provides their names, links (when available), and the reasons why participants mentioned them. Similar tools were mentioned in cases where participants mentioned using them in the past, using them now, or intending to use them in the future.

Table 5.8. Overview of similar tools mentioned by interviewees

Tools mentioned by participants	Reasons for mentioning
Regional climate monitor	Ability to see climate change-related data and scenarios in useful granularity level
ClimateOS	
Data Supply Energy Transition Built Environment (DEGO)	
Climate Damage Atlas	
Climate Impact Atlas	
Climate Adaptation Signal Map [1]	
Municipal 3D Digital Twin	
Climate Policy Database	Access to relevant climate policies

Table 5.8. Overview of similar tools mentioned by interviewees (cont.)

Tools mentioned by participants	Reasons for mentioning
Climate Adaptation Knowledge Portal	Information hub (provides access to additional tools, national plans and other resources)
PBL Climate Pledge NDC tool	Provision of relevant information for different countries
Climate Action Tracker (CAT)	
AR6 Scenario Explorer and Database	Ability to export data
Energy Transition Model	Previous experiences
Participatory Value Evaluation (PWE)	

[1] *Under development. The Climate Adaptation Signal Map is an evolving product and will be further developed in the near future. Treat the information with care and to observe this disclaimer.*

5.3.6 Most important aspects of decision-support tools according to the participants

When asked which factors or criteria would be the most important in their decisions if they were to choose a support tool such as EUCalc, DPET, or similar ones based on their previous experience and the challenges they face, ten groups of factors were identified based on participants' responses. Some of these factors were related to the tool's capabilities (e.g., allowing users to customise visualisations and providing a collection of tested policies for benchmarking), whereas others were more related to how the tool should be developed (e.g., in collaboration with policymakers) or how an ideal policy would improve their work (e.g., needs to be a means of communication with different stakeholders). Table 5.9 presents the list of identified factors, with the number of respondents that mentioned each factor inside brackets and examples of quotes illustrating how participants perceived such factors.

Table 5.9. Most important factors a support tools should have, according to interview participants.

Important characteristics (Number of respondents mentioning)	Example of quotes
Ability to customise visualisations (N = 1)	What I really like in tools is when I'm able to draw my own graphs and select how I want them to look and how they are displayed. When we were looking at the EUCalc tool, there were many graphs with stacked lines. I want to be able to choose to see only one or two categories. (RO1)
Being able to perform various analyses and monitor your situation (N = 2)	[it] should allow you to not only look at probability versus impact but also introduce cascading effects and other indicators, such as on what terms will a shock stress occur and the length of the crisis once it occurs. (RO2)
Being developed in collaboration with policymakers and other stakeholders (N = 1)	I think if you don't do it in collaboration, it's not going to work out because then they will never be tailored enough to specific questions that we have. And then people would look at it and be like, "Looks good!" but will continue with their work. (EPO1)

Table 5.9. Most important factors a support tools should have, according to interview participants (cont.)

Important characteristics (Number of respondents mentioning)	Example of quotes
Help to adress challenges and function as a means of communication with stakeholders. (N = 2)	It always needs to be a means of communication, so I can use it to communicate to the alderman or a director, and they can use it to communicate to citizens. (SA1)
Provide a collection of tested policies to serve as a benchmark and source of inspiration (N = 2)	I want to know what policies work. I want to know what they cost. I want to know whether they are generalisable to the extent that we can use them. Preferably I want to prioritise between policies in terms of which have a bigger impact than others. (ETP1)
Provide functionalities and information at the appropriate level of granularity (N = 2)	I would say it needs to have the right scope. So, on one hand the European level is, of course, very important because that's the level that we need to redefine our energy system. On the other hand, we need to interact with European policies, but we are making our own, so it needs to have the right level or focus. (EPO1) It should have data about buildings, who is the owner of the buildings, do they have gas or district heating or how the buildings are heated. (ETP3)
Provide trustworthy and transparent information (N = 3)	That the data behind it is validated, so I would ask one of my technical advisors to look at it and [check] what kind of data they use and how reliable it is. Because with the first tool [EUCalc], for example, with graphs, you can simulate anything, but what kind of information is behind it? (ETP2)
Should fit your policymaking language (N = 1)	I think it really helps if it would be in Dutch. Not even Dutch, but our policy language, if it's designed for our colleagues and it's connected with how we think about the policy process. If you design it from our process, it will be way easier to connect the dots in your mind with what you're looking at. (EPO1)
User friendly (N = 3)	Number 1, no matter what is ease of use, and this goes both to model experts, policy experts, and policymakers. So it has to be easy for anyone to look at it and understand it. This will always be the number 1 because If you want to ensure that your tool is widely used, even word of mouth makes a difference in these cases, so you must make it easy for everyone to use. (CPA2)
Visually appealing (N = 3)	I think you can only achieve impact if you make the data available to the wider public, and that's why it needs to be visually appealing. It's the same with language; we send out many letters to citizens, so it needs to be simple enough so 90 to 95% of the people can actually read them and understand them. I think it's the same if you communicate data. (SA1)

5.3.7 Participants' priority and ranking of the characteristics of policy platforms

Figure 5.4 depicts the results of the prioritisation question in a heatmap style of visualisation of how each participant evaluated each characteristic of policy platforms, allowing for easy visualisation of agreement and disagreements between the participants' perceptions of the priority of the characteristics. In the following subsections, each characteristic is discussed in detail, and quotes from participants are used to better illustrate the participants' perspectives on the various characteristics, priorities, and rankings. Section 5.4 depicts the results of the survey responses using a similar visualisation, and Section 5.5 compares and contrasts the MoSCoW prioritisation and ranking results from the survey and interviews.

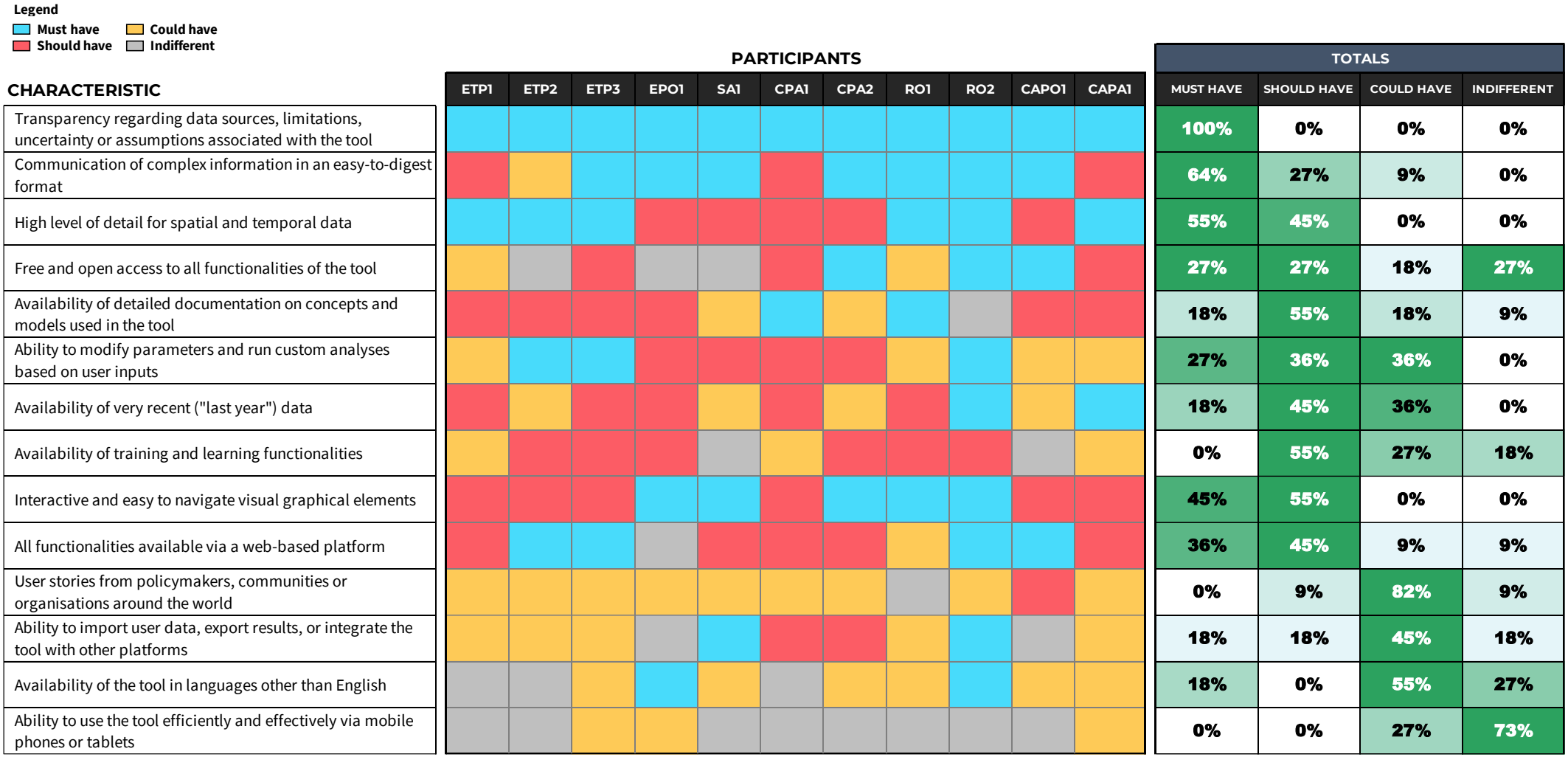


Figure 5.4. Overview of MoSCoW priorities assigned per characteristic and participant (interviews)

5.3.7.1 Transparency regarding data sources, limitations, uncertainty or assumptions associated with the tool

The *transparency* characteristic was assigned as a must-have by all 11 participants (100%), making it the only one on which all participants agreed on the MoSCoW priority. Furthermore, 82% of interview participants (9 out of 11) ranked *transparency* as one of the top three most important characteristics in the must-have priority group, indicating the highest importance placed on this characteristic.

The perceived importance of this characteristic is influenced in part by the legal constraints that policymakers in the Netherlands face. However, one interesting aspect of this legal requirement is that, while all participants perceived it as a must-have, some perceived it with the highest possible ranks (first positions), while others perceived it with the lowest possible ranks (last positions) within the must-have group, with the argument that, because it was a legal requirement, it was not perceived as something that could be chosen differently. Another important reason mentioned by participants is that support tools should be used to legitimise policymakers' choices, as they frequently have to report decisions and reasons behind them to the corresponding councils or, ultimately, the citizens of that given municipality, province, or the Netherlands itself. Knowing which organisations developed a given tool and the assumptions behind a policy platform were deemed most important in this context in order to have the necessary confidence to use such a tool to derive policies that are appropriate for that specific context. The importance of being open and transparent about data sources, assumptions, and limitations of a support tool was also emphasised, particularly in a context where policymakers may be unfamiliar with that tool, making it even more important to 'know who made it, who that organisation is, and what bias would they have' (CAPO1).

Table 5.10. Overview of interview results for Transparency regarding data sources, limitations, uncertainty or assumptions associated with the tool (square brackets indicate the participant's ranking position for that characteristic within that group)

MUST-HAVE (11 votes, 100%)
[1st] Transparency regarding data sources is definitely a must have, that is the biggest must have. We need to be very open and transparent about how decisions are made, not just because we want that, that's just by law. (SA1)
[10th] As a government in the Netherlands, this is legislation, so we have to do this. All our data is open data; therefore, it's a must-have but is not something up for choosing. (RO2)
[2nd] We need to frequently make sure that we don't violate our assumptions, because if the assumptions no longer hold, we might be off track without realising it, and then we won't be able to reach our goal. (ETP1)
[2nd] This is very important for me because I want to know what kind of data is behind it, if it reflects what we are working on or if it has very different assumptions from other countries behind it. (ETP2)
SHOULD-HAVE (0 votes, 0%)
N/A
COULD-HAVE (0 votes, 0%)
N/A
INDIFFERENT (0 votes, 0%)
N/A

5.3.7.2 Communication of complex information in an easy-to-digest format

Communication of complex information was the second characteristic most frequently classified as a must-have (7 votes, 64% of participants). Participants who perceived it as a must-have characteristic also usually ranked it high (5 out of 7 must-have votes within the top 2). Communication of complex information also received three votes (27%) as a should-have and one vote (9%) as a could-have priority, with the latter being assigned as the most important could-have characteristic (i.e., 1st place within the could-have priority group). Within the participants that classified this characteristic as a must-have, the intrinsic complexity of climate-change-related (visual) information was a crucial reason why policy platforms should aim to better communicate with many different groups. Those who did not consider communication of complex information to be a must-have characteristic stated that it is dependent on the purpose of the given support tool. Supposing the tool is tailored to a specific target group, but the user is already a member of that group and will potentially use that type of information on a regular basis. In that case, the overall perception was that it wouldn't be as necessary for the tool to communicate things in such an easy-to-digest manner because users can become familiar with practice. Another reason for not considering this characteristic a must-have was that the policymakers themselves could make the information more digestible when communicating with colleagues or other stakeholders, and if the tool is already interactive and easy to navigate, communicating information in an easy-to-digest manner was perceived as something that would be 'nice to have'.

Table 5.11. Overview of interview results for Communication of complex information in an easy-to-digest format (square brackets indicate the participant's ranking position for that characteristic within that group)

MUST-HAVE (7 votes, 64%)
[2nd] Not everybody's trained in reading graphs, so you need to really work on communicating it to regular people, like your mother or your father; they also should be able to understand. (EPO1)
[4th] I think all these climate-related topics have a certain [level of] complexity, so it's important to explain well so that most people can understand, not only those who formally studied those topics. (ETP3)
SHOULD-HAVE (3 votes, 27%)
[2nd] It should have an easy-to-digest format because I would then use it more often. (CAPA1)
COULD-HAVE (1 votes, 9%)
[1st] This makes my life easier, it's a bit similar to the interactiveness. I would like to have it, but if it's already interactive, then I think it's OK, then I can make it clear. I can even take a screenshot of what I see and use it. (ETP2)
INDIFFERENT (0 votes, 0%)
N/A

5.3.7.3 High level of detail for spatial and temporal data

Participants were divided into two groups when it came to High level of detail for spatial and temporal data: must-have (6 participants, 55%) or should-have (5 participants, 45%). During the interviews, this characteristic sparked some interesting discussions about what constitutes a high level of detail, particularly for spatial data. Some participants understood the naming of this characteristic (high level of detail) as being synonymous with data being available per building or street level. After being told that the researcher originally thought this characteristic would go until the city level (because even more granular levels would be increasingly difficult to find in tools), some participants mentioned that a city or province level (i.e., local level for them) would

be a must-have characteristic and that more granular levels would be seen as less desirable. Other participants emphasised that data has the most value for local policymakers at the most granular level because that is where they can influence decisions.

Table 5.12. Overview of interview results for High level of detail for spatial and temporal data (square brackets indicate the participant's ranking position for that characteristic within that group)

MUST-HAVE (6 votes, 55%)
[3rd] We have great graphs from the scientific literature that show along the entire coast what would happen if the sea level rises. It's great to know that, but it says very little for us at a local level because, for us, it's about knowing in which neighbourhood it will happen to. You need more information in order to make that expert judgement. (RO1)
[3rd] I don't need the trees and the streets, it makes everything slower, so for me it would be almost indifferent. But the city level or province level it would be a must-have. (ETP2)
[1st] We are a local municipality, so if it's going to be relevant for us, the most direct relevance is gained from having a high level of detail on the geographical and temporal data, especially the spatial data. (ETP1)
SHOULD-HAVE (5 votes, 45%)
[1st] The level of detail of the city would definitely be a must have. Anything more granular than that would be a should have. (SA1)
COULD-HAVE (0 votes, 0%)
N/A
INDIFFERENT (0 votes, 0%)
N/A

5.3.7.4 Free and open access to all functionalities of the tool

The characteristic with the highest level of disagreement among the participants was providing free and open access to all functionalities, with all MoSCoW groups having a relevant share. Three participants (27%) assigned this characteristic to all Must-have, Should-have, and Indifferent priorities (for a total of nine votes). This characteristic was perceived as a Could-have by the final two participants (18%). The perception among those who assigned a must-have priority was that this is an essential characteristic for a policy platform to be of interest to other stakeholders, such as businesses or even citizens, and that platforms developed with societal funding should always provide free and open access. Some participants argued that free and open access is also associated with a tool being more transparent because 'if the tool is free and open and everyone can use it, that adds to the transparency of the tool' (ETP3). Other participants that classified this characteristic as a should-have addressed that one should have a very clear idea that a particular paid tool will definitely add value before advocating for its use, but it is more desirable that a support tool be free and open access. Participants who prioritised this characteristic as Could-have or Indifferent expressed varying levels of scepticism about useful tools being free, owing to the fact that 'it costs time to produce good models, so how is this open and free, who is paying for it?' (EPO1). Other relevant considerations were regarding the difference between the data behind the tool being open data versus the analyses performed on the data being open access.

Table 5.13. Overview of interview results for Free and open access to all functionalities of the tool (square brackets indicate the participant's ranking position for that characteristic within that group)

MUST-HAVE (3 votes, 27%)

[5th] I think one of the most important [characteristic] is that it has to be free and open access to facilitate that other companies can use it and share their data as well, so for me this is of most importance. (RO2)

[4th] It should always be free and open for all functionalities. There's no point in making a tool that has a hidden Paywall or something or that you have to download software packages. So it's a must-have in this day and age, especially for projects that receive funding. (CPA2)

SHOULD-HAVE (3 votes, 27%)

[4th] I think it's a should-have. We may buy tools as the province, but it's a lot more difficult, so you need to know that it will definitely add value, so I think it should preferably be free and open access. (CAPA1)

COULD-HAVE (2 votes, 18%)

[5th] This is nice if it is there, but sometimes you just have to pay, right, and that's fine. (RO1)

INDIFFERENT (3 votes, 27%)

[Indifferent] I'm indifferent about that. I don't expect such a tool to be free, I think it's OK to charge people for it. I think the data needs to be open data, but the analyses and modifications I don't think they need to be open access. (SA1)

5.3.7.5 Availability of detailed documentation on concepts and models used in the tool

The availability of detailed documentation was a characteristic that the vast majority of participants (6 participants, 55%) classified as a should-have characteristic, with two other participants (28%) assigning it as either a must-have or a could-have priority and one participant (9%) perceiving it as indifferent. This characteristic was primarily perceived as being directly related to a policy platform's transparency and the use of the policy platform to perform more detailed analyses or monitor the progress of some policy or initiative. Some participants, however, stated that having a higher level of detail regarding model documentation or concepts is not required for a platform to be useful and add value if it provides good transparency regarding data sources, limitations, assumptions, and other aspects of the tool.

Table 5.14. Overview of interview results for Availability of detailed documentation on concepts and models used in the tool (square brackets indicate the participant's ranking position for that characteristic within that group)

MUST-HAVE (2 votes, 18%)

[4th] I like linking to sources, so I think that is a must-have. The same is true for the availability of detailed documentation, which is also a good thing to have because sometimes you just want to know what you're actually seeing. (RO1)

SHOULD-HAVE (6 votes, 55%)

[1st] The availability of detailed documentation is a should-have because it is connected to limitations, assumptions regarding how you can trust the data and what type of models are used. (CAPA1)

[3rd] I want to check some things, so if the tool is saying something, I want to [be able to] say “Hey, this is different from yesterday, why?”, so I want to see the detailed information. (ETP2)

COULD-HAVE (2 votes, 18%)

[3rd] This is sort of an elaboration of the transparency regarding data sources, where you want your sources and your assumptions there, but the level of detail is not necessarily a must for me. (SA1)

[3rd] I'm not indifferent to it, but it's also not really [very important]. As long as transparency regarding data sources and limitations is in place, the detailed documentation can be in the could have category. (CPA2)

INDIFFERENT (1 vote, 9%)

[Indifferent] That depends on whom you are building this model for, the aim, and to which group you want to present this model. For me, this is kind of indifferent, but if you ask a technician or a model expert, I think most likely this will stand in another [priority] group. (RO2)

5.3.7.6 Ability to modify parameters and run custom analyses based on user inputs

Four participants (36%) each classified this characteristic as a should-have or a could-have, and three participants (27%) classified it as a must-have. Participants who rated this characteristic as a must-have did so based on the needs they would have if using such a tool to assist them in decision-making or to monitor the progress of some initiative. Many interviewees also mentioned that such a characteristic is highly dependent on both the tool at hand and the goal one has when using it. As a result, they would see it as more desirable in some cases than others. The DPET was also used to exemplify that a platform can not have this characteristic and still be useful.

Table 5.15. Overview of interview results for Ability to modify parameters and run custom analyses based on user inputs (square brackets indicate the participant's ranking position for that characteristic within that group)

MUST-HAVE (3 votes, 27%)
[1st] This for me is very important, because I really want to use a tool as a kind of monitor system, so after two or three years I want to see what happened, what we did, and if it made any difference. Or, for example, what if we really go into hydrogen, or let's skip hydrogen, what will happen? And then you can see where we should focus more, insulation, cooling, and others. (ETP2)
[3rd] In my experience with data platforms, sometimes you want to know additional details or do something else, and it is not possible, so it helps if you can use the tool in your own way, customise it and modify parameters. (ETP3)
SHOULD-HAVE (4 votes, 36%)
(1st] Customisation and the ability to export or import data are great. A tool such as the EUCalc, if it doesn't have this right now, I will still use it. I will still play around with it because it is very interesting. (CPA2)
COULD-HAVE (4 votes, 36%)
[3rd] The ability to modify parameters and run custom analyses sometimes is nice to have. Not always, because it also requires you to have expert knowledge. (RO1)
[1st] This is a could-have because, in some cases, it would be nice if, such as if you're making scenarios, for example, then yes, but it depends on the tool. (CAPA1)
INDIFFERENT (0 votes, 0%)
N/A

5.3.7.7 Availability of very recent ("last year") data

A tool that provides up-to-date data was mostly considered a should-have or a could-have characteristic. Participants recognised the challenge of having up-to-date data to work with and base policies on, so some degree of delay was usually considered acceptable. However, participants mentioned that if the time gap becomes too large, making decisions based on such data becomes riskier.

Table 5.16. Overview of interview results for Availability of very recent ("last year") data (square brackets indicate the participant's ranking position for that characteristic within that group)

MUST-HAVE (2 votes, 18%)
[3rd] We still use some older climate change scenarios, so not last year data. But If it's too old, it's also not good and won't be used. So I would say not last year, but in the last five years. If it's older than five years, maybe it would also be already less valuable. (CAPA1)

SHOULD-HAVE (5 votes, 45%)
[3rd] If it's monitoring emissions and if it's monitoring progress, then it should be "last year" data. If it's proposing good policies, it shouldn't be antiquated or anything, so something in the last five or ten years, it's not as urgent to have the most recent data. (ETP1)
COULD-HAVE (4 votes, 36%)
[1st] This is something we've run into right now, I know how challenging it is to have very recent data, we don't have very recent data right now for a lot of things. So I would be very happy if it's there, but it's so challenging that it's nice to have, but it's not a necessity. (SA1)
INDIFFERENT (0 votes, 0%)
N/A

5.3.7.8 Availability of training and learning functionalities

Training and learning functionalities include video resources, Massive Open Online Course (MOOC) modules, workshops, training sessions, and others that can help users better understand concepts, models, and other tools available in the tool. Participants rated this characteristic as should-have (6 votes, 55%), could-have (3 votes, 27%), and indifferent (2 votes, 18%). Participants emphasised the importance of learning functionalities so that others could learn how to use the tool with a high degree of independence. This was also mentioned as important because policymakers may have a general idea of what they want to achieve when using a given tool but may not be completely familiar with it. However, if a tool is perceived to be so complicated that it requires prior training or tutorial, people may be hesitant to use it. Some other participants, on the other hand, saw the availability of training and learning functionalities within the tool itself as unnecessary, potentially replaceable by exceeding in other characteristics (e.g., transparency, availability via a web-based platform), or something that policymakers could achieve elsewhere, such as via learning communities, personal networks, or other learning resources beyond the policy platform itself.

Table 5.17. Overview of interview results for Availability of training and learning functionalities (square brackets indicate the participant's ranking position for that characteristic within that group)

MUST-HAVE (0 votes, 0%)
N/A
SHOULD-HAVE (6 votes, 55%)
[1st] This I think it's essential if you really make use of it, if you're going to stay using it for 5 to 20 years. So it's important that a certain number of people know how to use the tool. (ETP2)
[2nd] That would be nice for me because sometimes I sort of have a broad idea of what I'm looking for, but I don't know exactly, so in that case, it [learning functionalities] is probably pretty nice. (RO1)
COULD-HAVE (3 votes, 27%)
[5th] If it's easy to use, it's transparent, it has functionalities via a web-based platform, and the communication of information is easy to digest, then I don't think you need training; you just need to hire someone smart enough to do it. (ETP1)
INDIFFERENT (2 votes, 18%)
[Indifferent] For me that's indifferent. It is important to have training and learning, but they don't have to be integrated in the same tooling for me, it's also something you can find or organise elsewhere of course. (SA1)

5.3.7.9 Interactive and easy-to-navigate visual graphical elements

All participants rated an interactive policy platform as either a must-have (5 participants, 45%) or a should-have (6 participants, 55%). This characteristic was usually associated with a tool that could provide relevant information in an easily accessible manner because 'in order to reach a wide group of people, it needs to be user friendly' (SA1). This characteristic was also linked to the ability to communicate and translate information for key stakeholders involved in decision-making who may be unfamiliar with the concepts or potential models underlying a specific support tool.

Table 5.18. Overview of interview results for Interactive and easy-to-navigate visual graphical elements (square brackets indicate the participant's ranking position for that characteristic within that group)

MUST-HAVE (5 votes, 45%)
[2nd] The easier and more user-friendly you will make the tool, the more people will use it, right? I feel this is like a sort of law, so these kinds of elements are very important. (RO2)
SHOULD-HAVE (6 votes, 55%)
[2nd] This makes it a time saver if you want to translate it for the decision-makers. Quite often, we have a tool, and then we need to visualise it to make it readable for people that don't understand the subject or area you are working on. (ETP2)
[3rd] I think this helps a lot, but it's not necessary. Especially with climate adaptation, having visual elements in reports or advice for framing, for getting the message across to the politicians, it helps a lot. (CAPA1)
COULD-HAVE (0 votes, 0%)
N/A
INDIFFERENT (0 votes, 0%)
N/A

5.3.7.10 All functionalities available via a web-based platform

Policy platforms available in full via a web-based platform was mostly perceived as either a must-have (4 participants, 35%) or a should-have (5 participants, 45%) characteristic. Could-have and Indifferent formed the other 2 participants, with one vote for each group (9%). The main perceived benefit of having a web-based tool was the ease with which it could be accessed and shared among peers. Other participants thought it was 'nice to have', but it was not an issue if they needed to download software or a package. There were also views that this (online versus downloaded) is a strategic decision that organisations must make, but that having software that people must download to use can have the benefit of increasing the perception of a 'standard environment' for performing such tasks, rather than something that is freely available on the web.

Table 5.19. Overview of interview results for All functionalities available via a web-based platform (square brackets indicate the participant's ranking position for that characteristic within that group)

MUST-HAVE (4 votes, 36%)
[1st] A web-based platform for me is like a synonym for easy to share data with other companies, so I rank it quite high. (RO2)
[5th] I think that's the best way to share things instead of software programmes. I think there's a threshold to download a software programme and use that, so it helps to have a link, and it's often faster or smoother when it's a web-based platform. (ETP3)
SHOULD-HAVE (5 votes, 45%)

[4th] This is important as well, a lot of people would lose interest if you have to download and install a separate software in order to be able to use a tool. It needs to be as easily accessible as possible. (CPA2)

COULD-HAVE (1 votes, 9%)

[1st] All functionalities available via a web-based platform is very nice to have, but it doesn't necessarily always need to be. Sometimes it's not that big of a deal to download something. (RO1)

INDIFFERENT (1 votes, 9%)

[Indifferent] I think there's so much available on the Internet that it might lose a little bit of its seriousness, that it's another tool that you can go on a website. While if you would have an application on your laptop, it can be more like "this is the tool we use, this is our common ground, this is how we think about the energy system, if you have questions about it, we go through this tool", so it can be given more importance (EPO1)

5.3.7.11 User stories from policymakers, communities or organisations around the world

This characteristic was included in interview (and survey) questions to assess policymakers' perceptions of the importance of having access to best practices, case studies, interviews, articles, or other resources from which they could get inspiration or insights from other policymakers or organisations. This characteristic was rated as 'nice to have' (could-have) by the vast majority of participants (9, 82%). This was also one of the characteristics in which participants provided more detailed opinions about, and in general, demonstrated varying levels of scepticism about how applicable policies or success stories from other places would be to their contexts, despite the fact that they argued that 'some stories might be more easily digestible than a super-quantified model, and we want to have good policies' (ETP1). On the more positive perceptions regarding this characteristic, participants highlighted the potential to learn from other policymakers and make benchmarks and lessons learned more tangible, potentially increasing the likelihood of it being replicated elsewhere.

Table 5.20. Overview of interview results for User stories from policymakers, communities or organisations around the world (square brackets indicate the participant's ranking position for that characteristic within that group)

MUST-HAVE (0 votes, 0%)

N/A

SHOULD-HAVE (1 votes, 9%)

[1st] It really depends on the kind of problem you look at, what are the kind of risks you want to assess in the adaptation perspective and you look at the solution side of whatever you want to do. I think this is important, but it's not a must-have. It's a should-have if it wants to be a good tool. (CAPO1)

COULD-HAVE (9 votes, 82%)

[1st] There are other ways to learn from other people's experiences, so I don't think I would use a specific tool for that. (ETP3)

[2nd] As a municipality in the Netherlands, I'm sceptical of things that aren't culturally and geographically similar that they actually have something that we can implement with the same level of success. So, I would be sceptical towards whether that success would actually be achieved. (ETP1)

[4th] Best practices are always interesting, but we can draw from other sources to find them. And also the local context is always very specific, so if you have a best practice that is very dependent on the characteristics of the soil or weather of a given place, then you can't implement it in another city, so not every best practice is relevant for us. (SA1)

[4th] I like this, you could take a quote. For example, in Hamburg, they said this, or with this project, they said that. And then you can make it more real, because if you can catch a quote, not

scientifically, but from real people that used something, then it's way stronger than if you don't have it or if you have a list of literature articles. (ETP2)

INDIFFERENT (1 votes, 9%)

[Indifferent] It's very rare that what someone is doing in another country is that relevant because they have different cultures, problems, and issues. (RO1)

5.3.7.12 Ability to import user data, export results, or integrate the tool with other platforms

Two participants (18%) considered the ability to import user data, export results, or perform integrations with the policy platform to be a must-have characteristic. This characteristic was classified as must-have, should-have, or indifferent by the same number of participants (2). Participants who rated this characteristic as more desirable usually mentioned the need to use the results of analyses for purposes other than the ones performed, emphasising the importance of exporting data or results, integrating the tool, and having overall flexibility when working with large amounts of data. Participants who rated this as could-have or indifferent focused on additional complexities or challenges that could arise from using tools that are easy to expand or integrate.

Table 5.21. Overview of interview results for Ability to import user data, export results, or integrate the tool with other platforms (square brackets indicate the participant's ranking position for that characteristic within that group)

MUST-HAVE (2 votes, 18%)

[4th] The ability to import and export is also very important, because we would not only use it in the tool, we always want to use it for something else, so that's definitely something that the tool must have. (SA1)

SHOULD-HAVE (2 votes, 18%)

[3rd] Of course the exporting results is only a thing when it's about a lot of data, but then if it's about a lot of data, it is really important I think. (CPA1)

COULD-HAVE (5 votes, 45%)

[3rd] That would be, of course, the golden bullet, but that's for the very technical ones. If they want to integrate it, I'm sure it's nice [to have], but then you have to integrate everything, and it's too [much], it never ends, so somewhere you need to put it in a box. (ETP2)

[4th] It's nice when you can integrate things. I wonder whether we have the capacity to actually do something like that. (ETP1)

[2nd] I think for some tools, this goes to must-have; for others, it's indifferent because it's not necessary. A lot of the time though if you make scenarios or something, it would be nice to export the results and have a PDF or similar that you can then add your own advice. (CAPA1)

INDIFFERENT (2 votes, 18%)

[Indifferent] I think the integration and the import of data is too difficult, so if you have a tool like that, it's not going to be used by my colleagues. (EPO1)

5.3.7.13 Availability of the tool in languages other than English

Having a policy platform that is at least partially available in languages other than English was viewed as a must-have by two participants (18%), a could-have by six participants (55%), and indifferent by three participants (27%). Participants who considered this characteristic to be particularly significant emphasised the benefits it could bring when considering the policymaking context rather than just the language itself. However, these participants acknowledged that policymaking benefits could arise even if the tool is not designed in Dutch but is designed with Dutch policymakers in mind. The vast majority of participants, however, were either indifferent

about a policy platform's language requirements or saw them as something that could be improved even further, but their absence would not diminish the tool's value.

Table 5.22. Overview of interview results for Availability of the tool in languages other than English (square brackets indicate the participant's ranking position for that characteristic within that group)

MUST-HAVE (2 votes, 18%)
[4th] I think it really helps if it would be in Dutch. Not even Dutch, but our policy language, if it's designed for our colleagues and it's connected with how we think about the policy process. (EPO1)
SHOULD-HAVE (0 votes, 0%)
N/A
COULD-HAVE (6 votes, 55%)
[2nd] For me that's a could have. English is fine for me. I think it would be beneficial to the amount of users if it were in their own language, but it's also difficult, so for me it's not a must-have. (SA1)
[4th] Languages other than English to me is a non issue. I think it's probably nice sometimes, but it doesn't always really matter. (RO1)
[4th] For better or worse, most research in the field is in English. I definitely support other languages' inputs, but if the tool is only in English, that's fine. If it's a good tool, then it can be enhanced by including other languages, but it doesn't lose anything if it doesn't include other languages. (CPA2)
[6th] This is not really necessary. If it is more focused on the Dutch context, even if it's in English, it's the most preferable. (CAPA1)
INDIFFERENT (3 votes, 27%)
[Indifferent] We can all work in English, so that's fine. (ETP1)

5.3.7.14 Ability to use the tool efficiently and effectively via mobile phones or tablets

One of the characteristics on which the participants agreed the most was the use of a policy platform via mobile phones or tablets. This characteristic was evaluated as indifferent by eight participants (73%) and could-have by three participants (27%). Some participants assessed this characteristic as a 'nice to have,' imagining scenarios in which some people might benefit from the flexibility of using such a tool on their mobile phones while commuting to work or something similar. Even in these cases, however, they were primarily hypothetical scenarios rather than actual participant user needs. The vast majority of participants were either indifferent or even opposed to using such tools via mobile phones or tablets because important functionalities would most likely be hampered.

Table 5.23. Overview of interview results for Ability to use the tool efficiently and effectively via mobile phones or tablets (square brackets indicate the participant's ranking position for that characteristic within that group)

MUST-HAVE (0 votes, 0%)
N/A
SHOULD-HAVE (0 votes, 0%)
N/A
COULD-HAVE (3 votes, 27%)
[4th] I wouldn't use a tool on my mobile phone, so I think this is not necessary. But a lot of people work on the train, and then it's easier to use it on a smaller device, so maybe it would be useful to make it available on smartphones and tablets. But I wouldn't use it that way, I like big screens. (ETP3)

[3rd] This for me is a could-have, but it's not necessary. It's nice if I can also use it on the train using my phone, but it's not absolutely necessary. (CAPA1)

INDIFFERENT (8 votes, 73%)

[Indifferent] I don't care for this, mobile phones or tablets is really a luxury to me. (ETP1)

[Indifferent] I'm indifferent about that because I only use the laptop when I work. (SA1)

[Indifferent] Personally, I wouldn't really care. Of course, it's nice if it works on your phone, but then again, because there are a lot of maps and big things, if you want to put all the filters on your screen, it's just not going to work. (CAPO1)

[Indifferent] I would never use a mobile phone for a web tool like the ones we saw today. You lose a ton of details, and it's all very hard to navigate, even if the tools are well-made for mobile phones or tablets, it doesn't make sense at all for me. I would definitely prefer to use it on a laptop or a desktop if I can. (CPA2)

[Indifferent] Being able to use it on mobile phones or tablets is something I really do not care. (RO1)

5.4 Survey results

The results of the survey responses are presented in this section. At the time of collection, seventeen responses were available, of which nine (53%) were considered for further analysis because they were answered to completion (8 surveys were only partially filled and were not considered). When asked if they currently work as a policymaker or advisor to policymakers on climate-change-related issues, all nine respondents answered "yes"; otherwise, they would not be able to complete the survey because they would not be part of the target group. Five participants identified as policy advisors or policy officers, while four others chose "other" (not a policy advisor/policy officer, but also not a researcher or a politician). The majority of respondents (4 answers) mentioned having 3-5 years of experience in their current role, while three respondents mentioned having between 1-2 years, and two respondents mentioned having 10 years or more. Three respondents said they work in the private sector, two said they work for international organisations or the national government (4 responses in total), and one said they work for NGO organisations or the regional government (2 responses in total). Respondents from seven EU countries (Greece (3), Spain (1), Cyprus (1), Belgium (1), and France (1)) and two North American countries (Mexico (1) and the United States (1)) responded to the survey.

When asked if they had previously interacted with examples of policy platforms similar to EUCalc Transition Pathways Explorer or the Decarbonisation Policy Evaluation Tool (DPET) prior to the interview, almost all participants answered "no" (8 answers, 89% of valid answers), with only one responding "yes." When asked how they rated the usefulness of policy platforms such as EUCalc, DPET (or similar ones) in assisting them to deliver more effective advice or policies, respondents mostly answered "very useful" (7 answers, 78% of valid answers), with one answer of "barely useful" and one of "indifferent".

Figure 5.5 depicts a summary of the survey results. The subsections that follow describe how respondents perceived the usefulness of policy platforms, as well as their preferences in terms of priority and ranking of the various policy platform characteristics, as was done for the interviews. The following section (section 5.5) compares the results for the priority and ranking of the various characteristics of policy platforms obtained through interviews and surveys, as well as the overall analysis of these characteristics.

Figure 5.5. Overview of survey responses

5.4.1 Respondents' perception of the usability of EUCalc and DPET

The survey respondents' perceptions of the platforms EUCalc and DPET were investigated and classified as positive, negative, or mixed, in the same way that the interviews were. The vast number of options and functionalities available to users when using the EUCalc tool accounted for the majority of positive perceptions (4 out of 9 responses, 44%). Negative responses (3 responses, 33%) were related to the level of complexity involved in the charts and the tool itself, as well as the fact that the platform was perceived as being quite slow for some calculations (requiring users to wait for several seconds before the results were displayed on the front end). Mixed perceptions (2 responses, 22%) were associated with the tool's purpose not being completely understood and some aspects, such as the various pathways, not being clearly explained to users.

Only one respondent (11%) provided explicitly positive opinions about DPET, praising the available KPIs and the integration of scientific information on climate change mitigation policies. Negative perceptions (5 responses, 56%) focused on the fact that the user interface contains too much information, leaving users overwhelmed and potentially lost. Mixed perceptions (3 responses, 33%) were attributed to the tool's unclear purpose and respondents' feelings that, while the information appeared to be interesting, they were unsure how they could apply it in their daily lives. Table 5.24 presents respondents' answers to the usability questions of the survey.

Table 5.24. Overview of respondents perceptions on the usability of EUCalc and DPET (respondents ID are depicted inside parenthesis)

Policy Platform	Perception of usability	Quote
EUCalc	Positive (N = 4)	Very visual. *[It's]* always useful to understand *[the]* effect of single variables on the overall result and be able to visualize it in real time. (1)
		It was easy to understand the purpose, so as to perceive the information from the graphs and data analytics. (4)
		It was easy to use, and its goals were easy to perceive. I liked the colours, bar charts and even the exclamation marks (!) pointing out the great risk. (6)
		Easy to use, very informative, valuable tool. (8)
	Negative (N = 3)	Needs more instructions. Also the graphics are quite complex. (2)
		UI could use some improvements - not immediately clear what does what. (5)
		The purpose of the tool is clear, however it is quite slow to use when changing parameters, making it difficult to explore different settings. (7)
	Mixed (N = 2)	Yes, it was easy to understand the bigger image of the European GHG budget, although I believe that should optimize specific materials about the energy independence of every member state. (3)
		The purpose was not very clear. I'm always eager to start playing with these tools and don't want to read. It's better when you're not faced with a big text rather with an interactive introduction to the tool's purpose and function. The tool was quite intuitive and appealing. The main (and big) turn off was the 2 minutes waiting time to play around with the sliders. The predefined scenarios were not self explanatory (what does Tango mean and how can I use that information). There were some tabs that I didn't understand the relation to the fairness nor mitigation topics (water scarcity map??). (9)
DPET	Positive (N = 1)	Easy to use, really helpful, scientific basis, integrating technical information very succesfully, very useful kpi's (8)
	Negative (N = 5)	A little bit overwhelming. (1)
		It was quite ambiguous to use this platform. (4)
		Well, seems that it have been done a lot of work but the previous one *[EUCalc]* was easier to use. This has a lot of info and I got lost in a way. (6)
		Same as before - the UI is very crowded, and the dif ferent areas are not easily distinguishable.. (5)
		I did not understand the purpose of this platform. There *[are]* no elements for my country that the legislative framework of each member state. (3)
	Mixed (N = 3)	Not really sure that I understood the purpose of the tool, but the retrieved information (scientific article) was useful. (2)
		Interesting tool, showing limited researches in some areas. (7)
		I liked the walkthrough [explaining] the use of the tool but the purpose was not clear. It is very visual, fast and easy to digest. The cognitive load is decent. I found many deadends with combinations that yielded no results, but I still could chose the set of filters/criteria. The link to the paper was not the central part and did not fully understand what to use this for? should this help me compare policies? I didn't see how. (9)

5.4.2 Respondents' experiences with similar policy platforms

When asked if they had previously interacted with a policy platform or decision-support tool prior to taking the survey, eight respondents (89%) stated that they had not, while only one (11%) stated that they had. Among the reasons given for not having had prior contact were that they 'did not know about it' (7), 'it had never been incorporated into our process' (1), or because 'it is not very widely known to our country theses kind of platforms' (4).

The respondent that had previously interacted with similar tools mentioned having used the Climate Change Knowledge Portal by the World Bank and the ThinkHazard! web-based tool in professional contexts to communicate with clients or build custom models.

5.4.3 Respondent's perceptions of the usefulness of CCMA policy platforms

When asked how they would evaluate the usefulness of policy platforms such as EUCalc and DPET in assisting them to deliver more effective advice or policies (questions 12 and 13 from Table 5.6), seven respondents (78%) assessed them as being 'very useful', one (11%) as 'indifferent' and one (11%) as 'barely useful'. Among those who rated the tools as "very useful," perceptions included that they can help different users understand climate-change targets and aid in the beginning of new projects or research.

> It is an interactive tool to understand climate change policies and targets (4)
>
> As I work in this field, they were extremely useful not only for the policymakers but also for the general public. The first platform *[EUCalc]* is very easy to use by everyone (6)
>
> Very useful and scientific! Organizing in a great way deep knowledge and experience transformed into two useful tools (8)
>
> *[It]* could be useful to start new research (7)

One respondent considered a policy platform along the lines of EUCalc or DPET as 'indifferent', arguing that there are political aspects that also need to be taken into account.

> It covers a part of the job, but there is a lot more on the political side that also needs to be taken care of (1)

Finally, one respondent considered a policy platform similar to EUCalc or DPET as being 'barely useful' due to the difficulty in seeing how findings from using such tools can be used in practice.

> It was hard to export insights from this *[tool]* (9).

5.4.4 Most important aspects of decision-support tools according to respondents

Respondents made references to a few of the characteristics of policy platforms identified in this research when asked about the most important factors a decision-support tool should have (question 14 from Table 5.6), such as being interactive and easy to use and understand, providing flexibility to perform different types of analyses, and communicating information in an easy to digest manner, as illustrated in the answers below.

> User friendly. (1)
>
> Less graphics, more instructions. (2)
>
> It depends on how important the tool is for my work. If very important, I would take the time to learn the UI, even if not optimal. If not very important, a bad UI would make me avoid it. (5)
>
> The possibility to use different filters to be more precise on the results (7)
>
> Easy to use, agreeing with KPIs, informative, useful to elaborate decisions (8)
>
> [To] Be able to extract insights (images, PDF, data sets, etc). Having accessible resources to dive deeper and especially for the documentation for credibility. Being fast. Having some digested takeaways of the system that the tool represents and by interacting *[with the tool]*, you can understand more profoundly those takeaways. (9)

5.4.5 Survey respondents' priority and ranking of the characteristics of policy platforms

The results are presented in Figure 5.6. Section 5.5 compares and contrasts the survey results with the priority and ranking results from the interviews.

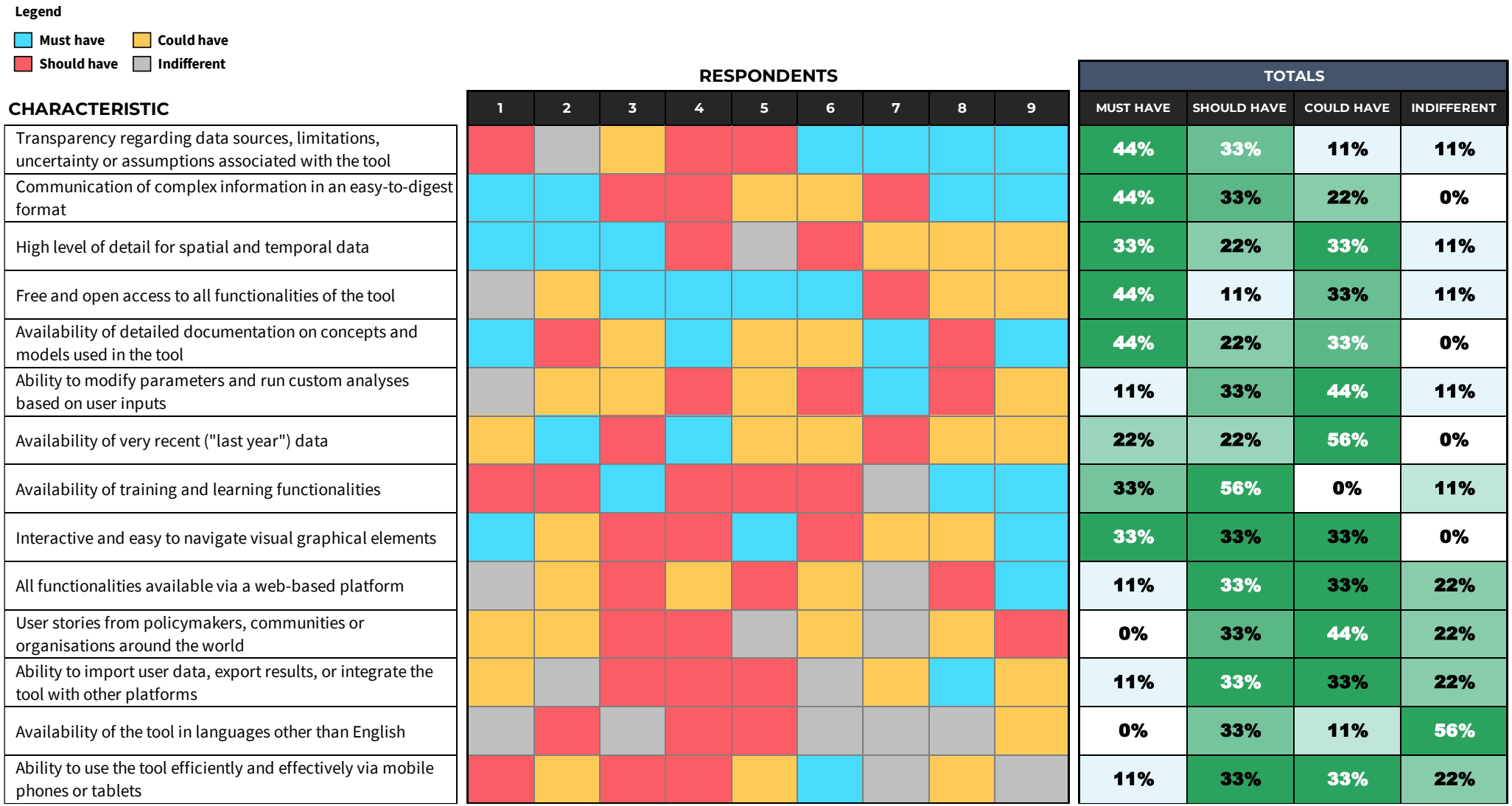


Figure 5.6. Overview of MoSCoW priorities assigned per characteristic and respondents (surveys)

The results from the prioritisation question in the surveys show a more balanced result than what was observed in the interviews (see the section below for a more detailed comparison between survey and interview results). For the must-have category, four characteristics received the highest number of votes (4 votes, 44%): *Transparency*, *Communication of complex information*, *High level of detail for spatial and temporal data* and *Free and open access to all functionalities* (names reduced for presentation purposes). No characteristic was classified as a must-have by more than 50% of the survey respondents.

For the should-have category, *Availability of training and learning functionalities* was the characteristic with the highest number of votes (5 votes, 56%), followed by multiple characteristics with 33% of the votes. For the could-have category, *Availability of very recent ("last year") data* was the characteristic with the highest number of votes (5 votes, 56%), followed by *ability to modify parameters* and *user stories from policymakers* (both with 44% of votes). For the indifferent category, *Availability of the tool in languages other than English* received the highest number of votes, again with five votes (56%). For the should-have, could-have and indifferent categories, beyond the characteristics just mentioned, no other obtained more than 45% of the votes, reinforcing the more balanced results between the different MoSCoW groups.

5.5 Consolidated analysis of the MoSCoW's prioritisation of policy platforms characteristics

This section provides a consolidated analysis of the MoSCoW prioritisation of policy platform characteristics results. Since both the interview and survey groups completed the same exercise with the same Qualtrics survey question (see Figure 5.3), the results were aggregated to determine policymakers' and policy advisors' overall perceptions of policy platform characteristics and their perceived MoSCoW importance.

To support the consolidated analysis, three figures have been developed. Figure 5.7 depicts the consolidated perception (panel A) of the priority of policy platform characteristics (taking into account both the results of interviews and surveys), as well as how those numbers were derived from the individual results of surveys (panel B) and interviews (panel C). The percentages shown in the consolidated table on panel A were calculated by dividing the total number of votes received by a given characteristic within a given priority group by the total number of possible votes (11 votes from interviews and 9 votes from surveys = 20 votes).

Figure 5.8 depicts a detailed analysis of the ranking of each characteristic, with the average ranking presented from various perspectives (overall, only surveys, only interviews, and only the priority group with the highest share of votes, as depicted in Figure 5.7). The findings depicted in Figure 5.8 allow for an in-depth analysis of how participants perceived the significance of various policy platform characteristics from different perspectives. It should be noted that lower numerical values indicate a higher level of importance.

Figure 5.9 presents a comprehensive breakdown of the voting results for both surveys and interviews. The figure illustrates the number of votes provided by each group, categorised by characteristic, ranking number, and MoSCoW priority group. This level of detail offers the highest level of granularity of the data. The sum of all the numbers in each interview row in Figure 5.9 is always equal to 11 (number of interview participants), and the sum of all the numbers in each survey row is always equal to 9 (number of survey respondents).

A Consolidated (surveys and interviews) [1]

Characteristics	MUST HAVE	SHOULD HAVE	COULD HAVE	INDIFFERENT
Transparency regarding data sources, limitations, uncertainty or assumptions associated with the tool	75%	15%	5%	5%
Communication of complex information in an easy-to-digest format	55%	30%	15%	0%
High level of detail for spatial and temporal data	45%	35%	15%	5%
Free and open access to all functionalities of the tool	35%	20%	25%	20%
Availability of training and learning functionalities	15%	55%	15%	15%
Interactive and easy to navigate visual graphical elements	40%	45%	15%	0%
All functionalities available via a web-based platform	25%	40%	20%	15%
Availability of detailed documentation on concepts and models used in the tool	30%	40%	25%	5%
User stories from policymakers, communities or organisations around the world	0%	20%	65%	15%
Availability of very recent ("last year") data	20%	35%	45%	0%
Ability to modify parameters and run custom analyses based on user inputs	20%	35%	40%	5%
Ability to import user data, export results, or integrate the tool with other platforms	15%	25%	40%	20%
Ability to use the tool efficiently and effectively via mobile phones or tablets	5%	15%	30%	50%
Availability of the tool in languages other than English	10%	15%	35%	40%

B Surveys [2]

Characteristics	MUST HAVE	SHOULD HAVE	COULD HAVE	INDIFFERENT
Transparency regarding data sources, limitations, uncertainty or assumptions associated with the tool	44%	33%	11%	11%
Communication of complex information in an easy-to-digest format	44%	33%	22%	0%
High level of detail for spatial and temporal data	33%	22%	33%	11%
Free and open access to all functionalities of the tool	44%	11%	33%	11%
Availability of training and learning functionalities	33%	56%	0%	11%
Interactive and easy to navigate visual graphical elements	33%	33%	33%	0%
All functionalities available via a web-based platform	11%	33%	33%	22%
Availability of detailed documentation on concepts and models used in the tool	44%	22%	33%	0%
User stories from policymakers, communities or organisations around the world	0%	33%	44%	22%
Availability of very recent ("last year") data	22%	22%	56%	0%
Ability to modify parameters and run custom analyses based on user inputs	11%	33%	44%	11%
Ability to import user data, export results, or integrate the tool with other platforms	11%	33%	33%	22%
Ability to use the tool efficiently and effectively via mobile phones or tablets	11%	33%	33%	22%
Availability of the tool in languages other than English	0%	33%	11%	56%

C Interviews [3]

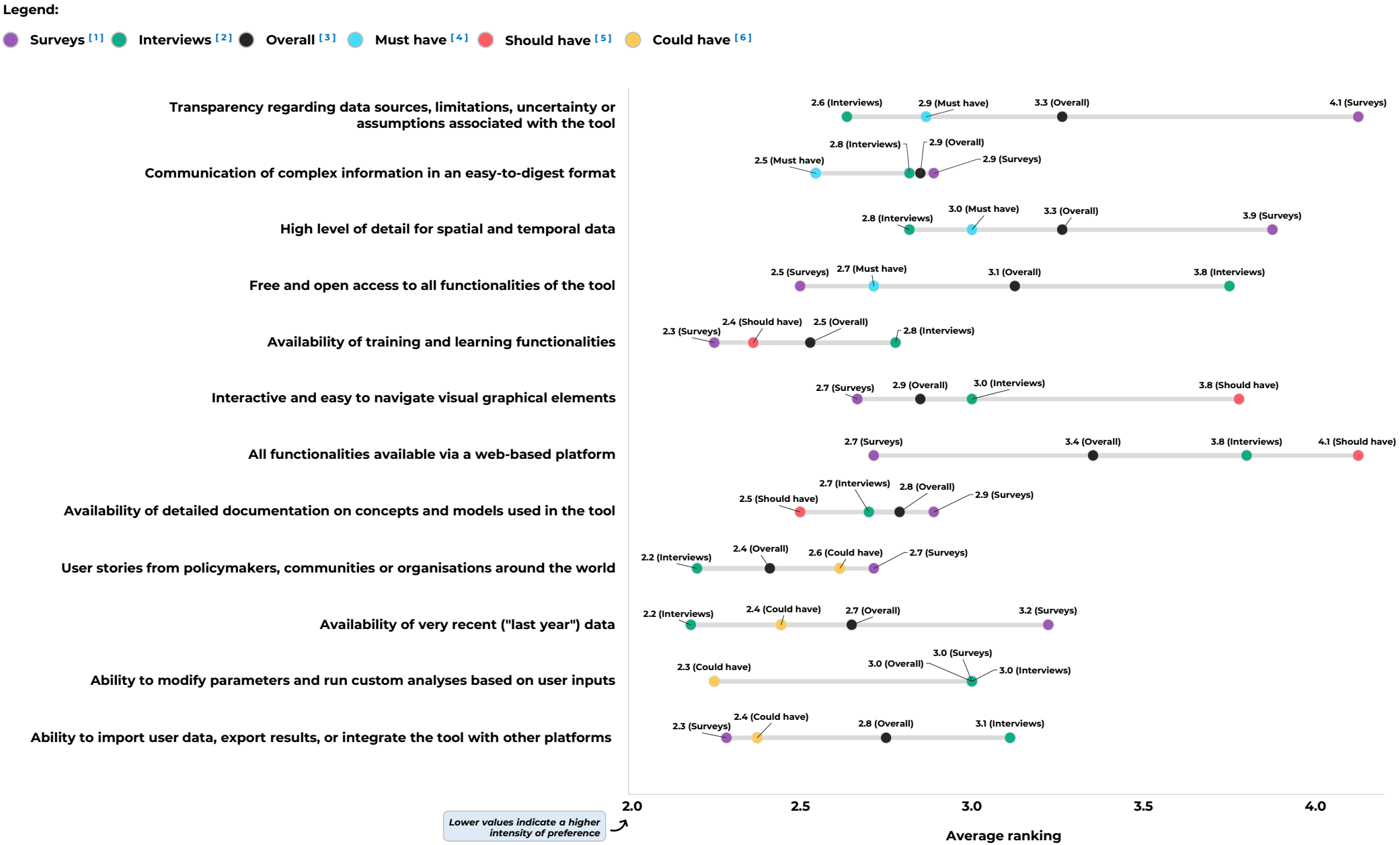
Characteristics	MUST HAVE	SHOULD HAVE	COULD HAVE	INDIFFERENT
Transparency regarding data sources, limitations, uncertainty or assumptions associated with the tool	100%	0%	0%	0%
Communication of complex information in an easy-to-digest format	64%	27%	9%	0%
High level of detail for spatial and temporal data	55%	45%	0%	0%
Free and open access to all functionalities of the tool	27%	27%	18%	27%
Availability of training and learning functionalities	0%	55%	27%	18%
Interactive and easy to navigate visual graphical elements	45%	55%	0%	0%
All functionalities available via a web-based platform	36%	45%	9%	9%
Availability of detailed documentation on concepts and models used in the tool	18%	55%	18%	9%
User stories from policymakers, communities or organisations around the world	0%	9%	82%	9%
Availability of very recent ("last year") data	18%	45%	36%	0%
Ability to modify parameters and run custom analyses based on user inputs	27%	36%	36%	0%
Ability to import user data, export results, or integrate the tool with other platforms	18%	18%	45%	18%
Ability to use the tool efficiently and effectively via mobile phones or tablets	0%	0%	27%	73%
Availability of the tool in languages other than English	18%	0%	55%	27%

[1] Consolidated results consider the total number of votes a given MoSCoW priority received for a given characteristic both in the interviews and surveys divided by the total of possible votes (11 votes from interviews and 9 votes from surveys = 20 votes)

[2] Survey results consider the total number of votes a given MoSCoW priority received for a given characteristic in the surveys divided by the total of possible votes (9 votes)

[3] Interview results consider the total number of votes a given MoSCoW priority received for a given characteristic in the surveys divided by the total of possible votes (11 votes)

Figure 5.7. Consolidated analysis of MoSCoW priority assigned to each characteristic of policy platforms.



Notes: **[1]** Represents average ranking considering only survey votes. **[2]** Represents average ranking considering only interview votes. **[3]** Represents average ranking considering all votes (no filters). **[4]** Represents average ranking when must-have was the priority with the highest number of votes overall. **[5]** Represents average ranking when should-have was the priority with the highest number of votes overall. **[6]** Represents average ranking when could-have was the priority with the highest number of votes overall.

Figure 5.8. Average ranking assigned to each characteristic of policy platforms.

CHARACTERISTIC	SOURCE	MUST HAVE										SHOULD HAVE										COULD HAVE						INDIFFERENT	TOTAL
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	1st	2nd	3rd	4th	5th	6th		
Transparency regarding data sources, limitations, uncertainty or assumptions associated with the tool	INTERVIEWS	5	3	1		1					1																		11
	SURVEYS	1		1	1		1					1				1					1			1				1	9
Communication of complex information in an easy-to-digest format	INTERVIEWS	2	3		1			1					1		1	1						1							11
	SURVEYS	2	1			1						1		1				1				1				1			9
High level of detail for spatial and temporal data	INTERVIEWS	2	1	2						1		1	2	1	1														11
	SURVEYS		1	2									1				1							1			2	1	9
Free and open access to all functionalities of the tool	INTERVIEWS			1	1	1						1			1	1								1		1		3	11
	SURVEYS	1	3										1										1	1			1	1	9
Availability of detailed documentation on concepts and models used in the tool	INTERVIEWS		1		1							2	1	2		1								2				1	11
	SURVEYS	1	1		2								1	1								1			1	1			9
Ability to modify parameters and run custom analyses based on user inputs	INTERVIEWS	1		1					1			1	1		1				1			3		1					11
	SURVEYS	1										1		1				1					2	1		1		1	9
Availability of very recent ("last year") data	INTERVIEWS			1	1							1	2	2								2	2						11
	SURVEYS			2								1					1						1	2	2				9
Availability of training and learning functionalities	INTERVIEWS											3	1	1		1							1			2		2	11
	SURVEYS	2		1								1	1	2	1													1	9
Interactive and easy to navigate visual graphical elements	INTERVIEWS		3	2								1	1	1	2			1											11
	SURVEYS		3												2	1						1	2						9
All functionalities available via a web-based platform	INTERVIEWS	1			2	1								1	1	2	1					1						1	11
	SURVEYS	1											1	1		1						1		1	1			2	9
User stories from policymakers, communities or organisations around the world	INTERVIEWS											1										3	3		3			1	11
	SURVEYS											2			1							1	1			2		2	9
Ability to import user data, export results, or integrate the tool with other platforms	INTERVIEWS				1		1						1	1									3	1	1			2	11
	SURVEYS			1									2	1								1	1	1				2	9
Availability of the tool in languages other than English	INTERVIEWS			1	1																		1	2	2		1	3	11
	SURVEYS											2							1			1						5	9
Ability to use the tool efficiently and effectively via mobile phones or tablets	INTERVIEWS																					1		1	1			8	11
	SURVEYS			1									1	1						1		2			1			2	9

Figure 5.9. Comparison of ranking preferences within each MoSCoW priority group between surveys and interviews.

5.5.1 Overall must-have characteristics

Transparency regarding data sources, limitations, uncertainty, or assumptions associated with the tool was assigned a must-have priority by 75% of the participants in this study, including interviews and surveys (Figure 5.7 A), which was composed of votes from 44% of survey respondents (Figure 5.7 B) and 100% of interview participants (Figure 5.7 C), making transparency the characteristic with the highest share of votes in the must-have priority group. The large difference observed between the groups (100% for interviews and 44% for surveys) was also observed in the intensity with which both groups prefer this characteristic. The average rank resulting from interviews was 2.6 (i.e., within the top three most important characteristics), while the average rank resulting from surveys was 4.1, indicating that *transparency is, on average, a must-have characteristic of considerably greater importance for interview participants than for survey respondents*. This finding is also supported by the fact that the average rank obtained from participants (interviews and surveys) who rated transparency as a must-have characteristic is 2.9, which is higher than the average rank obtained from the interview group alone. Given that all interview participants rated transparency as a must-have characteristic, such higher results can only be explained by a lower average rank derived from survey participants that assigned transparency as a must-have characteristic.

The results in Figure 5.7 (panel A) show that *communication of complex information in an easy-to-digest format* received the second highest share of total votes within the must-have priority group (55%), with interview participants (64%) having a higher perception of this characteristic as a must-have in a policy platform than survey respondents (44%), but with a smaller difference than what was observed for transparency. In fact, the results show that *survey respondents had the same level of preference (44%) for communication of complex information, transparency, free and open access, and availability of detailed documentation, implying that the must-have group of the surveys did not have a clear winner in terms of priority group alone*. This is not the case for the interview group, which shows a clear descending share of preference for the characteristics assigned to the must-have priority group, as shown in Figure 5.7 C. In terms of the intensity of preference for the characteristic of communication of complex information, the results in Figure 5.8 are much less spread than what was observed for the transparency characteristic, with the average rank for interview participants (2.8), survey respondents (2.9), and the overall average rank (2.9) displaying marginal differences. When only participants (from interviews and surveys) who evaluated communication of complex information as a must-have characteristic are considered, the average rank obtained is 2.5, which is lower than all average ranks for transparency. This finding provides a contrasting result, highlighting that *while transparency was the characteristic on which participants agreed the most in terms of priority (75% perceived it as a must-have characteristic), communication of complex information was the must-have characteristic that participants valued the most.*

High level of detail for spatial and temporal data received the third highest share of total votes (45%) within the must-have priority group, with interview participants (55%) having a higher perception of this characteristic as a must-have in a policy platform than survey respondents (33%). The overall pattern depicted in Figure 5.8 for the intensity of preference for high level of detail is the same as that observed for transparency, with a wide spread for the observed average ranks. Interview participants portrayed the highest preference (i.e., the lowest average rank), whereas survey respondents portrayed the lowest preference, suggesting that *high level of detail is, on average, a must-have characteristic of greater importance for interview participants than for survey respondents*. The average rank obtained from the interviews (2.8) was slightly lower than the

average rank obtained from all participants who assigned high level of detail as a must-have characteristic (3.0), indicating *that even interview participants who considered high level of detail as a should-have characteristic (rather than a must-have) still had a strong preference for this characteristic,* as shown in Figure 5.9 (all votes for that characteristic in the should-have priority group are in the top four).

As the final characteristic in the must-have priority group, *free and open access to all functionalities of the tool* received the fourth highest total vote share, 35% of the consolidated votes (27% for interviews and 44% for surveys). This was the characteristic within the overall must-have priority group where participants were most divided, with the should-have (20%), could-have (25%) and even indifferent (20%) groups presenting relevant shares of the overall preference, as depicted in Figure 5.7. In addition, free and open access is the only overall must-have characteristic in which survey respondents outvoted interview participants, and the overall pattern for the average rank of free and open access in Figure 5.8 depicts a 180° shift from what was observed for transparency and high level of detail. The average rank obtained from survey respondents (2.7) shows the greatest preference for that characteristic, whereas the average rank obtained from interview participants (3.8) represents the least preference for that characteristic. This suggests that *free and open access is, on average, a must-have characteristic of greater importance for survey respondents than for interview participants*. Furthermore, as with *high level of detail*, the average rank obtained from the surveys (2.5) was slightly lower than the average rank obtained from all participants who assigned free and open access as a must-have characteristic (2.7), indicating that *even survey respondents who considered free and open access a should-have (11%) or could-have (33%) characteristic - rather than a must-have - still had a strong preference for this characteristic,* as shown in Figure 5.9 (majority of votes for that characteristic in the should-have and could-have priority groups are in the top tree).

5.5.2 Overall should-have characteristics

The *availability of training and learning functionalities* was assigned a should-have priority by 55% of the study's participants (55% of interview participants and 56% of survey respondents), making it the characteristic with the highest share of votes in the should-have priority group and a nearly identical perception of it within the two groups (in terms of priority group). In terms of the intensity of preference for this characteristic, the results in Figure 5.8 show that survey respondents had a higher preference (average rank of 2.3) than interview participants (2.8) and also slightly higher than all participants who rated training and learning functionalities as a should-have characteristic (2.4), suggesting that *learning functionalities is, on average, a should-have characteristic of greater importance for survey respondents than for interview participants*. Furthermore, the lower average rank observed in the survey results (2.3) than the overall should-have average rank (2.4) indicates that other survey respondents who did not perceive this characteristic as a should-have still had a strong preference for it, as shown in Figure 5.9 (three survey respondents assigned this characteristic within the top three of the must-have group).

Interactive and easy-to-navigate visual graphical elements received 45% of total votes (55% for interviews and 33% for surveys), making it the characteristic with the second highest share of votes within the should-have priority group. Although interactive graphical elements was ranked as a should-have characteristic overall, it elicited widely divergent perceptions in both the survey (tie between must-have, should-have, and could-have, all with 33%) and interview (45% for must-have and 55% for should-have) groups. Figure 5.8's average ranks highlight this divided perception even more. The average rank of survey respondents was the lowest (2.7), followed by

the overall average (2.9), interviews (3.0), and. *Interactive and easy-to-navigate visual graphical elements is, therefore, on average, a should-have characteristic of greater importance for survey respondents than for interview participants*. Interestingly, the average of all participants who rated this characteristic as a must-have (3.8) demonstrated the least preference for this characteristic among all subgroups examined in Figure 5.8. Such contrasting average rank results can be better understood by looking at Figure 5.9, where it is clear that all participants, whether from interviews or surveys, who evaluated interactive graphical elements differently than should-have (i.e., either must-have or could-have) tended to place it typically in lower ranks (within the top three of each group) than the participants who evaluated interactive graphical elements as should-have (the winning priority for this characteristic).

Similar to interactive graphical elements, *all functionalities available via a web-based platform* was majority voted as a should-have characteristic of a policy platform (40% of all participants), but with mixed perceptions. In the survey group, this characteristic tied with the should-have and could-have priorities (both with 33%), and in the interviews, the should-have priority received the most votes (45%), but was closely followed by must-have (36%). The same visual pattern seen in the average ranks of the visual graphical elements characteristic was seen in the web-based platform characteristic, with *survey respondents showing the highest preference (average rank of 2.7) and the interview group showing a lower preference (3.8)*. The should-have group scored even lower (4.1) than the survey and interview groups. As shown in Figure 5.8, such behaviour (the average rank of the winning priority having the highest value, indicating the lowest intensity of preference) was only observed for interactive and easy-to-navigate visual graphical elements, as well as all functionalities available via a web-based platform.

As the final characteristic in the should-have priority group, the *availability of detailed documentation on concepts and models used in the tool* received the fourth highest total vote share, 40% of the consolidated votes (55% for interviews and 22% for surveys). Although this characteristic was perceived as a should-have overall, the majority of survey respondents classified it as a must-have (44%) rather than a should-have. Figure 5.8 shows that the should-have group had, indeed, the highest preference for this characteristic (2.5), with interview participants (2.7) having a slightly stronger preference than survey respondents (2.9).

5.5.3 Overall could-have characteristics

User stories from policymakers, communities, or organisations around the world was the characteristic with the highest vote share (65%) in the could-have priority group, receiving 82% of votes in interviews and 44% in surveys. Only transparency received a higher percentage of votes (75%) in the same category than user stories. Despite the fact that this characteristic was perceived as a 'nice to have' by the majority of participants, Figure 5.8 shows that *user stories (along with the availability of very recent ("last year") data) depicted the highest intensity of preference of all policy platform characteristics (2.2 for the interview group).* The average rank derived from survey responses (2.7) was also lower (i.e., indicating greater intensity of preference) than the average rank of some other must-have characteristics, such as "communication of complex information" and "high level of detail." This finding suggests that, while policymakers would still use a policy platform without user stories, providing access to user or success stories or other forms of benchmarks that support learning from other policymakers has the potential to significantly increase the perceived usefulness of such platform, particularly in the perspective of interview participants, as depicted in the number of votes for the could-have priority within the top two in Figure 5.9.

In the could-have priority group, *availability of very recent ("last year") data* was the second most-voted-for characteristic (45%). However, there was some disagreement, with the majority of interviewees (45%) seeing it as a should-have rather than a could-have characteristic. *The availability of very recent data, along with user stories from policymakers, had the highest intensity of preference of any characteristic (2.2 for the interview group).* However, the disparity between average ranks from interviews and surveys for this characteristic is greater than it was for user stories. The average rank derived from survey responses was 3.2, which was higher than the average rank for interview participants, as becomes clear by investigating the number of votes under should-have and could-have within the first ranking positions for the interview group in Figure 5.9.

Ability to modify parameters and run custom analyses based on user inputs and *ability to import user data, export results, or integrate the tool with other platforms* tied for 40% of the overall vote share in the could-have priority group. Regarding the interview group, interviewees were evenly divided between should-have and could-have preferences for *ability to modify parameters* (36% of interview votes each), but *import data and export results* received a clear could-have preference from the majority of interviewees (45%). In contrast, a majority of 44% of survey respondents rated the *ability to modify parameters* as a could-have, with a tie for the *ability to import data and export results* between the should-have and could-have priorities (both with 33% of survey responses). Both interview participants and survey respondents showed the same level of preference for *ability to modify parameters* (average rank of 3.0), but all participants who assigned a could-have priority to this characteristic showed a stronger preference (average rank of 2.3), as shown in Figure 5.8. This behaviour can be better understood by looking at Figure 5.9, which shows that participants in both interviews and surveys who assessed the *ability to modify parameters* as either a must-have or should-have ranked this characteristic more evenly across all available positions, whereas those who assigned a could-have priority to this characteristic mainly ranked it within the top three of the could-have group. In terms of the *ability to import data and export results* Figure 5.8 shows that survey respondents preferred this characteristic (average rank of 2.3) over interview participants (3.1).

5.5.4 Overall indifferent characteristics

"Ability to use the tool efficiently and effectively via mobile phones or tablets" and "Availability of the tool in languages other than English" close the list of characteristics of policy platforms assessed in this research, with the majority of interview participants and survey respondents being indifferent to both (50% for "ability to use the tool in mobile phones and tablets" and 40% for "availability of different languages"). Since the priority group with the highest number of votes for these two characteristics was the indifferent group, these two characteristics are not depicted in Figure 5.8 since, by definition, the logic of ranking does not apply to an indifferent characteristic. Figure 5.7 and Figure 5.9, however, depict the total votes (share and absolute numbers) that these two characteristics received, also considering the other MoSCoW groups.

The interview participants were overwhelmingly indifferent (73%) to the *ability to use the tool in mobile phones and tablets*. In fact, only the transparency characteristic received higher shares of votes from the interviewees (100%). Survey respondents, on the other hand, were split between a should-have and a could-have priority for the *ability to use the tool in mobile phones and tablets* (both with 33%). The *availability of different languages*, in turn, while being overall classified in the indifferent group, was perceived as a could-have characteristic for the majority of interviewees (55%). This shows a visible conflict with the opinion of survey respondents, which perceived the *availability of different languages* as indifferent with almost the exact share of votes (56%).

5.6 Conclusions of chapter 5

This chapter addressed the third and fourth subquestions of this thesis:

(SQ3) *How do policymakers and policy advisors perceive the usefulness of CCMA policy platforms?*

(SQ4) *What characteristics do policymakers and policy advisors look for in CCMA policy platforms to be used as support tools for policymaking?*

Eleven Dutch policymakers and policy advisors were interviewed, and nine respondents from seven countries (five EU and two North American) completed a survey to assess their perceptions of the CCMA policy platforms and preferences for policy platform characteristics. Interview summaries were thematically analysed after online semi-structured interviews. Line-by-line coding generated the initial codes, which were iteratively re-analysed and organised into themes to create this study's thematic framework in Table 5.7.

Based on their interests, preferences, and work challenges, interviewees were encouraged to explore the EUCalc Transition Pathways Explorer and Decarbonisation Policy Evaluation Tool (DPET). After exploring each platform, they discussed its usefulness and previous experiences with similar tools. A thinking-aloud approach encouraged participants to explore the tool and provide relevant input during interviews. To familiarise themselves with EUCalc and DPET policy platforms, survey respondents were asked to complete two short exercises. After that, they answered questions about platform usefulness. At the end of the survey or interview, all participants assessed their MoSCoW priority and ranking preferences for policy platform characteristics.

Perception of the usefulness of CCMA platforms like EUCalc and DPET

Positive EUCalc perceptions (21) were far less prevalent than negative (96) and mixed (21) views in interviews, suggesting that while the tool has merits, these may not be dominant or consistent across user interactions. The tool's detailed information (pathways, levers, ambitions) and ability to test scenarios and policies were generally praised in interviews and the ability to understand the effects of single variable changes on greenhouse gas emissions and other metrics was emphasised by survey respondents. EUCalc's clear user interface and visualisation capabilities were a point of agreement for both groups. The negative perceptions of EUCalc varied among interviewees and survey respondents. The most frequently expressed concern among interviewees was a lack of contextualisation of the tool's purpose and functionalities. The tool's user interface and the complexity of the graphs were also mentioned as areas for improvement by survey respondents, indicating a broader problem with the user experience. Interviewees expressed greater concern about contextualised and practical issues (such as the tool not enhancing comprehension of how to realise desired futures or not connecting to the policymaking level where the system can be influenced by the interviewees). Feedback from survey respondents expressed concern about the tool's usability and responsiveness to perform calculations. While mixed perceptions were less common than negative perceptions, they provided useful insights. Although interviewees recognised EUCalc's potential benefits, they felt they were not directly applicable to their context ("could be useful in different contexts or policymaking levels"). This indicates a more positive attitude, as interview participants saw benefits in using a tool like EUCalc, even if only for others. Survey respondents found the tool intuitive, but they had criticisms for the pathways' lack of clarity, demonstrating agreement with interviewees' perceptions on the same topic.

For the DPET, interview participants' perceptions were much more balanced, with positive perceptions accounting for a slight majority (25), followed by mixed and negative perceptions (21 for both). The tool's provision of benchmarks and policy inspiration from other locations was recognised as a valuable functionality by both groups, with interviewees stating that this was advantageous due to their current reliance on in-house expertise and survey respondents recognising the tool's scientific basis and usefulness. The vast policy literature available, allowing for custom searches, was another highlight from the interviewees' and survey respondents' perspectives. On the negative side, both groups' perceptions of the tool's content were relatively consistent, with usability and context inapplicability standing out as major concerns. The DPET's 'one-page' design was deemed too overwhelming by the different groups. Interviewees were more concerned with the practical implications, emphasising that the scientific findings were difficult to connect to their policymaking contexts and that the excessive detail resulted in a difficult-to-understand overview. Respondents to the survey echoed these sentiments, mentioning feeling confused and finding the UI crowded. The mixed perceptions highlight common threads among interviewees and survey respondents. The DPET had potential benefits, but interviewees were sceptical due to factors such as differences in political or cultural contexts, as well as differences in energy systems among the countries studied. They believed that the DPET would benefit more specialized users, such as those working for PBL or in highly technical sectors or those with more time to learn the details of each paper. Similarly, survey respondents found the tool interesting and noted the usefulness of the information obtained, but they were also unsure of its purpose and how to use the information provided. Furthermore, some users discovered that the combinations they tried yielded no results, resulting in 'dead ends,' which can be potentially frustrating.

SQ3 findings show that, while neither EUCalc nor DPET was perceived as not useful, the lack of applicability and relevance of the functionalities available in both tools to participants' policymaking contexts can have a significant impact on participants' perceptions of the usefulness of CCMA policy platforms. Chapter 6 discusses the usefulness of CCMA policy platforms in light of relevant concepts in the literature, such as credibility, relevance, applicability and accessibility in order to derive this thesis's conclusions regarding the usefulness of CCMA policy platforms beyond EUCalc and DPET.

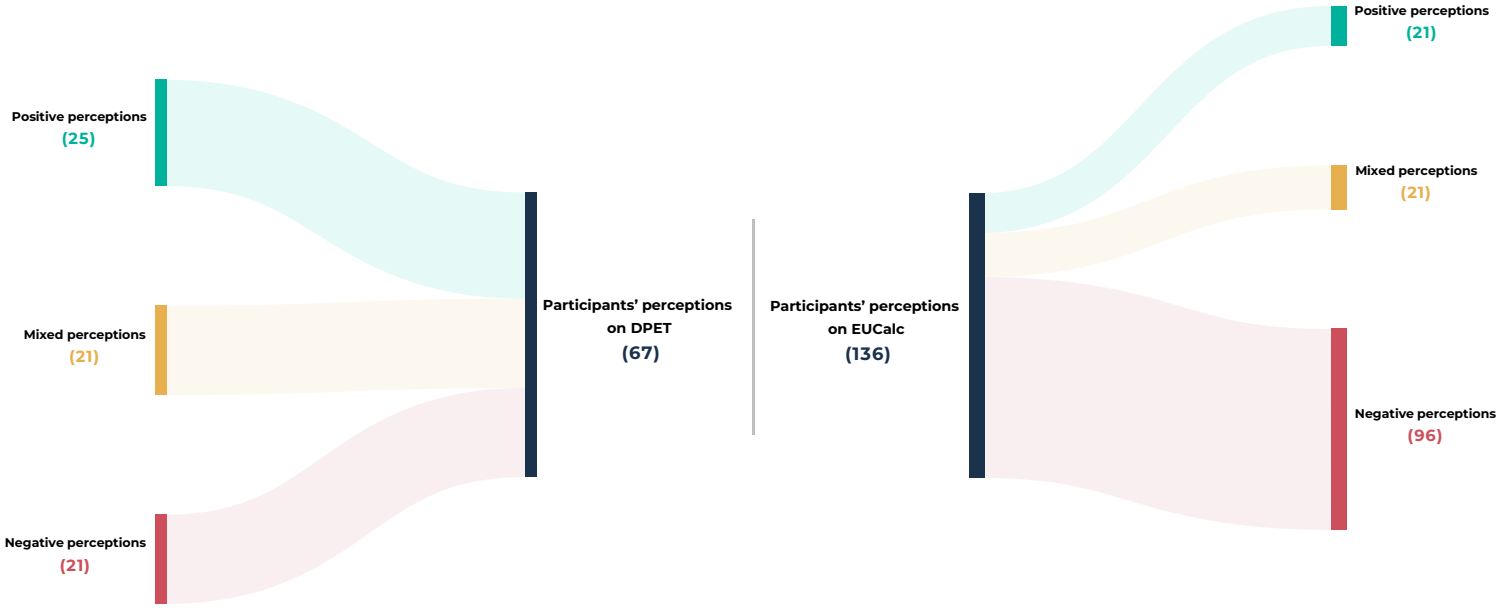


Figure 5.10. Overview of interview participants' perceptions on the EUCalc and DPET policy platforms (numbers derived from Table 5.7)

Preferences regarding characteristics of policy platforms

The MoSCoW prioritisation technique ('Must-have,' 'Should-have,' 'Could-have,' and 'Will not have,' replaced by 'indifferent' in this study) and a rank-ordering method were used to assess policymakers' and their advisors' preferences for policy platform characteristics. Except for security and privacy, the 14 items used in interviews and surveys for prioritisation included elements embodying all policy platform characteristics (as proposed in the framework in Table 3.4). Must-have characteristics are required for a policy platform to be useful. Should-have characteristics are those that are highly desirable but not mandatory. Could-have refers to desirable characteristics based on best-case scenarios, while Indifferent refers to characteristics about which the participants had no strong feelings. Using the same method, all participants (interviews and surveys) were asked to assign a unique position (priority group and ranking, such as must-have third or could-have first) to each of the 14 characteristic items. This prioritisation process omitted the characteristic of *Security & Privacy*. Given its critical importance and legal implications, it was assumed that all participants would regard it as either mandatory or too technical to assess. Furthermore, regardless of user preference, policy platform developers would most likely be required to adhere to minimum standards regarding safety and privacy.

The characteristics with the highest priority were those assigned to must-have, then should-have, and finally, could-have. Indifferent characteristics indicate that the participants have no particular preference. Furthermore, the characteristics with the lowest average rank represent what participants prefer the most. The must-have, should-have, could-have, and indifferent groups, as well as the corresponding rank of the characteristics within each group, were determined by combining the results of prioritisation and ranking by interview participants and survey respondents (results from Figure 5.7 A and Figure 5.8 overall rank).

Must-have group: *Communication of complex information in an easy-to-digest format* (1st), *Free and open access to all functionalities of the tool* (2nd), *Transparency regarding data sources, limitations, uncertainty, or assumptions associated with the tool* (3rd) and *High level of detail for spatial and temporal data* (4th) form the must-have group. These are the characteristics that participants deemed essential for a CCMA policy platform to provide in order for it to be useful in assisting them in their work.

Should-have group: *Availability of training and learning functionalities* (1st), *Availability of detailed documentation on concepts and models used in the tool* (2nd), *interactive and easy-to-navigate visual graphical elements* (3rd) *and all functionalities available via a web-based platform* (4th). Should-have characteristics are functionalities that users value highly, but they are willing to use a tool even if it lacks such characteristics. They do not, however, regard these elements as merely cosmetic but rather as very important characteristics that should ideally be incorporated into the tool in the future, assuming that the tool will still be updated and upgraded.

Could-have group: *User stories from policymakers, communities, or organisations around the world* (1st), *Availability of very recent ("last year") data* (2nd), *Ability to import user data, export results, or integrate the tool with other platforms* (3rd) and *Ability to modify parameters and run custom analyses based on user inputs* (4th). Could-have characteristics are those that users would like to have but consider 'nice to have'. As a result, they will continue to use a tool even if those items are never implemented in that tool.

Indifferent group: *Availability of the tool in languages other than English* and *ability to use the tool efficiently and effectively via mobile phones or tablets* were assessed as indifferent characteristics.

Indifferent characteristics have no effect on the user, neither positively (by their presence) nor negatively (by their absence).

Figure 5.11 summarises the findings for SQ4. In light of relevant recent literature, Chapter 6 presents some discussions on the findings on policymakers' preferences in terms of the typical characteristics of CCMA policy platforms.

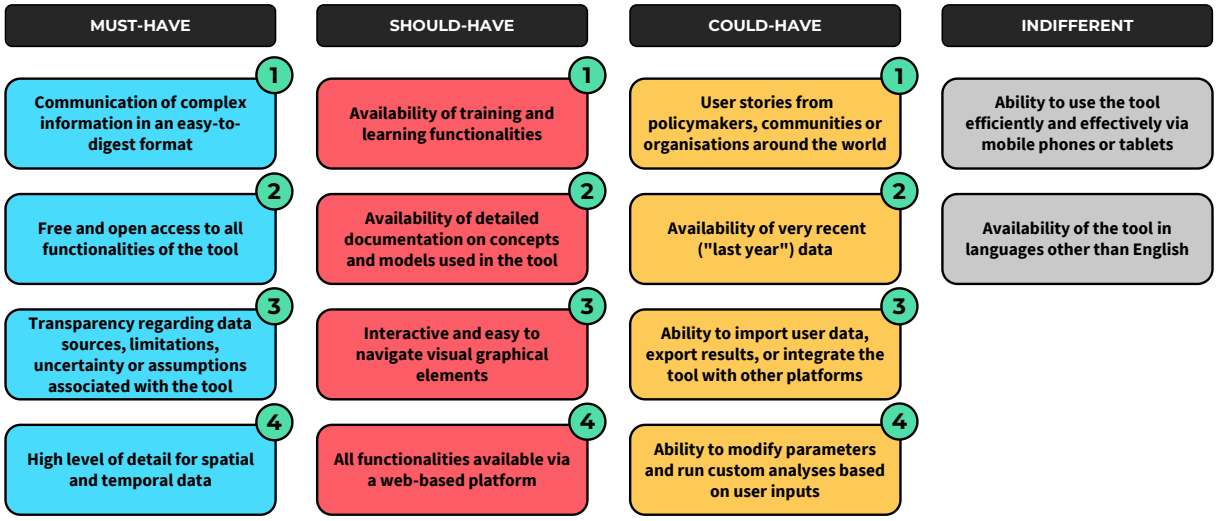
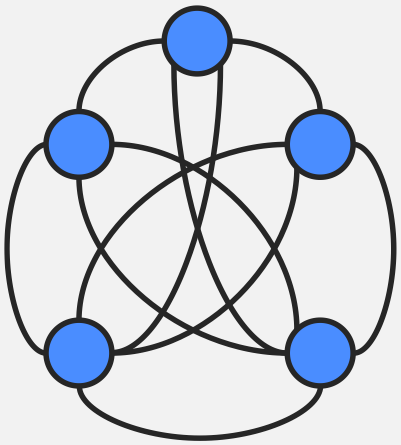


Figure 5.11. Consolidated assessment of MoSCoW priorities and ranking of characteristic of policy platforms (MoSCoW priorities derived from Figure 5.7 A and ranking positions derived from Figure 5.8 considering the overall average rank received by each characteristic)



Chapter 6
Discussions and conclusions

Main topics

1. Revisiting the conceptualisation of CCMA policy platforms
2. Discussions
3. Answering research subquestion 1
4. Answering research subquestion 2
5. Answering research subquestion 3
6. Answering research subquestion 4
7. Answering main research question
8. Limitations
9. Academic relevance
10. Societal relevance
11. EPA relevance
12. Recommendations for future work

6. Discussions and conclusions

6.1 Revisiting the conceptualisation of CCMA policy platforms

During the review of the literature to demarcate the space to which this thesis was connected, it became clear that a formal definition of policy platforms was lacking and that they could be viewed in a broader sense as tools for facilitating and promoting more effective policymaking, either by facilitating the understanding and communication of information and outcomes or by serving as hubs for disseminating relevant knowledge and information. This chapter provides a tentative updated conceptualisation of policy platforms in light of the findings obtained in this thesis.

CCMA Policy platforms are support tools that are designed to provide different stakeholder groups (of which policymakers and policy advisors are frequently key users) with functionalities to address one or more of the following needs:

1. **Allow policymakers to better understand the current situation and explore scenarios for possible futures based on developments in the scientific literature on climate change.** This includes, for example, the COACCH Climate Change Impact Scenario Explorer (which allows users to explore the economic costs of climate change at various geographic scales using various socioeconomic and climate scenarios) and the EnerMaps visualisation tool (which allows users to visualise dozens of datasets in interactive maps and run custom calculations based on their needs).

2. **Enable policymakers to investigate various levers and policy options for influencing the current state of different systems (e.g., emissions, energy, economic, social or environmental factors) to achieve desired futures**. This includes, for example, the EUCalc Transition Pathways Explorer (which allows users to create their own emissions scenarios and investigate the effects of various pathway scenarios, policy levers, and ambition levels on various sectors).

3. **Based on the developments in the climate-change scientific literature allow policymakers to better understand concepts, terminology, and models that are critical to making sense of the inherent complexities associated with climate change mitigation and adaptation and making more evidence-based policy decisions.** This includes the I²AM Paris platform (which provides detailed documentation on over 50 climate models, allowing users to understand what each model explorers, corresponding assumptions and policies available within each model, as well as a variable harmonisation heatmap that allows users to see how different variables are handled across the different models), the Senses Toolkit (which helps users to understand and communicate climate change scenarios using different learning paths related to policy and economic aspects of climate change), or the SOCLIMPACT Adaptation Support Tool (which allows users to explore different climate adaptation strategies for EU islands and archipelagos based on location, sector and hazards).

4. **Allow policymakers to investigate benchmarks and best practices of various policies that have been tested and proven effective, as well as policies that have been tested and proven ineffective so that users can benefit from lessons learned elsewhere.** This includes the INNOPATHS Decarbonisation Policy Evaluation Tool (which provides users with an interactive database of scientific literature on different policies aimed at accelerating the energy transition, allowing users to see what is known and unknown about the impacts of such policies in multiple performance indicators), the Climate Policy Database (which collects information on climate mitigation policies being implemented across 42 countries and allows users to investigate the type of policy instrument, sectors covered and mitigation area, as well as how such policies perform

against a policy matrix developed by the Climate Policy Database project), or the PLACARD Connectivity Hub (which provides users with relevant knowledge and organisations working on climate change adaptation (CCA) and disaster risk reduction (DRR) issues, helping users to connect with knowledge from multiple sources, such as the European Climate Adaptation Platform (Climate-ADAPT) and weADAPT).

CCMA Policy platforms can exist on a spectrum of the abovementioned needs, addressing one or more to varying degrees. All of the platforms investigated in this thesis, however, address at least one of the needs above. Following the assessment of policy platforms (Chapter 4), and the interviews and surveys (Chapter 5), it is worth noticing that policy platforms have been conceptualised in this research as *support tools* instead of *decision-support tools*, as policymakers and policy advisors may be interested in exploring some platform to improve their understanding of some models or concepts, or to explore tested policies without a direct link to a nearby decision to be made.

Although policy platforms not related to climate change mitigation and adaptation have not been formally assessed in this research due to time restrictions, the four main needs mentioned above are still expected to apply (with some necessary adjustments in terminology) to policy platforms in different contexts. One example is the EU Health Policy Platform (https://webgate.ec.europa.eu/hpf/), which is an interactive tool designed to stimulate discussion about public health issues and make it simple for stakeholders to share knowledge and best practices. A second example is the OECD Digital Economy Policy Platform (https://depp.oecd.org/), which makes OECD and partner economies' digital strategies and digital economy policies easily comparable. A third example can also be seen in the Doing Business platform by the World Bank (https://archive.doingbusiness.org/en/doingbusiness), which allows users to explore how 190 countries perform against 11 indicators related to measures of business regulations and their enforcement, as well as better understand such measures, how they are measured, and the assumptions behind them.

This study also discovered several terms used in scientific studies and online platforms potentially related to policy platforms, as shown in Figure 6.1. In 27 scientific papers consulted throughout this thesis, 12 distinct terms were identified, with decision support tools being the most frequently used (9 references), followed by climate services (5), decision support systems (5), and support tools (5). Furthermore, 52 distinct terms were identified in dozens of web resources consulted throughout this research, including the ten policy platforms evaluated in Chapter 4, examples of tools mentioned by interview and survey participants, and examples of tools mentioned in Lumley et al. (2022) and Friedrich et al. (2023), which were individually accessed (when available) in order to identify the terms used by each platform to refer to itself. The five most common terms identified in web examples are interactive map (10 references), tool (8), online platform (7), and platform (5), followed by several other examples with fewer references. ATLAS.ti was used to support the identification of different terms used to derive the numbers shown in Figure 6.1 for both the scientific and web examples.

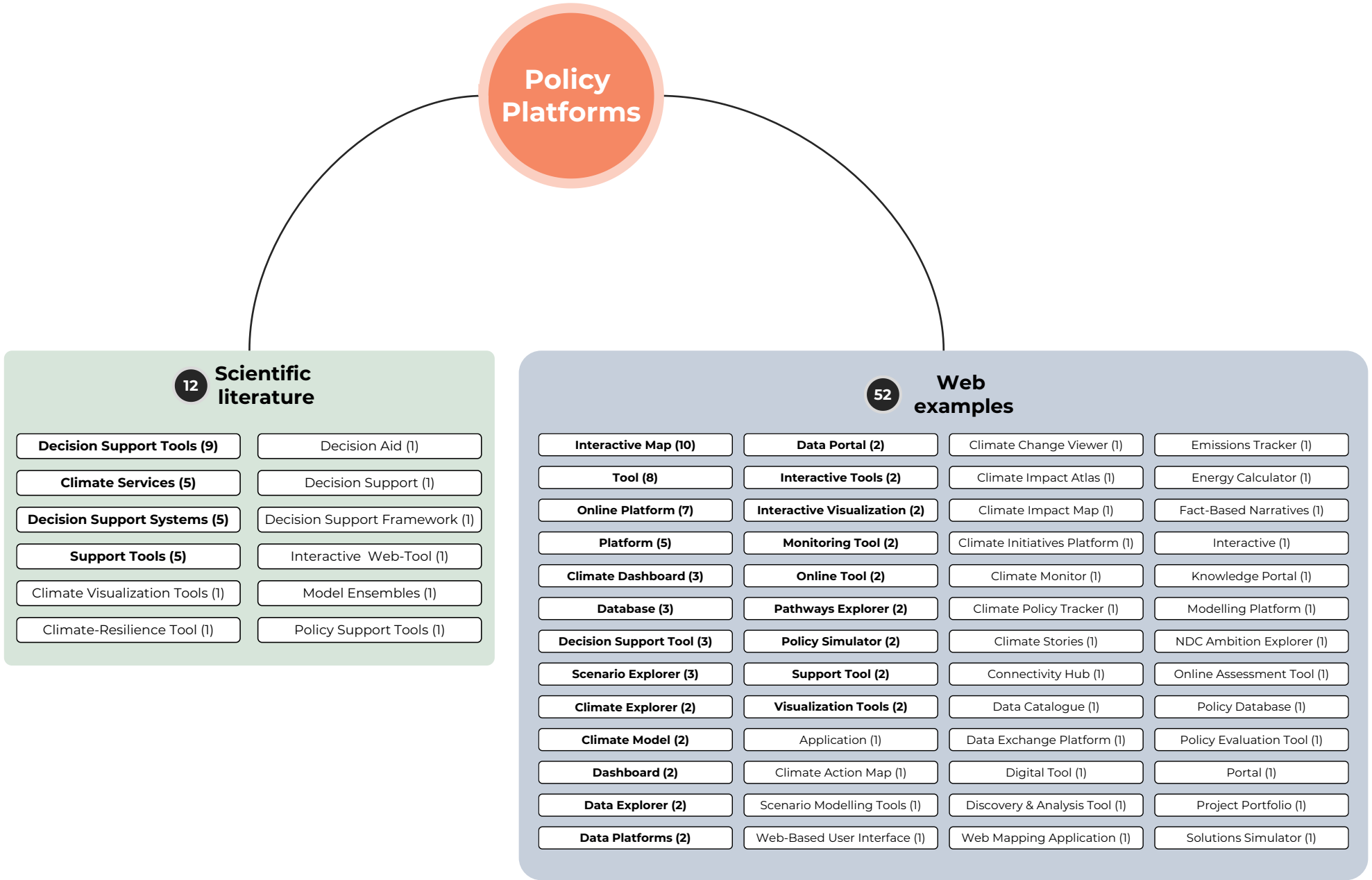


Figure 6.1. Overview of potentially policy platform-related terminology identified in scientific literature and online resources. The total number of distinct terms used in each group (scientific literature and web examples) is indicated by the numbers inside the circles, while the number of references to each term within each group is indicated by the numbers inside brackets.

6.2 Discussions

This section examines and contrasts the findings of the literature review, the evaluation of the H2020 climate change mitigation and adaptation policy platforms, and the findings of the interviews and surveys regarding typical policy platform characteristics in light of relevant literature.

6.2.1 Discussions on the usefulness of CCMA policy platforms

Subquestion 3 of this research investigated policymakers' and policy advisors' perceptions of the usefulness of CCMA policy platforms. One way in which the idea of the usefulness of climate information is frequently discussed in the scientific literature is in terms of the concepts of **credibility**, **relevance** (or salience), and **legitimacy** (**CRELE**), as discussed in a seminal paper by Cash et al. (2003) and later by several other researchers.

Credibility refers to information perceived as "meeting standards of scientific plausibility and technical adequacy" (Cash et al., 2003, p. 4), with the sources of the provided information being perceived as trustworthy. **Relevance** (or salience), in turn, refers to the importance that the provided information has for the decisions that actors have to make (Cash et al., 2003), especially in terms of the geographic context and timeliness of the provided information (Dunn & Laing, 2017). As a result, salient information is one perceived as relevant for users and the decisions they have to make (Jebeile & Roussos, 2023). Finally, Cash et al. (2003, p.5) mention **legitimacy** as to whether actors perceive "the process in a system as unbiased and meeting standards of political and procedural fairness".

In addition to the CRELE model, Dunn and Laing (2017) proposed the concepts of **applicability**, **comprehensiveness**, **timing**, and **accessibility** (**ACTA**) to assess decision-makers' concerns. **Applicability**, according to the authors, refers to scientific evidence that is applicable and usable for the problem at hand, with characteristics such as a focus on solutions (rather than problems), a focus on implementation (rather than just results), and tailored approaches perceived as relevant factors associated with the information's applicability (Dunn & Laing, 2017). **Comprehensiveness**, in turn, refers to evidence that is comprehensive and considers a wide range of factors, such as the life cycle of policy processes, broad and interdisciplinary perspectives on issues, and the economic cost and impact of various policies, which can "make or break a policy idea" (Dunn & Laing, 2017, p.150). The authors also state that policy change can occur only under certain conditions, often when opportunity windows for addressing policy concerns open; thus, the **timing** of when knowledge becomes available and reaches policymakers is critical. The authors' final point is **accessibility**, which refers to the degree to which scientific information is "readily accessible, readable, and intelligible to the audience they want to influence" (Dunn & Laing, 2017, p.148) and has the potential to jeopardise all other factors if policymakers are unable to locate or comprehend scientific research.

The usefulness of CCMA policy platforms was not explicitly contextualised in terms of the factors included in the CRELE or ACTA models for interview and survey participants in this study but instead left open for policymakers and policy advisors to discuss how they assessed the usefulness of platforms such as EUCalc and DPET in assisting them to deliver more effective advice or policies. However, both CRELE and ACTA provide valuable tools for discussing the perceived usefulness of CCMA policy platforms.

Credibility was a factor explicitly considered throughout this study. It represents the first characteristic depicted in the proposed framework in Figure 3.4, and participants explicitly

prioritised and ranked this characteristic in the interviews and survey. Most of the policy platforms assessed in this study also depicted very high levels of credibility and transparency of the information provided, with only Sentinel scoring lower than 80%, as depicted in Figure 4.2. Regarding the interviews and surveys, factors associated with credibility were not the main ones mentioned by participants (compared to some others in CRELE or ACTA). Usually, they mentioned credibility-related aspects as positive ones. Having access to literature references and benchmarks (for DPET) and different pathways, scenarios, levers and ambition levels, as well as contextualisation of these (for EUCalc), were aspects overall perceived as positive in both interview and survey results. Therefore, in terms of credibility, no challenges to the information being provided or the credibility of the sources were identified in this study.

On the other hand, the extent to which the information provided by EUCalc and DPET, and by extension any other similar policy platform, met the needs of participants produced significant mixed results. In terms of **relevance** and **applicability**, the overall results of the interviews shown in Table 5.7 show that the majority of interview participants had negative perceptions of EUCalc (96 instances), followed by mixed (21) and finally positive (19). Positive perceptions (25) outnumbered mixed and negative perceptions (21 instances each) for DPET, but only by a narrow margin. Concerns were also raised about the information's relevance and applicability to survey respondents' contexts, even though most (78%) rated policy platforms like EUCalc or DPET as "very useful". **While the information provided by EUCalc was perceived as interesting and informative, the participants, particularly those working at the municipal or provincial levels, did not consider it actionable**. EUCalc did not allow users to work with custom policy inputs to see how they would affect various scenarios, KPIs, or the overall depicted system behaviour.

Furthermore, interview participants perceived EUCalc as providing interesting levers to explore, but that were not factors that the participants could often influence (i.e., they were not within their action power), resulting in such a platform not effectively providing the means for participants to achieve their goals. Similar perceptions of DPET were expressed by interview participants and survey respondents, who stated that available policies they had an interest in investigating further in the tool ended up with results that were out of their policymaking reach or were still too scientific to be readily actionable. **These findings for EUCalc and DPET serve as a warning about how useful CCMA policy platforms can be for local policymakers if the relevance and applicability factors are not carefully considered.** The overall findings regarding the salience and applicability of the tested policy platforms reinforce that information that is not on the right scope and scale for a decision-maker can fail to influence action by not being salient enough (Kingdon 1995, as cited in Cash et al., 2003). Therefore, **CCMA policy platforms must be careful not to develop something that policymakers find very interesting to look at but then continue with their regular business with no perceivable impact**.

Another ACTA model factor that appeared multiple times in the results of the interviews and surveys was **accessibility**, which resulted in significant mixed perceptions among participants. On the plus side, particularly for DPET, being able to find benchmarks and tested and proven policies was regarded as highly beneficial, especially given that in their regular day-to-day work, policymakers frequently do not have the time to invest in searching for relevant literature and policies that may be potentially applicable to their context. As a result, having a platform that provides a curated set of scientific literature was deemed very interesting. However, these positive aspects were frequently accompanied by a negative perception of the information being difficult to digest, requiring a significant amount of time even to understand if it was applicable to their contexts, and having a high cognitive load. Such findings highlight that **it is not only about**

providing scientific information, even if in interactive formats, but also about making it accessible and understandable to the relevant users, with the risk of negatively affecting policymakers' perceptions of the usefulness of CCMA policy platforms if they cannot understand relevant research (Dunn & Laing, 2017).

The final ACTA factor identified in the study's findings was **comprehensiveness**, which was primarily related to the perception that EUCalc and DPET lack a more systemic perception of climate problems, with feedback loops, dependencies, and (political) choices that must be made in order for, say, the various pathways depicted in EUCalc to become a reality (e.g., by increasing ambitions on different key levers). This is consistent with Dunn and Laing's (2017) findings about the importance of comprehensiveness, and more specifically, holism, for effective science-policy interactions. One of the interview participants in this thesis encapsulated this perception when stating that this is "really what I am missing, this whole chain approach about decision-making because you have to approach the whole chain in order to make really good decisions" (RO2).

6.2.2 Discussions about preferences for CCMA policy platform characteristics

Subquestion 4 of this research investigated policymakers' and policy advisors' preferences regarding the identified typical characteristics of policy platforms. This subsection contrasts some relevant findings regarding *what* participants in this research find important (i.e., the characteristics assigned to each MoSCoW priority group) and what they find *most* important (i.e., the ranking of preferences within the different priorities) with findings from SQ2 and other pertinent literature on the topic in order to derive a more nuanced understanding of the preferences of policymakers and policy advisors regarding CCMA policy platforms.

6.2.2.1 Must-have characteristics

Participants ranked *communication of complex information* as the most critical must-have characteristic (i.e., lowest average rank), followed by *free and open access*, *transparency regarding data sources, limitations, and assumptions*, and *high level of detail for spatial and temporal data*. Communication of complex information is directly related to the accessibility component of the ACTA model, which helps to explain why, given participants' strong preference for *communication of complex information*, both EUCalc and DPET were perceived as lacking in this characteristic. This contrasts with the findings of SQ2, in which most platforms were given high marks for this characteristics (including EUCalc and DPET). The main reason for this is that **the results of the surveys and interviews revealed a gap between what policy platforms provide (e.g., policy briefs, infographics, and similar information, which was what was assessed in SQ2) and how well end-users understand the information provided**. The findings regarding communication of complex information also appear in line with the findings from a recent study by Arevalo et al. (2023) investigating how members of a Dutch community of practice for river studies perceive the usefulness of proposed components of an online platform for transdisciplinary research projects. According to the findings of 20 interviews, the authors discovered that participants perceived understandable presentation of available knowledge as a driver to accessing and sharing available knowledge via an online platform, but its absence could also be a barrier for non-expert users (Arevalo et al., 2023).

Free and open access is also related to the accessibility component of ACTA, and all ten policy platforms evaluated in this thesis received the maximum possible score of 100% (see component AP.2 in Figure 4.5). According to the literature review findings conducted to address SQ1, accessibility and portability (of which free and open access is a component) was the second (along

with transparency) characteristics with the highest number of references identified. These combined results show that the currently available CCMA policy platforms meet this critical user need. SQ2 findings show that the evaluated policy platforms performed well in terms of *transparency*, with many scoring 100%. Some of them were identified as not openly communicating limitations or intended users, which had a minor but not significant impact on their scores. Overall, *transparency* was a characteristic that the findings from the various subquestions yielded a consistent conclusion that the currently available CCMA policy platforms deliver such characteristic.

High level of detail for spatial and temporal data is the final characteristic within the must-have priority. This characteristic is part of the proposed framework's flexibility of use group (Table 3.4), which had the most references (20) identified in the consulted literature (Table 3.3). Almost all of the policy platforms evaluated in Chapter 4 met this criterion, as they typically provided more than one geographical scale for analysis (e.g., EU and different countries, sometimes also provinces within the EU). However, similar to *communication of complex information,* interview and survey results reinforced the importance of this characteristic (as identified in the literature consulted). However, they contradicted the performance obtained in SQ2 for DPET and EUCalc. High level of detail for spatial and temporal data directly relates to the relevance (salience) and applicability of the information provided in a policy platform, and, as discussed in the previous subsection, the overall perception of participants regarding relevance and applicability was not positive. **The high importance assigned to *high level of detail* thus helps to explain the low perception of relevance or applicability of DPET and EUCalc, given the unavailability of data on very granular levels (e.g., city and neighbourhood).**

6.2.2.2 Should-have characteristics

Within the should-have group, some characteristics did not depict significant contrasts that justify detailed discussions. The *availability of training and learning functionalities* (perceived as the most important should-have characteristic of policy platforms) and the *availability of detailed documentation* (2nd most important) are within this group. Findings regarding the *availability of training and learning functionalities* were overall consistent across the different subquestions, with relevant references identified in the literature regarding *education and awareness* (main group), but still less than some of the must-have characteristics. The results from the assessment in SQ2 also show that the platforms overall depicted high scores for education and awareness. The *availability of detailed documentation,* in turn, was perceived by interview participants as a higher level of detail than the *transparency* characteristic, meaning that it is still relevant but not so much as *transparency* (deemed mandatory by 100% of interview participants). Multiple participants mentioned that for them, such characteristic would not be fundamental. However, it would be important for other groups of users or if something very specific needed to be validated within the platform, and, therefore, that should be provided somehow. The survey results show an interesting contrast since most survey participants assessed the *availability of detailed documentation* as a must-have characteristic rather than a should-have. However, no additional information was identified in the survey results to help shed light on this difference.

Interactive and easy-to-navigate visual graphical elements ranked third within the should-have group, mostly driven by the preference of interview participants since survey respondents were split regarding the priority of this characteristic. The third position within should-have characteristics for *interactive and easy-to-navigate* contrasts a bit with the findings from Arevalo et al. (2023), which identified 'easy navigation and well-structured user interface design' as not only the most

mentioned item related to user interaction and design of an online platform, but also among the most mentioned factors overall in the study and, when missing, may become a disadvantage or make the interaction difficult.

All functionalities available via a web-based platform was the final characteristic assigned to the should-have priority group. This characteristic immediately contrasts with the *free and open access* characteristic within the must-have group (2nd), especially since both are within the *accessibility and portability* characteristic group of the proposed framework. **The consolidated results (shown in Figure 5.11) show that having a free and open-access tool to support policymakers in CCMA topics is more important (even if it requires free software to be downloaded) than having an online CCMA support tool, which is one of the most important findings of this study in terms of comparisons between policy platform characteristics**. Even though being a web-based tool was not discussed as a mandatory attribute for a policy platform in this thesis, all policy platforms evaluated to answer SQ2 and all tools accessed to derive the web examples part of the policy platform-related terminology presented in Figure 6.1 were all web-based platforms. As a result, if being an online tool is not as important to policymakers, it can significantly impact the development of future policy platforms. However, when the preferences of interview participants and survey respondents are examined individually, the results for *all functionalities available via a web-based platform* paint a very different picture. For interview participants, having an online platform is far more important (overall) than having a free and open-access tool. In fact, 36% of interview participants thought an online platform was a must-have, while 45% thought it was a desirable trait (the winning group). In turn, free and open access was the characteristic most divided among the interview participants' priority groups (18% saw it as a could-have and 27% as indifferent). For the survey respondents, a web-based platform, on the other hand, was either a should-have or a could-have (33% each), while having a free and open-access tool was mainly perceived as a must-have (44%). This indicates that **interviewees and survey respondents had very different perceptions regarding the importance of the characteristics of free and open access and availability via a web-based platform**. All survey respondents who rated free and open access as a must-have were from EU countries other than the Netherlands (Belgium, Greece, and Cyprus). One possible explanation for the higher preference for free and open-access tools might be related to the available budget such policymakers in these countries have for buying paid solutions compared to Dutch policymakers. According to recent CBS data, for example, the Netherlands ranks fourth in the EU in terms of GDP per capita, while Belgium (8th), Cyprus (14th) and Greece (22nd) are all behind the Netherlands in that regard (Statistics Netherlands, 2023).

Analysing the ranking preference attributed by participants is especially important in the context of should-have characteristics (and also for the could-have group to a lesser extent). This is because should-have requirements are frequently thought of as highly desirable functionalities in the literature on software development, and their designation as a should-have simply means that their delivery is not guaranteed and not that they will not happen (Agile Business Consortium, 2014). As a result, **for researchers and organisations developing policy platforms, understanding their should-have functionalities is critical to properly understand "what comes next?" in future developments of that platform.**

6.2.2.3 Could-have characteristics

The consolidated could-have characteristics of policy platforms were *user stories from policymakers, communities, or organisations around the world* (1st), *availability of very recent ("last year") data* (2nd), *ability to import user data, export results, or integrate the tool with other platforms* (3rd), and *ability to*

modify parameters and run custom analyses based on user inputs (4th). These characteristics were perceived as 'nice to have' by participants, but their absence (even if permanent) would not reduce the perceived value of a CCMA policy platform if relevant must-have and should-have characteristics are in place. *User stories* illustrated a disparity in behaviour between interview and survey results. Survey respondents saw this as a 'nice to have' (44%), but the should-have group remained relevant (33%). In contrast, interview participants (82%) overwhelmingly selected this as a could-have functionality in a policy platform, with many participants preferring to learn from their own network of sources rather than from policy platforms themselves, primarily due to scepticism about foreign practises fitting into the Dutch policymaking context. An important finding emerges from analysing the rankings provided by the survey and interview participants. **User stories (along with the *availability of very recent data*) demonstrated the highest intensity of preference (i.e., the lowest average rank) of all the evaluated policy platform characteristics (2.2 for the interview group).** This suggests that, **while interview participants perceive the availability of user stories from policymakers and communities around the world as challenging to obtain in a policy platform (and thus not mandatory), if a policy platform can effectively provide relevant policy benchmarks, this could significantly affect policymakers' perceived usefulness of such a platform.**

Availability of very recent data, while also showing the highest level of intensity regarding its preference (tied with user stories), showed a different priority preference between the groups, with survey respondents (56%) mostly seeing it as a could-have characteristic and interview participants (45%) mostly seeing it as a should-have characteristic. Participants in the interviews stated that, while they would always prefer to have the most up-to-date climate data, they understood that some level of delay was likely unavoidable. However, the **results suggest that policymakers and policy advisors in the Netherlands have a higher demand for up-to-date climate data than policymakers in other countries who responded to the survey.**

As a could-have characteristic, the ability to import data and export results showed minor differences between survey (33%) and interview (45%) groups, with survey respondents (2.3) indicating a stronger preference than the interview group (3.1). The relatively low MoSCoW priority and intensity preference (rank) contrasts with the findings of Arevalo et al. (2023), who discovered that the possibility of downloading or reusing available knowledge was the most frequently mentioned driver by participants within the knowledge exchange-related requirements. However, in the context of this study, while participants stated that the *ability to import data, export results, and integrate the tool with others* would be helpful, they also saw it as potentially increasing the related complexity, and thus most did not see it as being of such high importance.

The *ability to modify parameters and run custom analyses* completes the list of could-have characteristics. Although it was perceived as a could-have characteristic overall, with some interview participants mentioning that such a characteristic is not as necessary on a regular basis, a notable finding relates to the level of intensity that all participants demonstrated for this characteristic. Figure 5.8 shows that the overall average rank, survey rank, and interview rank all resulted in the same position (3.0) for the ability to modify parameters and run custom analyses. This suggests that, **while the survey and interview groups perceived the ability to modify parameters and run custom analyses slightly differently in terms of priority, all groups converged on how important such a characteristic would be within the groups**, reinforcing the perception of this characteristic as not being among the most fundamental in a CCMA policy platform.

6.2.2.4 Indifferent characteristics

The *ability to use the tool efficiently and effectively via mobile phones or tablets* and the *availability of the tool in languages other than English* round out the list of policy platform characteristics, with participants generally indifferent about the presence or absence of such functionalities in CCMA policy platforms. When it came to the *availability of the tool in different languages*, interview participants (55% for could-have) had a significantly different opinion than survey respondents (56% for indifferent). This implies that, while interview participants would still use a CCMA policy platform that never provides functionalities in Dutch and would not consider this to reduce the added value of such a platform (because they mostly perceived such functionality as 'nice to have' and not must-have or should-have), the **results show a stronger preference for providing content in languages other than English from the interview group than from the survey group** (which was mostly indifferent to such a functionality). All survey respondents who rated the language characteristic as indifferent work for the national government, the private sector, or international organisations, whereas interview participants who did not rate the language characteristic as indifferent work primarily for municipalities or provinces in the Netherlands. One possible explanation for this disparity is that users on higher policymaking levels (national and international organisations) may be more accustomed to using English on a daily basis, and thus these participants do not see the need for a tool to be available in other languages.

In terms of the *ability to use the tool efficiently and effectively via mobile phones or tablets,* interviewees were overwhelmingly indifferent (73%). In comparison, survey respondents were split between a must-have and a could-have (33%). Such findings show a wide disparity in perception between groups, which may be related to survey participants (who work more on the national level, private sector, and international organisations) having a higher demand for a tool that can deliver information via mobile phones in a convenient manner while in transit. However, there was insufficient information in the survey results to understand this behaviour fully, so this reason is speculative.

Arevalo et al. (2023) discovered two criteria connected to the above indifferent characteristics: ability to choose the language of the content and use of the online platform on multiple devices. The authors discovered that participants mentioned being able to choose the language of the content five times, and using the online platform on multiple devices had a lower number of mentions, being mentioned two times, both within a total of 37 in what they identified as the group of functional requirements. Although Arevalo et al. (2023) do not mention drivers or barriers as having an indifferent priority (or any of the priorities used in this research), the results they obtained for the possibility of choosing the language of the content would make it comparable to what was seen in this research for the *availability of the tool in languages other than English* in the surveys (56% indifferent), and the results for the use of the online platform on multiple devices would make it similar to what was observed for the *ability to use the tool efficiently and effectively via mobile phones or tablets* in the interviews (73% indifferent).

6.3 Answering research subquestion 1

What are the typical characteristics of climate-change mitigation and adaptation (CCMA) policy platforms?

A systematic literature review was used to identify relevant characteristics of CCMA policy platforms, using scientific and grey literature as sources of information. The review of the

literature (17 scientific papers and 4 grey literature documents) revealed nine characteristics of policy platforms, as shown in Table 6.1.

Table 6.1. Typical characteristics of policy platforms

Characteristic	Number of references to characteristic identified	Number of sources mentioning characteristic
Transparency & Credibility of information	15	8
Ease of use	12	8
Flexibility of use	20	12
Accessibility and portability	15	9
Education and awareness	12	8
Communication of complex information	12	8
Data visualisation & interactivity	9	6
Actively maintained and supported	9	7
Security & privacy	2	1

The above characteristics were identified in the context of climate change mitigation and adaptation support tools. However, given the generic nature of this set of characteristics, they are also likely to be directly applicable to policy platforms in a variety of other domains, such as healthcare, business, innovation, economics, transportation, and others where there is a focus on the use of policy support tools to improve policymaking.

6.4 Answering research subquestion 2

What are the similarities and differences between existing CCMA policy platforms at the EU level, considering the typical characteristics of policy platforms?

Based on the proposed framework for assessing CCMA policy platforms, the subsequent stage involved the application of the proposed framework to specific examples of platforms. This was performed to understand better how existing CCMA policy platforms compare against the identified typical characteristics. This research evaluated ten CCMA policy platforms within the H2020 programme, namely Sentinel, COACCH, SOCLIMPACT, EUCalc, INNOPATHS DPET, CD-Links Climate Policy Database, ERA4CS Senses Toolkit, Paris Reinforce I2AM Paris, PLACARD, and EnerMaps.

The results of applying the proposed framework to the CCMA policy platform examples above show that *Transparency & Credibility of Information*, *Education & Awareness*, and *Communication of Complex Information* are the characteristics in which the assessed platforms perform best, with multiple examples of platforms achieving 100% in those characteristics. These are areas where projects involved in policy platform development consistently meet high standards. Future projects aiming to develop CCMA or other types of policy platforms can draw inspiration from how the evaluated platforms generally approached these characteristics.

However, the main findings from this subquestion come from the characteristics for which the assessment using the proposed framework shows the worst performance: *Actively maintained and*

supported, *Security & privacy*, and *Accessibility & Portability*. Only two platforms (Climate Policy Database and I2AM Paris) received a perfect score for the *Actively maintained and supported* attribute, while the rest received 50% or less. Similar outcomes were obtained for *Security & privacy*, with Sentinel, Climate Policy Database, and the Senses Toolkit receiving the highest scores (all others scoring up to 67%). For *Accessibility & Portability*, despite having higher overall scores than for *Actively maintained and supported* and *Security & privacy*, 80% of the assessed platforms failed to obtain the minimum passing scores for the Lighthouse accessibility tests, with only Sentinel and Climate Policy Database receiving sufficient high scores.

The findings of SQ2 show that currently available policy platforms are significantly lacking in relevant characteristics required for a support tool to be not even *useful* but *used* by policymakers. If a given policy platform is not deemed safe to explore, accessible to a wide range of users, and provides up-to-date and relevant (salient) information, potential users may be unwilling to even invest the time required to get to know a platform and see if it meets other important needs.

6.5 Answering research subquestion 3

How do policymakers and policy advisors perceive the usefulness of CCMA policy platforms?

The CRELE (credibility, relevance, and legitimacy) and ACTA (accessibility, comprehensiveness, timing, and applicability) models can help to understand the usefulness of CCMA policy platforms better. The results of interview participants' perceptions of the usefulness of the tested platforms (DPET and EUCalc) show a very divided perception of DPET's usefulness (with nearly a third of opinions being either positive, mixed, or negative) and a mostly negative perception of EUCalc's usefulness (with an overwhelming 71% of the identified perceptions being negative). The survey results show an overwhelmingly positive opinion about the usefulness of both tools, with 78% of survey respondents describing tools like EUCalc and DPET as "very useful." This demonstrates a significant disparity in the perceptions of the usefulness of those two tested CCMA policy platforms among the various groups. This difference in perceptions is challenging to explain in detail because the way information was gathered in the surveys did not allow for the same rich levels of analysis as the interviews. However, by looking at the usefulness of CCMA policy platforms on a larger scale, the question of how policymakers and policy advisors perceive the usefulness of CCMA policy platforms can be answered.

Accessibility, relevance, applicability, and credibility were identified as the primary factors driving the perception of the usefulness of CCMA policy platforms. *Enhancing comprehension of how to realise desired futures*, *being connected to the policymaking level in which the system can be influenced*, *allowing the evaluation of the effects of custom policies on the system*, and *being connected to the challenges faced by participants in their policymaking context* were among the most important themes identified in the interview analysis, emphasising the importance of salience and applicability. When participants referred to the provided information in DPET and EUCalc, some described it as *excessively detailed and scientific information with a high cognitive load* and having *insufficient contextualisation of purpose, concepts, and functionalities available*. Finally, participants praised the availability of tested policies that can serve as benchmarks, as well as the ability to test different scenarios and policy levers in DPET and EUCalc. Other factors from CRELE or ACTA, such as timing, legitimacy, and others, were mentioned more in context and were not perceived as having the same importance as relevance, applicability, accessibility, and credibility.

To summarise and answer SQ3, a useful CCMA policy platform is one that assists policymakers and policy advisors in achieving their goals and delivering better policies (or advice) by providing

information and functionalities relevant to their policymaking context, translating complex information into accessible and actionable insights, and being developed by credible sources while being transparent in terms of its capabilities and limitations.

6.6 Answering research subquestion 4

What characteristics do policymakers and policy advisors look for in CCMA policy platforms to be used as support tools for policymaking?

Policymakers and policy advisors look for aspects of CCMA policy platforms that will be useful in helping them deliver better policies or advice. As stated in SQ3, such aspects are closely related to accessibility, relevance (salience), applicability, and credibility. According to interview and survey participants, SQ4 provides a higher level of detail on the characteristics participants value in a policy platform.

To address the need for accessibility, a useful CCMA policy platform must provide functionalities that support the *communication of complex information in an easy-to-digest format* and *free and open access to all functionalities of the tool*. To meet the need for relevance and applicability, a CCMA policy platform must provide *high level of detail for spatial and temporal data*. To meet the need for credibility, a CCMA policy platform must have *transparency regarding data sources, limitations, uncertainty, or assumptions associated with the tool*. These characteristics (in that order) constitute the identified **must-have characteristics** of a CCMA policy platform. Must-have characteristics are those that are *sine qua non* for policymakers even to consider using a given policy platform, and the lack of such characteristics can significantly impact the perceived usefulness of a CCMA policy platform.

A useful CCMA policy platform should, in addition to the fundamental characteristics mentioned above, provide *training and learning functionalities* (to assist users in understanding topics and learning how to use the tool), *detailed documentation on concepts and models used in the tool* (to assist users in understanding details of available models and increasing the perception of transparency and credibility of the tool), *interactive and easy to navigate visual graphical elements*, and *all functionalities available via a web-based platform* (to facilitate the adoption of the tool by multiple users and the communication and sharing of information). These are the identified **should-have characteristics** of a CCMA policy platform (in that order). Should-have characteristics are regarded as highly desirable by users and comprise the list of priority items to be included in a given tool in future developments and updates. If should-have characteristics are never met by a support tool, it can have a significant effect on its perceived usefulness and added value.

The results also show that it would be 'nice to have' a CCMA policy platform that provides *user stories from policymakers, communities or organisations around the world* (so users can learn from each other and share best practices), *very recent ("last year") data* (so decisions can always be based on the most up to date data), the *ability to import user data, export results, or integrate the tool with other platforms* (so users can continue previous scenarios and integrate obtained results in a bigger analysis workflow) and the *ability to modify parameters and run custom analyses based on user inputs* (so users can run specific what-if scenarios, sensitivity analysis or specific analysis according to particular hypothesis or needs). These are the identified **could-have characteristics** of a CCMA policy platform (in that order). Could-have characteristics are those that, if successfully met, significantly increase the perceived usefulness and added value of a specific CCMA policy platform. However, even if a policy platform never provides these capabilities, policymakers

would still find such a tool useful (as long as other relevant must-have and could-have characteristics are also present).

Finally, the participating policymakers were **indifferent** to a CCMA policy platform that is *available in languages other than English* and allows users to *use it efficiently and effectively via mobile phones or tablets*. Indifferent characteristics represent factors for which users do not have a strong preference, and neither the presence nor absence of such functionalities significantly influences users' perceptions of the usefulness of such a platform. Unless perceptions of preference change or different groups (with different preferences) are to be prioritised, researchers and organisations developing policy platforms should not invest significant time and effort with indifferent characteristics.

6.7 Answering main research question

What recommendations can be made for the design and use of CCMA policy platforms in order to improve their usefulness as support tools for policymakers and policy advisors?

Based on the findings obtained in this research and the answers to each of the subquestions, the main research question above can be revisited and answered. Some recommendations to improve the usefulness of climate change mitigation and adaptation policy platforms are discussed below.

1. **Incorporate systematic reviews of existing CCMA policy platforms into projects for new platform development.** This recommendation is important for a variety of reasons. First, given that over 100 examples of CCMA web tools have been identified in the context of this thesis alone (potentially including duplicated results), having a clear understanding of how a new CCMA policy platform connects to the existing body of support tools could improve the understanding of how that new tool fills existing gaps. Second, some policy platforms developed in projects funded by programmes such as H2020 already have deliverables related to literature reviews (for example, to better understand the nuances and various perspectives on concepts such as energy citizenship, prosumerism, and others that may have a direct impact on how the project is developed). As a result, a formal review of comparable platforms appears to be appropriate scientific practice to be implemented. Finally, when such EU-funded projects are added together, they account for significant research funding. The Horizon Europe budget exceeded the EU Horizon 2020 program's nearly €80 billion budget. Since this money could have been allocated to other areas that may also require funding, it is critical to be well-invested to achieve the greatest societal gains possible. Multiple projects to develop new policy platforms without clearly understanding why those are needed and how they connect with existing platforms is not ideal. This recommendation is best suited for organisations that incentivise research and provide funding (for example, the European Commission in the case of H2020 and Horizon Europe) and could be implemented as part of the regulations that guide project deliverables.

2. **Involve boundary organisations in the development and use of CCMA policy platforms and information.** One of the main negative perceptions expressed by policymakers and policy advisors during the interviews was that the EUCalc and DPET platforms were too far removed from the reality of local policymakers. Despite positive perceptions of both platforms, this perception highlights a potential gap between many of the EU-level policy platforms and the context and policies that local policymakers can indeed implement to influence the context in which they operate. Policymakers and policy advisors praised organisations such as PBL and the Royal Netherlands Meteorological Institute (KNMI) for making climate science more actionable in the interviews. These two examples, along with others in other countries, such as the Potsdam

Institute for Climate Impact Research (PIK) in Germany, the International Institute for Applied Systems Analysis (IIASA) in Austria, and the CICERO Center for International Climate Research in Norway, have the potential to play a significant role as boundary organisations, as described in the literature. Boundary organisations contribute (in addition to conducting scientific research when applicable) by assisting in the translation, mediation, and communication processes that can make climate science more usable to various stakeholders (Lemos et al., 2012), as well as assisting policymakers in more effectively accessing and using data and tools for climate policymaking (Moss et al., 2014). In the case of the Netherlands, PBL and KNMI also serve as official data institutes (Government of the Netherlands, n.d.), raising policymakers' perceptions of the usefulness of the information these organisations provide (by impacting factors such as relevance and accessibility). Boundary organisations can help by directly participating in the development of the support tools (as is already sometimes the case with PBL, IIASA, and PIK, who are part of the consortium responsible for the development of the CD-LINKS H2020 project, for example), developing guidelines or primers on how to better communicate climate science to policymakers (according to best practices recommended by literature), or by, whenever possible, using models and CCMA policy platforms as tools to derive policy advice to be made available to policymakers across the EU.

3. **Develop CCMA policy platforms that will be available in the long run**. Another important point that emerged when analysing the various policy platforms in the context of the H2020 programme is the life expectancy of policy platforms. Six H2020 projects that were shortlisted for analysis no longer had accessible websites, with some already having completely different websites using those domains. These projects were completed between 2018 and 2021, so the list includes projects completed approximately five years prior to being tested in this research and projects completed within the last two years. Naturally, website maintenance is expensive, and the dedicated project team is often no longer involved in those initiatives after the end of the corresponding project, so this does not appear to be an easy problem to solve. However, platforms that are not regularly updated will eventually become unsuitable for policymakers, who will likely no longer trust the data provided, according to feedback from policymakers. If the website that hosts the policy platform becomes inaccessible, policymakers will be hesitant to learn about and use some platforms because there is no guarantee that they will be available in a few years. Similar issues were discovered in the privacy and security characteristic group, with some policy platform websites remaining accessible despite lacking critical security credentials (such as valid SSL certificates that enable an encrypted connection). Depending on the IT systems in place for various policymaking organizations, a policy platform that is not deemed secure by antivirus and other similar software used in those organisations may be automatically blocked, preventing policymakers from even being aware of such tools. Connecting completed projects with new projects is one method for ensuring that knowledge generated in EU projects is kept alive, as is the case with the I2AM Paris platform, which is linked to one ongoing H2020 project (ENCLUDE) and two Horizon Europe projects (IAM Compact and DIAMOND). This could be a viable solution if projects are logically linked, such as research approach, objectives, universities, research organisations involved, or researchers. Another option would be for organisations that incentivise research and provide funding (for example, the European Commission in the case of H2020 and Horizon Europe) to allocate specific budgets for the long-term maintenance of developed policy platforms and, eventually, have solutions in place for the migration of such platforms to other domains or the eventual decommissioning of the tools.

4. **Develop CCMA policy platforms that can accommodate the needs of different users**. Some perceptions shared by policymakers for EUCalc and DPET were that both platforms were too complex to understand, or that the amount of information displayed on the screen at once was too overwhelming or detailed, and that it was difficult to quickly understand how to use such tools. Although these perceptions were present, they were not shared by all participants, with other participants possibly viewing the same items as positive characteristics (e.g., being detailed and thorough or depicting a clean UI). As a result, having a single layout for the tool to serve all users is unlikely to meet everyone's needs. Researchers and organisations developing CCMA policy platforms may choose to present information to users incrementally or in layers. Instead of providing the most detailed information up front and leaving it up to users to find and filter what is relevant, a hypothetical CCMA policy platform could approach user interaction in layers. This can be accomplished, for example, by first asking users to select what they want to achieve with that tool (e.g., explore scenarios, learn topics, find user stories), and then presenting incrementally different options for further selection by the user based on the previous selection. This design is not guaranteed to please everyone, but it may be able to serve better different needs (more general versus more detailed information). Some aspects of this have been observed in the Senses Toolkit (which provides users with access to different portals, policy, and finance, leading to distinct learning paths) and the I2AM Paris platform (which allows users to select different layout options for some screens based on the level of detail they are interested in). The recent rapid advancements in technologies such as Artificial Intelligence can also play an important role in making information more adaptable to different needs, as well as potentially explaining concepts, models, and results obtained by using a CCMA policy platform in the near future, thereby making information more digestible and actionable.

6.8 Limitations

Despite being as thorough as possible in the time available, this analysis has important limitations that deserve formal mention.

6.8.1 Limitations of the proposed framework for assessing policy platforms

The proposed assessment method of assigning either a "√" mark (if successfully meets the criterion), a "✗" mark (if the policy platform does not meet the criterion), or a "N/A" mark (if that criterion does not apply to that policy platform) to the different criteria in the proposed framework, while relevant for an initial assessment, does not represent a fully validated and robust assessment method. This approach was proposed because no detailed methodology was identified. The literature review revealed several important characteristics of policy platforms. However, no method was identified for evaluating such characteristics at a higher level of detail, as proposed in the framework. As a result, the various criteria were designed to be as simple as possible and to support a binary type of assessment (pass or fail). However, in reality, different levels of transparency, ease of use, flexibility of use, and others exist that cannot be fully captured in the simple assessment method proposed. Furthermore, while some criteria were assigned to one group, they shared intersections and similarities with other groups (for example, ease of use and communication of complex information may share some of the proposed criteria due to similarities).

Besides the assessment method mentioned above, the proposed criteria are subject to differing opinions, as they were developed through the critical evaluation of only one researcher (the student writing this thesis), with some level of feedback collected from experts. As a result, when

evaluating the various policy platforms using the proposed criteria, the same set of questions, in some cases, proved to be more applicable to one platform but much less to others, highlighting some potential redundancies in the criteria list. This was the case with criterion EU.3 ("*does the tool produce outputs that are brief, clear, or simple to understand and use (e.g., brief reports, takeaways, summaries, etc.)?*") and criterion CI.1 ("*does the tool provide brief resources (e.g., key takeaways, summaries) to synthesise complex information in a more easily digestible format?*"), which address slightly different perspectives of how information is provided in a support tool.

The above limitations, while present, were not found to have a significant impact on the results obtained because they primarily affect SQ2 and not the entire thesis. They also highlight the need for additional research on this topic to revise and advance the proposed framework.

6.8.3 Limitations of the assessment of the perceptions of usefulness and preferences of interview participants and survey respondents

The number of interview participants (11) and survey respondents (9), while deemed adequate when considering the duration of this thesis, is potentially insufficient for drawing generalisable conclusions. The findings of this study can thus be used to improve current knowledge of policy platforms and climate-change-related support tools, but they do not provide automatically extendable results. The small number of participants (20, including interviews and surveys) impacts how sensitive the results are to minor changes in policymakers' perceptions. With eleven interview participants and nine survey respondents, even a single change in opinion about a characteristic's MoSCoW priority could potentially change the results and move characteristics to different groups, leading to different results. Minor changes would most likely have no major effect on the overall results, but larger changes in participant opinions could have changed the final MoSCoW groups obtained in this study.

Furthermore, the inherent differences in the design of the interviews and surveys limited the depth of what could be analysed regarding survey respondents' perceptions of the usefulness of CCMA policy platforms and their typical characteristics. Survey respondents and interview participants had significantly different perspectives on the usefulness of CCMA policy platforms. Similarly, for some policy platform characteristics, the two distinct groups sometimes perceived the same characteristic in two different priority groups (e.g., the ability to use a policy platform via mobile phones and tablets and the availability of the tool in different languages). Due to the limited amount of information available from the survey results regarding why respondents chose each priority and rank, some of these disagreements could not be fully investigated and explained in this study.

This thesis addresses the above limitations by (i) aggregating the results of interviews and surveys to derive a consolidated perspective on the usefulness and preferences of policy platform characteristics to provide answers to the various research questions and (ii) being transparent about these limitations and suggesting additional research to improve the robustness of the findings.

6.9 Academic relevance

This study contributed to the academic literature on climate change decision-making in a variety of ways. First, based on examining 21 literature references (17 scientific, 4 grey literature), this study identified nine typical characteristics of CCMA policy platforms. Based on the identified characteristics, this study proposed a framework consisting of the nine characteristic groups identified in the literature plus 42 criteria (embedded in the 9 different characteristic groups) to

operationalise the assessment of policy platforms based on how well they meet the identified characteristics. To the best of my knowledge, no such framework at this level of detail had been identified in the literature, making it an important first step toward moving from *what* are the relevant characteristics to *how* to assess these identified characteristics in practice. Given its generic nature, the proposed framework can be used to evaluate not only CCMA policy platforms but also policy platforms and decision-support tools in other contexts.

Second, this thesis provides an overview of recent work in this area and evaluates ten available CCMA policy platforms using the proposed framework by systematically evaluating CCMA H2020 projects linked to policy platforms. This type of analysis can help future policy platforms be developed by better understanding how newer platforms compare and contrast to what has previously been developed in terms of proposed characteristics and criteria. To the best of my knowledge, no previous systematic analysis of a large repository of projects (such as the H2020 programme repository) has been identified with a focus on identifying projects developing CCMA policy platforms or other types of support tools. Based on the findings from this analysis, this thesis also recommends that projects tasked with developing new platforms conduct literature reviews of existing policy platforms to better understand how the new platform fits into the existing body of knowledge and practice.

This thesis presented the findings of an analysis of policymakers' perceptions of the usefulness of CCMA policy platforms and their preferences (in terms of functionalities available in policy platforms). Following multiple rounds of literature reviews conducted throughout this thesis, identifying policymakers' preferences and needs regarding climate change data and tools proved to be an area in need of further research. This thesis advances current knowledge on climate change support tools and climate decision-making by assessing the perceived usefulness and most relevant characteristics of CCMA policy platforms according to this target group.

The analysis of the usefulness of CCMA policy platforms confirmed extensive literature findings regarding the impact of factors such as credibility, relevance (salience), and legitimacy (CRELE), as well as accessibility, comprehensiveness, timing, and applicability (ACTA) on the usefulness and usability of climate information. However, the findings of this thesis indicate that relevance, applicability, and accessibility were more important than other factors in policymakers' perceptions of the usefulness of CCMA policy platforms. More research is needed to confirm or update such findings. Concerning preferences for policy platform characteristics, the consolidated results show a clear organisation and ranking of characteristics into must-have, should-have, could-have, and indifferent. Based on the literature reviewed, most previous work focused on identifying what policymakers and other users liked or disliked in different support tools or what they thought could have been different or improved. No previous systematic method for assessing policymakers' preferences by combining MoSCoW prioritisation and numerical ranking applied to CCMA support tools had been identified in the literature consulted in this research. Therefore, this study's findings provide important contributions to current knowledge about the most important attributes of CCMA support tools as perceived by some end-users.

Finally, as a result of the research findings, this thesis provided a preliminary demarcation of the concept of CCMA policy platforms. There were 52 distinct terms potentially related to policy platforms identified in web examples and 12 distinct terms potentially related to policy platforms identified in scientific literature, highlighting the importance of further research to provide a more harmonised definition in climate information science.

6.10 Societal relevance

Addressing the climate change crisis is perhaps humanity's greatest challenge of the century. SDG 13 ("Climate Action") is the Sustainable Development Goal (SDG) that most directly mentions the need to address climate change, though the topic is intertwined with several other SDGs, reinforcing its core relevance as a major international grand challenge. During the course of this study, the Intergovernmental Panel on Climate Change (IPCC) released its Climate Change 2023: Synthesis Report, which provides the main scientific input for the upcoming COP28, to take place at the end of 2023 and marks the midpoint between the Paris Agreement (2015) and the targets for the end of the decade. As one of the synthesis report's main messages, it is stated that there is a "rapidly closing window of opportunity to secure a liveable and sustainable future for all" and that the “choices and actions implemented in this decade will have impacts now and for thousands of years” (AR6 Synthesis Report: Summary for Policymakers Headline Statements, n.d.). Furthermore, on July 2023, a few weeks before this thesis is being submitted, the average global temperature reached all-time high values in two consecutive days (Paddison, 2023), providing a case-in-point example of what UN Secretary-General António Guterres called the arrival of the “era of global boiling” (Guterres, 2023, p.1).

The urgency of climate action is undeniable. However, many problems remain in meeting the essential targets to decrease the effects of climate change to the bare minimum that is still feasible. This study contributes to this by examining how climate-change mitigation and adaptation policy platforms may better promote evidence-based policymaking. Given that climate decisions must be made quickly and often under conditions of high uncertainty, policy platforms can potentially be powerful partners in the fight against climate change.

6.11 EPA relevance

This study was conducted as part of TU Delft's MSc in Engineering and Policy Analysis (EPA). Following the objectives of the MSc programme, this thesis addressed a societal grand challenge (climate change mitigation and adaptation, CCMA) while taking into account the political environment in which it is embedded (by engaging with policymakers and policy advisors working on such issues to identify their perception of the usefulness of CCMA policy platforms and their preferences regarding their typical characteristics). This thesis presents a multi-actor perspective by gathering information from policymakers at various organisational levels (municipal, provincial, and national) and from various countries. This thesis employs a variety of research methods, including surveys, interviews, and document analysis, as well as a proposed framework to assess examples of CCMA policy platforms and an adapted MoSCoW prioritisation with embedded numerical ranking methods to gain a more nuanced understanding of the potential of CCMA policy platforms to inform decision-makers and support evidence-based policymaking.

6.12 Recommendations for future work

This section provides recommendations for future work based on the findings from this research.

1. **Promote research to harmonise terminology involving CCMA policy platforms, decision-support tools, decision-support systems, and similar terms.** As a result of the research conducted in this thesis, dozens of distinct terms were identified that can potentially be related to CCMA policy platforms (or support tools in general), as shown in Figure 6.1 (52 identified in web examples and 12 in scientific literature). This demonstrates that the climate decision-making field is producing a large number of research and output tools, but it also appears to be very dispersed.

A more consistent definition of the concept of CCMA support tools could improve understanding of how the literature is organised in this field and aid in implementing literature reviews of available policy platforms (as recommended in the answer to the MRQ in section 6.7).

2. **Investigate how best to incorporate user stories from policymakers into CCMA policy platforms**. *User stories from policymakers and organisations around the world* was perceived as a 'nice to have' (could-have) characteristic by policymakers from both interview and survey groups, who stated that they could obtain relevant benchmarks and lessons learned from other sources such as their networks. However, this was characteristic with the highest intensity of preference (average rank of 2.2 for interviews), indicating that it could significantly improve the perception of the usefulness of a policy platform if it is implemented efficiently. This is an important finding from this study, but it also raises new questions about how to best implement this characteristic to meet the needs of policymakers. One option, which has been identified in the PLACARD policy platform, is to provide access to external already consolidated platforms (via hyperlinks to relevant stories or case studies) such as weADAPT, Climate-ADAPT, ThinkHazard!, Climate Change Knowledge Portal (CCKP), among others. Additional research can provide insights into how to best incorporate this relevant characteristic into new policy platforms.

3. **Investigate the potential of technologies such as artificial intelligence to improve the usefulness and functionalities available on CCMA policy platforms**. Recent developments in the field of artificial intelligence have been exceptionally quick, and functionalities such as the ability to have the AI interact and answer questions using images and documents as inputs by the users are already available to the general public to some extent (e.g., via Bing Chat and Perplexity AI). New developments in Artificial Design Intelligence (ADI) promise users the ability to create websites tailored to different users (e.g., Wix AI Site Generator). No robust solution applied to CCMA support tools involving AI has been identified in this thesis. However, the rate at which advancements have occurred allows one to imagine a CCMA policy platform being developed still within the Horizon Europe programme with embedded AI capabilities to help users understand complex climate concepts and scenarios, explore models, and provide high levels of customisation. More research is needed to determine how to best use such technologies for policy platforms and what important considerations may arise.

4. **Verify the robustness of this research's findings by conducting similar research with a larger sample of policymakers and more recent CCMA policy platforms (e.g., from Horizon Europe).** Further research based on the proposed framework can help improve the proposed criteria and assessment methods, leading to better results when assessing different policy platforms. Additionally, by conducting additional research with more recent policy platforms and with a larger sample size of policymakers, the results obtained in this thesis regarding the perceptions of the usefulness of CCMA policy platforms and the preferred characteristics can be reviewed and potentially updated, leading to better policy platforms being developed and delivered to policymakers.

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Appendix 1

Content

Table A1.1. References of characteristics of decision-support tools and systems in consulted literature

Characteristic	Source	Relevant references
Transparency & Credibility of information	International Organization for Standardization (2011)	Functional correctness: degree to which a product or system provides the correct results with the needed degree of precision [Part of ISO/IEC 25010:2011 Product quality model]
	McIntosh et al. (2011)	Credibility and reliability also have a significant impact on EDSS adoption in terms of trust between user and developer, and in terms of the attributes of the information provided by the system (certainty, relevance, completeness, reliability)
	Broekx et al. (2012)	Provide information in a structured way in order to contribute to decision making. This includes a representation of the state of the water system, the pressures coming from different economic sectors and the potential impact of measures. Data on measures need to be detailed, include uncertainty margins and include the source of information
	Palutikof et al. (2019)	What do you think are the key features of a Coastal Climate Risk Management Tool that will make it useful for coastal decision makers? [The tool] is authoritative: gives guidance that has been developed, reviewed and approved by experts
	Hewitt and Macleod (2017)	The digital application will aim to be credible, with transparency in the information and methods used
	Hewitt and Macleod (2017)	**Uncertainty, credibility and trustworthiness:** Participants emphasized the need to deal honestly with uncertainty, both of data and of model/application outputs. This was regarded as having important implications for the credibility and trustworthiness of the information provided by the decision-support application
	Hewitt and Macleod (2017)	Openness about limitations/transparency: It was regarded as important to be transparent about what a tool can and cannot do. Transparency of the tool and of the decision-making process was a key principle
	McIntosh et al. (2011)	Representation of uncertainty in results (Summary of success criteria for different EDSS roles)
	Schumacher et al. (2020)	Shortcomings that end-users associated with known DSTs included oversimplification and poor communication of data quality and uncertainties.
	Hewitt and Macleod (2017)	Clarity of purpose and objectives: Participants highlighted the need for clarity about the intended purpose and objective of the application

Table A1.1. References of characteristics of decision-support tools and systems in consulted literature (cont.)

Characteristic	Source	Relevant references
Transparency & Credibility of information	Bartke and Schwarze (2015)	**Transparency**: How transparent are the assessment methods and the calculation algorithms? Are there clearly defined time frames and goals? Are the evaluation methods comprehensible and traceable? Do they indicate risks and uncertainty?
	Collini et al. (2022)	The resulting features recommended during Phase Two for the online tool spanned both function and content. […] elements for transparency (e.g., a list of all tools), tool factsheets and other tool-specific outputs
	McIntosh et al. (2011)	Be open and honest about system weaknesses and areas in need of improvement, including model uncertainties and assumptions
	McIntosh et al. (2011)	Actions that would assist adoption: the tools being well documented with adequate help resources available online.
	McIntosh et al. (2011)	Tools should be well-documented with adequate help facilities (Best Practice Recommendations)
Ease of use	MS10: Validated Requirements for the ICARUS DSS (2016)	According to the feedback received the user requirements should comprise the following: • Design of a user-friendly and readily accessible Web-based air quality and carbon footprint information service.
	Aristotle University of Thessaloniki et al. (2018)	The user-centric tools must be as user-friendly as possible
	Fürst et al. (2010)	Self-explanatory user interface, as precondition for broad acceptance and use. The system must be suitable for users inexperienced with the use of computer-based tools.
	González and Connell (2022)	Several stakeholders stressed that the large number of datasets available was overwhelming to navigate... It is hoped that the resulting inclusion of a user manual on how to navigate data groupings, visualise individual layers and apply data exploration and assessment functionality helps address the observed difficulties
	Clar and Steurer (2018)	Because the tool aims to address all actors irrespective of their adaptation expertise, its modules proceed from basics to advanced support
	McIntosh et al. (2011)	Actions that would assist adoption: the tools being presented in a simple fashion to the end user to reduce complexity

Table A1.1. References of characteristics of decision-support tools and systems in consulted literature (cont.)

Characteristic	Source	Relevant references
Ease of use	Harold et al. (2016)	Graphics can be made more accessible and more easily understood by matching graphic parameters with parameters that influence or make up prior knowledge of the viewer
	Harold et al. (2016)	Reduce complexity: An excess of visual information can create visual clutter and impair comprehension
	Clar and Steurer (2018)	Both tools are comparatively simple to use and produce outputs that are relatively easy to apply (e.g., short reports, briefing notes, presentations).
	International Organization for Standardization (2011)	Operability: degree to which a product or system has attributes that make it easy to operate and control [Part of ISO/IEC 25010:2011 Product quality model]
	International Organization for Standardization (2011)	User error protection: degree to which a system protects users against making errors [Part of ISO/IEC 25010:2011 Product quality model]
	Clar and Steurer (2018)	local actors who were unfamiliar with but interested in adaptation might value the step-by-step introduction provided by the tool (NG1, NG2, LG1, LG2).
	Collini et al. (2022)	The resulting features recommended during Phase Two for the online tool spanned both function and content. […] case studies and help features (tutorials on how to use the tool, help boxes)
	McIntosh et al. (2011)	User interface should be adaptable to different types of users, based on their knowledge/expertise
Flexibility of use	MS10: Validated Requirements for the ICARUS DSS (2016)	Other key requirements expressed by stakeholders included: • The possibility of getting results from the simulation of different policy options and technological measures (how they will impact on the AQ and CF levels) • A guided procedure for future scenario design to allow users to formulate their own scenarios for various parameters should be incorporating in the system. • Download of data
	Bartke and Schwarze (2015)	**Flexibility**: Is the method tied to local circumstances or does it work only for certain categories of land or use? To what extent can the methods' modalities (such as criteria) be adapted to local conditions? Is reversibility addressed?

Table A1.1. References of characteristics of decision-support tools and systems in consulted literature (cont.)

Characteristic	Source	Relevant references
Flexibility of use	Roth et al. (2014)	Decision support systems that allow for high-level 'what if scenario' modelling (Rippen, 2005) and thereby provide the possibility to feed in and analyze specific data and parameters (Power, 2000) could as well help to allay the impression of users that a tool does not take account of local circumstances and that they have to conduct everything for their own.
	Schumacher et al. (2020)	Some end-users also suggested that increased flexibility of DSTs could improve their practical relevance. For instance, DSTs should be flexible, so that outputs can be adjusted according specific end-users needs
	Broekx et al. (2012)	The ability to easily compose and exchange scenarios across different water aspects was considered very interesting
	Szimba et al. (2017)	Modular structure allowing stepwise validation
	Schlobinski et al. (2011)	Users need to be able to specify the values for parameters within a scenario (including initial and boundary conditions), as well as the particular models to be included for each scenario.
	Collini et al. (2022)	The resulting features recommended during Phase Two for the online tool spanned both function and content. […] log-in feature to save searches, specific navigation features to move through the tool, and ability to see progress throughout the search.
	McIntosh et al. (2011)	Design a EDSS that can be used to solve multiple environmental problems
	Hewitt and Macleod (2017)	"Specify intended scale of data and operation"
	McIntosh et al. (2011)	"Base model selection on spatial and temporal scale and level of complexity required for problems, and to fit with end user decision strategies" (Best Practice Recommendations)
	Hewitt and Macleod (2017)	Logic Model: can logic models potentially be viewed and edited?
	Schlobinski et al. (2011)	The system shall support analysts by including design features which facilitate manipulation of elements of the modelled system (e.g. parameters, variables, input data).

Table A1.1. References of characteristics of decision-support tools and systems in consulted literature (cont.)

Characteristic	Source	Relevant references
Flexibility of use	González and Connell (2022)	The LARES web-tool viewer allows the examination of multiple environmental, planning and resource potential criteria. The LARES widgets enable assessment and identification of potential development sites for each renewable energy technology on the basis of constraint/ exclusion criteria pre-defined by the user
	Hewitt and Macleod (2017)	To establish a genuine process of knowledge exchange, information needs to flow in both directions, so some form of user interaction is necessary, either in terms of allowing the user to pull data from the system, or in actually offering the possibility to upload and work with users' own data
	Schlobinski et al. (2011)	In order to support the generation of information products beyond basic reports, the analyst will need to be able to export artefacts (such as model execution results or visualized data) to other formats for use of external tools.
	Hewitt and Macleod (2017)	The tool should allow developers and end-users to develop and extend the software/existing application
	McIntosh et al. (2011)	Actions would assist adoption: the tools being flexible enough to meet end users' require ments to use them in ways that suit them personally and organisationally.
	International Organization for Standardization (2011)	Flexibility: degree to which a product or system can be used with effectiveness, efficiency, freedom from risk and satisfaction in contexts beyond those initially specified in the requirements (Note: Flexibility can be achieved by adapting a product for additional user groups, tasks and cultures) [Part of ISO/IEC 25010:2011 Quality in use model]
	International Organization for Standardization (2011)	Modifiability: degree to which a product or system can be effectively and efficiently modified without introducing defects or degrading existing product quality [Part of ISO/IEC 25010:2011 Product quality model]
Accessibility & Portability	International Organization for Standardization (2011)	Accessibility: degree to which a product or system can be used by people with the widest range of characteristics and capabilities to achieve a specified goal in a specified context of use [Part of ISO/IEC 25010:2011 Product quality model]
	Calvo et al. (2021)	Accessibility: Discipline and rules that guarantee that websites and technologies are designed and developed so that people with disabilities can use them independently from their capability limitations: auditory, visual, cognitive, physical, or neurological

Table A1.1. References of characteristics of decision-support tools and systems in consulted literature (cont.)

Characteristic	Source	Relevant references
Accessibility & Portability	MS10: Validated Requirements for the ICARUS DSS (2016)	According to the feedback received the user requirements should comprise the following: • Design of a user-friendly and readily accessible Web-based air quality and carbon footprint information service.
	MS10: Validated Requirements for the ICARUS DSS (2016)	According to the feedback received the user requirements should comprise the following: • Low operational cost to the users and ease to use (on-line help and guidance at all times).
	Aristotle University of Thessaloniki et al. (2018)	The user-centric tools must be available through a web-interface
	Aristotle University of Thessaloniki et al. (2018)	The user-centric tools must also be available as a mobile application
	Fürst et al. (2010)	Broad accessibility for users at any time and any place, e.g., provision of an online service or online support.
	Hewitt et al. (2020)	**Cost**. In the case of APoLUS, researchers were keen to develop software thatwas free-to-use and multi-platform, in keeping with both the ethos of the COMPLEX project and of Open Science.
	Szimba et al. (2017)	Free, open source and transparent (traceability).
	Hewitt and Macleod (2017)	The tool/software Should work on touch devices like mobile phones, tablets and larger touch tables.
	Hewitt and Macleod (2017)	Making applications web-based facilitates access, which might be expected to lead to faster and more widespread adoption by taking advantage of existing internet infrastructure and appealing to users of modern mobile devices
	Hewitt and Macleod (2017)	The tool/software Should be free at the point of use.
	International Organization for Standardization (2011)	Availability: degree to which a system, product or component is operational and accessible when required for use [Part of ISO/IEC 25010:2011 Product quality model]
	Collini et al. (2022)	The resulting features recommended during Phase Two for the online tool spanned both function and content. […] multi-platform compatibility (desktop, tablet, smartphone)

Table A1.1. References of characteristics of decision-support tools and systems in consulted literature (cont.)

Characteristic	Source	Relevant references
Accessibility & Portability	International Organization for Standardization (2011)	Portability: degree of effectiveness and efficiency with which a system, product or component can be transferred from one hardware, software or other operational or usage environment to another [Part of ISO/IEC 25010:2011 Product quality model]
Education & Awareness	Haße and Kind (2019)	Each module (of Klimalotse) now contains more explanation, real-world case studies illustrating how other municipalities dealt with the tasks and exemplar documents from municipalities and template documents, as well as links to other useful instruments and literature.
	Roth et al. (2014)	As found for the BCT (BalticClimate Toolkit) people appreciated examples that show how others are solving similar types of problems and explicitly called for an extension of these examples. Sharing best practices and lessons learned can help to improve the understanding which climate change adaptation activity is more or less suitable under given sitespecific circumstances. The development of best practice databases through which users can systematically search for examples might help stakeholders to find best suitable decision options.
	Schumacher et al. (2020)	Another limiting factor was lacking experience in applying DSTs. To overcome this, end-users need guidance or training. […] User-friendly and easily accessible guidelines, free online tutorials or webinars for potential end-users are needed.
	Schumacher et al. (2020)	Another limiting factor was lacking experience in applying DSTs. To overcome this, end-users need guidance or training. […] User-friendly and easily accessible guidelines, free online tutorials or webinars for potential end-users are needed.
	Clar and Steurer (2018)	The accompanying services [of the support tools] either aim to facilitate the use of a tool, or they aim to facilitate climate change adaptation in general in combination with support tools.
	Hewitt and Macleod (2017)	Decision support, not decision automation: Participants were keen to emphasise the need to be clear that the tool supports decisions, but does not actually make them
	McIntosh et al. (2011)	The use of EDSS may provide educational benefits in terms of changing mental conceptualisations of real-world systems (Kolkman, 2005), and in terms of providing a tool to learn about and adapt to environmental changes
	Clar and Steurer (2018)	the Wizard and related tools sometimes helped to “start a conversation” with stakeholders (LUK1, LUK3), and to raise awareness for climate change adaptation among the public (LUK2).

Table A1.1. References of characteristics of decision-support tools and systems in consulted literature (cont.)

Characteristic	Source	Relevant references
Education & Awareness	Clar and Steurer (2018)	They [local interviewees] expect knowledge brokerage not only from sci ence to policy-makers but also among the latter, for example, by exchanging good adaptation practices (LG2, LG3).
	International Organization for Standardization (2011)	Learnability: degree to which a product or system can be used by specified users to achieve specified goals of learning to use the product or system with effectiveness, efficiency, freedom from risk and satisfaction in a specified context of use [Part of ISO/IEC 25010:2011 Product quality model]
	Clar and Steurer (2018)	23 [of analysed support tools] give overviews of other support tools
	Webb et al. (2019)	Complement the platform and product development process with ongoing enablers, and especially communities of practice and knowledge brokering. […] Communities of practice can be developed to contribute to product development, enhancement and improvement and help sponsor knowledge brokering and sharing.
Communication of complex information	Haße and Kind (2019)	The first version (of Klimalotse) had contained too much technical jargon and potential users mentioned that communicating adaptation-related information and triggering action had been a major challenge. Hence, the content of the updated Klimalotse was revised to make the language more accessible. Users now receive more support on how to communicate in a way that maximises political support and motivates colleagues to take action.
	Bartke and Schwarze (2015)	**Practicability**: How quickly and straightforwardly can the method be applied? Does understanding the method involve training or reading lengthy manuals? What costs are entailed by conducting the method e and how much time is required? How much data is needed? Do the methods provide decision support? Are the results easy to assess and are they comprehensible?
	Roth et al. (2014)	As especially policy makers called for a condensed amount of information it might probably make sense to provide them with just a few pages of information that contain the most essential things in the beginning. If subsequently, further steps are taken in a planning process more information could be provided later on
	Roth et al. (2014)	The BCT (BalticClimate Toolkit) was perceived as too detailed by a lot of interviewees; especially policy makers called for a more condensed and less excessive amount of information.

Table A1.1. References of characteristics of decision-support tools and systems in consulted literature (cont.)

Characteristic	Source	Relevant references
Communication of complex information	Aristotle University of Thessaloniki et al. (2018)	The user-centric tools must present environment-friendly advice and incentives in an attractive and comprehensible way
	Aristotle University of Thessaloniki et al. (2018)	The user-centric tools must present environment-friendly advice and incentives in an attractive and comprehensible way
	Hewitt et al. (2020)	In the case of COLLAGE, the key emphasis was on immediately providing easily digestible information on achievement of RE targets in a visually attractive way
	McIntosh et al. (2011)	However, integrated assessment modelling workshop evidence suggests that decision-makers are not particularly interested in uncertainty per se (UNECE, 2002). Rather, they are interested in knowing whether particular decision strategies are robust across a range of possibilities
	McIntosh et al. (2011)	Ability to produce understandable results
	Hewitt and Macleod (2017)	Synthesizing complex information into a digestible message
	Clar and Steurer (2018)	[the Wizard tool was perceived as being] “sort of complicated and academic” or “a bit too heavy on the theory”.
	Clar and Steurer (2018)	local interviewees called for less theoretical and more practical support that can be understood easily by local administrators (LG3), among them easy-to-use blueprints for cost–benefit analyses (LG1), self-assessments and benchmarking tools that help to prioritize and justify single adaptation projects (LG1, LG226).
Data visualisation & interactivity	MS10: Validated Requirements for the ICARUS DSS (2016)	According to the feedback received the user requirements should comprise the following: • Possibility to communicate the resulting data in the form of maps, tables, and time series diagrams.
	International Organization for Standardization (2011)	User interface aesthetics: degree to which a user interface enables pleasing and satisfying interaction for the user (Note: This refers to properties of the product or system that increase the pleasure and satisfaction of the user, such as the use of colour and the nature of the graphical design) [Part of ISO/IEC 25010:2011 Product quality model]

Table A1.1. References of characteristics of decision-support tools and systems in consulted literature (cont.)

Characteristic	Source	Relevant references
Data visualisation & interactivity	Roth et al. (2014)	The way that information is presented should be carefully regarded as well. An overall text-heavy representation acts as repellent and does not help to arise interest and concern as has been found in the case of the BCT. To visualize information e.g. about potential climate change impacts helps people to understand them more easily; creating a 'virtual world' that depicts how a region will likely be affected by climate change can help people to grasp how a possible future may look like. […] Visualizations like diagrams enable users to directly extract information and do not require as much further processing efforts as an equivalent textual representation of information
	Hewitt et al. (2020)	The interactive component of the COLLAGE tool, with its attractive touch table interface was central to the goal of drawing stakeholders' attention and encouraging them to try to work with the tool. This "high-tech" elementwas a key to raising stakeholders' desire to participate, while the instantaneous display of charts showing RE targets added an addictive gamification component that enticed users to "play".
	Schlobinski et al. (2011)	Many model runs will generate spatial and/or temporal data which need to be visualized to be interpreted by the analyst.
	Schlobinski et al. (2011)	Analysis of the results from multiple comparable model runs (such as under different scenarios) requires the ability to simultaneously represent model results visually.
	Calvo et al. (2021)	Visual encoding: Translating the data into a visual element on a chart/map or graph using visual properties as length, position, size, color, slope, opacity, etc.
	Calvo et al. (2021)	Multidimensional visualization: Graph or visualization showing more than one variable through visual encoding (color, size, etc.).
	Calvo et al. (2021)	Our results identify relevant aspects that can improve user experience and reduce cogni- tive load and that are worth considering when designing climate data visualizations. These include […] offering interactive elements that allow users to filter nonrelevant information or highlight relevant information for the decision at hand.
Actively maintained and supported	Roth et al. (2014)	Scientific knowledge like the one in the field of climate change is subject to regular changes, therefore it is especially of importance to regularly update and integrate most recent scientific findings in the information pools of DSTs. If this is not properly done, users might lose confidence in the reliability of the information given.

Table A1.1. References of characteristics of decision-support tools and systems in consulted literature (cont.)

Characteristic	Source	Relevant references
Actively maintained and supported	Fürst et al. (2010)	The need to refer the support as best as possible to real-world conditions and most recent knowledge was emphasized by the participants.
	Schumacher et al. (2020)	Long-term maintenance [of Decision Support Tools] needs to be ensured and end-user needs have to be taken into account in the database development. Furthermore, end-user suggestions addressed the need to widely distribute information about available DSTs, e.g., by providing links on social media or web pages and ensure that they are permanently accessible.
	Broekx et al. (2012)	Actualisation of data is another big challenge. The proposed reference year for the next generation management plans is 2012. This means we need to be able to integrate data on state, pressures and measures in a very short time frame (6 months)
	Hewitt and Macleod (2017)	[The tool] should be actively maintained, preferably through a large, open user community. Given the previously mentioned interest in software that is free (at least at the point of use), it is important to distinguish between projects that are no longer actively maintained and those that are, preferable with a large or active user community. This is an important factor in ensuring the ability to modify or extend the software in the future
	Hewitt and Macleod (2017)	Is it still being supported? (inactive = little evidence of activity over the past year, active = evidence of activity over the past year)
	Hewitt and Macleod (2017)	It will be designed to be updateable with new information as it comes available (Integrated general principles for application development)
	Palutikof et al. (2019)	What do you think are the key features of a Coastal Climate Risk Management Tool that will make it useful for coastal decision makers? [The tool] is reliable—is based on up-to-date information and is regularly updated
	Webb et al. (2019)	Consolidate national effort into core authoritative adaptation platforms and products, with common and linked process guidance and data sources, and a commitment to ongoing support and continuous improvement

Table A1.1. References of characteristics of decision-support tools and systems in consulted literature (cont.)

Characteristic	Source	Relevant references
Security & privacy	International Organization for Standardization (2011)	Security: degree to which a product or system protects information and data so that persons or other products or systems have the degree of data access appropriate to their types and levels of authorization [Part of ISO/IEC 25010:2011 Product quality model]
	International Organization for Standardization (2011)	Confidentiality: degree to which a product or system ensures that data are accessible only to those authorized to have access [Part of ISO/IEC 25010:2011 Product quality model]

Table A1.2. References of characteristics dependent on users' perceptions and judgements

Characteristic	Source	Relevant references	Comments
Appropriateness recognizability	International Organization for Standardization (2011)	Appropriateness recognizability: degree to which users can recognize whether a product or system is appropriate for their needs [Part of ISO/IEC 25010:2011 Product quality model]	These characteristics are inherently dependent on users' perceptions and judgements and thus cannot be objectively assessed by the researcher. These characteristics are potentially suitable for addressing during the interviews.
Appropriateness recognizability	Palutikof et al. (2019)	What do you think are the key features of a Coastal Climate Risk Management Tool that will make it useful for coastal decision makers? [The tool] provides the knowledge needed to make the best possible decisions	
Comfort	International Organization for Standardization (2011)	Comfort: degree to which the user is satisfied with physical comfort [Part of ISO/IEC 25010:2011 Quality in use model]	
Effectiveness	International Organization for Standardization (2011)	Effectiveness: accuracy and completeness with which users achieve specified goals [Part of ISO/IEC 25010:2011 Quality in use model]	
Efficiency	International Organization for Standardization (2011)	Efficiency: resources expended in relation to the accuracy and completeness with which users achieve goals (Note: Relevant resources can include time to complete the task (human resources), materials, or the financial cost of usage.) [Part of ISO/IEC 25010:2011 Quality in use model]	
Functional completeness	International Organization for Standardization (2011)	Functional completeness: degree to which the set of functions covers all the specified tasks and user objectives [Part of ISO/IEC 25010:2011 Product quality model]	
Functional suitability	International Organization for Standardization (2011)	Functional suitability: degree to which a product or system provides functions that meet stated and implied needs when used under specified conditions[Part of ISO/IEC 25010:2011 Product quality model]	

Table A1.2. References of characteristics dependent on user perceptions and judgements (cont.)

Characteristic	Source	Relevant references	Comments
Meets users' needs	McIntosh et al. (2011)	Ability to produce results addressing end user questions (Summary of success criteria for different EDSS roles)	These characteristics are inherently dependent on users' perceptions and judgements and thus cannot be objectively assessed by the researcher. These characteristics are potentially suitable for addressing during the interviews.
Meets users' needs	International Organization for Standardization (2011)	Usability: degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use [Part of ISO/IEC 25010:2011 Product quality model]	
Pleasure	International Organization for Standardization (2011)	Pleasure: degree to which a user obtains pleasure from fulfilling their personal needs (Note: Personal needs can include needs to acquire new knowledge and skills, to communicate personal identity and to provoke pleasant memories.) [Part of ISO/IEC 25010:2011 Quality in use model]	
Satisfaction	International Organization for Standardization (2011)	Satisfaction: degree to which user needs are satisfied when a product or system is used in a specified context of use [Part of ISO/IEC 25010:2011 Quality in use model]	
Trust	International Organization for Standardization (2011)	Trust: degree to which a user or other stakeholder has confidence that a product or system will behave as intended [Part of ISO/IEC 25010:2011 Quality in use model]	
Usefulness	Roth et al. (2014)	Another task DSTs should fulfil is to provide information that should bridge the gap between scientists and practitioners. In the case of the BCT this goal seems still not completely achieved as it was perceived as too challenging and academic by some interviewees, especially local policy makers.	
Usefulness	International Organization for Standardization (2011)	Usefulness: degree to which a user is satisfied with their perceived achievement of pragmatic goals, including the results of use and the consequences of use [Part of ISO/IEC 25010:2011 Quality in use model]	

Table A1.3. References of technical characteristics

Characteristic	Source	Relevant references	Comments
Accountability	International Organization for Standardization (2011)	Accountability: degree to which the actions of an entity can be traced uniquely to the entity [Part of ISO/IEC 25010:2011 Product quality model]	These characteristics are inherently technical and, while relevant for evaluating software and decision support tools, are beyond the scope of this research.
Analysability	International Organization for Standardization (2011)	Analysability: degree of effectiveness and efficiency with which it is possible to assess the impact on a product or system of an intended change to one or more of its parts, or to diagnose a product for deficiencies or causes of failures, or to identify parts to be modified [Part of ISO/IEC 25010:2011 Product quality model]	
Authenticity	International Organization for Standardization (2011)	Authenticity: degree to which the identity of a subject or resource can be proved to be the one claimed [Part of ISO/IEC 25010:2011 Product quality model]	
Capacity	International Organization for Standardization (2011)	Capacity: degree to which the maximum limits of a product or system parameter meet requirements (Note: Parameters can include the number of items that can be stored, the number of concurrent users, the communication bandwidth, throughput of transactions, and size of database) [Part of ISO/IEC 25010:2011 Product quality model]	
Co-existence	International Organization for Standardization (2011)	Co-existence: degree to which a product can perform its required functions efficiently while sharing a common environment and resources with other products, without detrimental impact on any other product [Part of ISO/IEC 25010:2011 Product quality model]	
Compatibility	International Organization for Standardization (2011)	Compatibility: degree to which a product, system or component can exchange information with other products, systems or components, and/or perform its required functions, while sharing the same hardware or software environment [Part of ISO/IEC 25010:2011 Product quality model]	

Table A1.3. References of technical characteristics (cont.)

Characteristic	Source	Relevant references	Comments
Fault tolerance	International Organization for Standardization (2011)	Fault tolerance: degree to which a system, product or component operates as intended despite the presence of hardware or software faults [Part of ISO/IEC 25010:2011 Product quality model]	These characteristics are inherently technical and, while relevant for evaluating software and decision support tools, are beyond the scope of this research.
Installability	International Organization for Standardization (2011)	Installability: degree of effectiveness and efficiency with which a product or system can be successfully installed and/or uninstalled in a specified environment [Part of ISO/IEC 25010:2011 Product quality model]	
Integrity	International Organization for Standardization (2011)	Integrity: degree to which a system, product or component prevents unauthorized access to, or modification of, computer programs or data [Part of ISO/IEC 25010:2011 Product quality model]	
Interoperability	International Organization for Standardization (2011)	Interoperability: degree to which two or more systems, products or components can exchange information and use the information that has been exchanged [Part of ISO/IEC 25010:2011 Product quality model]	
Maintainability	International Organization for Standardization (2011)	Maintainability: degree of effectiveness and efficiency with which a product or system can be modified by the intended maintainers [Part of ISO/IEC 25010:2011 Product quality model]	
Maturity	International Organization for Standardization (2011)	Maturity: degree to which a system, product or component meets needs for reliability under normal operation [Part of ISO/IEC 25010:2011 Product quality model]	
Modularity	International Organization for Standardization (2011)	Modularity: degree to which a system or computer program is composed of discrete components such that a change to one component has minimal impact on other components [Part of ISO/IEC 25010:2011 Product quality model]	
Non-repudiation	International Organization for Standardization (2011)	Non-repudiation: degree to which actions or events can be proven to have taken place, so that the events or actions cannot be repudiated later [Part of ISO/IEC 25010:2011 Product quality model]	

Table A1.3. References of technical characteristics (cont.)

Characteristic	Source	Relevant references	Comments
Performance efficiency	International Organization for Standardization (2011)	Performance efficiency: performance relative to the amount of resources used under stated conditions (Note: Resources can include other software products, the software and hardware configuration of the system, and materials (e.g. print paper, storage media)) [Part of ISO/IEC 25010:2011 Product quality model]	These characteristics are inherently technical and, while relevant for evaluating software and decision support tools, are beyond the scope of this research.
Recoverability	International Organization for Standardization (2011)	Recoverability: degree to which, in the event of an interruption or a failure, a product or system can recover the data directly affected and re-establish the desired state of the system [Part of ISO/IEC 25010:2011 Product quality model]	
Reliability	International Organization for Standardization (2011)	Reliability: degree to which a system, product or component performs specified functions under specified conditions for a specified period of time [Part of ISO/IEC 25010:2011 Product quality model]	
Replaceability	International Organization for Standardization (2011)	Replaceability: degree to which a product can replace another specified software product for the same purpose in the same environment [Part of ISO/IEC 25010:2011 Product quality model]	
Resource utilization	International Organization for Standardization (2011)	Resource utilization: degree to which the amounts and types of resources used by a product or system, when performing its functions, meet requirements [Part of ISO/IEC 25010:2011 Product quality model]	
Reusability	International Organization for Standardization (2011)	Reusability: degree to which an asset can be used in more than one system, or in building other assets [Part of ISO/IEC 25010:2011 Product quality model]	
Testability	International Organization for Standardization (2011)	Testability: degree of effectiveness and efficiency with which test criteria can be established for a system, product or component and tests can be performed to determine whether those criteria have been met [Part of ISO/IEC 25010:2011 Product quality model]	
Time behaviour	International Organization for Standardization (2011)	Time behaviour: degree to which the response and processing times and throughput rates of a product or system, when performing its functions, meet requirements [Part of ISO/IEC 25010:2011 Product quality model]	

Appendix 2

Content

Project name: SENTINEL

Webpage(s): https://sentinel.energy/

H2020 webpage: https://cordis.europa.eu/project/id/837089

Overview of the project: the Sentinel project aimed to accelerate the energy transition and achieve total decarbonisation of the energy sector, which necessitated the development of a new set of energy modelling tools capable of representing and analysing the drivers and barriers to total decarbonisation. The project created the Sustainable Energy Transitions Laboratory (SENTINEL), a new modelling framework comprised of modular models focusing on specific technological, geographic, and societal aspects of the transition to a low-carbon energy system. The Sentinel H2020 project consortium included 11 partners from across Europe, including universities and research institutions. The platform gives users access to a wide range of resources, including stories about the energy system and decarbonisation, case studies at various levels (continental, regional, and national), e-learning materials on energy system modelling, electricity costs, market value, and other topics, as well as scientific publications. The platform also includes detailed descriptions of 14 energy system models, allowing users to investigate each model's inputs, outputs, and reference links. Users can also explore the deliverables generated by the Sentinel project.

Project name: COACCH

Webpage(s): https://www.coacch.eu/ | https://www.scenarioxplorer.coacch.eu/

H2020 webpage: https://cordis.europa.eu/project/id/776479

Overview of the project: COACCH (CO-designing the Assessment of Climate Change Costs) was a collaboration of 13 European research institutions. It aimed to create an improved downscaled assessment of the risks and costs of climate change in Europe that could be accessed directly for the various needs of end users in research, business, investment, and policymaking. The project produced a number of Policy Briefs on The Economic Cost of Climate Change and best practises for co-creating research, as well as references to scientific publications and project deliverables. The project's main output is the COACCH Climate Change Impact Scenario Explorer, which allows users to visualise COACCH's findings on the economic costs of climate change at various scales (EU-wide, national, regional, gridded) for various socioeconomic and climate scenarios. Users also had the opportunity to visualise the findings from the project on the economic costs of various adaptation and mitigation policies over different time horizons.

Name: SOCLIMPACT

Webpage(s): https://soclimpact.net/

H2020 webpage: https://cordis.europa.eu/project/id/776661

Overview of the project: the SOCLIMPACT project aimed to model downscaled Climate Change effects and their socioeconomic consequences for European islands and archipelagos between 2030 and 2100. The project consortium included over 20 partners. Users can access information on the various islands via the SOCLIMPACT platform, which includes a brief history, geography, political context, key figures, and sectoral projects. SOCLIMPACT provides users access to a knowledge library with curated content about various islands, industries, and the effects of climate change written in simple language and infographic format. The SOCLIMPACT project also includes a Regional Exchange Information System (REIS) platform, which provides a multidisciplinary platform for EU islands where regional stakeholders, policymakers, sector rulers, and practitioners can interact and propose new ideas for collaborative work and engagement activities. The SOCLIMPACT project produced as well an Adaptation Support Tool, which assists regional and national policymakers and coordinators in designing tailored climate change adaptation by providing practical guidance for understanding the physical, market, and

non-market effects of climate change on islands, as well as the macroeconomic implications of these changes on islands and Europe's economic systems.

Name: EUCalc

Webpage(s): https://www.european-calculator.eu/ | http://tool.european-calculator.eu/intro

H2020 webpage: https://cordis.europa.eu/project/id/730459

Overview of the project: The EUCalc project aimed to map emission and sustainable transformation pathways at the European and Member State levels. It created an open-source model that includes a Transition Pathways Explorer platform and learning tools intended to engage and be used by European and national policymakers, businesses, NGOs, and other stakeholders. The project consortium included 13 partners, including universities and research institutions. Many resources are available through the EUCalc platform, including module documentation (where users can see details about the pathways, key behaviours, ambition levels, and other parameters and calculations considered in the Transition Pathways Explorer), project deliverables, scientific papers, policy briefs, videos, events, media stories and newsletters, and a page where users can see recommendations of similar tools and projects. The Transition Pathways Explorer is the project's main output, allowing users to run their own emission scenarios and build pathways to a net-zero carbon future at the European and Member State levels, directly visualising the effects of their choices. Users can investigate various pathways, key behaviours and levers, as well as scenarios and sectors such as emissions, energy, agriculture, and water, among many others. The EUCalc Transition Pathways Explorer was chosen as one of the policy platforms to be used in interviews and surveys, with participants interacting with it to answer questions about their opinion of the EUCalc platform's usefulness in helping the participants to deliver more efficient policies or advice (details can be found in chapter 5).

Name: INNOPATHS (DPET)

Webpage(s): https://innopaths.eu/ | https://dpet.innopaths.eu/#/

H2020 webpage: https://cordis.europa.eu/project/id/730403

Overview of the project: INNOPATHS (Innovation Pathways, Strategies, and Policies for Europe's Low-Carbon Transition) developed low-carbon pathways for the EU. The project investigated scenario and pathway studies for technical, economic, and social insights. It investigated key energy sector innovation systems as well as policy landscapes. Based on this knowledge, INNOPATHS collaborated with stakeholders to co-design new low-carbon pathways and evaluated them quantitatively and qualitatively for technical, economic, and social outcomes. The INNOPATHS project consortium included 15 universities, research institutions, and other organisations. Transition-related newsletters, blogs, and policy briefs are available on the INNOPATHS platform. Project deliverables and journal articles provide additional information. In addition, four interactive online tools were developed as part of the project: the Technology Matrix Tool (TMT), the Energy System Decarbonisation Simulator (ESDS), the Low Carbon Pathways Platform (LCPP), and the Decarbonisation Policy Evaluation Tool (DPET). Due to time constraints, this study only evaluated the DPET tool. The DPET is a research summary of low-carbon energy transition policies. The DPET employs seven performance indicators based on systematic literature reviews to assess each policy instrument's positive, negative, or neutral impact and study consensus. It includes each policy's research methods, time periods, locations, design elements, and contextual factors. The DPET was the second policy platform chosen for interviews and surveys, with participants interacting with it to answer questions about their opinion of the DPET platform's usefulness in helping the participants deliver more efficient policies or advice (details can be found in Chapter 5).

Name: CD-LINKS (Climate Policy Database)

Webpage(s): https://www.cd-links.org/ | https://climatepolicydatabase.org/

H2020 webpage: https://cordis.europa.eu/project/id/642147

Overview of the project: CD-LINKS investigated climate action and development on a global and national scale. It aimed to contribute to climate and development policies that were complementary. The project investigated how climate change mitigation and adaptation policies affect long-term development objectives. It also examined past and current policies to determine their effectiveness. CD-LINKS developed globally consistent, national low-carbon development pathways to ensure country coherence. In addition, the project established a research network and a capacity-building platform to encourage collaboration and expertise among participating institutions. The project consortium included 16 partners from universities, research institutions, and government agencies. The CD-Links platform contains policy briefs and project deliverables, as well as eight CD-Links-related tools: an Atlas of Climate Policy Barriers, a Global Stocktake Indicator Tool, the CD-LINKS Scenario Explorer, the IAMC 1.5°C Scenario Explorer, the Climate Policy Database, the Energy Investment Tool, the Country-level Social Cost of Carbon/Database Explorer, and the open-source Python package pyam. Because of time constraints, this study only looked into the Climate Policy Database. The Climate Policy Database collects information on currently implemented climate change mitigation policies from countries worldwide, providing a collaborative platform to access policies quickly and best practices.

Name: Era4CS (Senses Toolkit)

Webpage(s): https://jpi-climate.eu/programme/era4cs/ | https://climatescenarios.org/toolkit/

H2020 webpage: https://cordis.europa.eu/project/id/690462

Overview of the project: the European Research Area for Climate Services (ERA4CS) researched how to generate, transfer, communicate, and use reliable climate data to deal with current and future climate variability. The goal of ERA4CS was to improve scientific expertise on climate change risks and adaptation options by developing and assessing climate adaptation strategies and pathways at various scales and to link that knowledge to decision-making. The consortium for ERA4CS included 19 countries, 130 partners, and 26 projects. Because of time constraints, this study only looked into the Senses Toolkit. The Senses Toolkit modules investigate climate change scenarios by providing users with tools for investigating climate change scenarios as well as practical guidelines for various user groups. The Senses Toolkit was designed to be understandable, accessible, trustworthy, and useful to stakeholders. Users can progress through various learning modules and paths using the Senses Toolkit, including a policy portal aimed at informing policymakers about the risks of human-induced climate change, climate mitigation options, and how to adapt to warming effects, and a finance portal aimed at informing financial decision-makers about the economic impacts of climate change in terms of financial assets and investment opportunities.

Name: Paris Reinforce (I^2AM Paris)

Webpage(s): https://paris-reinforce.eu/ | https://www.i2am-paris.eu/

H2020 webpage: https://cordis.europa.eu/project/id/820846

Overview of the project: The Paris Reinforce project developed a novel, demand-driven, integrated assessment model-oriented framework to help the EU, other major emitters, and selected lower-emitting countries design and analyse climate policies in light of the Paris Agreement and its challenges. The Paris Reinforce consortium includes 18 universities and research institutions. The Paris Reinforce website contains news, events, project deliverables, policy briefs, scientific publications, articles, and the I2AM Paris platform. The I^2AM Paris platform aims to foster effective communication among various stakeholders (modellers/scientists, policymakers, business representatives, NGOs, and so on) on climate change issues. The I^2AM Paris platform aims to enable modellers to communicate and stakeholders to interact in an informative manner with modelling capabilities, scenario

assumptions, and results in order to understand which decarbonisation pathways are most relevant and realistic, improving model and tool transparency. Users can view detailed model documentation, an interactive view of the models, a model comparison, and a variable harmonisation heatmap, which shows how different variables are handled across the various available models. On the I²AM Paris policy platform, users can view the models, sectors, emissions, mitigation and adaptation measures, policies, and SDGs in four different layouts, according to their preferences.

Name: PLACARD

Webpage(s): https://www.placard-network.eu/ | http://connectivity-hub.placard-network.eu/

H2020 webpage: https://cordis.europa.eu/project/id/653255

Overview of the project: the PLACARD (PLAtform for Climate Adaptation and Risk Reduction) platform sought to encourage communication, knowledge sharing, and collaboration among the Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) groups through fostering dialogue and consultation, designing effective science-policy-practice dialogues, understanding the decision-making context, facilitating knowledge exchange and mobilisation between CCA and DRR. The project consortium comprised 19 universities, research organisations, and government agencies. PLACARD offers users a Foresight for policymakers and decision-makers, guidelines, a manifesto, and a storytelling recipe book for making stories that engage people and strive towards a climate-proof and disaster-resilient society. PLACARD also offers policy briefings, webinars, workshops, and a Connectivity Hub. The Connectivity Hub provides users access to CCA and DRR organisations and knowledge. Google Translate is linked with the tool on the Connectivity Hub, allowing users to do searches in over 100 languages.

Name: EnerMaps

Webpage(s): https://enermaps.eu/ | https://enermaps.openaire.eu/ | https://lab.idiap.ch/enermaps/

H2020 webpage: https://cordis.europa.eu/project/id/884161

Overview of the project: the EnerMaps project aimed to improve data management and accessibility in the renewable energy business, helping to accelerate the energy transition. It developed a user-friendly digital platform for centralising energy datasets, bridging the gap between the energy research community and field professionals. The EnerMaps platform ensures the quality of important datasets and makes them more accessible to academics and policymakers. The project's consortium comprised six partners, including universities and research institutions. Enermaps's website allows users to access project deliverables, several videos with training and seminars linked to the project, and learning paths (storymaps) concerning energy use, economic activities, and renewables. In addition, the Enermaps project has a scientific gateway page in the OpenAire platform where users can find scientific papers, projects, and datasets, as well as a visualisation tool that allows users to select from over 30 different datasets and see how European countries, regions, and cities perform in an interactive heatmap style map. Custom analyses can also be done using the visualisation calculation modules.

Appendix 3

Content

Dear participant,

You are being invited to participate in a research study titled "*Policy Platforms as tools for climate-change mitigation and adaptation policymaking: a case study of policymakers' perceptions of policy platforms as policymaking support tools and how to improve their design and use*". This study is being done by Alexandre Caldas Curley as part of a Master's thesis at the TU Delft in the Netherlands.

The purpose of this research study is to investigate what recommendations can be made for the design and use of policy platforms to improve their usefulness as decision-support tools for policymakers and advisors of policymakers in climate-change-related areas. In a broader sense, policy platforms can be viewed as tools for facilitating and promoting more effective policymaking. Policy platforms can achieve this by facilitating understanding of information, assumptions, limitations, and outcomes or by disseminating relevant knowledge and information on some topic. This may include, for instance, a policy platform that allows users to understand climate change models, learn about relevant concepts and factors influencing climate change, or explore best practices/success stories from around the world.

This survey is being sent to policymakers (or advisors of policymakers) and its goal is to understand this group's experience, perceptions and preferences regarding climate-change mitigation and adaptation policy platforms and their characteristics. **Once started, filling out the survey completely will take you around 10 – 15 minutes to complete**. The collected data will be used for research purposes as part of a Master's thesis that will investigate potential recommendations for improving the design and use of policy platforms for policymakers. You will be asked questions regarding your experience using policy platforms, your perceptions regarding their usefulness, your preferences regarding characteristics of policy platforms and what you look for in such platforms when using (or considering using) them as decision-support tools in your work.

As with any online activity the risk of a breach is always possible. To the best of our ability your answers in this study will remain confidential. We will minimise any risks by anonymising the responses, only analysing aggregated data, and deleting the survey answers after they have been used for the research purposes. No commercially or professionally sensitive data will be asked in the survey. **No personal information or individual survey responses will be published or made publicly available**. All data collected in the surveys will be deleted at the latest 2 years after the publication of the corresponding MSc. thesis and, until then, will be stored securely within TU Delft.

Your participation in this study is entirely voluntary, and you can withdraw at any time. Because the survey is completely anonymous, it will not be possible to remove data once the form has been completed and sent. No financial compensation will be provided for participating in the study.

In case you need to contact the research team for any reason, you can reach them through the following contact details:

- Alexandre Caldas Curley (corresponding researcher): A.CaldasCurley@student.tudelft.nl
- Özge Okur (responsible researcher): O.Okur-1@tudelft.nl

By clicking through to the online survey and completing all mandatory questions in the survey, you are agreeing to this Opening Statement and providing informed consent to your participation.

Please indicate if you agree to the terms of consent provided.

Yes

No

Do you currently work as a policymaker or advisor of policymakers on climate-change mitigation and adaptation-related areas (e.g., energy transition, climate and urban resilience, nature-based solutions etc.)?

- Yes
- No

What is your current position?

- Policy Advisor/Policy Officer
- Politician
- Researcher
- Other

How many years of experience do you have in your current position?

- Less than one year
- 1 - 2 years
- 3 - 5 years
- 6 - 9 years
- 10 or more years

Which sector do you work in?

- National Government
- Regional Government
- Local Government
- University or Research Institution
- Non-Governmental Organisation
- Private Sector
- International organisation

From which country is the organisation you work for?

We would like you to interact briefly with two examples of Policy Platforms so that we can better understand your perspectives on them. **You will be asked to interact with each Policy Platform for approximately 2 minutes (or longer if you choose to) and complete a few tasks**. In each of these questions, **a timer will count down from 2 minutes until the button appears to move to the next section.**

For this question, **you will be asked to interact with a Policy Platform for approximately 2 minutes (or longer if you choose to) and complete a few tasks**. The above timer will count down from 2 minutes until the button appears to move to the next section (you can also take longer than 2 minutes if you choose to).

The first tool is called **EUCalc.** Please open the following link (http://tool.european-calculator.eu/) and perform the tasks below. **After performing the below tasks, you can freely interact with the tool for another 1 minute - 2 minutes and/or proceed with the survey.**

1. Read the introduction message and select the option "**choose warming and fairness**"
2. Select the "**Warming limit**" and the "**European share**" options according to your preferences and then select "**start calculating**"
3. Investigate one (or more) of the "**key behaviours**" by clicking on one of them to expand your options (e.g., by clicking on "**Travel**", the options "**Passenger distance**", "**Mode of transport**" and others become available).
4. **Increase** the ambition level on some of the "**key behaviours**" parameters (e.g., "**Power**" > "**Wind**") by selecting (i.e., clicking on) all the corresponding circles next to this parameter.
5. Investigate how the "**Greenhouse gas emissions**" chart and how the **blue bar at the top** get updated.

Based on your interaction with the EUCalc tool while performing the previous tasks, what are your opinions about the usability of the EUCalc tool? (e.g., was it easy to use? Do you think you were able to understand the purpose of the tool? etc)

For this question, **you will be asked to interact with a Policy Platform for approximately 2 minutes (or longer if you choose to) and complete a few tasks**. The above timer will count down from 2 minutes until the button appears to move to the next section (you can also take longer than 2 minutes if you choose to).

The second tool is called **Decarbonisation Policy Evaluation Tool (DPET).** Please open the following link (https://dpet.innopaths.eu/) and perform the below tasks. **After performing the below tasks, you can freely interact with the tool for another 1 minute - 2 minutes and/or proceed with the survey.**

1. Read the introduction message and select the option "**Start tutorial**"
2. Follow along the short tutorial presented to better understand how to use the tool
3. Investigate one (or more) of the "**policies**" by clicking on the corresponding checkbox (e.g., by clicking on "**GHG emissions allowance trading scheme**").
4. Select a "**Jurisdiction level**" (e.g., "**Local**")
5. Choose one or more of the results shown in the table (depending on your search) and investigate the information provided.

Based on your interaction with the Decarbonisation Policy Evaluation Tool (DPET) while performing the previous tasks, what are your opinions about the usability of the Decarbonisation Policy Evaluation Tool (DPET)? (e.g., was it easy to use? Do you think you were able to understand the purpose of the tool? etc)

Before completing this survey, had you ever interacted with a climate-change-related Policy Platform, such as the ones mentioned above or others?

Yes

No

Many of these Policy Platforms are developed with policymakers in mind as one of the intended users. Do you see any particular reason why you haven't used any tool like that before?

Can you elaborate more about the context in which you used such tool(s) (e.g., name of tool(s), reason for using etc)?

Having interacted with both the EUCalc and the Decarbonisation Policy Evaluation Tool (DPET), how would you evaluate the usefulness of policy platforms such as these in assisting you in delivering more effective advice or policies?

Extremely useful | Very useful | Indifferent | Barely useful | Not at all useful

Can you elaborate on the reasons behind your previous answer?

If you were to choose an online tool such as the ones provided as examples or a similar one to support you in your work, what aspects (in terms of characteristics, functionalities or capabilities of the tool) would be the most important in your decision to use a given tool?

Considering your current role and the challenges associated with it, your interactions with the examples of Policy Platforms provided (and experiences with other Decision-Support Tools), please evaluate your preferences regarding the characteristics of a useful Policy Platform according to the options below:

- **Must have:** refers to characteristics that, in your opinion, are mandatory for a Policy Platform to be useful to you and add value to your work.
- **Should have:** refers to characteristics that, in your opinion, are much desired in a Policy Platform but are not mandatory for it to be useful to you and to add value to your work (e.g., you could wait for it to be released (maybe) in future versions of the tool).
- **Could have:** refers to characteristics that, in your opinion, are 'nice to have', but their absence would not negatively impact your perception of usefulness and value added by a Policy Platform (e.g., the tool could never provide this functionality and you would still use it and find it valuable).
- **Indifferent**: refers to characteristics that you don't have a particular preference or opinion about.

Please **drag and drop each item** to one specific group (Must have, Should have, Could have, Indifferent) according to your preferences.

For each group (Must have, Should have, Could have, Indifferent), **please arrange the characteristics according to your order of preference within that group (e.g., number 1 is the most important characteristic in this group for you, number 2 is the next one, and so on).**

Please check the **"details"** text for additional information on the characteristics.

ILLUSTRATIVE EXAMPLE OF PRIORITISATION AND RANKING

Must have

1. Transparency regarding data sources, limitations, uncertainty or assumptions associated with the tool (details)
2. Interactive and easy to navigate visual graphical elements (details)
3. High level of detail for spatial and temporal data (details)
4. Free and open access to all functionalities of the tool (details)
5. Availability of detailed documentation on concepts and models used in the tool (details)
6. Availability of very recent ("last year") data (details)

Should have

1. Ability to modify parameters and run custom analyses based on user inputs (details)
2. Ability to import user data, export results, or integrate the tool with other platforms (details)
3. Communication of complex information in an easy-to-digest format (details)
4. Availability of the tool in languages other than English (details)
5. All functionalities available via a web-based platform (details)
6. Availability of training and learning functionalities (details)

Could have

1. User stories from policymakers, communities or organisations around the world (details)

Indifferent

1. Ability to use the tool efficiently and effectively via mobile phones or tablets (details)

Can you elaborate on the reasons behind your choices above?

Thank you so much for your time in completing this survey! In case you have any feedback regarding this survey, you can provide it below.

Otherwise, you can just click the button (→) to proceed.

We thank you for your time spent taking this survey.
Your response has been recorded.