30.01.2024

Carbon driven energy equilibrium at the municipal scale – Energy Equilibrium

GoA 1.4 - Organize group model building activities with local public authorities and energy service providers

D 1.4. Final report

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Interreg Baltic Sea Region
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ENERGY TRANSITION
Energy Equilibrium

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1 About the Energy Equilibrium project

1.1 Context and challenge

To compensate the variability and non-controllability of seasonally generated renewable energy (RES) (daily fluctuations in solar radiation intensity, wind speed, etc.) development of sufficient energy storage infrastructure in the regions will play a major role in transforming RES supply potential into reality. However, local public authorities that are responsible for creating an enabling policy environment for RES infrastructure development in regions encounter numerous challenges and uncertainties in deploying sufficient energy accumulation that often remain unanswered due to a lack of knowledge and on-site capacity, which in turn significantly hinders the regional path to climate neutrality.

The project aims to identify renewable energy potential in local energy systems and to support local public authorities in decision-making regarding the development of sufficient renewable energy infrastructure in the region, including the integration of energy storage.

1.2 Aim of the Energy Equilibrium project

This project aims to develop an Energy Equilibrium Platform – an interactive and easily applicable tool to support municipalities and energy suppliers in decision-making related to the development of efficient action plans to accelerate local RES utilization in the region. Energy Equilibrium Platform will help municipalities to:

1) Identify the most optimal RES storage development strategy and its impact on energy flexibility in the region;
2) Help to determine the key factors affecting energy equilibrium (balance between the produced and the consumed energy) in the region;
3) Help to develop policy mechanisms and action plans to enhance local RES in the region;
4) Help to anticipate risks and avoid making expensive mistakes (e.g. investing in inappropriate technological solutions).

2 Group model building activities

2.1 Aim of group model building events

During the Energy Equilibrium platform development three group model building events/activities were organised (in the scope of GoA 1.4.). This activity is responsible for including the relevant parties in Energy Equilibrium platform building process to facilitate shared understanding of the relevant factors and causalities in the system and allow to improve and fine-tune the model.

Group model building (GMB) is a method to facilitate shared understanding of structures and relationships that determine system behaviour. Aim of the group model building events is to identify the relevant factors and build causal maps of factors influencing the RES development in local setting. Perceived strengths of the GMB process are representation of diverse stakeholder viewpoints and complex system synthesis in a visual causal pathway, the process inclusivity, development of shared understanding, new idea generation and momentum building. Creation of a shared mental model in GMB session allows model builders to improve the initial model.

In group model building sessions representatives from project target groups were involved (municipalities, energy consulting companies, state owned and private energy utilities, researchers from engineering and social sciences, professional associations from the energy sector). The representatives from these target groups were invited and gathered from various BSR countries to increase its cross-border significance.

Three group model building sessions were carried out in order to fine-tune the model:

- First group model building event held on 19 October, 10:00-12:00 CET, online on ZOOM platform. Announcement of the event published on project page here. Energy Equilibrium platform prototype from first group model building activity available here: https://exchange.iseesystems.com/public/testlearntestsagain/model-rtu-campus/index.html
- Second group model building event held on 28 November, 10:00-12:00 CET, online on ZOOM platform. Announcement of the event published on project page here.
- Third group model building event held on 18 January, 10:00-12:00 CET, online on ZOOM platform. Announcement of the event published on project page here. Energy Equilibrium platform prototype from the second and third group model building activity available here: https://exchange.iseesystems.com/public/testlearntestsagain/municipality-model/index.html#page1

Each session included the discussions and interactive exercises in order to receive the valuable feedback. Feedback from each session was analysed and incorporated in the model.

GMB are critical to support the creation of the model, validate its structure and behaviour, train relevant partners and decision-makers in the use of the model, receive critical input for the simulation of relevant intervention options, and share results with a variety of target audiences. Group model building activities were held online, and all the municipalities of the partnership participated in these meetings.

2.2 Aim of this report

As a result of group model building activities produced deliverable "Improved Energy Equilibrium platform based on group model building sessions (D 1.4.)" This deliverable produces 2 main sub-deliverables:

1) Summarized feedback from the group model building sessions;
2) Improved Energy Equilibrium Platform prototype and user interface available for target groups and end-users.

This report describes deliverable D 1.4. which summarizes the main findings from all group model building activities organized. This deliverable is the first step for validation and improvement of Energy Equilibrium platform. The findings from the group model building activities served as inputs for development of the final version of the Energy Equilibrium platform which is the main output of this project.

This activities performed in GoA 1.4. are in line with the validation and verification tests, investigating the behavior of platform technical features and functions: (1) model structure verification tests that assess the structure and elements of the model without analysing the relationship between the structure of the system and its behaviour; (2) model behaviour verification tests that assess the adequacy of the model structure by analysing the behaviour generated by the system; (3) policy impact assessment tests. During group model building sessions these tests were performed through implementation of exercises demonstrated during the sessions. These activities are in line with GoA 1.5. where testing and model approbation is continued based on municipal data. This report summarizes all the outcomes from group model building activities, including the main key takeaways from platform tests with main target groups and stakeholders of the project.

3 Energy Equilibrium first group model building session

3.1 Description of the event

During this event, the Energy Equilibrium platform held its first group model building session with project partners. Initial model prototype and a practical case study was introduced. All participants got the chance to try out the prototype and share their early feedback. This way, we make sure that our main target groups and partners are involved in model building right from the start. This helps us all understand the important factors in the system and refine the model effectively. The event also included discussions and activities to gather valuable feedback from all participants. Table 1 below summarizes the agenda of the event organized.

Table 3.1.

Agenda of the Energy Equilibrium first group model building session

Time	Topic	Presenter
11:00 – 11:05	Opening remarks	Project manager, Dr.sc.ing. Dagnija Blumberga, project communications manager, M.sc.ing. Kristiāna Dolge, Riga Technical University
11:05 – 11:35	Model prototype demonstration & case study results	Leading researcher Ph.D. Ieva Pakere, Scientific assistant B.sc.ing. Ģirts Bohvalovs, Riga Technical University
11:35 – 11:50	Introduction to model interface	Project communications manager, M.sc.ing. Kristiāna Dolge, Riga Technical University
11:50 – 12:45	Group model building exercises	All participants
12:45 – 13:00	Feedback & discussion	All participants

The event lasted a total of two hours. In the first half of the event, the prototype of the model was presented to the participants and specific case study was presented and discussed. In the second half of the event, group model building exercises were introduced to the participants and they were able to try out the developed model interface themselves. Afterwards, a feedback discussion was held between all the participants of the event.

3.2 Description of the group model building exercises

For the group model building exercises, all participants were divided into separate groups (3-4 people per group). Each group included participants from different countries and backgrounds, e.g. municipality representatives, energy consulting companies, energy production companies, researchers, etc. To participate in the exercise all participants were provided with the access link to the Energy Equilibrium platform prototype interface. Energy Equilibrium platform prototype from first group model building activity available here: https://exchange.iseesystems.com/public/testlearntestsagain/model-rtu-campus/index.html .

In total there were 2 rounds of exercises, where after each exercise participants were asked to participate in the discussions in their groups by giving their initial feedback on the functionality of the platform interface functionality.

In the first round, participants were asked to familiarise themselves with the tool and the parameters available in it. Then they had to formulate 3 different strategies/scenarios to achieve maximum energy self-sufficiency and write them down. The participants then had to present and discuss in the group which different measures each participant intends to implement at different levels (changing the input parameters in the model) in order to achieve the goal.

In the second round, participants were asked to run simulations for their defined alternative strategies and write down their input parameters. The participants then had to present and discuss various questions in the group, such as: (1) Which of the formulated scenarios achieved the highest degree of energy self-sufficiency? (2) What payback time was achieved in the scenarios; (3) What did the energy storage balance of the model show as a result?

After all the exercises and discussions, the participants were asked to fill the feedback survey which was available here: https://forms.gle/ayqcZ4j2rLzHscSE9

3.3 Main findings from the participant feedback survey

The purpose of the survey was to gather feedback on the first prototype of the Energy Equilibrium platform presented during the first group model building session on 19/10/2023. Before the actual survey questions, respondents were asked to specify the organization represented by themselves. The answers are summarized in Fig. 3.1. below.

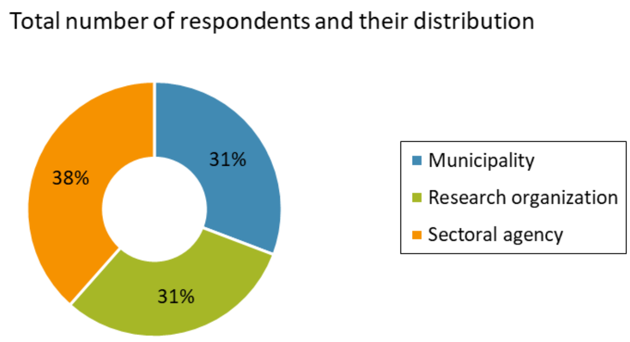

Fig. 3.1. Distribution or respondents according to main stakeholder groups of the project.

The main stakeholder groups attending the first group model building session were almost evenly split – 31% of participants were representatives of municipalities, 31% were representatives of research organisations and 38% were representatives of sectoral agencies dealing with energy transition issues.

The respondents were asked to rate the level of information received during the workshop to sufficiently fulfil the given exercise. The answers are summarized in Fig. 3.2.

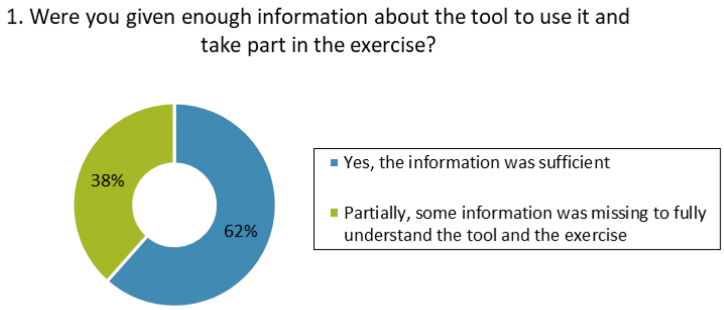

Fig. 3.2. Distribution of the respondent answers on information sufficiency to fulfil the exercise.

To enhance the evaluation of the newly created tool, the participants were questioned about any elements that might be absent or lacking in the initial version of the Energy Equilibrium platform (Fig. 3.3.).

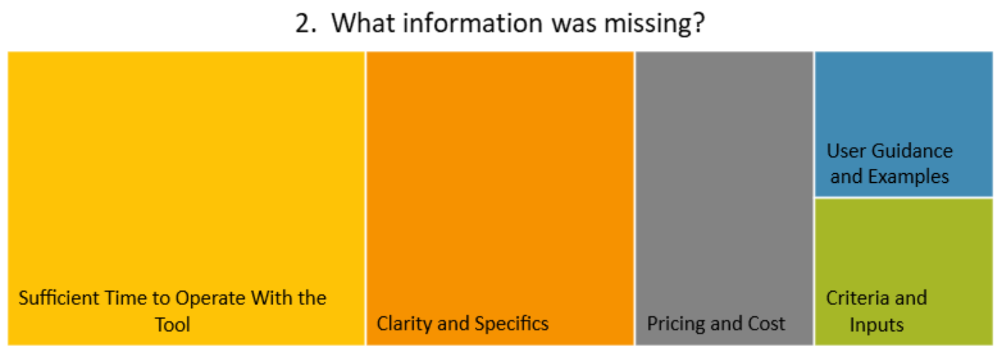

Fig. 3.3. Summary of the key responses on identified information deficiencies.

The main participant answers to the question "What information was missing?" are placed below:

- "Need for a Walkthrough for all the pages and an example to get the users an impression on how to achieve the goal".
- "Need to define some criteria (self-sufficiency) and the input criteria".
- "At solar irradiation the different colours should be explained more. More information needed about calculations and how much indicators affect each other. Need to specify prices for storage units (maybe price per kWh) and energy efficiency of buildings and what costs apply to renovation".
- "It was sufficient but more time to investigate the tool would be useful, because the system (I am not talking about the interface) is too complicated (although this is due to the level of complexity of the issue)"
- "Additional information about the parameters included in the specific section is required to better understand the tool as well as additional knowledge is needed to understand how each indicator affects further processes".

Key takeaways

Walkthrough and Example: Participants want a comprehensive walkthrough of all pages. An example is deemed crucial for guiding users in achieving their goals through the interface.

Definition of Criteria: Participants stress the need to define criteria, especially in terms of self-sufficiency and input criteria, for effective interface use.

Solar Irradiation and Calculations: Concerns raised about explaining colours in solar irradiation. Participants seek detailed information on calculations and indicator interplay, including clarification on their mutual effects and pricing specifics for storage units.

Clarity on Prices and Energy Efficiency: Participants seek more information on storage unit prices, suggesting clarity on costs, potentially in terms of price per kWh. Additional details requested on building energy efficiency and renovation costs.

Interface Investigation Time: Participants acknowledge sufficiency but desire more time for tool investigation. Complexity of the system, aside from the interface, is noted, suggesting more time is beneficial due to the intricate issue.

Additional Information for Understanding: Participants emphasize the need for more information on parameters in each interface section. Deeper understanding requires additional knowledge about how each indicator influences subsequent processes.

Participants were asked to elucidate the key indicators they employed in completing the exercise and to elaborate on the strategies they chose. Their insights shed light on the thought processes and approaches employed during the task (Fig. 3.4.).

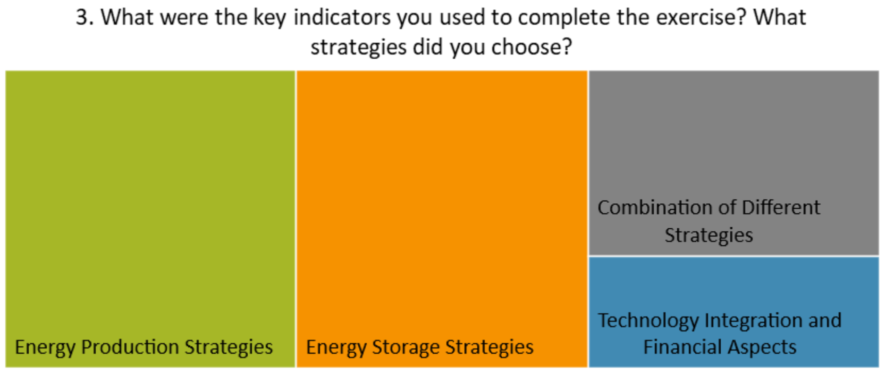

Fig. 3.4. Summary of the key responses on the used strategies for exercise completion.

The main participant answers to the question "What were the key indicators you used to complete the exercise? What strategies did you choose?" are placed below:

- "Strategy 1: All other measures + PV installation (2500 m2) + Wind Turbine Power (2,5MW). Self-sufficiency: 24,5 % self-sufficiency. Payback time: 3,37 years. Expenses: 410k euro/year.
- Strategy 2: Installed storage (Heat storage, 250 m3, hydrogen storage 100 kg, battery size 5000 kwh) + installed energy (PV – 2500m2, Wind -2,5 MW) Self-sufficiency: 14,5".

- "In 1. step I put all measures 100% on in campus section and no changes made in building section. 2. step all as previous, only ticked off in other measures all except connected to district heating grid. 3. step All measures as it was in 2. step and in building section all measures were 100% on.".
- "Maximum use of renewable energy and energy storage".
- "1. Heat storage with energy efficiency measures, 2. Batteries with PV and heat pumps. As well as Investments, payback time, self-sufficiency."
- "First choose everything and delete indicators afterwards to simulate the effect".
- "Mostly PV and a mixture with wind turbines. Tried a multiuse solution".

Furthermore, participants were asked to specify in what results there were interested the most (Fig. 3.5.). For user friendly interface development, it is very crucial to understand the main needs and interests of the key target audiences.

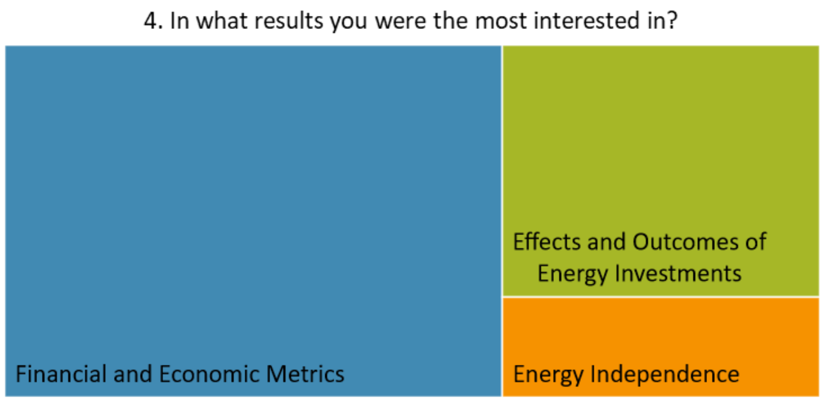

Fig. 3.5. Summary of the participants' responses to the results that aroused their greatest interest.

The main participant answers to the question "In what results you were most interested in?" are placed below:

- "Amortisation and Simulation Over Time"
- "Effect of Storages (Input and Output)"
- "Payoff Time and Investment Cost in Relation to Renewable Energy"
- "Energy Investment Prices and Annual Savings"
- "Payback Time, Investments, and Self-Sufficiency"
- "Energy independence"
- "I was open to all kinds of results. I was mostly interested in seeing how the tool worked and how the results were presented. Because the task was to achieve high energy efficiency, I focused on that, but other people in my group were mostly interested in investments and expenses."
- "In investment part and payback time because I looked up in internet, how much costs, for example, battery stations or heat pumps. I think investment part calculated costs are too low."

The respondents' views on the overall quality of the tool were assessed by analysing their answers to the question "How would you rate the tool's understandability" (Fig. 3.6).

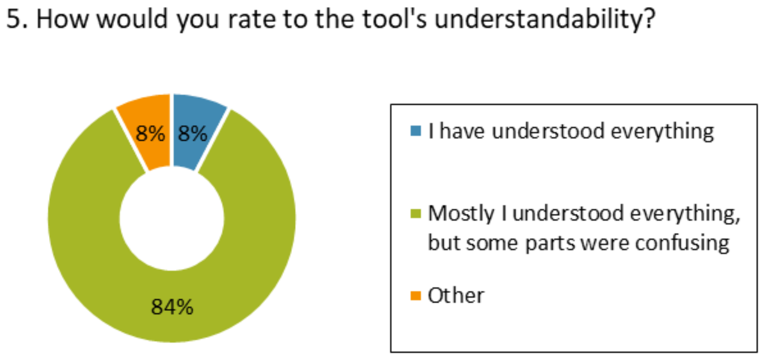

Fig. 3.6. Respondent answers on the level of tool's understandability.

The majority (84%) of respondents answered that they mostly understood everything in the tool, but some parts were confusing. Only 8% of respondents answered that they understood everything in the tool. This indicates that there is great potential to improve the interface to make it more understandable.

The participants were also asked to provide insights on any aspects of the tool that caused confusion or were difficult to comprehend (Fig. 3.7.).

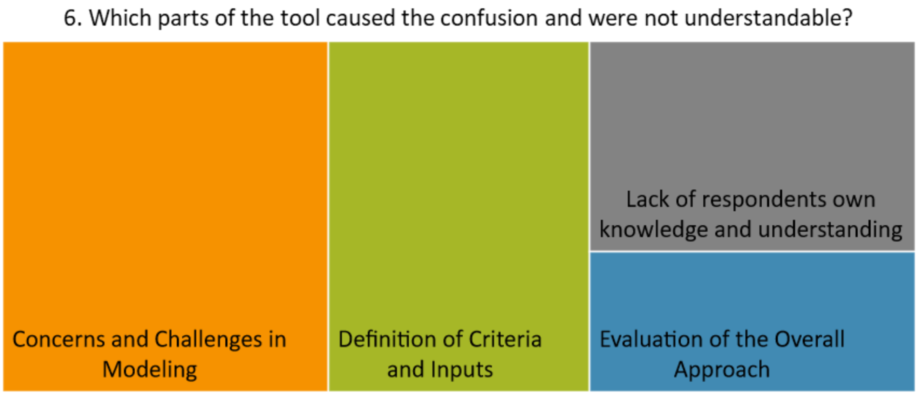

Fig. 3.7. Respondent answers on inconsistencies in the model interface.

The main participant answers to the question "Which parts of the tool caused the confusion and were not understandable?" are placed below:

- "Buildings section – temperature chart. Was it related to the indoor temperature of the building or the outdoor air temperature?"
- "It was difficult to understand the context, i.e. the sizes of the installations. I am not well-versed in different energy measurements and what can be considered a large vs small installation of energy storage (in particular). The information beside the different measurements help to a certain extent, but when filling in the measurements I tested rather than did strategic inputs."
- "Speaking about municipal level, more details would be needed."

- "Definition of some criteria (join district heating, efficiency measures, heat recovery). Maybe there should be less for the municipal level. And some of the input criteria (temperature and wind speed)"
- "Too much text and not intuitive paths A -> B -> C -> Goal"
- "The connection between campus and buildings"
- "The calculations were not always reasonable; in one case the payback time was -422 years. Plus, the climate inputs were chosen in a small range".

Key takeaways

Understanding Installations and Context: Participants struggled to understand the context, especially in sizing installations. Lack of familiarity with various energy measurements made it challenging to distinguish between large and small energy storage installations.

Need for More Details at Municipal Level: Participants expressed a need for more details, particularly when considering the municipal level. Insufficient information was highlighted, indicating a desire for a more comprehensive understanding at this level.

Unclear Criteria Definitions: Confusion was reported regarding the definition of criteria, such as join district heating, efficiency measures, and heat recovery. Suggestions were made for simplifying criteria at the municipal level, specifically regarding temperature and wind speed.

Text Overload and Non-Intuitive Paths: Participants noted an overload of text and identified non-intuitive paths within the tool (A -> B -> C -> Goal). The user experience was hindered by excessive textual information and a lack of intuitive navigation.

To evaluate the clarity of the tool, participants were instructed to provide a rating based on its comprehensiveness. The answers on the question" Was the information and results presented comprehensively in the tool?" are summarized in Fig. 3.8.

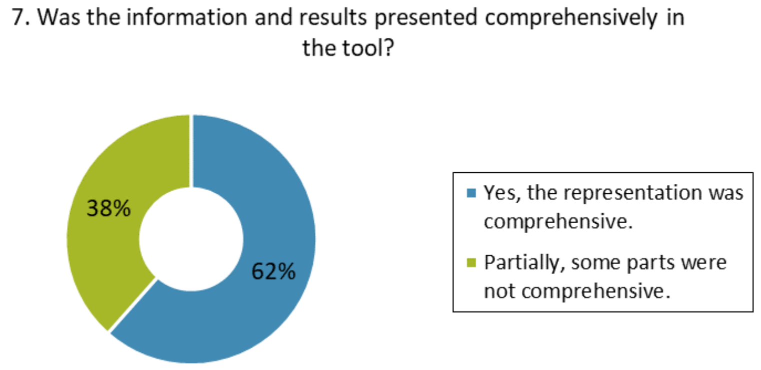

Fig. 3.8. Respondent answers on level of comprehensiveness of the tool.

Almost two thirds of participants (62%) rated the tool's representation as comprehensive, while 38% felt that some parts of the tool were not comprehensive. This indicates a potential for improvement in the presentation of the results.

The respondents were asked to elaborate about specific aspects of the information and results in the tool that they found lacking or insufficient in comprehensiveness (Fig. 3.9.)

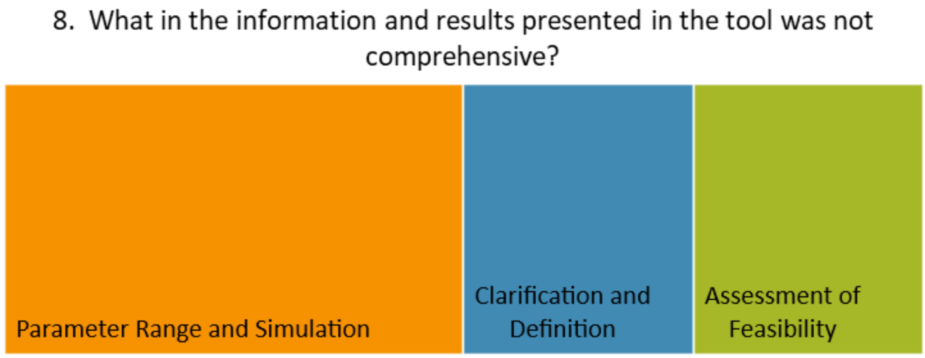

Fig. 3.9. Summary of the key responses on the information and results that lacked comprehensiveness.

The main participant answers to the question "What in the information and results presented in the tool was not comprehensive?" are placed below:

- "It was a little bit difficult to understand the role of energy storage, the role in the system, when storage was loaded and when it was unloaded."
- "Apparently within the limits given, all possibilities were realistic, and construction is possible?"
- "From other measures a parameter range could be implemented. If you do more than one simulation, you should be able to check back later which parameters you used in older simulations".
- "More definition of criteria and maybe discussion of results".

Key takeaways

Unclear Role of Energy Storage: Participants found it challenging to understand the role of energy storage within the system. Specifically, there was difficulty discerning when the storage was loaded and when it was unloaded.

Parameter Range for Other Measures: Participants suggested implementing a parameter range for other measures, allowing for more flexibility. The ability to check and reference parameters used in older simulations was deemed valuable for users conducting multiple simulations.

Need for More Definition of Criteria and Result Discussion: Participants expressed a desire for more detailed definition of criteria. They also called for a discussion of results, indicating that a deeper understanding could be achieved through more explicit criteria and a comprehensive analysis of the simulation outcomes.

Furthermore, participants were asked to express their confidence in the accuracy and dependability of the outcomes produced by the tool's simulations. The participants were asked to provide their opinion on the reliability of the results produced by the tool (Fig. 3.10.).

Majority of the respondents (54%) responded that the results provided by the tool seemed reliable while 46% responded that the results produced by the tool were only partly reliable.

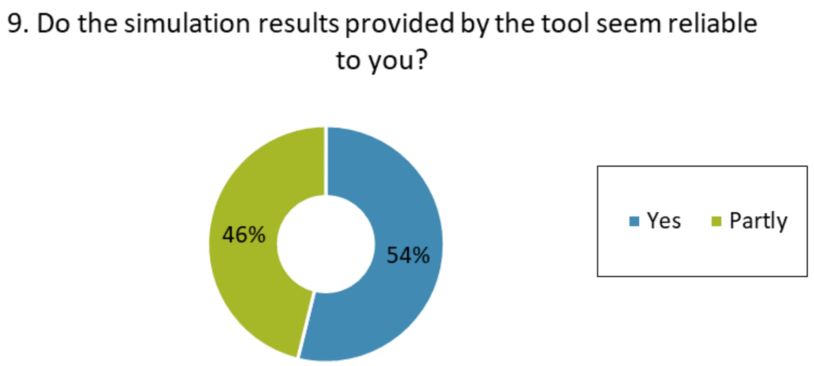

Fig. 3.10. Respondent answers on level of comprehensiveness of the tool.

Participants' perspectives on the reliability of specific aspects within the simulation results generated by the tool were identified in the question that asked, “Which parts of the simulation results did not seem reliable to you in the tool and why?” (Fig. 3.11.).

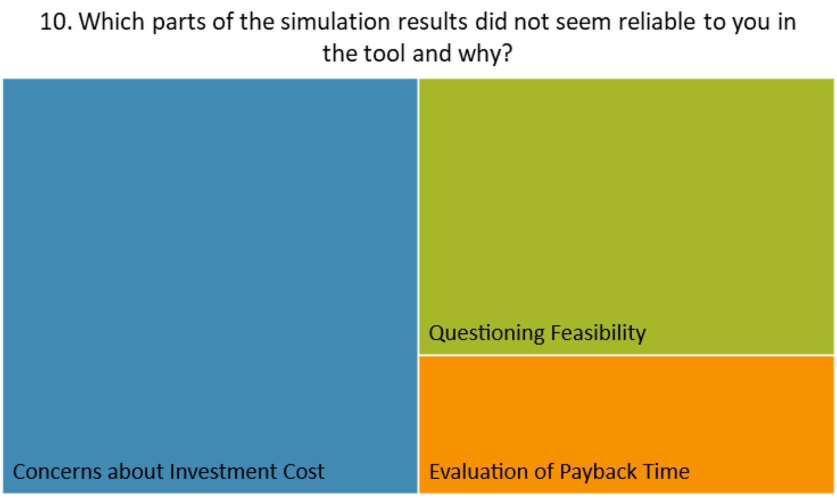

Fig. 3.11. Summary of the key responses on parts of the results that seemed unreliable in the tool.

The main participant answers to the question “Which parts of the simulation results did not seem reliable to you in the tool and why?” are placed below:

- “Very short payback time, investment cost was underrated, questions like whether wind power can really be built in this area?”.
- “Would like to know assumptions behind strategies having only the (ON/OFF mode), e.g., Energy policy”.
- “I would like some background information on how the investment costs and expenses are calculated, and what they entail. How certain is it that it is the correct investment cost, and what is included in the investment cost?”.
- “I think that it is better for understanding use kWh instead of area, m^2 for photovoltaic panels”.

Key takeaways

Short Payback Time and Underrated Investment Costs: Participants raised concerns about very short payback times and the potential undervaluation of investment costs.

Assumptions Behind Strategies (ON/OFF Mode): Participants expressed a desire to understand the assumptions behind strategies employing only the ON/OFF mode, especially in relation to energy policy.

Lack of Background Information on Investment Costs: Participants requested background information on how investment costs and expenses are calculated. Concerns were raised about the certainty of the correctness of the investment cost and what is included in this cost.

Preference for kWh Instead of Area (m2) for Photovoltaic Panels: Participants suggested that using kWh instead of area (m2) for photovoltaic panels would enhance understanding.

Participant's perspective on the level of detail in the results presented by the tool was assessed, prompting them to provide a rating based on the depth and thoroughness of the information provided (Fig. 3.12.).

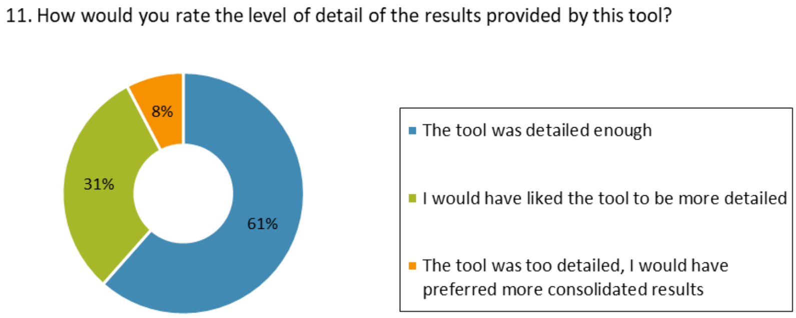

Fig. 3.12. Respondent answers on level of detail in the results provided by the tool.

Most of the respondents (61%) felt that the tool was detailed enough. however, 31% stated that they would have liked a more detailed tool. 8% of respondents answered that the tool was too detailed and that they would have liked more consolidated results. To understand what details the participants were missing, the respondents were asked to elaborate on the factors that they wished to see in the tool.

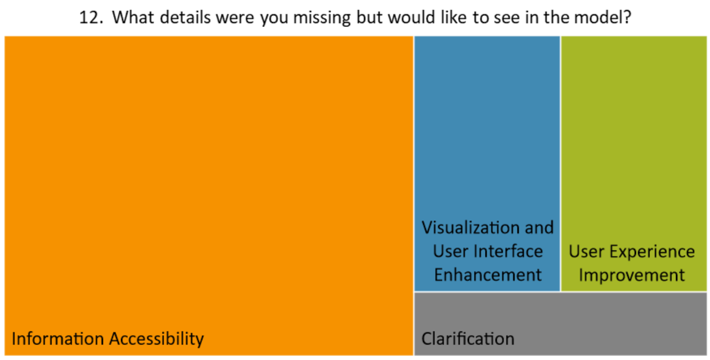

Fig. 3.13. Summary of the key responses on parts of the details that were missing and could be improved.

The main participant answers to the question "What details were you missing but would like to see in the model?" are placed below:

- "More information about context and also what is included in investment costs."
- "Energy efficiency (in buildings, industry, streets lightening, etc.); waste heat recovery (buildings, industry, wastewater, etc.), no transport section, the scale of storage and other installations should be increased."
- "A clearer flow chart of produced electricity, loading of energy storage and unload energy storage".
- "Add a info button for the simulations and what categories show what (and what key indicators flow into each simulation category)".

Key takeaways

More Information on Context and Investment Costs: Participants expressed a need for more information about the context and details included in investment costs.

Additional Areas for Energy Efficiency and Waste Heat Recovery: Participants highlighted the absence of details on energy efficiency in buildings, industry, street lighting, etc. They called for information on waste heat recovery in buildings, industry, wastewater, etc. Participants noted the absence of a transport section and suggested scaling up storage and other installations.

Clearer Flow Chart of Electricity Production and Storage: Participants requested a clearer flow chart depicting electricity production, energy storage loading, and unloading.

Info Button for Simulations and Key Indicators: Participants suggested adding an info button for simulations to explain what each category represents and how key indicators contribute to each simulation category.

Furthermore, the respondents asked to assess the tool's potential adaptability for municipal-level applications and its suitability for use at the local government level (Fig. 3.14.).

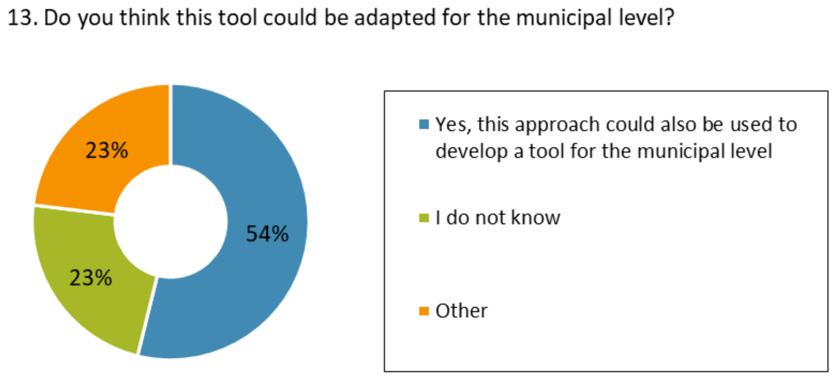

Fig. 3.14. Respondent answers on the tool's potential applicability to the municipal level.

Most respondents (54%) thought that the same approach could be used to develop a tool for the municipal level, while 23% of respondents did not know whether it could be adapted to the municipal level.

Participants were also asked about specific indicators they believe should be incorporated into the upcoming municipal-level modelling tool for a more comprehensive and insightful analysis (Fig. 3.15.).

14. What additional indicators would you like to see in the tool that will be developed for modelling at the municipal level?

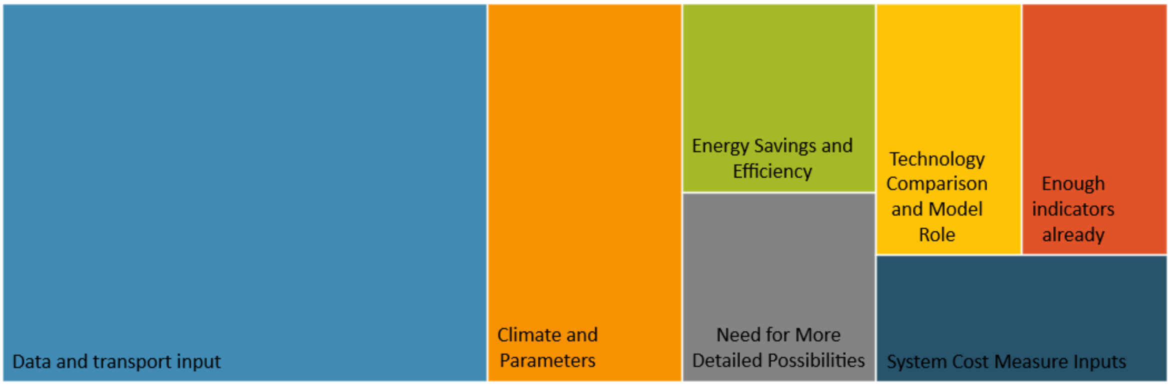

Fig. 3.15. Summary of the key responses on additional indicators that could be included in the tool that will be developed for modelling at the municipal level.

The main participant answers to the question "What additional indicators would you like to see in the tool that will be developed for modelling at the municipal level?" are placed below:

- "Less results, predefined input data, more flexible sizes of indicators, flow chart of electricity."
- "Household and municipal buildings, energy saving options in the level of 5-20 %".
- "A wider range of climate factors, a range of parameters to choose from in the 'other measure' category".
- "Municipalities need more detailed possibilities, include info about transport, more detailed technology comparison (e.g., storage solutions)".
- "In the Input section add System cost measure inputs. For example, PV panel system cost or Heat pump cost."

Key takeaways

Less Results, Predefined Input Data, and Flexible Indicator Sizes: Participants preferred fewer results, predefined input data, and more flexibility in sizing indicators. They emphasized the importance of a flow chart depicting electricity.

Wider Range of Climate Factors and 'Other Measure' Parameters: Participants called for a wider range of climate factors and parameters to choose from in the 'other measure' category.

Detailed Municipal Possibilities, Including Transport: Participants emphasized the need for more detailed municipal possibilities, including information about transport and a more detailed technology comparison, such as storage solutions.

System Cost Measure Inputs in the Input Section: Participants recommended adding system cost measure inputs in the Input section, specifying costs for PV panels, heat pumps, etc.

Furthermore, the questions explored the potential utilization and application of the tool in enhancing planning and future strategy development in municipality (Fig. 3.16.).

Fig. 3.16. Respondent answers on the tool's potential use for better planning and future strategy development at municipal level.

Final questions focused on evaluating the tool's quality in terms of serving as both an information source and a decision-making support (Fig. 3.17.).

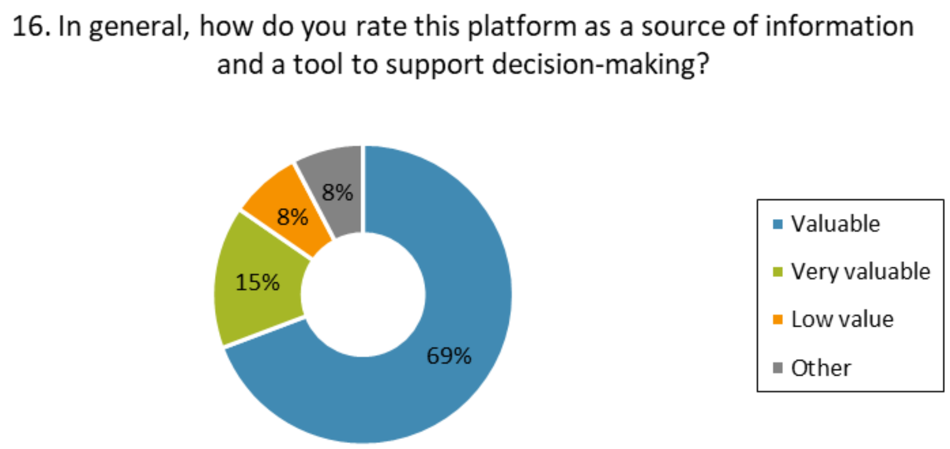

Fig. 3. 17**.** Respondent answers on the tool's quality in terms of serving as both an information source and a decision-making support.

The majority of respondents (69%) rated the tool as valuable and 15% of respondents rated it as very valuable. However, 8% of respondents rated the tool as not very valuable.

To identify potential improvements in the tool, participants were asked for insights on enhancing the tool's functionality. Moreover, the respondents were asked to share any information which could help to proceed with improving the tool's functionality and representation (Fig. 3.18.).

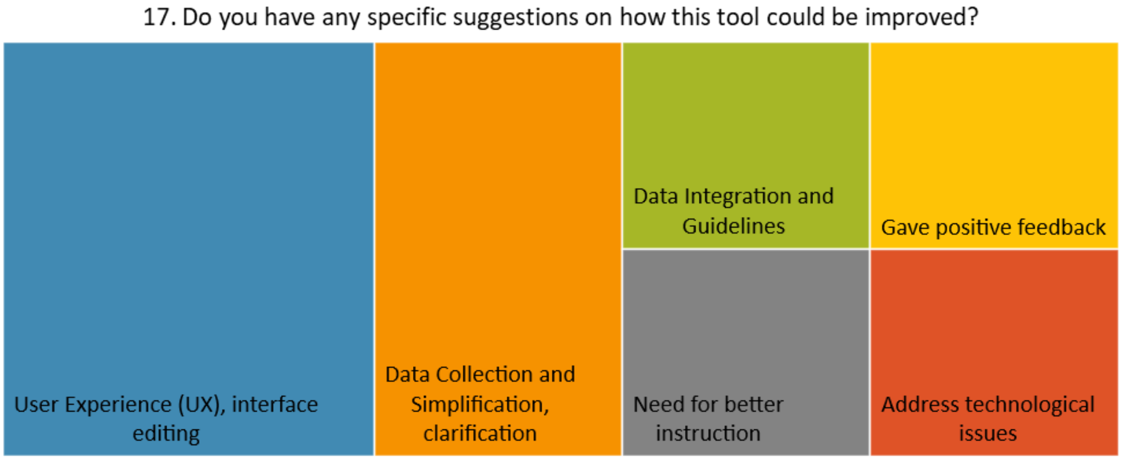

Fig. 3.18**.** Summary of the key responses on specific suggestions on the how the tool could be improved.

The main participant answers to the questions “Do you have any specific suggestions on how this tool could be improved?” “Is there any other information or opinion that we have not asked for but that you would like to express?” are placed below:

- “More explanations, for example, what it means that investment costs in millions are negative in modelling scenarios.”
- “Work with a UX designer after doing interviews with users and focus groups to enhance the accessibility”.
- “Guideline for the integration of input data and own infrastructure and indicators”.
- “When changing the graph, in the buildings category changing the buildings profile, add some help so that you can put numbers into the graph, or you can draw a straight line.”
- “Info about measures that are taken into account in section calculations and inputs for Investment part, for different systems cost.”

Key takeaways

Enhanced User Experience (UX): Recommendations were made to collaborate with a UX designer after conducting user interviews and focus groups to improve the tool's accessibility.

Guidelines for Data Integration and Infrastructure: Participants expressed a need for guidelines on integrating input data with their infrastructure and indicators, aiming to streamline the process.

Enhanced Graph Interaction in Buildings Category: Participants suggested improvements in graph interaction, particularly when changing the buildings profile. Specifically, they recommended adding guidance for entering numbers into the graph or drawing a straight line for better user engagement.

Additional Information on Section Calculations and Investment Part: Participants desired more information about the measures considered in section calculations and inputs for the Investment part, particularly for different system costs.

4 Energy Equilibrium second group model building session

4.1 Description of the event

In this event we further advanced our Energy Equilibrium platform development efforts and invited stakeholders to join and share their expertise in enhancing model functionality. This event provided an opportunity to delve into the exploration of the most effective scenarios and strategies on the path towards achieving regional carbon neutrality. Participants were able to engage in interactive exercises and collaborative discussions with a diverse range of stakeholders and target groups. Table 2 below summarizes the agenda of the event organized.

Table 4.1.
Agenda of the Energy Equilibrium second group model building session.

Time	Topic	Presenter
10:00 – 10:15	Introduction about Energy Equilibrium project	Project communications manager, M.sc.ing. Kristiāna Dolge, Riga Technical University
10:15 – 10:25	Model structure demonstration	Scientific assistant B.sc.ing. Ģirts Bohvalovs, Riga Technical University
10:25 – 10:40	Introduction to model interface	Project communications manager, M.sc.ing. Kristiāna Dolge, Riga Technical University
10:40 – 11:20	Group model building exercises	All participants
11:20 – 11:40	Reflection on the exercises	Scientific assistant B.sc.ing. Ģirts Bohvalovs & Project communications manager, M.sc.ing. Kristiāna Dolge, Riga Technical University
11:40 – 12:00	Feedback & discussion	All participants

The event lasted a total of two hours. In the first half of the event, the overall structure of the model was presented, and the Stella Architect software was demonstrated to explain the main approach of the model development. The participants were also familiarised with the developed model interface and received detailed training on how to use the interface. In the second half of the event, group model building exercises were introduced to the participants, and they were able to try out the developed model interface themselves. The exercises developed served as a validation tool for the comprehensibility of the modelling interface. This was followed by a feedback discussion between all participants of the event.

4.2 Description of the group model building exercises

To participate in the exercise all participants were provided with the access link to the Energy Equilibrium platform prototype interface. Energy Equilibrium platform prototype from the second group model building activity available here: https://exchange.iseesystems.com/public/testlearntestsagain/municipality-model/index.html#page1 .

In total, there were two sets of tasks that had to be completed individually. The exercises contained instructions on the input parameters that had to be set in the model so that the results could be simulated. The results could then be obtained and analysed. Below is the description of the exercises that had to be completed by all participants.

The context of the exercise: You are the energy manager of the municipality of Valka and your goal is to significantly promote the share of renewable energy resources in the municipality's energy system. You would therefore like to predict which measures you could use to significantly increase the proportion of renewable energy resources in the municipality by 2040 and what the cumulative costs of these measures would be.

Objective: Replicate the energy system of the municipality of Valka by setting the given input indicators. Run the simulations and answer the questions based on the simulation results obtained.

1st exercise: Given input indicators

Energy demand and economic parameters:

- Current energy demand mix is composed from 25% of electricity demand and 75% of heat demand.
- Projected change in electricity demand is: annual growth of 2%; Projected change in heat demand is: annual decrease by 1%.
- Current electricity import tariff in municipality is 50 EUR/MWh;
- Discount rate is 7%

There are following energy production technologies in use in Valka municipality:

- Solar collectors (*Collector Solar Sun Medium*) with full-load production hours of 3900 hours annually, economic lifetime of 20 years and technical lifetime of 25 years. Municipality projects change in fixed O&M costs of 1% increase annually.
- Natural gas boiler (*Boiler Gas NaturalGas*) with full-load production hours of 3200 hours annually, economic lifetime of 20 years and technical lifetime of 30 years. Municipality projects change in variable O&M cost to increase by 3% anually.
- Natural gas turbine (*PowerPlant Condensing NaturalGas Large*) with full-load production hours of 3000 hours annually, economic lifetime of 25 years and technical lifetime of 30 years. Municipality projects change in variable O&M cost to increase by 2% anually.
- PV panels (*PV Utility Sun Large*) with full-load production hours of 2300 hours annually, economic lifetime of 15 years and technical lifetime of 20 years. Municipality plans new installations for PV panels with a planned newly installed capacity of 2 MW which will be ordered in 2024 and construction time will be 1 year. Municipality projects change in fixed to decrease by 2% annually.

1st exercise: Questions

- What were achieved share of RES and total cost of production for the entire system.
- What were the total cost of production for PV panels?
- What was the identified electricity storage potential in 2030?

2nd exercise: Given input indicators

The energy manager is considering the possibility of installing energy storage technologies with the following parameters:

- A lithium-ion battery (*LithiumIon Electricity Large*) with a capacity of 1 MWh for electricity storage in the municipality which could be ordered in 2024. It is projected that the total construction time of battery would take 0.5 years. Battery would have depth of discharge rate of 35%, annual cycles – 300, and round-trip efficiency of 90%, economic lifetime of 20 years, technical lifetime of 25 years.
- Water tank heat storage (*WaterTank Heat Large*) with a capacity of 3 MWh for heat storage in the municipality which could be ordered in 2024. It is projected that the total construction time of heat storage would take 1 year. Technology would have depth of discharge rate of 100%, annual cycles – 200, and round-trip efficiency of 98%, economic lifetime of 20 years, technical lifetime of 40 years.
- Municipality projects that fixed initial costs, variable operation and maintenance costs and fixed operation and maintenance costs will stay unchanged in the future for selected energy storage technologies.

2nd exercise: Questions

1. What was battery storage share of supply in 2040?
2. What was achieved share of RES for the entire system?

Participants were asked to answer to the questions provided in the exercises and share their answers to the questions. Additional reflection exercise was held to give guidance through the solution of the exercises. After all the exercises and discussions, the participants were asked to fill the feedback survey which was available here: https://forms.gle/Qy2gT8eC9baDynYJ8

4.3 Main findings from the participant feedback survey

The purpose of this survey was to gather feedback on the first prototype of the Energy Equilibrium platform presented during the second group model building session on 28/11/2023. Before the actual survey questions, respondents were asked to specify the organization represented by themselves. The answers are summarized in Fig. 4.1. below.

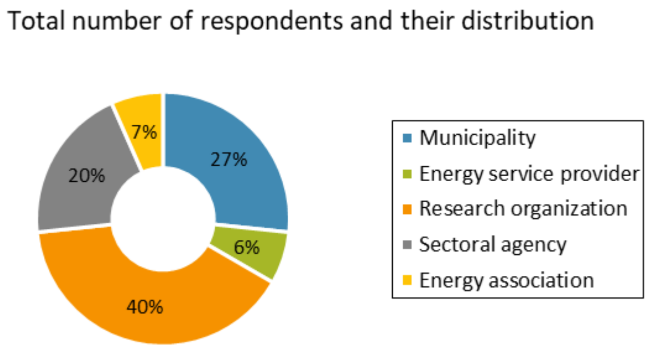

Fig. 4.1. Distribution or respondents according to main stakeholder groups of the project.

The pie chart illustrates that most participants were delegates from research organizations, constituting 40%. The second-largest group in attendance comprised representatives from municipalities, accounting for 27%. Respondents were asked to rate the level of information received during the workshop to sufficiently fulfil the given exercise. The answers are summarized in Fig. 4.2.

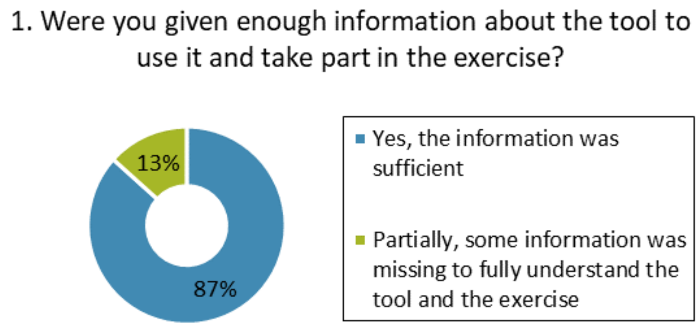

Fig. 4.2. Distribution of the respondent answers on information sufficiency to fulfil the exercise.

To enhance the evaluation of the newly created tool, the participants were questioned about any elements that might be absent or lacking in in the initial version of the Energy Equilibrium platform (Fig. 4.3.).

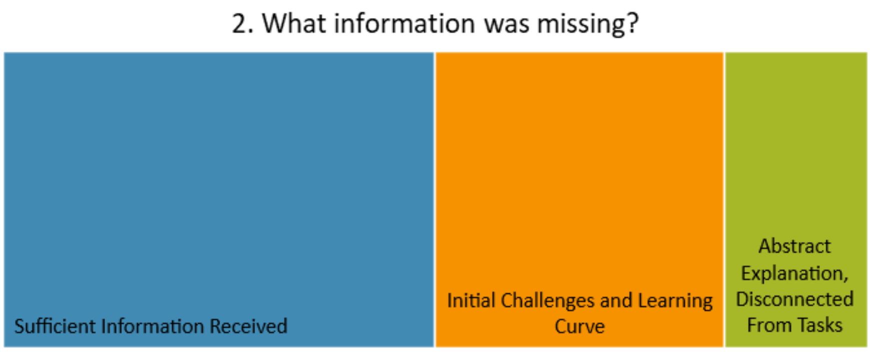

Fig. 4.3. Summary of the key responses on identified information deficiencies.

The main participant answers to the question “What information was missing?” are placed below:

- “I don't know much technical English.”
- “You provided an ample amount of information, but it might have been somewhat abstract in relation to the exercise. Perhaps the initial explanation could be more closely tied to the exercise. However, I believe I eventually gained a better understanding of it.”
- “At first I pressed simulate button after each technology setting and got 4 simulations.”
- “The information was sufficient + valuable consultations were provided if necessary.”

Key takeaways

Language barrier: Because participants come from diverse stakeholder groups, and some may not regularly engage with these technologies, certain terminology may be unfamiliar or not well understood. Therefore, it is recommended to either employ simpler terminology or provide explanations for every term used, ensuring that all participants can effectively utilize the tool.

Walkthrough and Example: Participants require a thorough guide through all the pages, along with specific information pertaining to the tool and indicators in advance, to ensure that everyone is well-informed and on the same page.

The respondents' views on the overall quality of the tool were assessed by analysing their answers to the question “How would you rate the tool’s understandability” (Fig. 4.4).

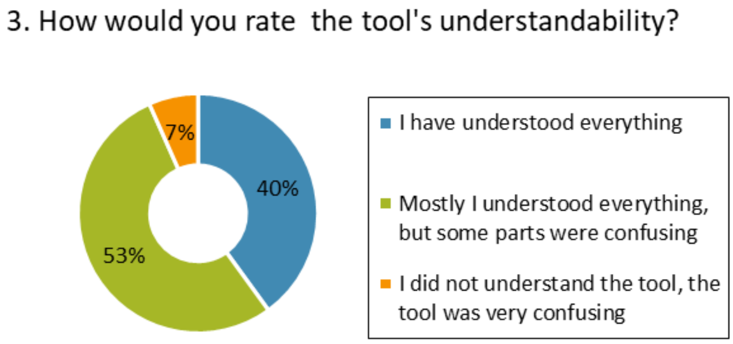

Fig. 4.4. Respondent answers on the level of tool’s understandability.

A majority of respondents (53%) indicated that they generally grasped the content within the tool, though some sections posed confusion. Additionally, 40% of respondents reported a complete understanding of the tool, marking a fivefold increase compared to the feedback from the initial modelling sessions feedback form, suggesting that participant opinions and recommendations were considered, leading to enhanced user-friendliness in the tool.

The participants were also asked to provide insights on any aspects of the tool that caused confusion or were difficult to comprehend (Fig. 4.5.).

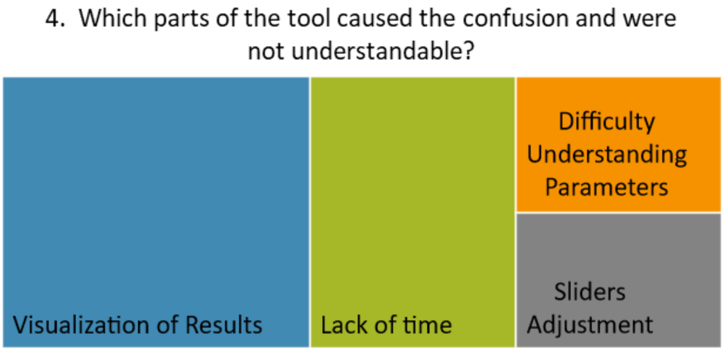

Fig. 4.5. Respondent answers on inconsistencies in the model interface

The main participant answers to the question "Which parts of the tool caused the confusion and were not understandable?" are placed below:

- "Little time to prepare, understand data."
- "A bit difficult to understand how the tool will visualise the results in the graphs and diagrams. I would prefer a system diagram with the selected technologies all in the same chart but possible to read out each and one of them."
- "Some sliders were difficult to adjust to exact value".
- "The visualization of the results is somewhat confusing, when the number of estimated cases is growing."
- "For someone who does not have a technical background it was difficult to understand the parameters. I think that the explanations of the parameters are sufficient, but I think that for people who do not have a technical background there should be a short introduction of the parameters (maybe a power point) or a "factbook". "

Key takeaways

Visualization of Results: Participants indicated a preference for a more user-friendly system diagram, suggesting a need for simplified and clarified graphs and diagrams. This would enable the ability to review each case individually and comprehend the interconnected parameters.

Lack of time: Participants understood the tool but highlighted the need for more time to familiarize themselves with the model.

Difficulty Understanding Parameters: Clearer parameter explanations for those without a technical background is required.

Sliders Adjustment: Several participants brought up issues with sliders, suggesting that an alternative method should be considered.

The respondents' answers on the question "Did you understand the buttons, the value range of the slider and the windows of the tool? "are summarized below (Fig. 4.6).

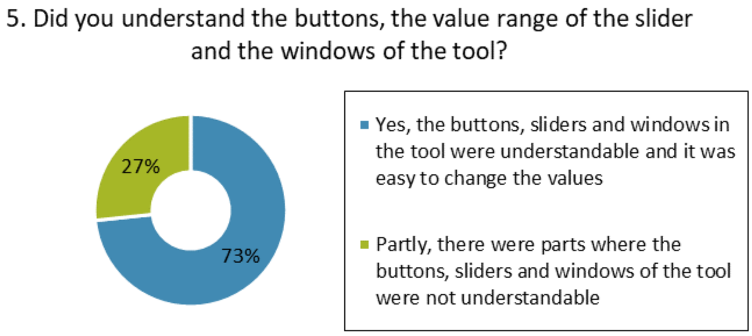

Fig. 4.6. Responses regarding the acquaintance with the user interface.

About one-third of the participants encountered difficulties in comprehending the user interface, primarily due to insufficiently clear explanations of parameters and buttons, as well as challenges in adjusting sliders.

To gather feedback on specific aspects of the tool that participants found confusing or difficult to comprehend they were asked: “What was incomprehensible about the functionality of the tool? Which buttons, slider values or windows you did not understand?   What would you like to change?” (Fig. 4.7.).

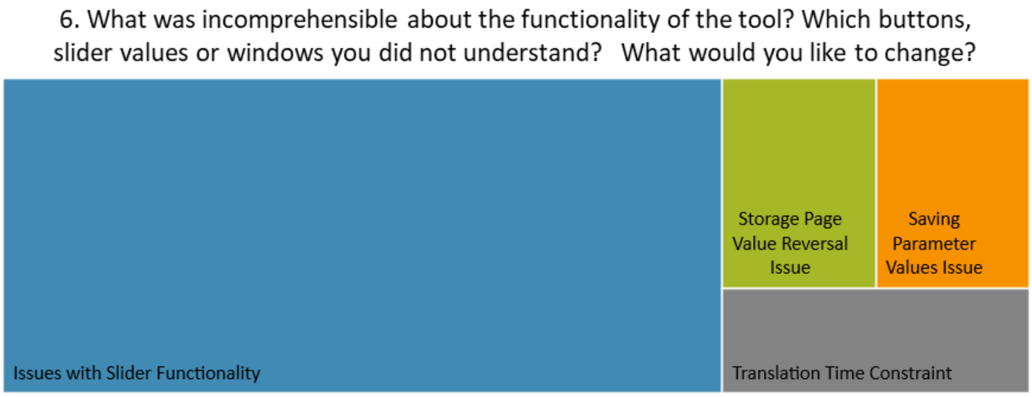

Fig. 4.7. Respondent answers on areas that may need improvement or clarification.

The main participant answers to the 6th question are placed below:

- "Values are understandable; however, in some cases, sliding is complicated when you need to tune fine values and your screen is not very large; might be digital input would be more acceptable."
- "On the storage page, the amount changed back to what it was originally after I set the right amount; it took 3 or 4 attempts to get it mostly right."
- "Little time to translate the data."
- "I note that some parameter values for the different energy production technologies were not properly saved."

Key takeaways

Issues with Slider Functionality: Some respondents suggest using keyboard arrows for precision, because of difficulties establishing values with sliders. A preference for typing values rather than using sliders also was expressed.

Saving Parameter Values and Storage Page Value Reversal Issue: Examine and address technological errors and bugs.

To evaluate the clarity of the tool, participants were instructed to provide a rating based on its comprehensiveness. The answers on the question" Was the information and results presented comprehensively in the tool?" are summarized in Fig. 4.8.

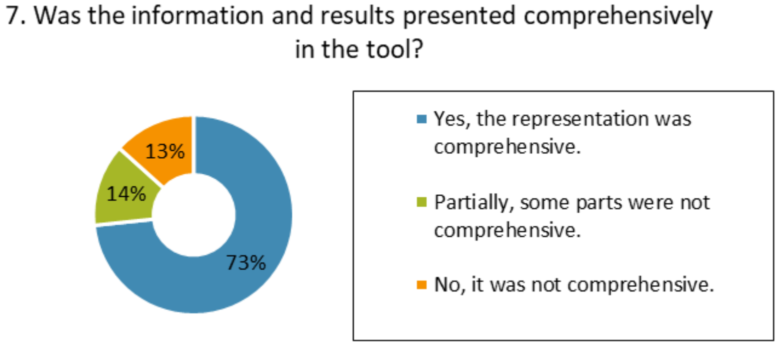

Fig. 4.8. Respondent answers on level of comprehensiveness of the tool.

Over 70% of respondents, specifically 73%, considered the tool's depiction to be thorough, while 14% believed that certain aspects of the tool were not comprehensive. Notably, the proportion of participants finding the tool's representation comprehensive has increased since the initial modelling session. Interestingly, however, the percentage of individuals perceiving it as not comprehensive has also risen. This could be attributed to the increased diversity among stakeholder groups in the second session, leading to a greater variety of opinions.

The respondents were asked to elaborate about specific aspects of the information and results in the tool that they found lacking or insufficient in comprehensiveness (Fig. 4.9.)

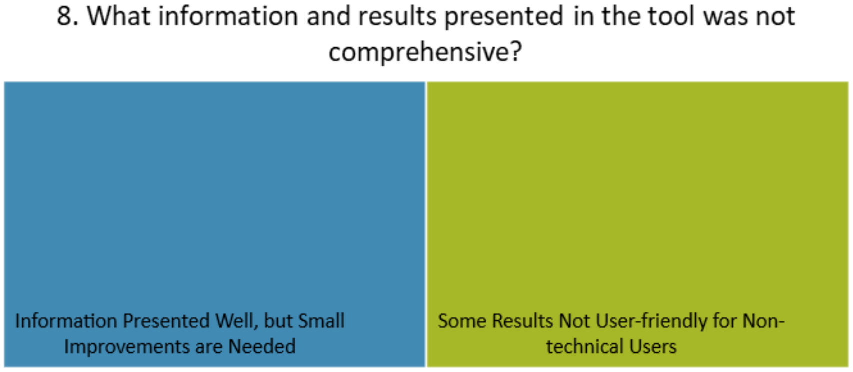

Fig. 4.9. Summary of the key responses on the information and results that lacked comprehensiveness.

The main participant answers to the question “What in the information and results presented in the tool was not comprehensive?” are placed below:

- “Information was OK, not all the results were attractive for non-technical user.”
- “For the most part the information was presented in a good way, but make sure that all axels have units, for example MWh/year or %. Sometimes it was difficult to find the value in the axis because the program was not cooperating, but once it did it was easy to read and understand. “
- “The representation was comprehensive.”

Key takeaways

Information Presented Well, but Small Improvements are Needed: Overall, the presentation of information was effective, but need to ensure that all axes include units, such as MWh/year or %.

Some Results Not User-friendly for Non-technical Users: It is necessary to review the current presentation of results and strive to simplify it for better understanding.

Furthermore, participants were asked to express their confidence in the accuracy and dependability of the outcomes produced by the tool's simulations. The participants were asked to provide their opinion on the reliability of the results produced by the tool (Fig. 4.10.).

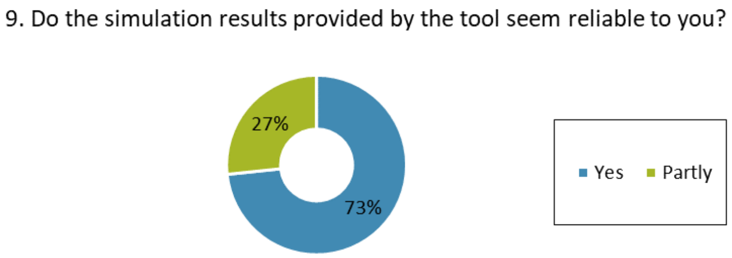

Fig. 4.10. Respondent answers on level of reliability of the tool.

The majority of participants (73%) expressed confidence in the reliability of the tool's results, while 27% indicated that the tool's outcomes were only somewhat dependable.

Participants' perspectives on the reliability of specific aspects within the simulation results generated by the tool were identified in the question that asked, “Which parts of the simulation results did not seem reliable to you in the tool and why?” (Fig. 4.11.).

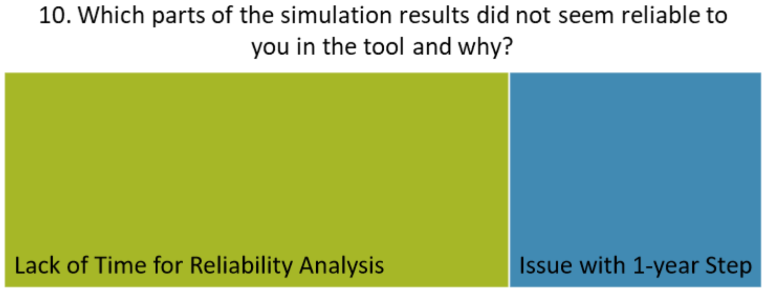

Fig. 4.11. Summary of the key responses on parts of the results that seemed unreliable in the tool.

The main participant answers to the question “Which parts of the simulation results did not seem reliable to you in the tool and why?” are placed below:

- “I have a problem with 1 year step in the program (it excludes short energy storages)”
- “Parts of the simulation for which there was not enough time to translate the data. “
- “I believe I need so more time to compare and evaluate the results.”
- “This time the cost also seemed closer to the truth.”

Key takeaways

Issue with 1-year Step: Participants recommended to include information about short duration energy storage.

Lack of Time for Reliability Analysis: More time is needed for a thorough comparison and evaluation of results.

Participant's perspective on the level of detail in the results presented by the tool was assessed, prompting them to provide a rating based on the depth and thoroughness of the information provided (Fig. 4.12.).

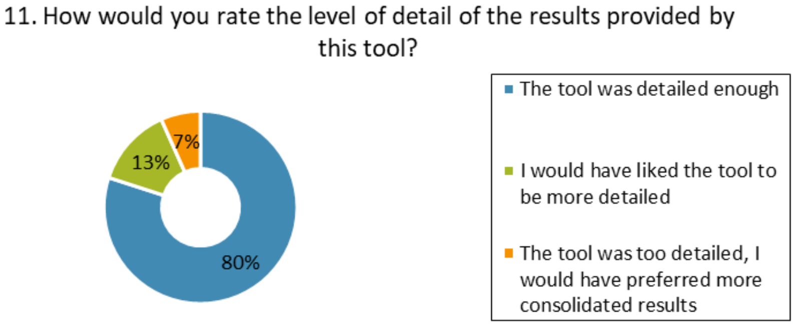

Fig. 4.12. Respondent answers on level of detail in the results provided by the tool.

The majority of participants (80%) believed that the tool provided sufficient detail. Nevertheless, 13% expressed a desire for a more elaborate tool, while 7% found the tool overly detailed and preferred more consolidated results. To identify the specific details participants felt were lacking, respondents were prompted to elaborate on the factors they wished to see in the tool (Fig. 4.13.).

Fig. 4.13. Summary of the key responses on parts of the details that were missing and could be improved.

The main participant answers to the question “What details were you missing but would like to see in the model?” are placed below:

- “It would be interesting to know what financial benefits not only the municipalities but also the inhabitants of the area would have.”
- “I think engineers in the local authority need to take part in running the tool.”
- “I'm interested in whether I find/ if there is possibility to check the base values, for example what is the investment cost of each technology what was used in the calculations.”
- “It would be nice if this data could be shared with other people.”

Key takeaways

Financial Benefits for Municipalities and Inhabitants: Respondents express interest in understanding the financial benefits for both municipalities and residents in the area.

Involvement of Local Authority Engineers: Participants suggested the inclusion of local authority engineers in using the tool and exploring the option of sharing the generated data with a wider audience.

Request for Base Values and Investment Costs: Some expressed curiosity about verifying base values, such as the investment costs of technologies used in calculations.

Participants were also asked about specific indicators they believe should be incorporated into the upcoming municipal-level modelling tool for a more comprehensive and insightful analysis (Fig. 4.14.)

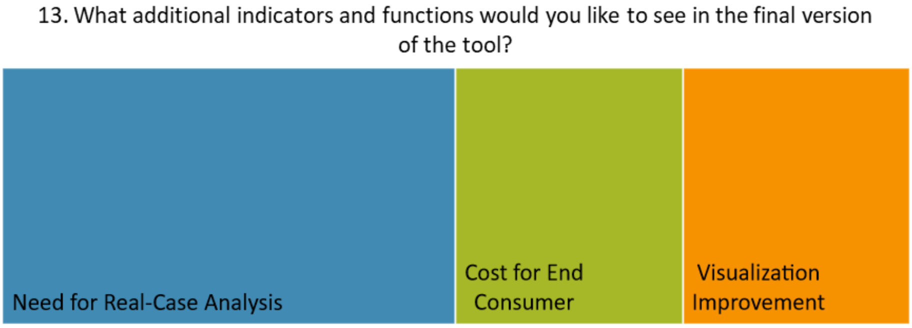

Fig. 4.14. Summary of the key responses on additional indicators that could be included in the final version of the tool.

The main participant answers to the question “What additional indicators and functions would you like to see in the final version of the tool?” are placed below:

- “Cost for end consumer.”
- “A better and easier visualisation of selected renewable technologies and their relation to the energy storage. It is possible to see now but not easy to understand which graphs to use to get the data out of the tool.”
- “This question can only be answered after trying a real case and analysing the results.”
- “It could be nice, to get some kind of export function, where the simulation results could be seen.

Key takeaways

Need for Real-Case Analysis: Respondents note that answering specific questions requires testing a real case and analysing the results. Additionally, there's a desire for an export function to view simulation results more conveniently.

Finances: Participants suggest including costs for end consumer.

Visualization Improvement: Need for improved visualization of selected renewable technologies and their connection to energy storage.

The participants' perspective on the desired simulation period aids in aligning the model with users' needs and objectives, thereby enhancing its usefulness and effectiveness in addressing particular issues. (Fig. 4.15.)

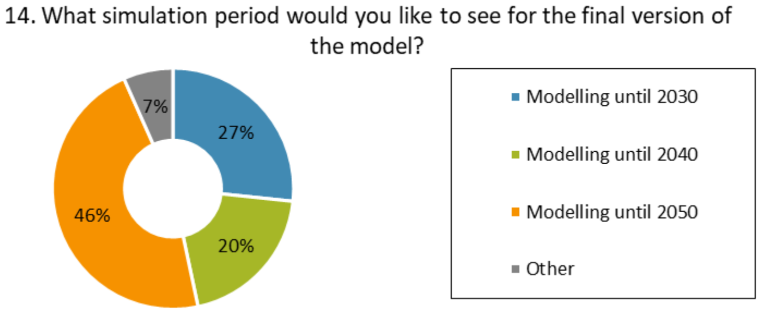

Fig. 4.15. Participants' responses regarding their preferred simulation period for the tool.

Responses to this question varied significantly. Most participants indicated a preference for the tool to encompass a simulation period extending until 2050. Additionally, 7% mentioned a preference for a longer simulation period, emphasizing that the longer the duration, the better.

The 15th question focused on evaluating the tool's quality in terms of serving as both an information source and a decision-making support (Fig. 4.16.)

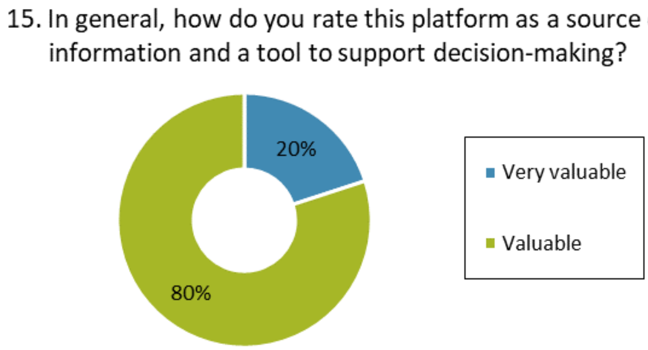

Fig. 4.16. Respondent answers on the tool's quality in terms of serving as both an information source and a decision-making support.

Most participants (80%) deemed the tool valuable, and an additional 20% considered it very valuable, reflecting positive statistics.

Understanding participants' perceptions of the tool's end users helps in clarifying the target audience. This insight aids in tailoring the tool to meet the specific needs and expectations of the intended users (Fig. 4.17.).

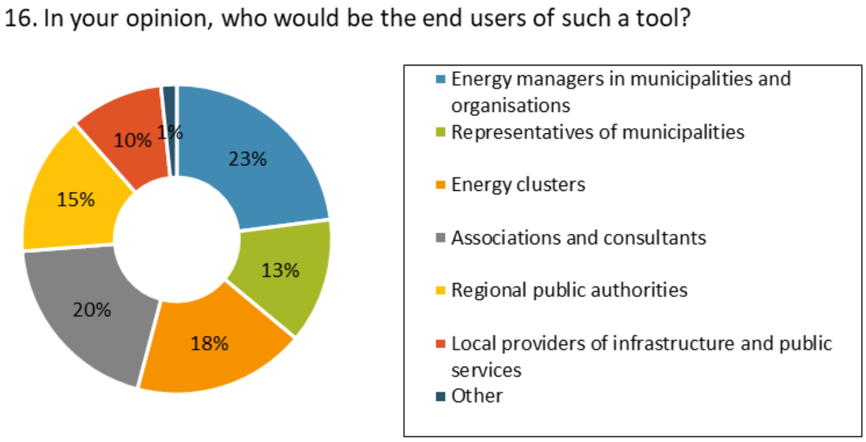

Fig. 4.17. Respondents' answers on who could be the end users of this modelling tool.

Responses to this question displayed significant diversity, with the majority indicating that energy managers in municipalities and organizations (23%) and associations and consultants (20%) would constitute the primary users. 1% of participants suggested that network owners would be also one of the main users.

Inquiring about participants' views on the competency of representatives from municipalities and energy supply companies in using the tool for decision-making is crucial to assess the perceived proficiency of potential users. This information is essential for determining whether the target audience has the requisite skills and knowledge to proficiently utilize the tool (Fig. 4.18.)

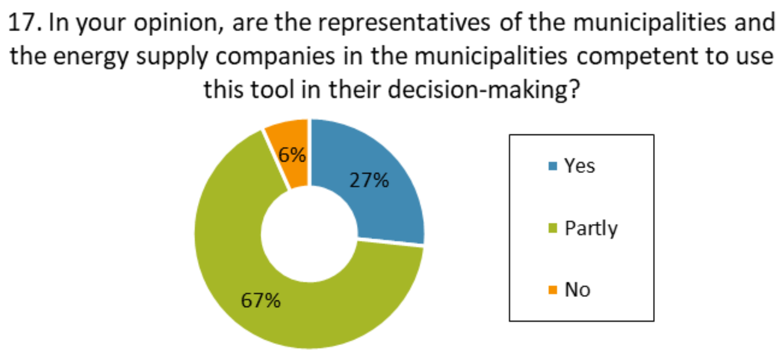

Fig. 4.18. Participants' responses regarding the competency of the anticipated primary users of the tool.

The majority of participants (67%) indicated that representatives from municipalities and energy supply companies may only have partial competence in using this tool. Additionally, 6% expressed the opinion that these representatives are not competent to use the tool. However, nearly one-third of respondents believe that these representatives could potentially work with the tool without requiring any additional training.

Understanding participants' perspectives on the necessary knowledge reveals potential challenges in usability. This valuable information guides the enhancement of the tool's design, aiming to make it user-friendly and accessible to individuals with diverse levels of expertise (Fig. 4.19.).

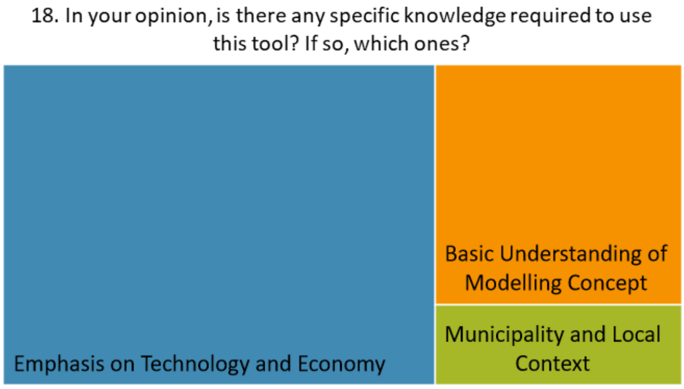

Fig. 4.19. Participants opinion on whether there needs to be specific knowledge to use this modelling tool.

The main participant answers to the question "In your opinion, is there any specific knowledge required to use this tool? If so, which ones?" are placed below:

- "Yes. Need specific knowledge of technologies and economy. Specific evaluation experience needed also. Such tool isn't for everybody in my opinion. "
- "Knowledge is needed what RES is best in what conditions and best combined with what storage system. Some kind of technological and economical knowledge is needed beforehand to include all parameters in a logical and reasonable way."
- "Technical/economic knowledge."
- "I believe some basic instructions and example calculation are needed to include in the instructions for a user to convince that he/he is using the tool in the right way."
- "Users need to be informed about situation in municipality and understand how the producing systems and accumulating systems work."

Key takeaways

Emphasis on Technology and Economy: Participants emphasize the need for specific knowledge, particularly in technologies and economics, as well as evaluation experience to effectively use the tool.

Municipality and Local Context: Understanding the municipality's situation and the functioning of production and accumulation systems is deemed essential for users.

Basic Understanding of Modelling Concept: Some participants expressed the need for basic instructions and example calculations to ensure proper tool usage.

Survey participants' insights into potential obstacles help anticipate challenges during the tool's adoption. This foresight allows for proactive strategies to address and mitigate these challenges, ensuring a smoother integration into daily work practices (Fig. 4.20.).

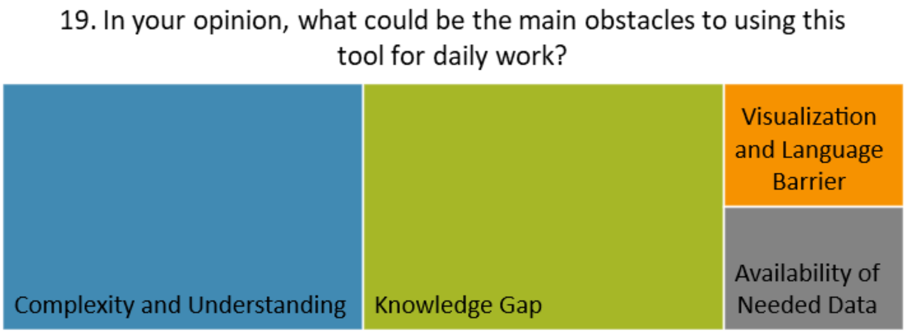

Fig. 4.20. Participants opinion on what could be the main challenges to using the tool daily.

The main participant answers to the question "In your opinion, what could be the main obstacles to using this tool for daily work?" are placed below:

- "In some way the complexity could be an obstacle. While I personally don't think it is possible to shrink the tool to a less complex tool."
- "Lack of technical knowledge."
- "The main obstacles to using this tool for daily work could be the availability of all needed data."
- "Visualization of the results too complicated, maybe translation into national languages would be useful as well."
- "It will be difficult to explain to new people if you are not very technically skilled, and I fear that tools like this risk to be forgotten. Therefore, it is important that the municipalities work to integrate the tool in day-to-day work."
- "One of the aspects could be the trust of municipal specialists in the truth of the simulations of the tool, because they will not be able to understand all the nuances of the model."
- "The size of the municipal budget and the possibilities to initially invest in technologies that are expensive or currently not fully developed."
- "Training is required to use the tool to its full potential."

Key takeaways

Complexity and Understanding: Participants shared concerns about its complexity and the challenge of shrinking it without compromising detail.

Knowledge Gap: The lack of technical knowledge, coupled with the need for better usability understanding, was identified.

Visualization and Language Barrier: Participants recognized that complex result visualization might be a factor that complicates working with this tool and that maybe translating the tool could help with that.

Availability of Needed Data: Participants identified issues related to data availability as well as trust in the accuracy of simulations, budget constraints, and the need for training to unlock the tool's full potential.

Gaining an understanding of the expected time commitment offers valuable insights into the tool's user-friendliness, and feedback on time estimates serves as a guide for potential enhancements to the tool's usability (Fig. 4.21.).

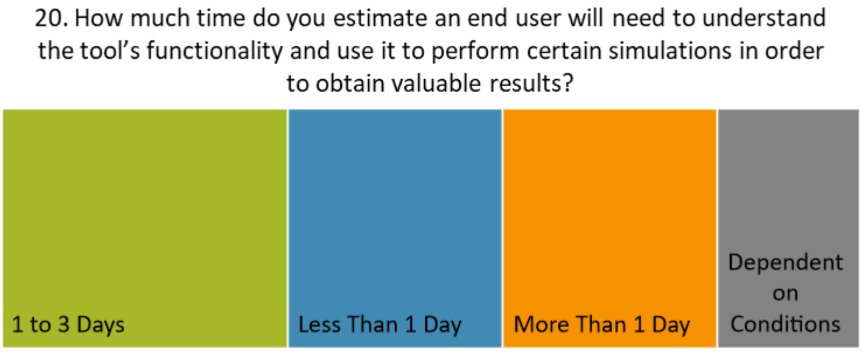

Fig. 4.21. Respondents' answers on how much time would an end user need to understand the tool.

The main participant answers to the question "How much time do you estimate an end user will need to understand the tool's functionality and use it to perform certain simulations in order to obtain valuable results?" are placed below:

- "Probably about 1 to 3 hours"
- "1 day for specialist"
- "4-8 hours"
- "Half a day, but it depends on user's knowledge."
- "Some time for testing with guidance could be useful."
- "If all data which need to make as input for model to start the simulation has been gathered, less than half a day."
- "2-4 days."

Key takeaways

Short Time (1-3 hours): Participants indicated that, with appropriate guidance, it could be feasible to comprehend the tool relatively swiftly.

Dependent on Conditions: Most participants acknowledged that the time required to grasp the tool is contingent upon the users' level of knowledge.

To identify potential improvements in the tool, participants were asked for insights on enhancing the tool's functionality. Moreover, the respondents were asked to share any information which could help to proceed with improving the tool's functionality and representation (Fig. 4.22.).

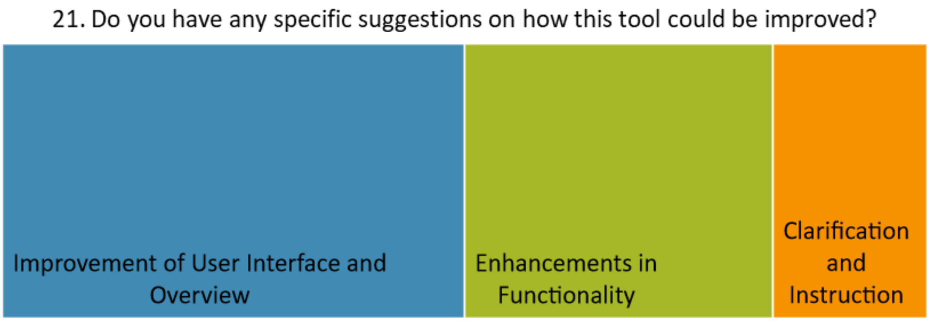

Fig. 4.22. Summary of the key responses on specific suggestions on the how the tool could be improved.

The main participant answers to the questions "Do you have any specific suggestions on how this tool could be improved?" are placed below:

- "The possibility to save simulations."
- "User instruction and better visualisation."
- "Visualization of results and easier sliding/input, as currently it is a bit complicated."
- "Making evaluations in real environment to check is it working reliably."
- "There are no more recommendations currently. I look forward to seeing the additional sections."

Key takeaways

Improvement of User Interface and Overview: There is a need for improved visualization to ensure that individuals with varying levels of knowledge can easily comprehend the graphs and diagrams.

Enhancements in Functionality: Participants recommended replacing the sliders with an alternative option as well as adding the option of saving the created simulations.

Clarification and Instruction: Participants acknowledged the necessity for user instructions and guidance to gain a clearer understanding of the tool's functionality.

As the last query, participants were invited to share any additional information or opinions not covered in previous questions but that they wished to express. The key responses from participants are provided below:

- "It had better functionality than last time, and I liked the parameters more. Also including multiple storage and energy production systems into one calculation was very beneficial."
- "The pilot using the model in local authorities will be valuable to develop the model."
- "I really liked the way we learned about the model through these scenarios that you provided."
- "Great work!"
- "You have done a good job. We will also start testing within the working group, so that we can provide more valuable recommendations in the future."

5 Energy Equilibrium third group model building session

5.1 Description of the event

During this event, new version of the Energy Equilibrium platform was demonstrated and tested. The current version of the model includes the added segment of building energy demand and energy efficiency indicators for various sectors. During the event the participants were asked to provide their feedback on the newly developed page. Second part of the event included discussion on the proposed plan on the organization of the platform pilots in six municipalities. The main goal of the event was to determine a practical and effective plan for the most efficient organization of the pilots in the municipalities.

Table 5.1.

Agenda of the Energy Equilibrium third group model building session.

Time	Topic	Presenter
10:00 – 10:10	Opening remarks & reflection on the model building status	Researcher, M.sc.ing. Kristiāna Dolge, Riga Technical University
10:10 – 10:20	Introduction to the new version of the model interface	Researcher, M.sc.ing. Kristiāna Dolge, Riga Technical University
10:20 – 10:45	Group model building exercise	All participants
10:45 – 10:55	Reflection on the exercise	Research assistant B.sc.ing. Ģirts Bohvalovs, Riga Technical University
10:55 – 11:10	A walkthrough example demonstration on model validation	Research assistant B.sc.ing. Ģirts Bohvalovs, Riga Technical University
11:10 – 11:20	Proposed plan for municipality pilots	Researcher, M.sc.ing. Kristiāna Dolge, Riga Technical University
11:20 – 12:00	Discussion	IMP PAN & all participants

The event lasted a total of two hours. In the first half of the event, a short reflection of the model building status was discussed. Then, new version of the model prototype was demonstrated. Participants were asked to test the prototype by filling the exercise and feedback survey. Second half of the event included discussions on pilot plan. Proposed pilot plan was demonstrated and confirmed between the partners. The event resulted in valuable feedback regarding the platform improvement and detailed plan for the next steps in the project implementation.

5.2 Description of the group model building exercises

To participate in the exercise all participants were provided with the access link to the Energy Equilibrium platform prototype interface. Energy Equilibrium platform prototype from the third group model building activity available here: https://exchange.iseesystems.com/public/testlearntestsagain/municipality-model/index.html#page1 .

In total, there were two sets of tasks that had to be completed individually. The exercises contained instructions on the input parameters that had to be set in the model so that the results could be simulated. The results could then be obtained and analysed. Below is the description of the exercises that had to be completed by all participants. The set of exercises of the third group model building included energy demand of the buildings segment only.

The context of the exercise: You are the energy manager of the municipality of Valka and your goal is to monitor building energy consumption. You would therefore like to analyse the energy efficiency of the buildings and the possibilities for renovation in the future in order to reduce the overall energy demand in the region.

Objective: Replicate the energy demand of buildings of the municipality of Valka by setting the given input indicators. Run the simulations and answer the questions based on the simulation results obtained.

1st exercise: Given input indicators

Household building energy demand and efficiency indicators:

- Total area of the single-family buildings is 378950 m2, out of which 40% are renovated and 60% non- renovated, non-renovated building specific electricity consumption is 60 kWh/m2/year and heat consumption is 160 kWh/m2/year. On average after the renovation electricity consumption decreases by 20% and heat consumption by 50%. Renovation works by single family building owners are financed by 40% self-financing and 60% from the loan with the interest rate of 5% and loan term of 10 years. However, only 60% of single-family owners are aware of the energy efficiency benefits and financing opportunities (information campaign strength). Building investment costs for renovation are 260 EUR per m2.
- Total area of the apartment buildings is 248220 m2, out of which 30% are renovated and 70% non- renovated, non-renovated building specific electricity consumption is 40 kWh/m2/year and heat consumption is 100 kWh/m2/year. On average after the renovation electricity consumption decreases by 15% and heat consumption by 60%. Renovation works by apartment building owners are financed by 20% self-financing, 50% by subsidies and 30% from the loan with the interest rate of 6% and loan term of 15 years. On average 80% of projects are successfully implemented. However, only 45% of apartment owners are aware of the energy efficiency benefits and financing opportunities (information campaign strength). Building investment costs for renovation are 190 EUR per m2.

There are several social factors that influence the decision to start renovation and implement energy efficiency measures. These factors influence future renovation rate in the sector (energy efficiency diffusion impact factors).

- When social indicators on energy efficiency diffusion are evaluated for the apartment sector then it can be observed that initially in a scale from 1 (very low prevalence) to 10 (very high prevalence) there are the following observations for Valka municipality - trust in neighbours is evaluated at 9, belief of benefits at 6 and fear of losing apartment at 7, other values stay unchanged.

1st exercise: Questions

1. What is average specific electricity and heat consumption in 2030 for single family and apartment buildings?
2. What is the total energy consumption of single family and apartment buildings in MWh at the simulation end?

2nd exercise: Given input indicators

Municipal building (public sector) energy demand and efficiency indicators:

- Total area of the municipality buildings (public) is 110107 m2, out of which 52% are renovated and 48% non- renovated, non-renovated building specific electricity consumption is 35 kWh/m2/year and heat consumption is 160 kWh/m2/year. On average after the renovation electricity consumption decreases by 30% and heat consumption by 65%. Renovation works of municipality buildings are financed by 20% self-financing and 80% by state subsidies. On average 95% of projects are successfully implemented. Approximately 80% of municipality representatives are aware of the energy efficiency benefits and financing opportunities (information campaign strength). Building investment costs for renovation are 235 EUR per m2.

There are several social factors that influence the decision to start renovation and implement energy efficiency measures. These factors influence future renovation rate in the sector (energy efficiency diffusion impact factors).

- When social indicators on energy efficiency diffusion are evaluated for the public sector then it can be observed that initially in a scale from 1 (very low prevalence) to 10 (very high prevalence) there are the following observations for Valka municipality - payback time is evaluated at 8, knowledge about of energy efficiency at 9 and involvement of other municipalities of 8, other values stay unchanged.

2nd exercise: Questions

1. What is average specific electricity and heat consumption in 2030 for municipal (public) buildings?
2. What is the total energy consumption of single family and apartment buildings in MWh at the simulation end?

Participants were asked to answer to the questions provided in the exercises and share their answers to the questions. Additional reflection exercise was held to give guidance through the solution of the exercises. After all the exercises and discussions, the participants were asked to fill the feedback survey which was available here: https://forms.gle/Vh2RCqzhoUGz2jKm7

5.3 Main findings from the participant feedback survey

The purpose of this survey was to gather feedback on the new version of the Energy Equilibrium platform presented during the third group model building session on 18/01/2024. Before the actual survey questions, respondents were asked to specify the organization represented by themselves. The answers are summarized in Fig. 5.1. below.

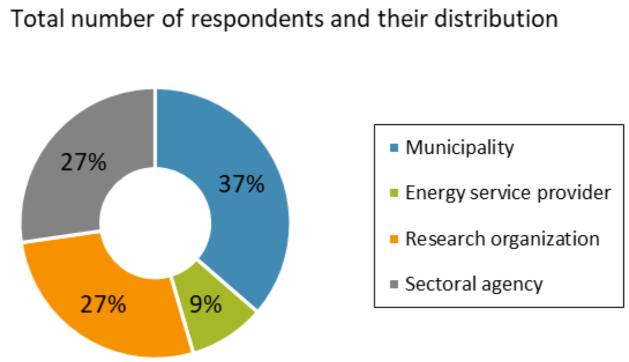

Fig. 5.1. Distribution or respondents according to main stakeholder groups of the project.

The pie chart illustrates that most participants were representatives from municipalities, constituting 37%. The second-largest group in attendance comprised representatives from sectoral agencies and research organizations, accounting each for 27%. Respondents were asked to rate the level of the understandability of the building energy demand page. The answers are summarized in Fig. 5.2

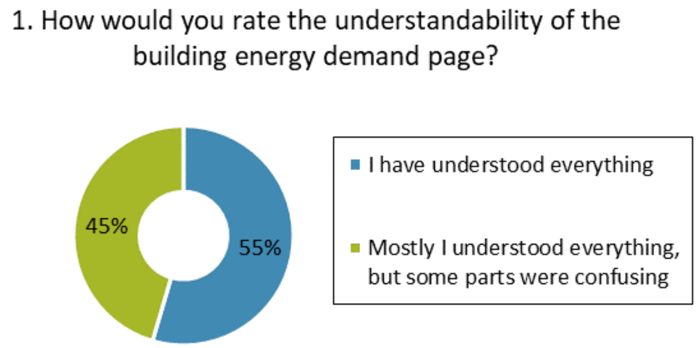

Fig. 5.2. Participants' ratings on the understandability of the building energy demand page.

To identify elements that led to confusion and hindered comprehension, participants were asked for insights (Fig. 5.3.).

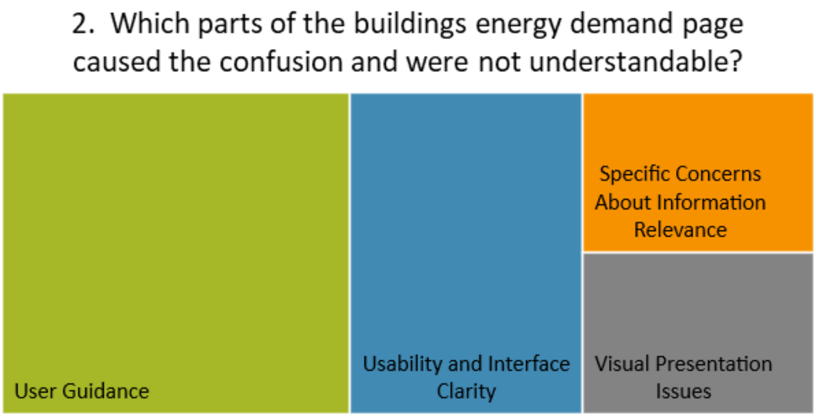

Fig. 5.3. Summary of the key responses on parts of the new page that caused confusion.

The main participant answers to the questions "Which parts of the buildings energy demand page caused the confusion and were not understandable?" are placed below:

- "I think the energy efficiency impact factors will be difficult to understand for users."
- "Needed more time to find all the right places where to put in needed information."
- "The parts like successfully implemented and awareness of the energy efficiency benefits, how do they affect the results."
- "Energy efficiency diffusion impact factors - I am not quite sure if such information is available and if it is very informative for municipalities."
- "Need for a short explanation of the simulation results in an intro of the model."
- "The results presented in the charts were not always legible."

Key takeaways

Usability and Interface Clarity: Some users faced personal challenges in locating the correct input fields and encountered issues with section switching.

User Guidance: Participants recommended replacing the sliders with an alternative option as well as adding the option of saving the created simulations.

Specific Concerns About Information Relevance: Consider reevaluating the inclusion of certain information if its relevance is unclear or questionable.

Visual Presentation Issues: Need to consider improving the visual presentation of results to ensure clear and easily interpretable charts for better user engagement.

The respondents' answers on the question "Did you understand the buttons, the value range of the slider and the windows of the tool? " are summarized below (Fig. 5.4).

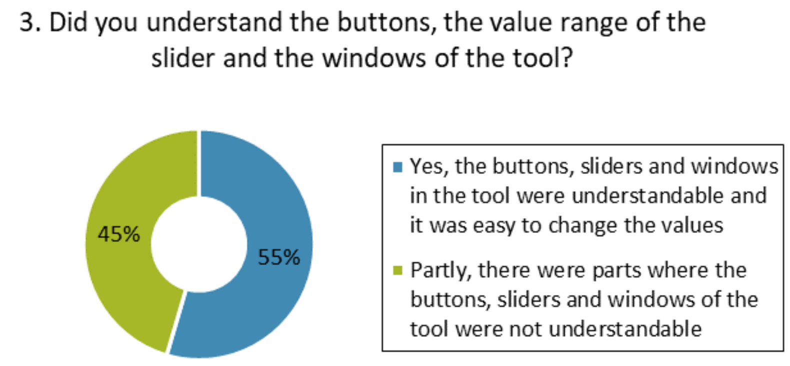

Fig. 5.4. Responses regarding the acquaintance with the user interface.

More than half of the participants felt that the user interface was understandable, the other half thought that there is still room for improvement.

To evaluate the clarity of the new tool's page, participants were instructed to provide a rating based on its comprehensiveness. The answers on the question "Was the information and results presented comprehensively in the tool's buildings energy demand page?" are summarized in Fig. 5.5.

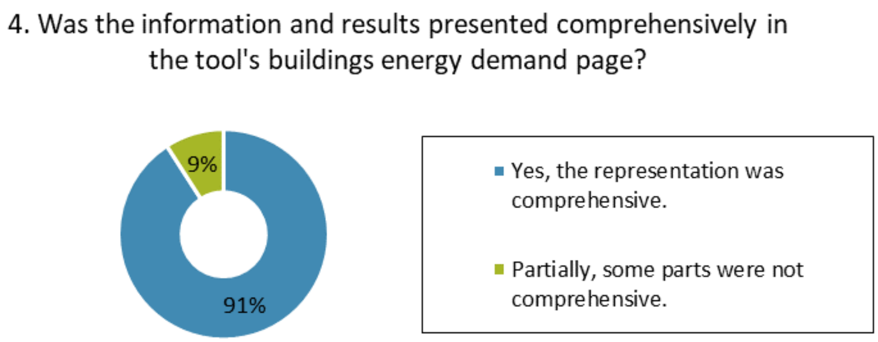

Fig. 5.5. Respondent answers on level of comprehensiveness of the new page.

Majority of the participants agreed that the information and results were provided and presented sufficiently, only one respondent felt that some parts were not completely understandable.

To identify the specific details participants felt were lacking, respondents were prompted to elaborate on the factors they wished to see in the tool's buildings energy demand page (Fig. 5.6.).

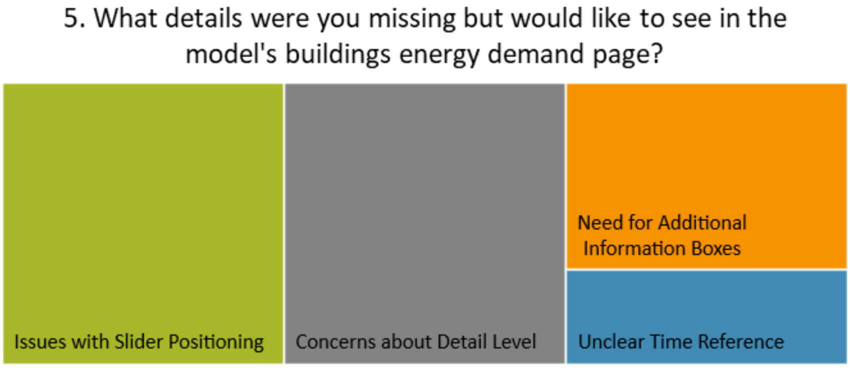

Fig. 5.6. Summary of the key responses on parts of the details that were missing and could be improved.

The main participant answers to the question "What details were you missing but would like to see in the model's buildings energy demand page?" are placed below:

- "I think it will be difficult for users to choose from the results, up to 13 different factors to choose from."
- "There are problems with positioning of sliders on required data."
- "Maybe too many details - In Lithuania, municipalities are not responsible and do not participate in energy efficiency improvement measures in single-family houses, industry."
- "It would be nice if this data could be shared with other people."
- "I wish that there is a range beside the windows so there is some guidance for what values are reasonable."

Key takeaways

Unclear Time Reference: Respondents identified that the year taken as the present year in the tool should be clarified.

Issues with Slider Positioning: Participants identified the need for windows where it would be possible to input data, instead of sliders.

Need for Additional Information Boxes: Recognized need for extra information boxes that could clarify the use of the model.

Concerns about Detail Level: Some participants suggested that maybe the tool is too specific, detailed for municipality representatives to use.

To identify potential improvements in the tool, participants were asked for insights on enhancing the tool's functionality. Moreover, the respondents were asked to share any information which could help to proceed with improving the tool's functionality and representation (Fig. 5.7.)

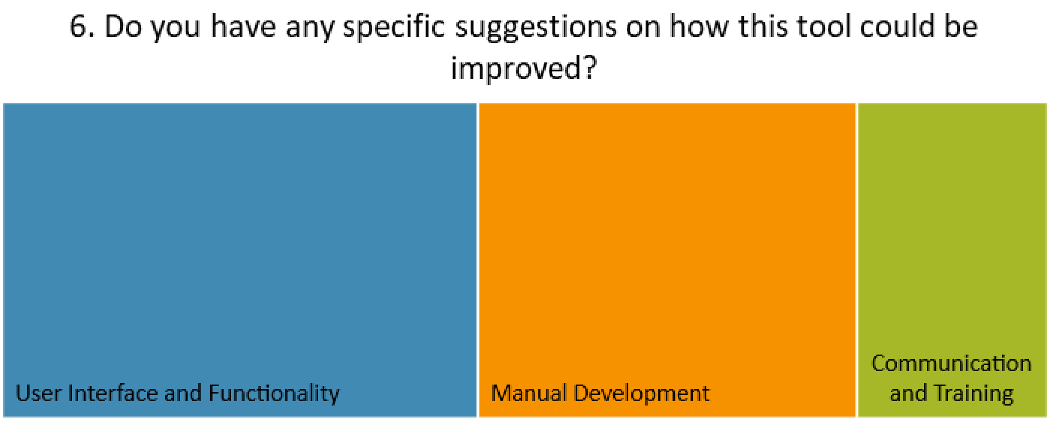

Fig. 5.7. Summary of the key responses on specific suggestions on the how the tool could be improved.

The main participant answers to the questions "Do you have any specific suggestions on how this tool could be improved?" are placed below:

- "I think you should do the model in an easy version very where the very basic factors are possible to choose from and to present and then you can have a professional mode for professional users where all factors in the model is available to use."
- "My suggestion is: sliders with the range between 0 and 10 are OK, but with ranges between 0 and 100 and more could be replaced by windows for numerical values, as it is difficult to tune the necessary number."
- "There could be a little bit more improvement in explaining the single fields besides the big bulk of text next to the "Question button" ".

Key takeaways

User Interface and Functionality: There was a suggestion to make the tool in various versions – simple and advanced as well as to improve slider functionality.

Communication and Training: Participants recommended more explanations; information about tool's functions.

Manual Development: Participants acknowledged that manual for using the platform would be useful for the future.

6 Summary and conclusions

Implementation of GoA 1.4. "Organize group model building activities with local public authorities and energy service providers" resulted in valuable outcomes which helped to approbate and improve Energy Equilibrium platform.

In total three group model building sessions were successfully completed within GoA 1.4., each focused on interaction with main target groups of the project during the model building process.

In group model building sessions representatives from project target groups were involved (municipalities, energy consulting companies, state owned and private energy utilities, researchers from engineering and social sciences, professional associations from the energy sector). The representatives from these target groups were invited and gathered from various BSR countries to increase its cross-border significance.

Each group model building session included the discussions and exercises in order to receive the valuable feedback regarding the Energy Equilibrium platform functionalities, reliability, and practical applicability. Feedback from each session was carefully analysed and summarized in this deliverable. Findings from the feedback analysis allowed to identify main positions for the overall model improvement and enhancement of the Energy Equilibrium Platform.

The testing phase with stakeholders discovered significant insights into key aspects of the platform's functionality, manual development, level of detail, and time dedication. Stakeholders appreciated the platform's flexibility in allowing input values and sliders for customization. However, a common challenge emerged regarding the difficulty in understanding specific parameters within the model. Addressing this concern will be crucial to enhance the user experience and ensure accurate input.

Stakeholders emphasized the need for comprehensive training materials which could serve as a manual on platform usage. Additionally, stakeholders found a practical walkthrough example beneficial in navigating the platform. Developing more illustrative examples and use cases will contribute to better user understanding and proficiency. Relevant training materials will be developed in WP3.

The demand for real-case analysis was underscored, highlighting the need for the platform to incorporate practical, real-world scenarios. However, a significant challenge emerged as stakeholders varied in their preference for a higher level of detail, while others favored a simpler version. Reevaluating which indicators to include and exclude is essential to strike a balance that caters to diverse user preferences. Target groups also emphasized the importance of allocating sufficient time for platform usage. There is a need for an adequate timeframe to explore the platform's features comprehensively. This ensures that users can derive maximum benefit from its capabilities and fosters a positive user experience.

Through exercises, model developers were able to verify whether the group model building participants were able to use the previously presented input indicators to arrive at the proper outcome in the platform. Most participants were able to arrive to the correct solution, according to the participant replies for the tasks. This suggests that the primary functionalities and comprehension of the Energy Equilibrium platform prototypes were attained in general.

In summary, the group model building sessions illuminated critical areas for improvement, including the need for parameter clarity, enhanced training materials, real-case analyses, and a nuanced approach to the level of detail. Addressing these findings in the next development iterations will contribute to a more user-friendly, versatile, and widely adopted platform. This iterative process ensures that the final platform aligns closely with stakeholder expectations and effectively serves its intended purpose.

The next crucial steps in project implementation involve piloting the platform in municipalities and expanding its testing to larger audiences. This phase is essential to assess the platform's viability, usability, and effectiveness in real-world scenarios.