



# The impact of MAMCA as a stakeholder engagement tool during the setup of an energy community

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## ABSTRACT

As they foster active participation in their daily operations, energy communities (ECs) are often regarded as important tools for the empowerment of civil stakeholders in the energy system. To ensure the incorporation of stakeholder needs, participation must also be guaranteed throughout the design phase of the EC. Despite a general consensus on the importance of stakeholder engagement in the setup of sustainability-fostering projects, the impact of engagement initiatives often goes unassessed. This makes it difficult to determine whether their application advances stakeholder interest.

Therefore, we wanted to study the effects of a specific stakeholder engagement tool (Multi Actor Multi Criteria Analysis, MAMCA) that was used in the setup phase of eight different ECs. Through a survey with 102 participants, three core aspects are assessed: 1) the effect on participants' knowledge of ECs, 2) the effect on social learning, and 3) the extent to which the engagement goals and participant expectations are fulfilled. The study results show that stakeholder appreciation of the method is high and MAMCA has important value as a learning methodology, with 96% of participants indicating their knowledge was raised significantly and 94% marking increased awareness of other viewpoints. This led to a relevant rise in willingness to join an EC (from 75% of participants to 93%). The interactive aspect and expert assistance are seen as crucial elements in the MAMCA process. More attention to raising participants' technical knowledge and feedback on the follow-up of the engagement initiative results are identified points of improvement for future applications.

## 1. Introduction

The ongoing energy transition, which encompasses an evolution from predominantly centralized energy production and management towards a more decentralized system based on renewable energy (RE) is regarded as an evolution that enhances sustainability in its many forms [1]. It is in part a social transformation in which civil society plays an essential role [2]. As more stakeholders invest in (smaller) RE assets, they can become producers and prosumers, thereby increasing their influence on the system. Various initiatives

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have emerged that allow citizens to actively participate in the energy system in a collective way, such as energy community (EC) projects. ECs have become a focal point of European Union legislation through the ‘Clean energy for all Europeans’ package, with definitions for citizen energy communities (CECs) and renewable energy communities (RECs) which emphasize that democratic participation and environmental and social benefits for the community need to be guaranteed [3,4]. Therefore, apart from being promoters of environmental and economical sustainability, ECs are seen as important mechanisms to foster the participation and decision-making empowerment of citizens and other relevant stakeholders in the energy system [5].

As EC participation is voluntary, a successful deployment can only be guaranteed when the initiative fulfills the needs and wishes of its potential members. This can be achieved by involving stakeholders throughout the whole setup process. By identifying their objectives, translating them into technical and organizational solutions, and incorporating active feedback moments in this process, an EC tailored to the needs of the stakeholders can be ensured. While citizens often are primarily engaged in the implementation phase of ECs, it is important that their voices are also represented in the design process []. However, this practice is not widespread and examples of such engagement initiatives are not common. To the authors’ knowledge, only one methodology has been used as an engagement tool specifically for designing and setting up ECs in different locations: the Multi Actor Multi Criteria Analysis (MAMCA) [6]. As there is an added value in stakeholder engagement methods that actively involve relevant actors throughout the whole EC setup process, it is important to further develop and promote them.

Additionally, participation initiatives should not only be deployed but also assessed. There is a general agreement that stakeholder engagement is an essential element for sustainability-related projects, but in reality, it is often lacking, insufficiently developed, or not evaluated [7]. Research reports on participation initiatives typically describe the essential aspects of best practices but rarely provide directions for the evaluation of the engagement process [8]. Even fewer studies have focused on the concrete examination of process impacts [8,9]. It is however necessary to gain insight into the actual impact and results of the used methodology, and whether they align with the pre-set aim. This guarantees that the true goal of the participation effort is not missed, and the used approach can be adjusted to better fit its aim. For example for the previously mentioned MAMCA method, no one has ever tested whether this tool achieves its objectives, if it can be an instrument to boost EC uptake when promoted for future use, and if there are adjustments needed to make it fit its aims better. Thorough evaluations of the effects of applied engagement methods are necessary to give a clear insight into their effectiveness, and improvements that have to be made.

As the involvement of stakeholders in the design and setup of an EC initiative is important to create broad support for implementation and hence boost the roll-out of EC initiatives, with our research we want to focus on an engagement methodology aimed at this, which has not been done before. We center our attention on two detected research gaps: the absence of an existing method that was designed specifically for involving stakeholders in the design and setup of an EC initiative, and the lack of evaluation of the effects of similar engagement efforts. By focusing on an existing general engagement tool (MAMCA) that has been used in EC processes, looking into its generated effects, and detecting opportunities for improvement, we aim to assess its potential for future utilization and boosting the uptake of ECs. Our study intends to determine the impact a MAMCA workshop has (or has not) on participants during an EC setup initiative, and which specific effects of the method are considered the most important. This helps to determine the main purposes MAMCA can fulfill in participatory EC design processes, as well as potentially desirable adjustments for future use.

In section 2 the literature study looks into research that motivates the importance of ECs, stakeholder engagement during their setup, and existing literature on the assessment of engagement techniques. Section 3 clarifies the applied research methodology for the impact assessment of MAMCA as a stakeholder engagement tool during the setup of ECs, including an introduction of the MAMCA, the 8 studied cases, and the survey questions that were presented to the participants. Section 4 gives an overview of the survey answers, which are analyzed in section 5. Section 6 contains the conclusion, limitations, and suggestions for future research.

## 2. Literature study

Fig. 1 depicts the subjects that are addressed within the literature review.

### 2.1. ECs as a means to a more sustainable environment

Through the ongoing energy transition, which stimulates the deployment of RE installations and enables the empowerment of

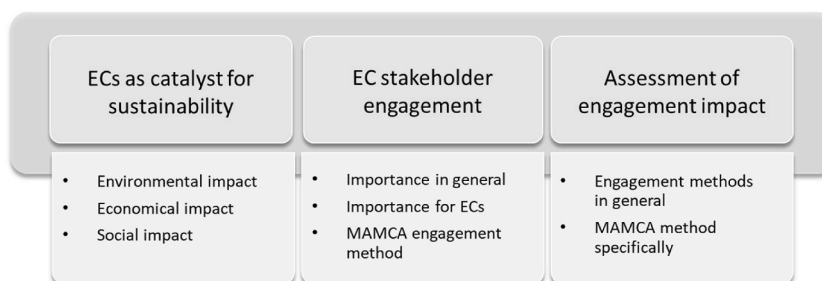


Fig. 1. Topics covered in the literature study.

various stakeholders in the energy system through a shift in ownership and decision-making power [10], sustainability in its many forms is enhanced [1,11]. Many RE assets do not require a lot of space or investment, giving rise to citizens and other local stakeholders becoming the owners of an installation. Individually or collectively they enhance the rise of the RE share in the overall energy system [12,13]. Various forms of collective energy initiatives are being developed, with ECs receiving a major push since being brought to the forefront through the EU's 'Clean Energy for All Europeans' package [14]. As part of its Paris Agreement commitments to reducing greenhouse gas emissions, the EU revised its energy policy framework and issued a variety of new regulations and directives that support the ongoing transition towards a system that relies primarily on renewable energy [15]. Facilitating the development of ECs is part of this strategy. These ECs are considered a way to organize collective energy actions in a democratic way, stimulating the empowerment of local stakeholders in the energy system [16]. According to EU legislation, ECs are non-commercial entities for which *'the primary purpose is to provide environmental, economic or social community benefits for its shareholders or members or for the local areas where it operates, rather than financial profits'* [4].

## 2.2. Environmental impact

ECs are generally believed to be able to play an important role in the energy transition and the potential subsequent carbon emissions reduction [17,18]. They can form a crucial driver toward the use of more RE sources [19,20], as they act as a stimulus for private (citizen) investment in RE [21]. CE Delft predicts that by 2050 around 17% of the EU's electricity demand will be covered by collective energy citizen projects [22]. Research also shows that participation in EC initiatives can significantly enhance knowledge, energy efficiency awareness, and subsequent behavior change, as well as the willingness to embrace low-carbon technologies and other sustainable practices that support the energy transition [13,23].

## 2.3. Economic impact

ECs can have an economic impact on an individual as well as on a larger scale. Financial benefits for individuals are gained through collectiveness and its associated economies of scale, opportunities to tap into new markets, and increased negotiating leverage [24]. Potentially reduced energy bills [18], together with having the opportunity to make investments that would not have been feasible on an individual basis, enhance the economic strength of EC members. On a larger societal scale, the rise of EC initiatives can have an indirect economic influence: In countries with electric capacity shortages, new initiatives such as ECs can stimulate the development of domestic energy resources and enhance the overall amount of available energy, resulting in potential economic growth [25]. Studies also show that a rise in RE consumption, which is related to an increase in ECs, is positively related to the economic growth of a country [26].

## 2.4. Social impact

The energy transition as a whole and ECs in specific are characterized by a new role for citizens, from passive energy consumers to active prosumers [27,28]. Linked to the various EC initiatives that have been set up in the past, the acceptance of sustainable energy initiatives has increased and the voice of participants within the energy system has become more powerful through active involvement instead of their former passive end-user status [29]. Increased civil ownership leads to wider responsibility and empowerment of non-traditional actors within the energy system [11]. The option to join a collective initiative lowers their threshold to participate actively in the system, as the operational burden can be shared and personal risks limited. This makes ECs potential drivers of energy democratization. They are also found to reduce public resistance to energy infrastructure development [30,31]. Additionally, the inclusive nature of EC initiatives allows for more active participation of a broader range of stakeholders in the energy system, such as citizens without an opportunity to invest in individual RE installations because of limited financial means, location, or tenant status [32–35]. Therefore, ECs can play an important role in the fostering of a just energy transition that all population segments can participate in and benefit from.

## 2.5. Stakeholder engagement for ECs

### 2.5.1. The importance of stakeholder engagement for sustainability initiatives in general

Stakeholder engagement is considered to be one of the fundamental components of sustainable development as it is proven to enhance inclusiveness, local decision-making, and the empowerment of all actors involved [7,36,37]. The necessary context-specific customization of initiatives can be refined through the involvement of local actors [38]. The development of sustainable projects therefore calls for special attention to stakeholder management, including a more proactive involvement approach [39]. Specifically for energy projects, multiple authors state that making sure all stakeholders are involved in the project in an equal way can contribute to distributive energy justice, with a fair distribution of the costs and benefits of the energy transition as an aim [40,41]. A just and inclusive transition also requires a variation of viewpoints on sustainability to be taken into account, which is why efforts should be made for the co-design and co-ownership by locals, to make sure the results represent all available ontological diversity [42]. Given that, in the ongoing energy transition, individuals are moving away from their traditional passive consumer role to embrace the role of genuine agents of change, it seems only logical to offer them a greater opportunity for involvement in all aspects [43].

### 2.5.2. The importance of stakeholder engagement during the setup of ECs

As one of the key elements of ECs is its community-building aspect, it is essential that the relevant stakeholders are closely involved in the setup as well as the deployment phase. Because they are the actors who are responsible for the daily operation and all participating on a voluntary basis, they need to see their objectives reflected in the form the EC takes on and have an established trust in the collaboration with the other stakeholders. Democratic and open participation is an essential aspect of ECs [4] and therefore requires an active role from its members, to whom various levels of decision-making responsibility [31] can be attributed. Heuinckx et al. [44] identify three major phases in the process that require a different engagement approach: the awareness-raising phase, the design and setup phase, and the implementation phase. Without thorough actor involvement at every stage, a supported roll-out of the EC is hard to achieve. An evaluation of the used methods can therefore contribute to enhanced stakeholder engagement and resulting support and deployment success.

Most engagement efforts in EC initiatives focus on the implementation phase and having local stakeholders take up an active role in the deployment [45]. EC design is sometimes adjusted to increase social acceptance based on prior research on stakeholder needs [46], but examples of active participation opportunities during this phase, where the particular design and setup of an EC are determined, are rare. To the authors' knowledge, only cases that applied the MAMCA methodology have specifically mentioned it as an aim of their stakeholder engagement strategy [6]. Therefore MAMCA is chosen as the methodological research subject in this study.

### 2.5.3. The MAMCA method as a stakeholder engagement tool

The MAMCA framework is a tool that has frequently been used for the engagement of stakeholders during decision-making processes [47]. In a context with multiple potential solutions to a study topic and an array of objectives of different relevant stakeholders that need to be taken into account, MAMCA can be used to evaluate the solutions for each of the stakeholders. It is a participatory tool that gathers the needs and wants of all stakeholders and visualizes to what extent potential solutions comply with everyone's needs, so a broadly supported consensus solution can be developed. Active involvement is stimulated through the use of an interactive online tool and workshop sessions. The engagement aspects include the stakeholders indicating their objectives, giving a weight to them according to their importance, evaluating the solutions, and jointly discussing the results. A subsequent consensus-building discussion with all actors, based on the visualized results, works as a decision-making aid.

The MAMCA methodology contains seven main steps (Fig. 2): the definition of various potential solutions (scenarios) (1), identification of the relevant stakeholders and their main objectives (2), weighting of the objectives or criteria of each of the stakeholders (3), linking these criteria to assessable indicators (4), evaluation of the scenarios (5), visualization of the scenario ranking for every stakeholder, based on the evaluation results, and a consensus-building discussion to determine the overall preferred scenario for implementation (6). If deemed necessary, steps 1 to 6 are iterated (7) [48].

Various research domains have used the MAMCA methodology in their participatory evaluation and decision-making processes, such as transportation research [50,51], energy studies [52], and healthcare exploration [53]. Multiple studies mention that MAMCA was specifically chosen for sustainability and inclusiveness reasons, as the method allows for the voice of all relevant stakeholders to play an equally important role in the process [53–55]. MAMCA can also support various engagement process goals, with existing

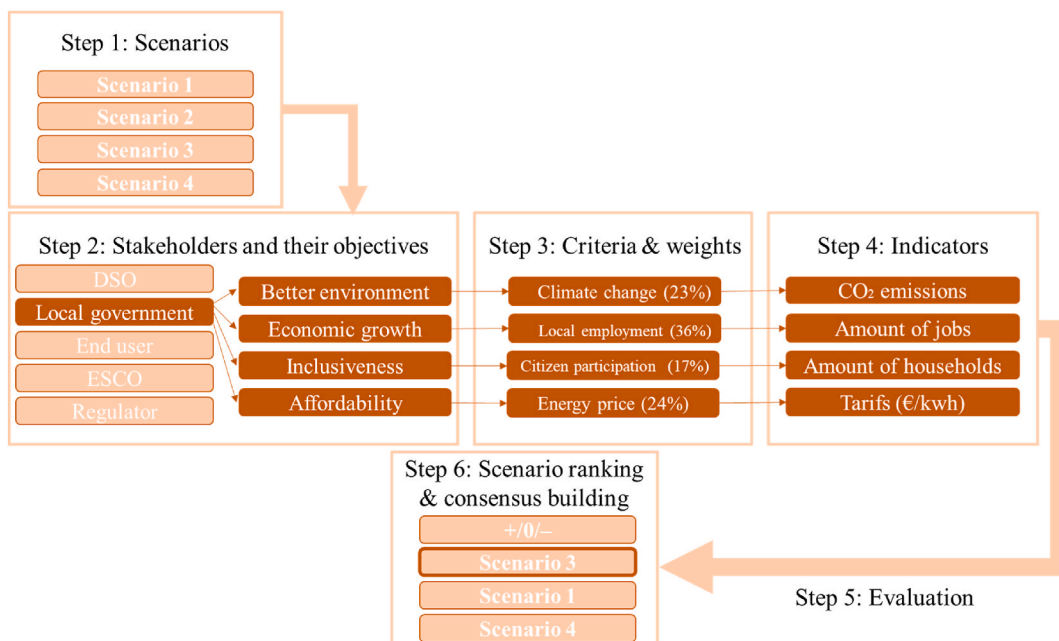


Fig. 2. – MAMCA methodology. Source: adapted from [49].

examples of cases where the methodology was for example used as an educational tool [56,57], to gather input on the needs and wants of stakeholders [58,59], and as a co-creation tool [60,61].

Some of the studies mention the advantages MAMCA brought to their project, such as increased citizen engagement in the evaluation through co-design of the solutions and a better insight into who are the relevant stakeholders [62], but until now no systematic evaluation of the specific impact of MAMCA as a stakeholder engagement tool has been undertaken. A detailed assessment can give an insight into the added value this method can bring to a participation initiative as well as the elements in which it does not fulfil its pre-set goals [42].

## 2.6. Assessment of the impact of engagement techniques

### 2.6.1. The impact of participatory methodologies in general

While the added value of stakeholder participation in planning and decision-making processes is generally recognized, resulting in increasing engagement efforts and a variety of tools, in prior research less attention has been paid to the actual assessment of the results of participation approaches [8,63].

The impact of engagement initiatives and techniques often cannot be measured unequivocally. In many cases, a significant amount of time passes between the engagement efforts and the actual implementation, and in the meantime many (external) influences contribute to the final result. This makes it impossible to accurately determine the exact impact of the engagement process on the end result. Especially since it is not possible to make a comparison with a fictional situation in which stakeholder participation would not have taken place. Furthermore, the effects can take many forms so they cannot be reduced to a limited amount of strictly defined aspects. A multitude of indicators and variables shape the impact [63].

Past research initiatives have often focused on specific topics in their assessment of the impact of engagement efforts, and have mainly used qualitative methods such as interviews with participants and surveys to describe the resulting effects. As indicated by Wals [64], interpretive ways of knowledge collection, like narrative inquiry, are essential in transdisciplinary environmental research, where the applicability of statistical measuring methods is limited.

**2.6.1.1. Impact assessment methods.** A variety of case study examples of effect assessment can be found in research literature. To determine the impact of participation initiatives for community development in a Boston neighborhood, Leung [63] resorted to citizen interviews, with stories of the perceived effects as an outcome. The impact could not be quantitatively measured, but stakeholders qualitatively described the difference it made. The opportunity to exercise a voice in the process, ensuring the accountability of involved institutions and customer satisfaction with the results, an increased sense of community, and personal empowerment, are specifically mentioned as significant outcomes.

Fulton et al. [65] argue that most quantifiable outcomes of an engagement process (such as the number of participants) do not give an insight into its actual consequences and the impact on the participants. They advocate an assessment approach based on interviews, observations, and surveys, that estimates in a qualitative way the differences compared to when the engagement had not taken place. This allows for gaining a better insight into stakeholders' understanding and behavior than the valuation of the limited quantifiable elements that are available.

Esmail et al. [9], who examined a variety of papers with studies on stakeholder engagement, also found that the majority of those that include an impact evaluation aspect focus on qualitative tools to assess experiences such as interviews, focus groups, and surveys.

More quantitative methods and tools for stakeholder engagement assessment exist but often require a strict formalization of the participation process and a significant amount of resources. Therefore they are mostly utilized outside of the field of social sciences. Bruce and Shelley [66] studied the usefulness for small and medium enterprises (SMEs) of the in the economic sector widely applied AccountAbility's AA1000 Stakeholder Engagement Standard (AA1000SES). They concluded that tools like this can bring added value but are too formal and demand too many resources for smaller initiatives. Their suggestion is to only partly use them and in a more informal way, as a reflective (and hence more qualitative) tool.

These studies show that a qualitative assessment can provide important insights into the effect of stakeholder engagement initiatives, especially in cases where no strictly measurable (physical) process outcomes have been realized yet. Therefore, we choose a qualitative assessment over a quantitative one in our research case, with the setup of a survey to gather stakeholder input.

**2.6.1.2. Assessment parameters.** Over the years, various potential elements or parameters to evaluate the effect of an engagement effort have been identified. Reed et al. [67] mention 'social learning' as a desired goal of stakeholder engagement in decision-making processes. They define the term through three key aspects, being that 1) the stakeholders involved have experienced a change in understanding, 2) the learning has taken place collectively among the community and not just individuals, and 3) the learning came about through social interaction.

Mathur et al. [37] argue that depending on how the engagement is conceptualized, the aim and associated assessment parameters differ. They also describe social learning as a valuable outcome, in which stakeholders contemplate their own and each other's viewpoints and work on consensus building. Other aspects mentioned are elevating knowledge and advancing inclusive local decision-making.

For their assessment of the effects of stakeholder engagement in a management strategy evaluation (MSE) project in Australia, Fulton et al. [65] defined four classes of potential impact: 1) project development changes, 2) changes in the interaction between stakeholders, 3) MSE computer model alterations, and 4) stakeholder attitude and awareness adaptations.

Based on her analysis of existing analysis frameworks, Petts [68] has identified ten evaluation parameters for engagement processes. Some of them focus on the level of influence of stakeholders in the process and on the outcome, others on the promotion of mutual understanding, on awareness creation and knowledge provision, on the encouragement of new ways of thinking, and on consensus-building opportunities. In the test application of the framework, surveys were used for the more qualitative assessment parameters.

For the evaluation of the process of collaborative planning efforts, van Driesche and Lane [69] determine two important criteria: the consensus-building ability and willingness of the stakeholders, and their perception of fairness and inclusiveness of the process that leads to the decision-making.

An often-cited work on the evaluation of collaborative planning initiatives is written by Innes and Booher [70]. They have developed a framework with principles and criteria, based on their analysis of existing consensus-building research and practice. For the assessable potential outcome of the process, they make a distinction between effects that occur right after the process (first order) and those that can be observed later, during, or after implementation (second and third order). The following first-order effects are defined by them:

- “Social Capital: Trust, relationships
- Intellectual Capital: Mutual understanding, shared problem frames, agreed-upon data
- Political Capital: Ability to work together for an agreed end
- High-Quality Agreements
- Innovative Strategies”

Based on these literature insights we identify three main parameters that form a solid basis for a qualitative impact assessment:

1. Knowledge raising
2. Social learning (awareness raising as well as impact on personal viewpoints and willingness to take action)
3. Fulfillment of stakeholder expectations of the engagement initiative and of goals of the engagement initiative

By studying the outcomes of a participatory initiative and evaluating how the used engagement method scores in terms of these three parameters, a deeper insight can be gained into the specific impact of this methodology, and its potential to boost EC uptake.

### 2.6.2. The impact of MAMCA specifically

Keserü et al. [62] evaluated the impact of applying MAMCA in a co-creation process about traffic safety problems in Brussels. They conclude that the overall impact was positive, by finding five compelling advantages. These include the fact that stakeholders feel more invested in the overall process, resulting in less challenging solution implementation. They are also encouraged to contemplate their priorities instead of their result preference, facilitating an ex-ante evaluation of the solutions based on stakeholder interests. Additionally, mutual understanding of viewpoints is raised through the MAMCA visualization of stakeholder preferences, and insight into evaluation methods is increased, which creates more trust in the outcome. Furthermore, MAMCA structures the ranking of the solutions, which can make decision-making easier.

However, this study only performed a high-level qualitative evaluation of the MAMCA method. In our research, we test if the advantages that are described qualitatively by Keserü et al. [62] can be confirmed through a more detailed analysis based on surveys with MAMCA workshop participants in various projects.

## 3. Methodology

Fig. 3 depicts the different steps of the methodology that was used in this study. After the selection of the stakeholder engagement method this research wants to assess and the selection of the case studies where this technique is implemented, a survey is developed that is aimed specifically at the evaluation of the effects the used method generates in the selected cases. This survey is distributed partly before and partly after the engagement initiative, to be able to study potential shifts in participants' answers in the results analysis step.

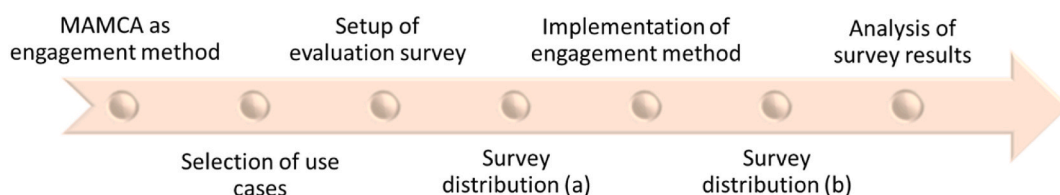


Fig. 3. Overview of the methodology structure.

### 3.1. Theoretical framework: the MAMCA method as an engagement tool for ECs

As ECs can take on various forms, an EC setup project always includes decision-making on the implementation details. Seeing that it is a voluntary initiative, a successful deployment can only be guaranteed when all relevant stakeholders (e.g., citizens, local government, investors, etc.) see their varying needs reflected in the end result. Given that the MAMCA framework is geared specifically towards cases with multiple potential solutions and stakeholders with different objectives that need to reach a consensus, it is considered a promising engagement tool for the setup of EC initiatives. Therefore it is chosen as the subject of our research. By evaluating the generated effects of this methodology we want to assess its usefulness for future EC setup initiatives and formulate suggestions for future use.

Heuinckx et al. [44] propose a customization of the MAMCA framework specifically for ECs, which was used in the case studies of this paper. Table 1 depicts how the different MAMCA framework steps were implemented for the EC setup in these cases.

### 3.2. Selection of the cases

The cases that are part of this research setup are selected because MAMCA was specifically used as the main engagement method for the development of an EC solution in each of them. They are all part of the EU-funded Horizon 2020 project RENAISSANCE [71], which ran from 2019 until 2022 and was aimed at building a scalable and replicable approach to set up ECs (not strictly confined by EU definitions) in a varied context. The developed tools were refined in 4 European pilot sites and further tested worldwide in 10 replication sites on 4 different continents, to guarantee that throughout the different geographical and social contexts as well as the different types of energy community configurations and their associated challenges, a generally applicable approach could be developed. The cases are also selected because we as authors were directly involved in the project, which assured a systematic and uniform approach to the data gathering. We were able to attend the MAMCA workshops and collect survey answers from all the participants.

All 8 RENAISSANCE cases in which the MAMCA method was paired with an on-site workshop are used in this research. All participants had only a general but vague notion of what they aimed to accomplish through an EC establishment, lacking any specific knowledge or detailed plan. The case studies are the following:

- Auroville, India. A self-sustainable community with residential and business activities that wants to set up a local energy community, aimed at collective self-consumption and production of renewable energy on-site.
- Florence, Italy. A residential neighborhood just outside of the city whose inhabitants want to install more photovoltaics (PV) and set up an energy-sharing initiative.
- Relleu, Spain. A rural compound with tourist homes whose owners want to make the houses and/or the complex energy neutral. In this case, the scenario definition (step 1 of the MAMCA framework) was not done by the project leaders but by the stakeholders themselves, in a co-design exercise, assisted by energy experts.
- Lacor, Uganda. A hospital site with medical buildings, a school, a residential area, and workplaces, that wants to guarantee a more environmentally friendly and reliant electricity supply for the enclosure and potentially its surroundings, as a substitute for the diesel generators currently in use.
- Medellín, Colombia. A low-to middle-income urban residential neighborhood was used as a test case by an external industry-academia partnership for initiating social and environmental change through the development of energy communities in Colombia.
- San Pedro de Atacama, Chile. An observatory site in the desert with telescopes that wants to replace its current gas and diesel generators and look into the opportunity of renewable energy sharing with two nearby residential communities.
- Reserva Tajamar and Brinkmann, Argentina. Both are more upscale residential neighborhoods that aim to increase the usage of renewables, through the setup of an energy community.

### 3.3. Survey setup

To gain a better insight into the effects the MAMCA methodology generates when it is used as an engagement tool for the setup of ECs, an analysis of the impact on the participants in the 8 case studies is performed.

The methodology used for this study is a combination of qualitative and quantitative survey research. The used survey is compiled specifically for this study. Since the questions that are to be answered concern the experience and perspective of the participants, a qualitative approach is generally deemed best suited [72]. Within qualitative survey research the diversity of answers within a given population can be examined [73]. This approach is used for the questions that require free text input from the participants on their expectations of and remarks on the used method. Additionally, the survey is used to determine the numerical distribution of answers to other questions in that same population, which requires a quantitative analysis approach [73]. This is applied to questions regarding the impact evaluation where the required response is a choice between 'Yes', 'Maybe', and 'No', or a score on a 0–10 Likert scale (with an explanation indicating the meaning of the scale numbers for each question). The studied population consists of all participants of the MAMCA process in the selected cases.

Two surveys are prepared: one to be distributed before the MAMCA workshop and one for after the workshop. Throughout the RENAISSANCE project, minor adaptations are made to the survey questions, as a result of progressive insight.

For the 3 previously defined assessment aspects the following survey questions are developed:

#### **Knowledge raising:**

**Table 1**  
Implementation of the MAMCA framework steps for the EC setup in the study cases.

MAMCA step	Implementation
<b>Preparation</b>	Participants were contacted and invited by a local project representative they are familiar with. A specific information session with Q&A on Ecs was organized at the start of the MAMCA workshop.
<b>Step 1 (scenario definition)</b>	Potential EC scenarios were designed before the MAMCA workshop by the project leaders and technical experts, based on the local focus points and context.
<b>Step 2 (stakeholder and objectives determination)</b>	The project leaders determined the relevant stakeholders and provided them with a long list of potential objectives before the MAMCA workshop. The stakeholders scored the objectives according to personal relevance and could add additional ones
<b>Step 3 (objectives weighting)</b>	During the MAMCA workshop all stakeholders gave importance weights to their top-ranked objectives, with the help of the online MAMCA software tool. The outcomes were visualized for all participants and each stakeholder explained their objectives selection and weighting results to the others.
<b>Step 4 (linking indicators to objectives)</b>	Before the MAMCA workshop, for each of the selected objectives, a panel of energy experts defined corresponding assessable indicators that could be used for the evaluation.
<b>Step 5 (scenario evaluation)</b>	During the MAMCA workshop all stakeholders evaluated the EC scenarios based on their selected objectives, with the help of the online MAMCA software tool. Energy experts assisted with the scoring of the more complex topics.
<b>Step 6 (scenario ranking and consensus building)</b>	The resulting individual and joint preference rankings of the EC scenarios were visualized for all participants during the MAMCA workshop. This formed the basis of a group discussion that aimed to achieve a consensus on an existing or adapted scenario that could be supported by all.

- Did your knowledge of what an energy community in general encompasses increase?
- Did your knowledge of what an energy community for this site encompasses increase?
- How much do you know about shared renewable energy initiatives? \*<sup>1</sup>°<sup>2</sup>
- Do you know what an energy community is?\*

Social learning (awareness raising as well as impact on personal viewpoints and willingness to take action):

- Do you know about the other parties' objectives for an energy initiative?\*
- To what extent are you willing to compromise to reach a solution agreed upon by all?\*
- How likely do you think it is to reach an agreement with the other parties?\*
- Are you more aware of the benefits/challenges of an energy community for your site than before the MAMCA workshop?
- Did you learn things about the viewpoints of other participants that you did not know before?
- Has your awareness of other parties' viewpoints increased?
- Have some of your own viewpoints changed by participating in this workshop?
- With your current knowledge, would you join an energy community?\*
- Would you be willing to individually invest in renewable energy for your house?\*

Fulfillment of stakeholder expectations and goals of the engagement initiative:

- What do you expect from this MAMCA workshop?
- Have your expectations of the MAMCA workshop been met?
- Are there specific questions or doubts you want to have cleared out by means of the MAMCA workshop?
- Did you get an answer to the questions or doubts you wanted to have cleared out?
- Do you feel heard?
- Do you have the feeling that your input will be taken into account when final decisions are made?
- Any pros and/or cons of the workshop you want to emphasize? Or other things you would like to tell us?
- Do you have recommendations on how to make this MAMCA workshop better?

### 3.4. Distribution of the survey

Between March 2022 and July 2022, an on-site MAMCA workshop is organized in all of the cases. Before the start of the workshop, a first survey is handed out to all participants, and right after the workshop an alternative survey is distributed that contains the same questions as the pre-MAMCA version, as well as some additional ones. The surveys are used as the basis assessment instrument of this MAMCA valuation research. They are purposely tailored for the respondents' self-valuation of their participation in the MAMCA workshop and were distributed in a hybrid way, using a paper form and an online form through Qualtrics.

The survey is conducted in accordance with the regulations of the authorized Ethics Committee for Human Sciences of the research institution the authors are affiliated to, not needing prior ethics approval from the Committee as the research does not involve

<sup>1</sup> All questions marked with an \* are part of both the pre- and post-MAMCA survey.

<sup>2</sup> All questions marked with and ° were only presented to the participants of a limited amount of sites.



vulnerable groups or minors, no personal data is gathered, and the data collection is done entirely anonymous.

### 3.5. Analysis of the results

The answers to the questions with a free text input option are qualitatively described and analyzed, to reflect the general tendencies and diversity.

The Likert scale interval survey responses (interval data) [74] can be categorized into two groups, for which a different type of analysis is performed. For the interpretation of the results of the questions that are only part of the post-MAMCA survey, descriptive statistics are used, with graphs that visualize the main characteristics of the sample results, such as the dispersion, mean score, median score, and standard deviation [75]. For the analysis of the responses to the questions that are part of the pre-as well as the post-MAMCA survey additionally a Wilcoxon signed rank test is performed, to ascertain if there is a significant difference in the assigned scores, indicating whether participation in the workshop had an influence on the respondents or not. Moreover, a descriptive general analysis of the individual score evolutions is added. For this analysis, only the data from respondents who filled out both surveys is used.

## 4. Results

### 4.1. Responses

In total 102 participants from 8 workshops handed in their answers. 3 of them only partially filled out both surveys, 17 filled out only the pre-MAMCA survey, and 3 only the post-MAMCA survey. Per site, at least 5 full and valid double surveys were collected.

### 4.2. Impact on knowledge

When asked about the evolution of their knowledge of ECs in general and for their site in specific after the MAMCA workshop, most of the 82 responding participants indicated that their knowledge level clearly increased. Figs. 4 and 5 show the distribution of the given scores, with 0 meaning 'Not at all' and 10 'A resounding yes'. The average scores are respectively 7,8 and 7,7 and the median score for both is 8. Only 3 participants (4%) gave a score lower than 5, and the increase in general knowledge was rewarded a 10 by 19 participants (23%).

The 5 workshop participants in the Relieu site were questioned about their knowledge of shared renewable energy initiatives and ECs specifically before as well as after the workshop. 0 indicated 'I have never heard of it' and 10 'I am fully informed about what it encompasses'. Although the sample is limited, the results in Figs. 6 and 7 show a clear increase in knowledge level with all participants, with the mean scores going up from 0.2 to 7.0 and from 2.6 to 8.4 respectively.

### 4.3. Impact on social learning: awareness and alteration of personal viewpoints and willingness to take action

When asked about their awareness of other stakeholders' objectives for EC participation the responses in the pre-MAMCA survey differed from those in the post-MAMCA survey. The dispersion of the given scores is shown in Fig. 8.

A Shapiro-Wilk test showed that the data sets are not normally distributed:  $W(82) = 0.92$ ,  $p < .001$ , and  $W(82) = 0.87$ ,  $p < .001$

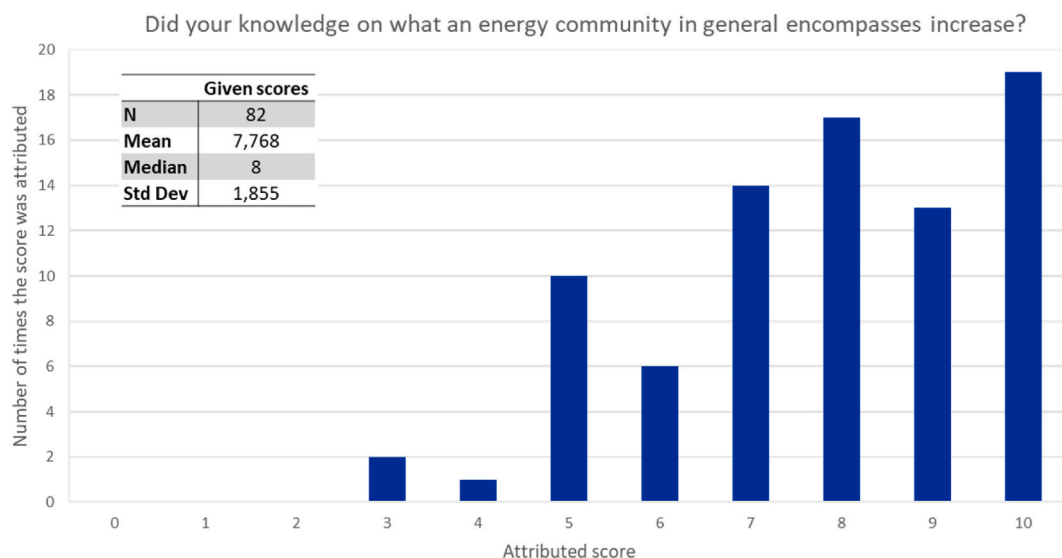


Fig. 4. Overview of the attributed scores on the question 'Did your knowledge of what an energy community in general encompasses increase?'

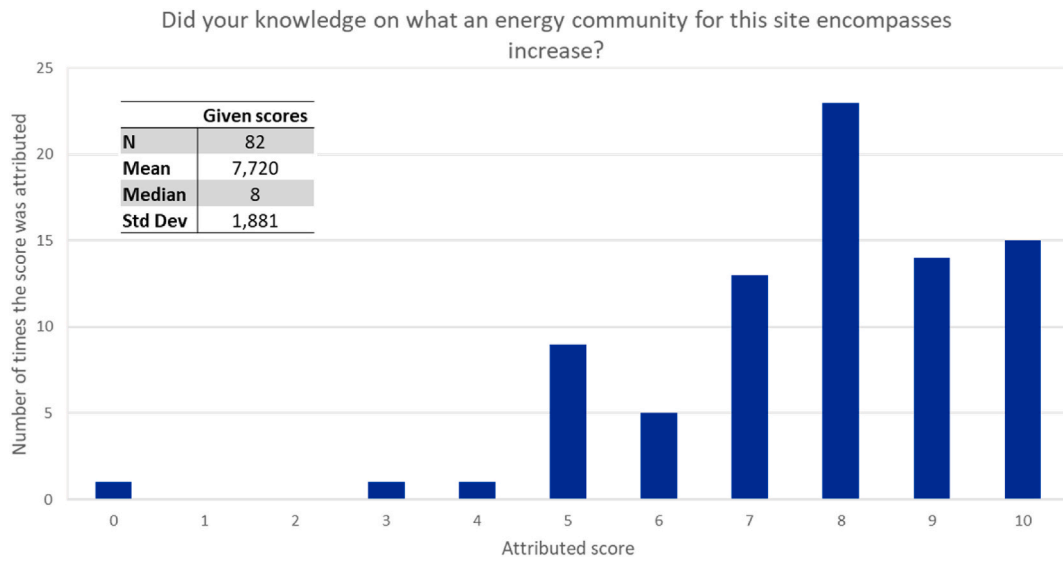


Fig. 5. Overview of the attributed scores on the question ‘Did your knowledge of what an energy community for this site encompasses increase?’

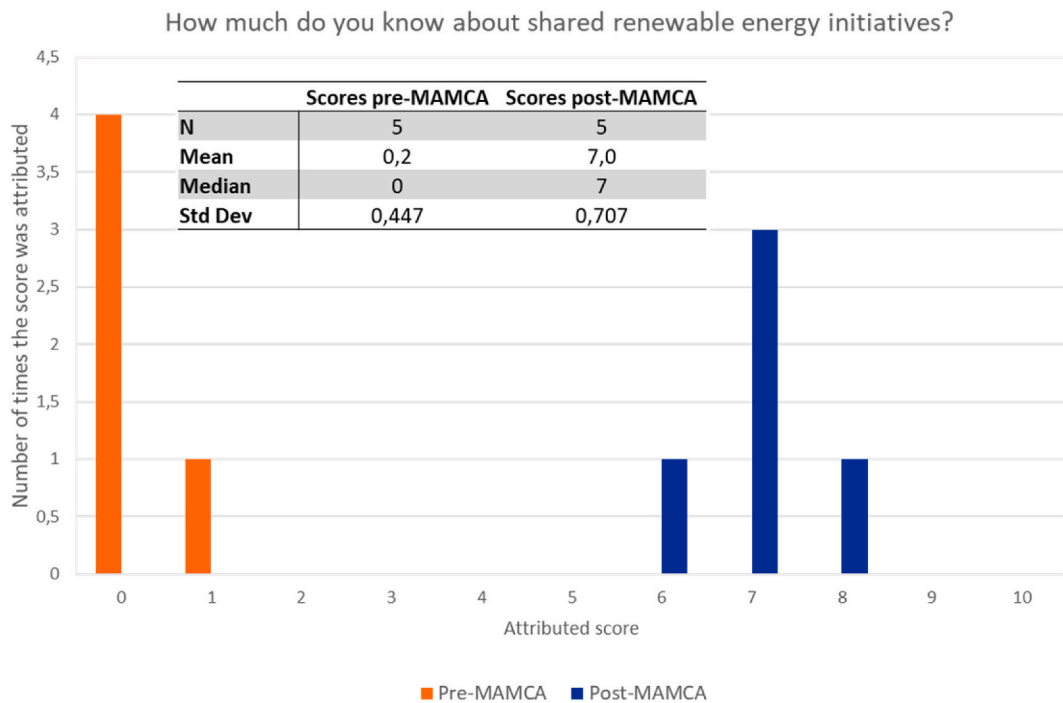


Fig. 6. Overview of the attributed scores on the question ‘How much do you know about shared renewable energy initiatives?’ before and after the workshop.

respectively. Therefore, a nonparametric statistical test was performed to compare the two sets of answers. The Wilcoxon Signed-Rank test indicated a statistically significant difference in mutual insight into stakeholder objectives before and after the workshop ( $p < .001$ ).

Fig. 9 gives an overview of the evolution of the scores of the individual participants. 8 of them (10%) gave a lower score after the workshop than before, 17 (21%) gave the same score and 57 (70%) gave a higher score, indicating their awareness grew through the MAMCA workshop participation.

The inquiry about stakeholders’ willingness to compromise, to reach a consensus EC that has wide support among all stakeholders, shows a high level of goodwill (Fig. 10). A Shapiro-Wilk test on the data sets of the post- and pre-workshop answers showed a

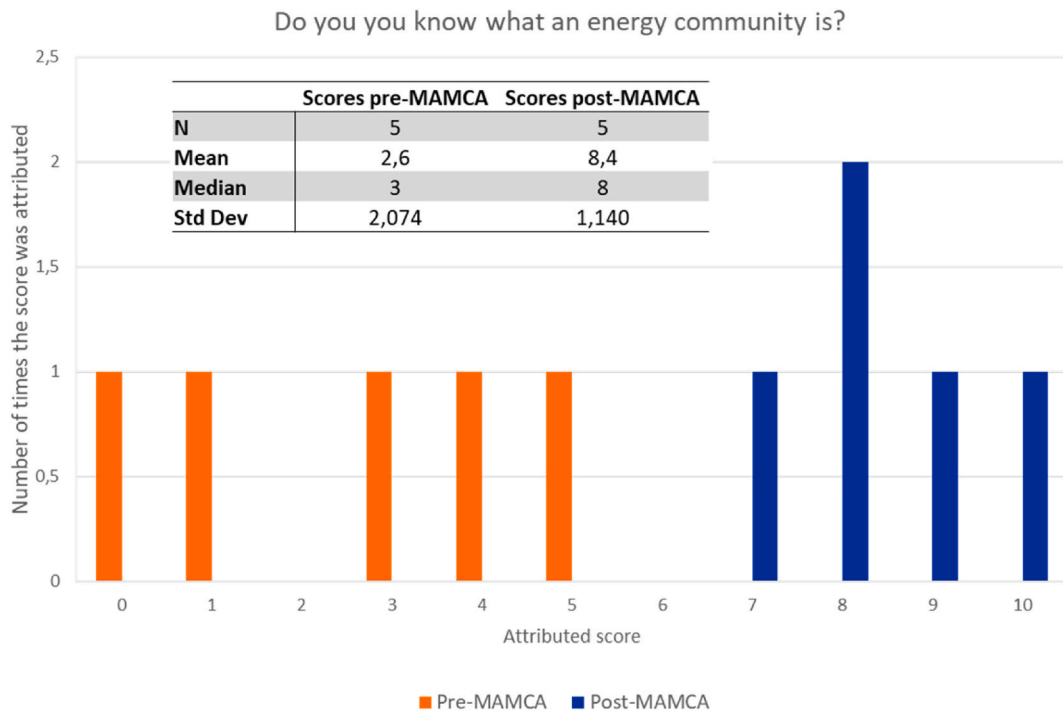


Fig. 7. Overview of the attributed scores on the question ‘Do you know what an energy community is?’ before and after the workshop.

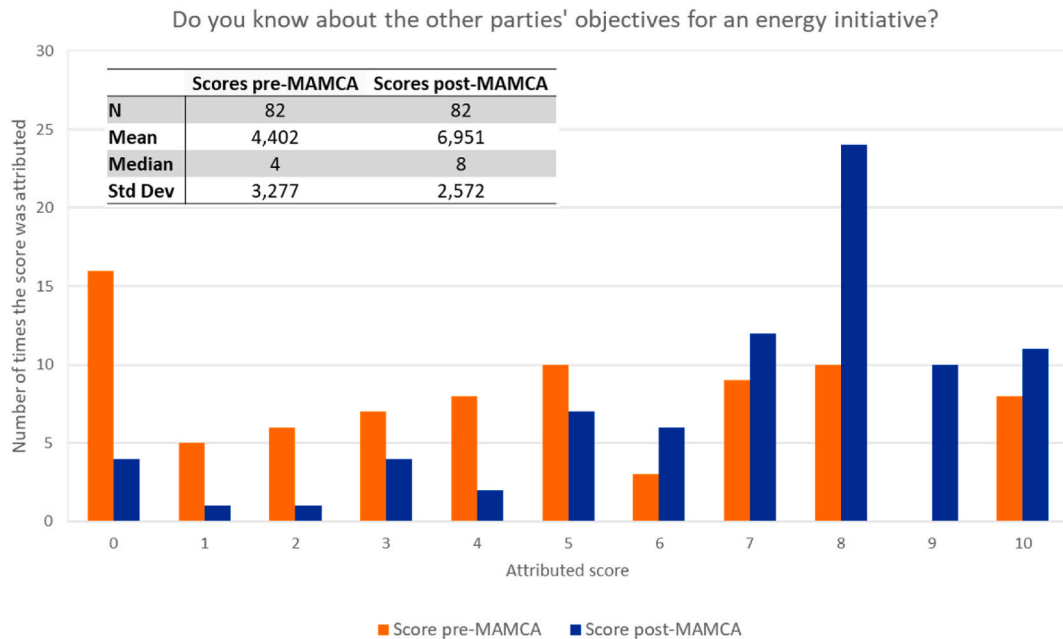


Fig. 8. Overview of the attributed scores on the question ‘Do you know about the other parties’ objectives for an energy initiative?’ before and after the workshop.

significant departure from normality:  $W(82) = 0.87, p < .001$  and  $W(82) = 0.81, p < .001$  respectively. The performed Wilcoxon Signed-Rank test marked no statistically significant difference between the answers that were given before and after the workshop ( $p = .28,462$ ). Fig. 11 shows that 35 participants showed more willingness to compromise after the workshop, 25 were less willing, and for 22 actors the participation did not affect their willingness.

The survey answers that were given to the question ‘How likely do you think it is to reach an agreement with the other parties?’ are

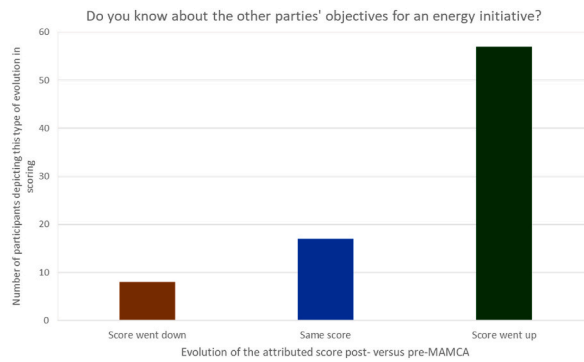


Fig. 9. Overview of the type of evolution in the scores of the different participants.

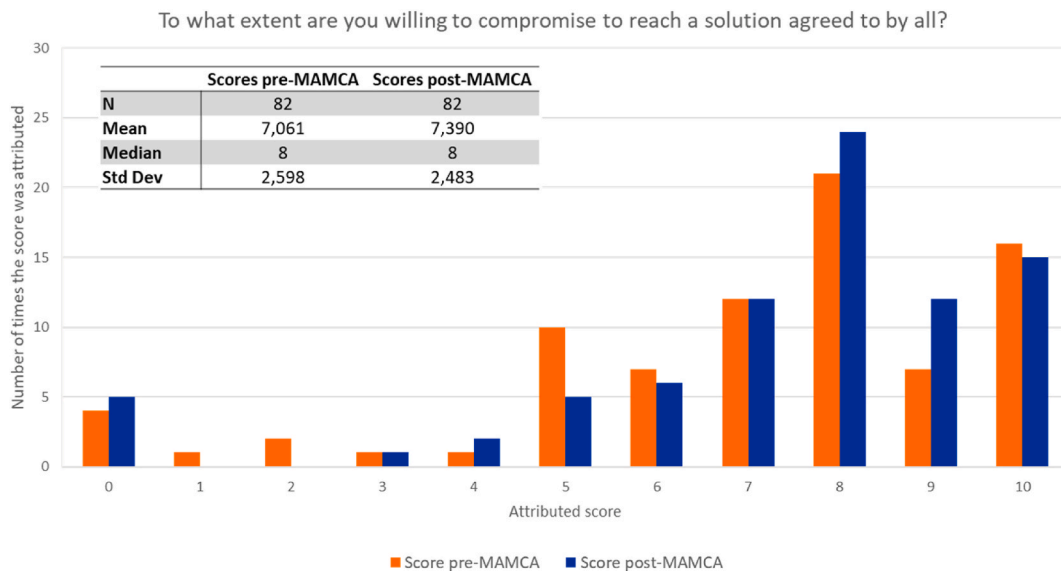


Fig. 10. Overview of the attributed scores on the question ‘To what extent are you willing to compromise to reach a solution agreed by all?’ before and after the workshop.

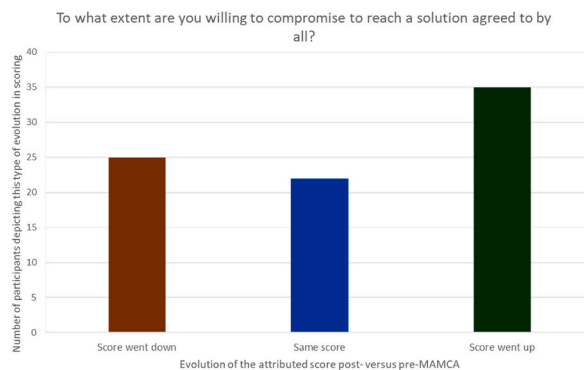
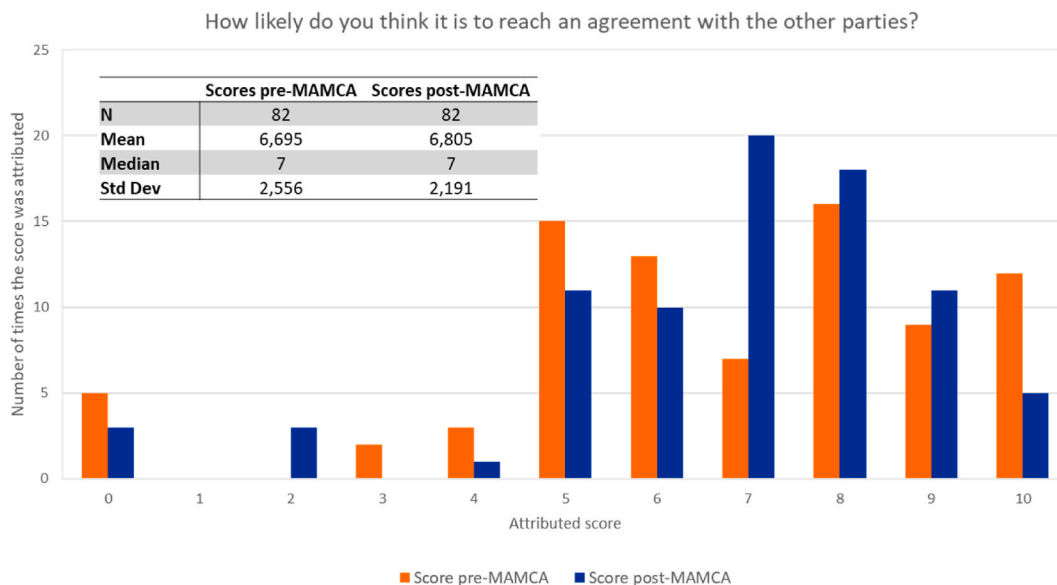
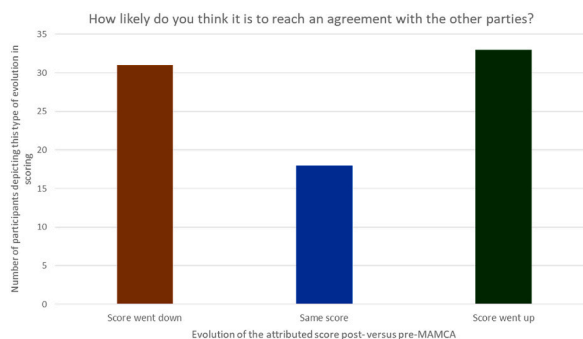


Fig. 11. Overview of the type of evolution in the scores of the different participants.

similar before and after the MAMCA workshop, as Fig. 12 shows. A Shapiro-Wilk test demonstrated that both data sets are not normally distributed:  $W(82) = 0.90, p < .001$ , and  $W(82) = 0.88, p < .001$  respectively. The nonparametric Wilcoxon Signed-Rank test revealed no statistically significant difference in responses before and after the workshop ( $p = .74,896$ ). Fig. 13 shows the varying evolution in the individual stakeholders’ assessment of the chances to come to a common agreement, with 31 of 82 participants (38%) having a



**Fig. 12.** Overview of the attributed scores on the question ‘How likely do you think it is to reach an agreement with the other parties?’ before and after the workshop.



**Fig. 13.** Overview of the type of evolution in the scores of the different participants.

more negative outlook afterward, 33 (40%) having a more positive outlook, and 18 participants (22%) not feeling any difference.

To the question ‘Are you more aware of the benefits and/or challenges of an EC for their site than before the MAMCA workshop?’ 82% of the participants (67 of the 82 that filled out the post-MAMCA survey) answered ‘yes’. 14 indicated they did not gain new insights and 1 participant indicated there was insufficient focus on the challenges in the workshop.

The evolution in insight into and awareness of the viewpoints of the other stakeholders was assessed with the post-MAMCA questions ‘Did you learn things about the viewpoints of other participants that you did not know before?’ and ‘Has your awareness of other parties’ viewpoints increased?’. Figs. 14 and 15 give an insight into the provided answers, with a score of 0 meaning ‘Not at all’ and 10 ‘A resounding yes’. The high mean given scores were respectively 7,8 and 7,1. The median scores are 8 and 7. Only 4 and 5 participants respectively indicated not having learned about others’ viewpoints and feeling no relevant increased awareness of these viewpoints, by giving a score lower than 5.

Additionally, the participants were asked about their own viewpoints regarding EC participation, and whether they had changed through the interaction with the other stakeholders. As Fig. 16 shows, a majority indicated that their viewpoints were indeed influenced, with a mean given score of 6,7 and a median of 7.

In the 4 South American cases an additional question was posed, being ‘With your current knowledge, would you join an energy community?’ and in the Rellu case this became ‘Would you be willing to individually invest in renewable energy for your house?’ Both questions were part of the pre- and post-MAMCA survey.

From the 55 South American participants only 2 showed less willingness to join an EC initiative after the workshop (their answers evolved from ‘Yes’ to ‘Maybe’). The 2 other stakeholders that answered ‘Maybe’ after the workshop gave the same answer before. No one answered ‘No’ in either survey (see Fig. 17). This means that 51 participants were convinced to join an EC in the end, with the boundary condition that the necessary technical and financial resources are provided. 12 of them indicated ‘Maybe’ in the pre-survey,

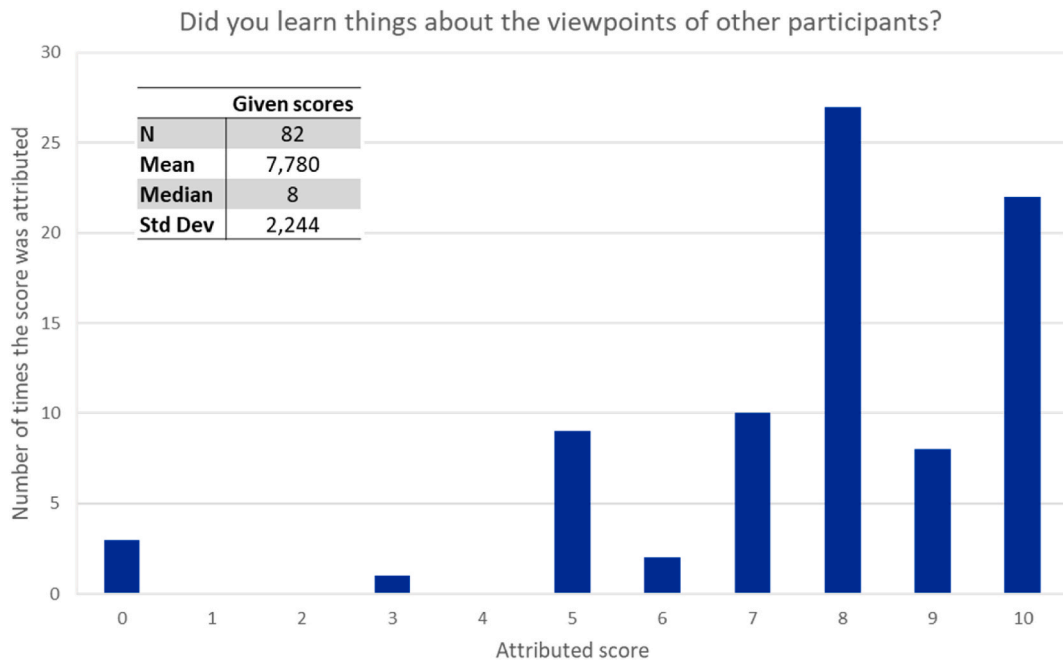


Fig. 14. Overview of the attributed scores on the question ‘Did you learn things about the viewpoints of other participants that you did not know before?’

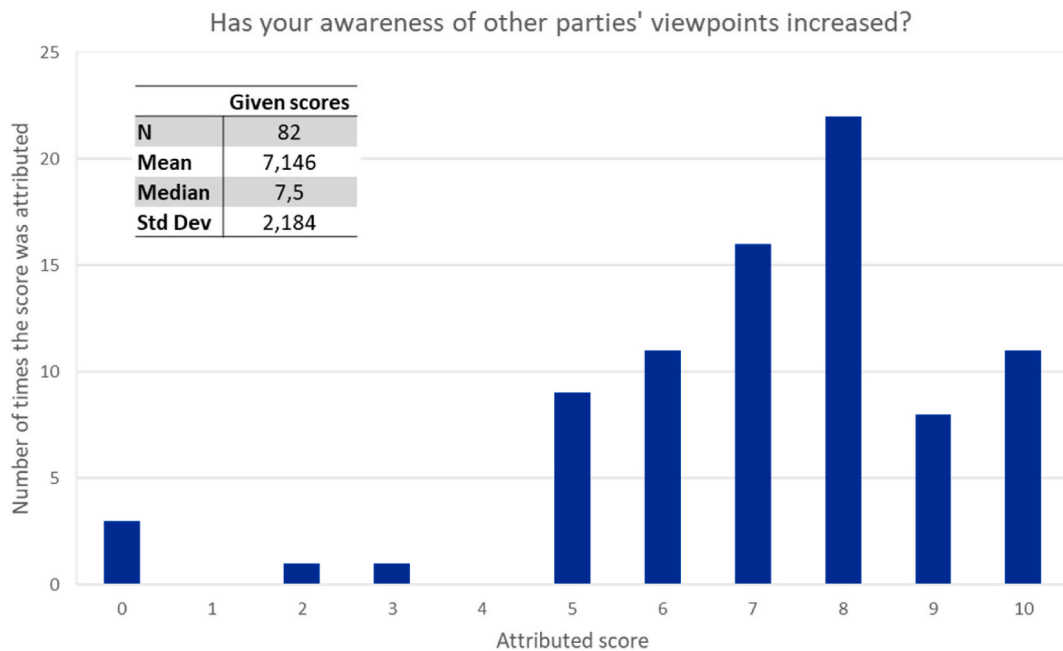


Fig. 15. Overview of the attributed scores on the question ‘Has your awareness of other parties’ viewpoints increased?’

and the others answered ‘Yes’ both times. This means that 93% of participants were willing to join an EC after the workshop, compared to 75% before.

In Relleu one participant went from ‘I don’t know enough about the subject to answer’ to ‘Maybe’, 2 answered ‘Yes’ in both surveys, one evolved from ‘Maybe’ to ‘Yes’ and one went in the opposite direction, from ‘Maybe’ to ‘No’.

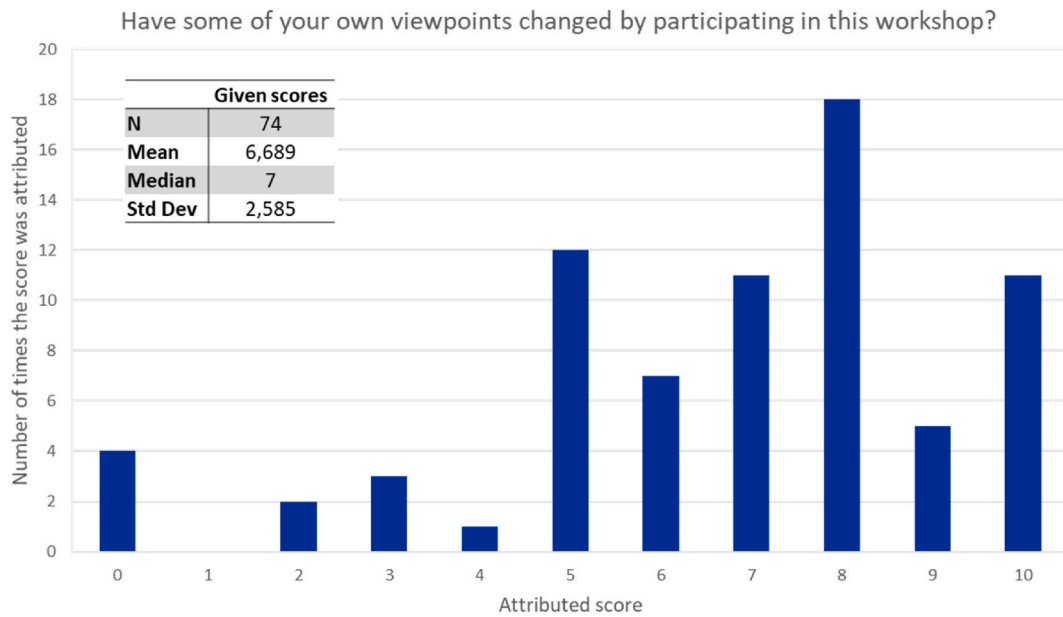


Fig. 16. Overview of the attributed scores on the question ‘Have some of your own viewpoints changed by participating in this workshop?’

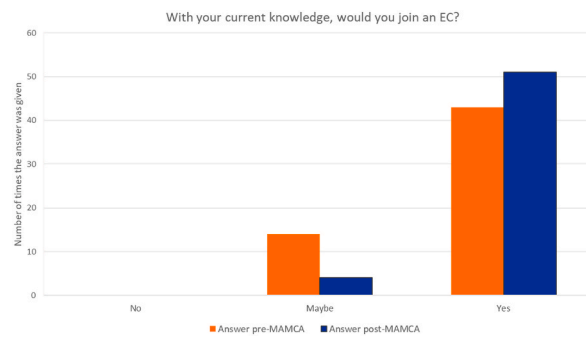


Fig. 17. Overview of the scores assigned in the South American cases to the question ‘With your current knowledge, would you join an energy community?’ before and after the workshop.

4.4. Fulfillment of stakeholder expectations and goals of the engagement initiative

The open question on the expectation of the MAMCA engagement initiative that was posed in the pre-survey yielded a variety of answers that can be classified into the following categories:

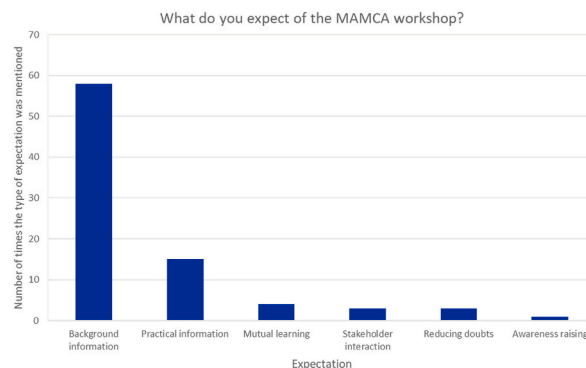


Fig. 18. –Expectations of the MAMCA workshops that were mentioned by the participants.

1. Background information on renewable energy initiatives in general and a better understanding of ECs
2. Practical information and guidance on the implementation of ECs
3. Experiencing an engagement initiative and learning about other stakeholders' opinions
4. Interaction with other stakeholders
5. Reducing doubts
6. Awareness raising

As Fig. 18 shows, out of the 84 answers, a majority of 54 indicated that gaining general knowledge (1) was their main reason for participating in the MAMCA workshop. 15 participants expected to learn more about the practical implementation of ECs for their specific site (2). The engagement aspect itself, with stakeholder interaction (3) and mutual learning (4) was generally not the main driver for participation since they were mentioned respectively 3 and 4 times. 3 stakeholders mentioned they participated to clear up some of the doubts they had about ECs (5) and 1 specifically mentioned they hoped the workshop would raise all participants' awareness on renewable energy.

When asked about specific questions or doubts they wanted to have cleared out, only 26 formulated a concrete question, mainly concerning a location-specific detailed practical aspect or information about renewable energy systems in general.

After the workshop, the participants were asked whether their prior expectations had been met. Out of the 78 received answers, 67 (86%) were 'Yes' and the other 11 were 'Partly'. The main remarks mentioned an insufficient focus on the practical aspects. 2 participants from the same site commented on the time management of the workshop itself and 2 from the same workshop on the use of technical language.

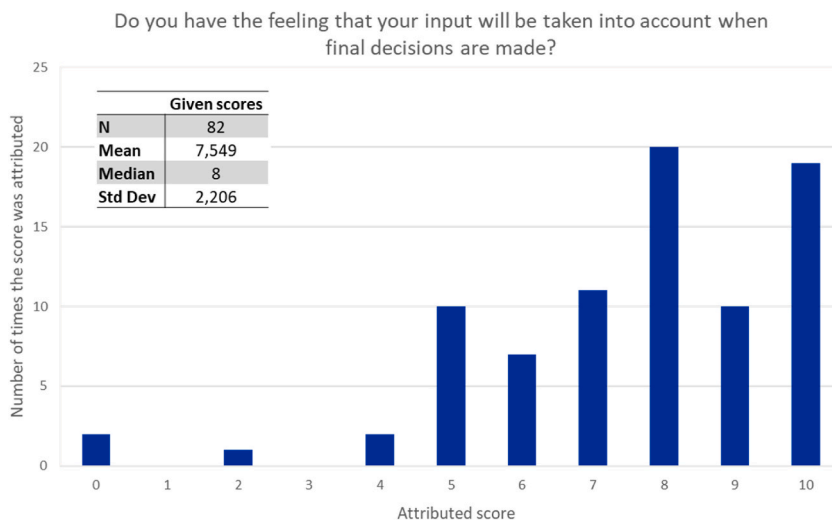
The survey question about whether they received an answer to all the questions they had prior to the workshop was answered with 'Yes' by all participants except 6. 1 answered 'No' and 5 'Partly'.

The answers to the question 'Do you have the feeling that your input will be taken into account when final decisions are made?' are presented in Fig. 19. A 0–10 Likert scale was used with 0 meaning 'I do not think so' and 10 'I am certain it will'. The majority of the 82 respondents (94%) gave a positive answer, with the mean score given being 7,5 and a median score of 8.

The question 'Do you feel heard?' also yielded mainly positive responses, as shown in Fig. 20. A score of 0 represents the answer 'Not at all' and 10 means 'A resounding yes'. A mean score of 8 was given, with a median score of 8.5.

In response to the question 'Any pros and/or cons of the workshop you want to emphasize? Or other things you would like to tell us?' 18 participants mentioned a positive element, with a majority focusing on knowledge and awareness-building aspects. 2 participants specifically mentioned the provided opportunity for dialogue and the insightful results visualization as a positive factor, and 1 the professional guidance throughout the workshop. The negative aspects mentioned were the time management that could be sharper (in one site), the lack of concreteness and detail in the developed EC scenarios, and the uncertainty about the follow-up. Some participants asked for a more detailed insight into the used data, as well as specific calculations of alternative EC aspects and options, while 2 participants were on the other spectrum and found the already presented technical aspects too complicated.

The recommendations on how to improve the MAMCA workshop for future comparable initiatives were limited. The inclusion of more stakeholders was mentioned 3 times, 2 participants suggested a follow-up with feedback and 2 others would have liked the workshop to have been more practical and concrete.



**Fig. 19.** Overview of the attributed scores on the question 'Do you have the feeling that your input will be taken into account when final decisions are made?'



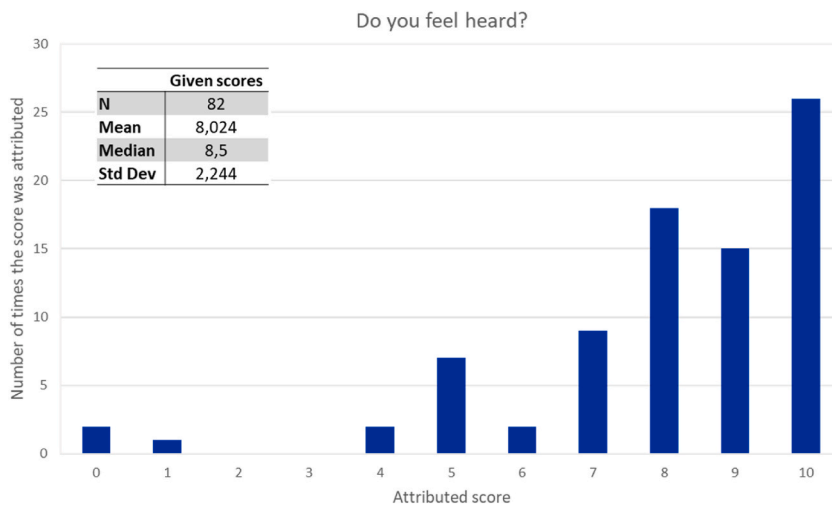


Fig. 20. Overview of the attributed scores on the question 'Do you feel heard?'

## 5. Analysis

### 5.1. Impact on knowledge

A majority of respondents (96%) answered they felt their knowledge of ECs in general as well as of the EC potential of their specific site increased through participation. Since in the survey mainly high scores were given to this aspect it can be concluded that a MAMCA workshop can have a significant impact on the participants' knowledge levels. General knowledge raising received a slightly higher average score than the specific one, indicating that additional attention to site specificities during the workshop is welcome. This is confirmed by the fact that more focus on the practical aspects was requested by several participants in their evaluation of the MAMCA process.

### 5.2. Impact on social learning: awareness and alteration of personal viewpoints and willingness to take action

The survey results show that participation in the MAMCA workshop provides the actors with a better insight into each other's objectives. Not only does the statistical analysis of the survey answers show a significant rise in the scores that were given to the question 'Do you know about the other parties' objectives for an energy initiative?' after the workshop, but a large majority of participants also specifically indicated raised awareness and knowledge of the viewpoints of other participants afterward. Most participants denoted that their awareness of the benefits and challenges of an EC grew as well. These results imply that the MAMCA process stimulates mutual understanding, with the stakeholders consciously realizing their raised insights. However, the raised awareness does not result in a more optimistic perspective on the chances of successful collaboration. The number of people who found it more likely to reach an agreement with other parties than they thought before the workshop is about the same as the number of participants who found it less likely. No statistically significant difference in responses could be found. Nevertheless, since most stakeholders changed their opinion (either positively or negatively) it could be stated that the MAMCA participation gave them a more thorough insight into the key aspects that need to be tackled for a successful collaboration. A similar evolution can be noted in the willingness to compromise to reach a solution. While most participants were more willing after the workshop, a significant number were less inclined to compromise and a minority did not show a shift in openness to compromise. We assume that the gained insights caused a change in willingness (either in a negative or a positive way) with the majority of participants, even though no statistically significant difference between the overall pre- and post-workshop answer datasets is detected.

Although more limited, also a clear change in their own objectives and viewpoints was indicated by a majority of participants. The insight into others' perspectives and the raised knowledge on the topic that the MAMCA process provided are most likely to be the source of this shift.

As a result of these newly acquired insights, the willingness to take action towards investing in RE and joining an EC grew stronger overall. A clear majority of participants were already motivated to join an EC initiative before the workshop, but after it almost all felt informed enough to profess a willingness to engage in proactive measures. This suggests empowerment and trust developed through MAMCA participation.

### 5.3. Fulfillment of expectations and goals of the engagement initiative

Beforehand, most participants indicated gained knowledge of ECs and RE in general as their main expectation from the MAMCA engagement process, as well as information on the practical implementation of ECs. Interaction with other stakeholders and aspects of

social learning were barely mentioned. After the workshop, all participants noted their expectations were at least partly fulfilled, with almost 90% being fully satisfied. Insufficient focus on practical aspects was the main remark. This teaches us that the goals of participants are often limited and of a concrete nature. If their expectations are made clear from the start MAMCA can fulfill them more specifically, for example by foreseeing more time for the steps that contribute to knowledge raising.

In general, the principal goals of an engagement initiative for ECs are gathering input to use in the EC design and decision-making, and giving a voice to all stakeholders in the process. From the answers of the survey participants, it is clear that MAMCA has the potential to gather the necessary information, with stakeholders having the feeling that their input will be used and taken into account in the decision-making process. In our study, a clear majority also indicated that there was enough opportunity within the workshop for their voice to be heard.

#### 5.4. Additional points of attention

As indicated by the participants as well as the initiators the attendance of energy and workshop professionals during the MAMCA process is considered an essential element. Since the (desired) focus is mostly on knowledge and awareness building, there is a need for topic-specific information that can be presented on the spot. And as most participants have no experience in engagement exercises and workshops, an experienced moderator who can adapt the approach to the site-specific needs is necessary. Time management as well as the level of detail and specificities need to be customized according to the local requirements and context.

In response to the survey question on experienced negative elements of the workshop, the participants indicated there is also a clear need for a follow-up of the engagement initiative results. This aspect is not yet embedded in the current MAMCA approach for ECs and deserves more attention in future projects.

#### 5.5. General contributions of this study

The carried out research aims to contribute to the development of an effective engagement methodology for involving stakeholders in the design and setup of an EC initiative, to increase the uptake of ECs and their accompanied sustainability benefits.

The first detected research gap, which is the absence of a method specifically designed for this purpose, is addressed by focusing on the evaluation of an existing general engagement methodology (MAMCA). MAMCA was proven to generate relevant effects in pre-defined fields, and can hence be considered a useful tool during EC setups when taking into account the presented approach suggestions. The theoretical contribution of this study lies in the qualitative evaluation of the effects of a stakeholder engagement initiative on the participants' insights, awareness, and willingness to participate in an EC project (the second identified research gap), and the developed approach to determine this impact based on three parameters.

## 6. Conclusions, limitations, and suggestions for future research

Although MAMCA was primarily developed as a participative decision-making methodology, in the studied cases it has mainly prove valuable as a learning methodology.

Overall, the MAMCA methodology was assessed positively by participants to EC setup initiatives in 8 different sites in which it was used as a stakeholder engagement tool. The highest importance, as well as the highest evaluation scores, were given to its knowledge-raising aspects. Although technical learning aspects are not a standard element of the MAMCA process, this evaluation shows that it is a component that needs to receive the main focus of attention in future engagement initiatives. The process also had a clear positive impact on the mutual awareness of other stakeholders' viewpoints and the insight into potential challenges and benefits, leading to a more realistic assessment of collaboration opportunities, together with a higher willingness to join an EC initiative. This indicates that the interactive aspect of MAMCA, in which stakeholders are brought together to mutually discuss their personal interests, is essential to arrive at the desired insights. It also provides them with the opportunity to have a voice in the process that can have an impact on the end result.

For future use of the methodology, the assistance offered by professionals during the MAMCA process is deemed essential, together with a clearer follow-up of the engagement results. To be able to fully fulfill the stakeholder expectations of the engagement initiative it is also recommended to organize a consultation round on these expectations before the start of the MAMCA process, so more focus can be put on specific steps.

Although the majority of participants indicated a positive personal effect on most aspects, leading to favorable overall outcomes, for some individual participants, only limited to insufficient progression was identified. The used survey format does not allow us to study in detail what the specific problems and reasons behind them are. It is however advisable to enable more information input from participants in future similar studies, to gain a better insight into what can be done to overcome the identified insufficiencies. This is for instance possible by expanding the survey to allow for more detailed comments, or by extending the research methodology with personal interviews.

The developed qualitative evaluation methodology, with a survey that questioned 3 main topics, yielded insightful results on various impact aspects of a MAMCA engagement methodology. However, to assess the inherent value of the evaluation method, and to determine the specific added worth MAMCA has over other engagement tools for the setup of ECs, or points of improvement that can be adopted, a wider study on more cases and different applied tools is necessary. A more elaborate study could also allow for an assessment of the effects of geographical location and implementation specifications. In this study the majority of each of the given scores on every question was given in more than one site, suggesting that the nature of the answers is not strongly related to the

context, but the current sample size per location is too limited to make robust conclusions on it.

In the studied cases the willingness of participants to join an EC initiative was already high from the start and was raised further by participating in the MAMCA process. To make a robust statement about the effectiveness of MAMCA in empowering participants and raising their willingness to take action, however, it is necessary to test the methodology with more skeptical actors. By applying the methodology in a case where willingness to engage in an EC initiative is low to non-existent additional insights can be gained on its capabilities and working points.

### Data availability statement

Data associated with this study has not been deposited into a publicly available repository, but will be made available on request.

### CRediT authorship contribution statement

**Shary Heuinckx:** Writing - original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Cathy Macharis:** Supervision, Resources. **Geert te Boveldt:** Supervision, Writing - review & editing. **Maria Luisa Lode:** Data curation. **Thierry Coosemans:** Resources.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Appendix A Supplementary data

Supplementary content related to this article has been published online at <https://doi.org/10.1016/j.heliyon.2023.e23068>

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