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# 1 About the Energy Equilibrium project

With the local energy system shifting towards greater integration of renewable energy, new challenges emerge, particularly around variability and system flexibility, therefore 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 storage 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 Energy Equilibrium project has developed the Energy Equilibrium platform, an innovative tool designed to provide municipalities and local energy suppliers with interactive energy modelling opportunities, accessible online to everyone. The platform aims to support local public authorities in making informed decisions, helping the development of efficient action plans to accelerate local renewable energy sources utilization and energy storage integration in the region. The Energy Equilibrium Platform offers several functions, including modelling the energy sector for the development of long-term energy policies, identifying optimal renewable energy strategies, identifying the expansion of local renewable energy potential through storage solutions and simulating energy development scenarios for low-carbon systems. By leveraging these capabilities, the Energy Equilibrium Platform empowers regions to overcome existing barriers and advance towards climate neutrality more effectively.

# 2 Energy Equilibrium piloting activities

## 2.1 Description on pilots

Energy Equilibrium Platform pilot activities were differentiated by two main approaches – platform pilots for project partners and general pilot activities for stakeholders outside the partnership. Project partner pilots were carried out in two rounds. The first round of pilots for the project partners included individual meetings with each partner municipality to discuss the characteristics of each municipality's energy sector based on the energy data provided by the municipality. Platform pilots took place in the following municipalities:

- Gulbene municipality (Latvia) - 07.02.2024.
- Tukums municipality (Latvia) - 15.02.2024.
- Mikolajki Pomorskie municipality (Poland) - 22.02.2024.
- Wejherowo municipality (Poland) - 29.02.2024.
- Taurage municipality (Lithuania) - 07.03.2024.
- Tomelilla municipality (Sweden) - 18.03.2024.

There were seven main steps of the first pilot round that were carried out for each municipality before the pilot meeting to determine the key positions to be discussed and clarified.

1) Adaptation of the formatting of the municipal energy data to the model template. For the data import of the system dynamics model, the data had to be converted into CSV files.
2) Once the data had been entered into the model templates, outliers and missing data items were identified. On this basis, RTU defined the questions to be discussed with the municipalities in the first pilot round.

3) The data for each municipality case was then imported into the model separately.
4) Model optimisation and data adjustment. During model calibration, the items were optimised for a better fit of the model.
5) Model validation based on historical data. Modelling is only carried out for the items for which data was available. In the segments with missing data, modelling can be performed on the basis of assumptions.
6) Identification of items that cannot be validated. Three main reasons for validation errors were identified: an error in the model; an error in the data; an unpredictable event (e.g. a reform) where the dynamics cannot be adequately assessed.
7) An individual meeting is held with the municipal representatives to discuss the results and any inconsistencies in the energy data.

After each individual meeting with the municipalities the model was improved and adjusted based on the responses provided by the municipalities during the first round of pilots. Moreover, municipalities were asked to provide additional data on their energy sector and municipal sociodemographics to be included in the model.

The second round of pilots included a webinar organized for all partner municipalities. Webinar on Energy Equilibrium second round of pilots took place on 24 May 2024. The webinar gathered 34 participants, including project partners, their stakeholders and internal working groups. During the webinar, the latest version of the Energy Equilibrium platform was explored, demonstrating its improved features and functionalities. Municipalities had the opportunity to delve into hands-on exercises, simulating various development scenarios tailored to the specifics of each municipality. The feedback received from the webinar participants is summarized in the project's deliverable.

Energy Equilibrium platform general pilots were carried out in three main events and activities where participants engaged in the workshop which included hands on local energy system modelling using the Energy Equilibrium platform.

1) Workshop using Energy Equilibrium platform as part of open study course "Environmental Engineering" which was held on 12 March 2024 and gathered around 100 participants from different fields of activities such as local public authorities, associations, companies from manufacturing and services sectors, and others.
2) Interactive workshop "Energy Sustainability Compass: The Role of Energy Storage in Future Energy Systems" that was organized in the scope of the European Sustainable Energy Days on May 17, 2024. This workshop gathered around 67 participants where 43 of them participating onsite and 24 participants joining online.
3) Webinar on the general piloting of the Energy Equilibrium platform, which took place on 31 May 2024. The webinar was attended by 19 participants who were introduced to the developed Energy Equilibrium platform.

## 2.2 Aim of this report

The aim of this report is to provide a comprehensive summary of the responses received from the feedback survey of participants involved in the piloting events for the Energy Equilibrium Platform. This report aims to analyze the feedback received from these diverse piloting events, providing insights into the platform's performance, areas of improvement, and overall participant satisfaction.

# 3 Piloting feedback analysis

## Outline of the pilots analysed

This section of the report provides an analysis of the feedback collected from participants regarding the platform's user experience and the outcomes of the tasks performed during the piloting events. It summarizes the results from the feedback surveys, which gathered participants' responses on both their task outcomes and their overall evaluation of the Energy Equilibrium platform. The feedback surveys included questions designed to assess the effectiveness of the platform, the ease of use, and the satisfaction with the results achieved in the simulated energy system development scenarios.

Feedback survey results are analyses for each piloting event separately:

1) Workshop using Energy Equilibrium platform as part of open study course "Environmental Engineering" which was held on 12 March 2024.
2) Interactive workshop "Energy Sustainability Compass: The Role of Energy Storage in Future Energy Systems" on May 17, 2024.
3) Webinar on the second round of pilots for project partners that took place on 24 May 2024.
4) Webinar on the general piloting of the Energy Equilibrium platform, which took place on 31 May 2024.

## Description of the piloting task

Each pilot event was organised in the form of a workshop in which participants had the opportunity to try out the Energy Equilibrium platform using a task prepared by the organisers.

In the task, the participants had to take on the role of an energy manager in a municipality and use the Energy Equilibrium platform to simulate different scenarios for the development of the energy system. Each participant was given access to the Energy Equilibrium platform. For each participant, data on the energy infrastructure of a specific municipality was provided. The data from all six partner municipality data were prepared and distributed to the participants. Each participant analysed a different municipality - (Gulbene, Tukums, Mikolajki Pomorskie, Wejherowo, Taurage or Tomelilla). Participants had to manually input the data in the platform to start modelling. Appendix 1 outlines the input data provided for all the participants on all the municipalities.

Below is the task description provided to participants:

***Access link to the Energy Equlibrium platform: https://exchange.iseesystems.com/public/testlearntestsagain/energy-equilibrium***

Context of the task: You are the municipal energy manager and your aim is to significantly increase the share of renewable energy sources in the municipal energy system. The municipality has committed itself to supplying 100% of the municipal infrastructure with renewable energy and to achieving the lowest possible system costs by 2050.

Aim of the task: Achieve a 100% share of renewable energy for municipal infrastructure objects (public sector) with the lowest system costs by 2050.

The task steps were as follows in Fig. 3.1.:

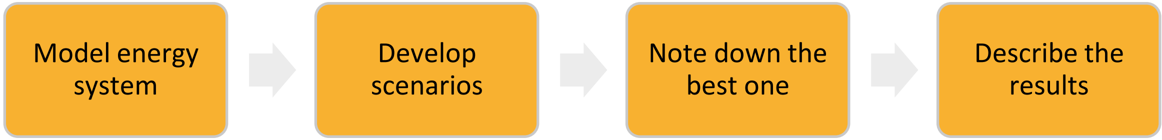



Fig. 3.1. Task steps

(1) Model the municipal energy system of the public sector by entering the given indicators in the tool that characterise the energy system.

(2) Develop 3 possible development scenarios and run simulations in the tool by changing the different input parameters.

(3) Note down the scenario with the highest achieved share of renewable energy resources in the municipality and the lowest system costs.

(4) Describe the results in a feedback survey.

## 3.1 Workshop using Energy Equilibrium platform as part of open study course "Environmental Engineering"

### 3.1.1 Description of the event

Workshop using Energy Equilibrium platform as part of open study course "Environmental Engineering" which was held on 12 March 2024 and gathered around 100 participants from different fields of activities such as local public authorities, associations, companies from manufacturing and services sectors, and others.

Fig. 3.2. Picture from the piloting event during the open study course "Environmental Engineering"

### 3.1.2 Main findings from the participant feedback survey

The purpose of the survey was to gather feedback on the Energy Equilibrium platform presented during the piloting event held on 12 March 2024 and summarize the main modelling results achieved by the participants.

#### 3.1.2.1 *Outline of the results from the task*

First part of the survey analysis focused on summarizing the main outcomes of the piloting task. Question 1 asked respondents to identify which municipality they represented in the task. Despite efforts to evenly distribute municipalities among participants, it was observed that most tasks were completed for Gulbene municipality, while the fewest were completed for Wejherowo municipality. The distribution of responses to question "Which municipal energy system did your group represent?" is shown below in Fig. 3.3.:

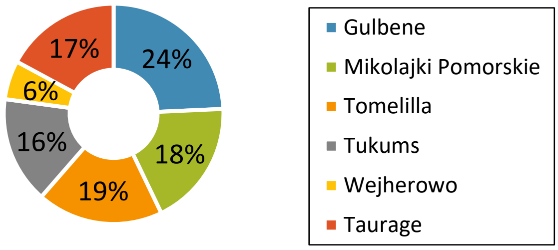
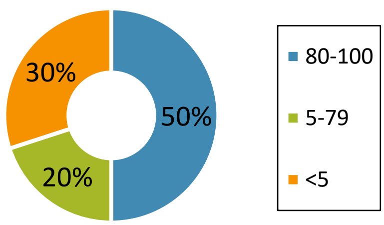



Fig. 3.3. Respondent answer distribution to the question "Which municipal energy system did your group represent?"

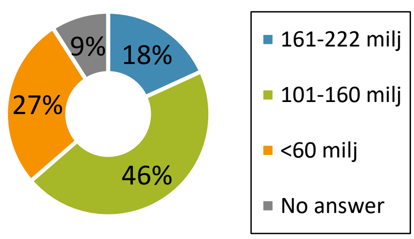
After the municipalities had been divided among the participants, a task was started, the first step of which was to determine from the terms of the task the initial share (%) of renewable energy sources (RES) in 2050 and the initial cost of a municipal system in 2050 in the specific municipality. In order to assess how well the participants understood the model functions, the model builders themselves performed the task and determined the correct value to compare the participants' results with. The following sections show the responses obtained from respondents for each municipality within the exercise and compared to the expected values.

### Tukums municipality

The distribution of responses for Tukums municipality is shown in Figure 3.4. The expected value for Tukums initial share (%) of renewable energy sources (RES) in 2050 was around 80%. In the Figure 3.4. a) it can be seen that 50% of the participants' responses were in the region of this value, which is a good indicator. The initial cost of a municipal system in 2050 should have been 220 M. No participant got this value.




a)

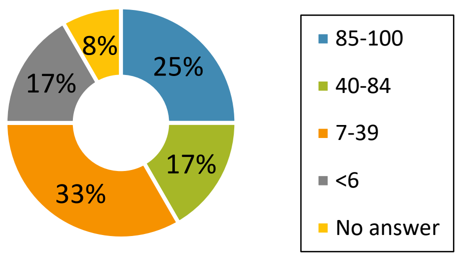



b)

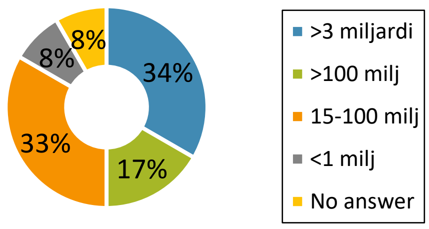
Fig. 3.4. a) Respondent answer distribution to the question "What is Tukums initial share (%) of renewable energy sources (RES) in 2050?"; b) Respondent answer distribution to the question "What is the initial cost of the municipal system in 2050?"

## Taurage municipality

The distribution of responses for Taurage municipality is shown in Figure 3.5. The estimated value of Taurage's initial share (%) of renewable energy sources (RES) in 2050 was around 23.2%. Figure 3.4. a) shows that 33% of participants' responses were within this value. The initial cost of a municipal system in 2050 should have been 3490 M. This value was obtained by 34% of participants.




a)




b)

Fig. 3.5. a) Respondent answer distribution to the question "What is Taurage initial share (%) of renewable energy sources (RES) in 2050?"; b) Respondent answer distribution to the question "What is the initial cost of the municipal system in 2050?"

## Wejherowo municipality

The distribution of responses for Wejherowo municipality is shown in Figure 3.6. The estimated value of Wejherowo's initial share (%) of renewable energy sources (RES) in 2050 was 0%. The representatives of this municipality did not understand the functionality of the model and were therefore unable to provide a specific value. The initial cost of a municipal system in 2050 should have been 158 M. No participant obtained this value.

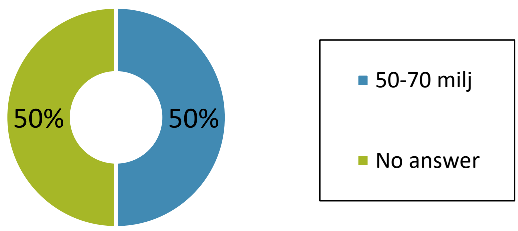
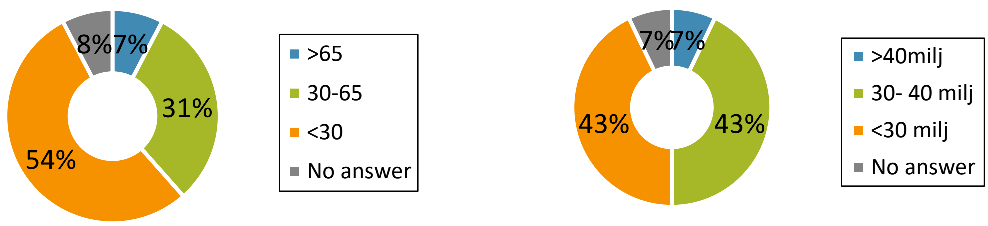



Fig. 3.6. Respondent answer distribution to the question "What is the initial cost of the municipal system in 2050?"

## Mikolajki Pomorskie municipality

The distribution of responses for Mikolajki Pomorskie municipality is shown in Figure 3.7. The estimated value of Mikolajki Pomorskie initial share (%) of renewable energy sources (RES) in 2050 was around 23,5%. Figure 3.7. a) shows that 54% of participants' responses were within this value. The initial cost of a municipal system in 2050 should have been 35,3M. 43% of participants got the results within the range of the correct value.

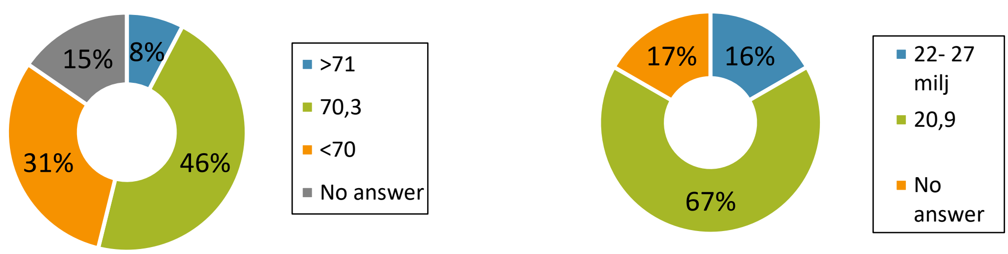



a) b)

Fig. 3.7. a) Respondent answer distribution to the question “What is Mikolajki Pomorskie initial share (%) of renewable energy sources (RES) in 2050?”; b) Respondent answer distribution to the question “What is the initial cost of the municipal system in 2050?”

## Tomelilla municipality

The distribution of responses for Tomelilla’ municipality is shown in Figure 3.8. The estimated value of Tomelilla’s initial share (%) of renewable energy sources (RES) in 2050 was around 99%. Figure 3.8. a) shows that 8% of participants' responses were close to this value. The initial cost of a municipal system in 2050 should have been 30,4 M. 16% of participants got the results within the range of the correct value.




a) b)

Fig. 3.8. a) Respondent answer distribution to the question “What is Tomelilla’s initial share (%) of renew-able energy sources (RES) in 2050?”; b) Respondent answer distribution to the question “What is the initial cost of the municipal system in 2050?”

## Gulbene municipality

The distribution of responses for Gulbene municipality is shown in Figure 3.9. The estimated value of Gulbene initial share (%) of renewable energy sources (RES) in 2050 was around 98,9%. Figure 3.9. a) shows that 35% of participants' responses were close to this value. The initial cost of a municipal system in 2050 should have been 57,8 M. 35% of participants got the results within the range of the correct value.

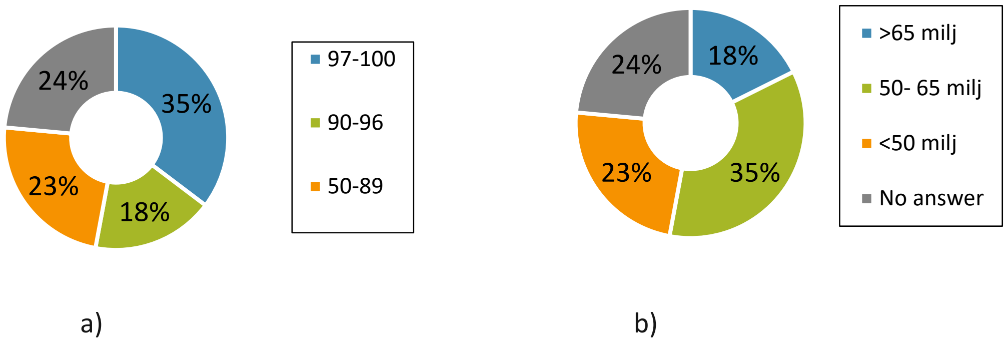



Fig. 3.9. a) Respondent answer distribution to the question "What is Gulbene initial share (%) of renewable energy sources (RES) in 2050?"; b) "What is the initial cost of the municipal system in 2050?"

Next, respondents were asked about their preferred strategies for completing the task. In Figure 3.10. the answers for all municipalities are summarised. Responses are visualised in a graph based on their correspondence to a category and frequency. It is evident that due to lack of knowledge and training, the task was mostly not fully completed, but those who succeeded implemented different technologies, information campaigns and policy, energy efficiency measures in the scenarios.

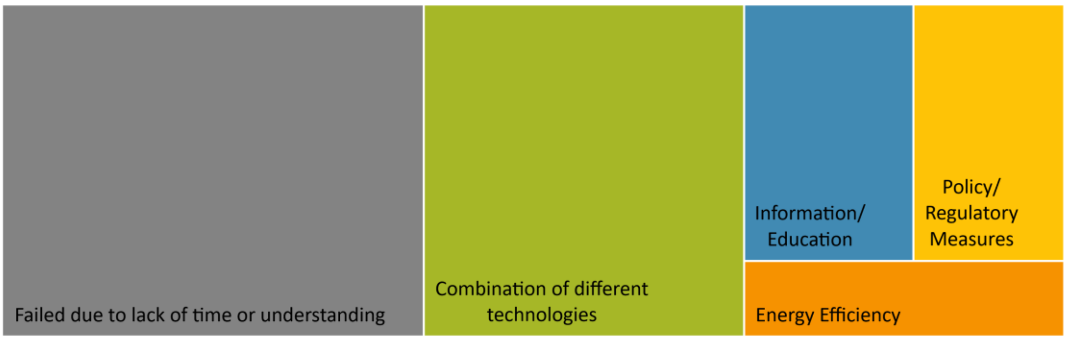



Fig. 3.10. Respondent answer distribution to the question "What 3 strategies/scenarios could be implemented in the municipality to increase the share of renewable energy by 2050?"

Most respondents admitted that they were not able to complete the task due to lack of time, knowledge and understanding of the functionality. However, those who managed to obtain results mostly used combined forms of green energy production. In Table 3.1. a summary for each municipality separately is outlined.

Table 3.1.

Participant choice of strategies implemented in each municipality

| Gulbene | Tukums | Taurage | Mikolajki Pomorskie | Wejherowo | Tomelilla |
|---|---|---|---|---|---|
| 1) Green energy technologies (solar, wind, biomass, heat pump)<br>2) Accumulation tanks<br>3) Energy efficiency measures | 1) Investments in renewable energy infrastructure.<br>2) Financial incentives and subsidies for the purchase and installation of renewable energy technologies.<br>3) Educational campaigns and seminars to raise public awareness of renewable energy and its benefits. | 1) Combination of green energy technologies (solar, HPP, biomass, heat pump).<br>2) Information campaign strength, expertise and knowledge.<br>3) Increase the effectiveness of the renovation information campaign. | 1) Reduction of fossil energy use<br>2) RES technologies<br>3) Heat pump | 1) Investment in renewable energy infrastructure<br>2) Financial incentives and subsidies for the purchase and installation of renewable energy technologies.<br>3) Educational campaigns and seminars | 1) Increase investment subsidies and installed capacity.<br>2) Educate the public and project management expertise.<br>3) Build value for money procurement and conduct in-depth procurement and supply chain analysis. |

Respondents were asked which parameters they changed in the first scenario (Fig. 3.11.). Responses are visualised in a graph based on their correspondence to a category and frequency.


Fig. 3.11. Respondent answer distribution to the question "What parameters were changed in the model in Scenario 1?"

As in the previous question, most could not answer because they did not understand the task or were struggling to complete it. Those who managed to complete the exercise changed the capacity, types of technology use and various financial aspects. In Table 3.2. a summary for each municipality separately is outlined.

Table 3.2.

Parameters changed in each municipality in Scenario 1

| Gulbene | Tukums | Taurage | Mikolajki Pomor-skie | Wejhe-rowo | Tomelilla |
|---|---|---|---|---|---|
| 1) Lithium batteries, accumula-tion tanks<br>2) HPPS<br>3) Wind tur-bines | Combination of green en-ergy technol-ogies (solar, HPP, biomass, heat pump) | 1) Combination of green energy tech-nologies (solar, HPP, biomass, heat pump)<br>2) Information cam-paign strength, ex-pertise and knowledge<br>3) Increasing the in-tensity of the reno-vation information campaign | 1) CHP removed<br>2) HPP | No answer | 1) Percentage of financing and in-stalled renewa-ble energy gen-eration capacity<br>2) Discount rate changed |

Then respondents were asked which parameters they changed in the 2nd scenario (Fig. 3.12.). Responses are visualised in a graph based on their correspondence to a category and frequency.

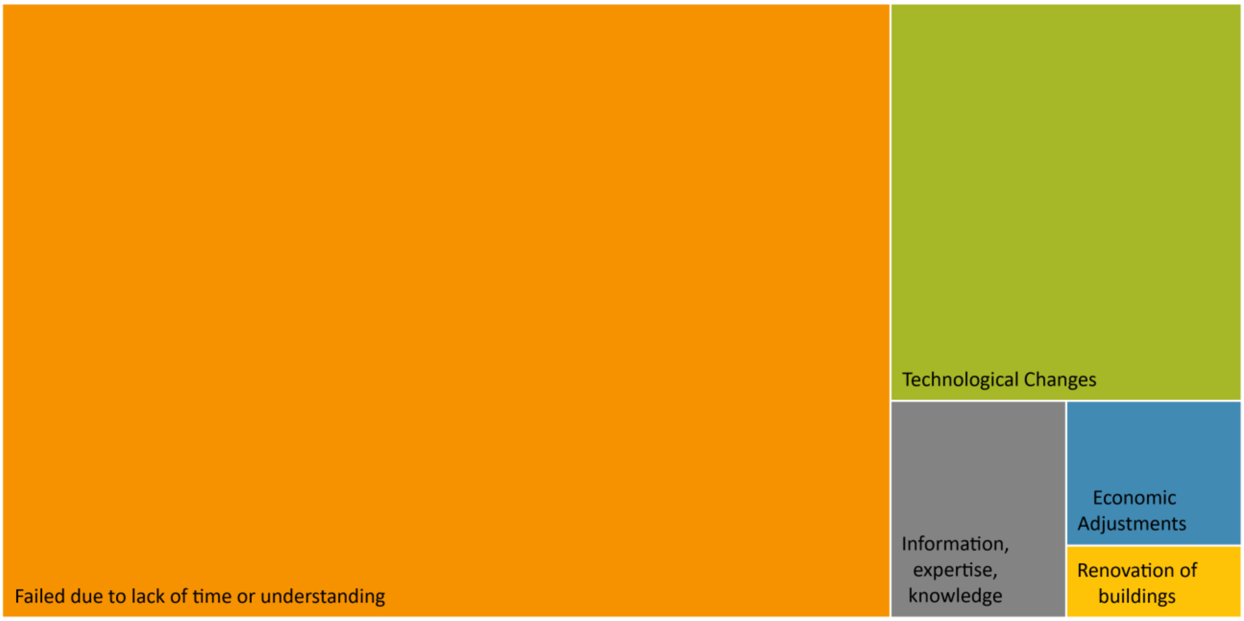



Fig. 3.12. Respondent answer distribution to the question “What parameters were changed in the model in Scenario 2?”

Again, most could not answer because they did not understand the task or were struggling to complete it. Those who managed to complete the exercise made technological changes, knowledge campaigns and various economical adjustments. In Table 3.3. a summary for each municipality separately is outlined.

Table 3.3.

Parameters changed in each municipality in Scenario 2

| Gulbene | Tukums | Taurage | Mikolajki Pomorskie | Wejherowo | Tomelilla |
|---|---|---|---|---|---|
| 1) Lithium batteries<br>2) Solar panels<br>3) Heat pump | No answer | 1) Combination of green energy technologies (solar, HPP, biomass, heat pump)<br>2) Information campaign strength, expertise and knowledge<br>3) Increasing the intensity of the renovation information campaign | 1) Chip CHP<br>2) Coal CHP off | No answer | 1) Increase organization support by 30%.<br>2) Changing the discount rate. |

Furthermore, respondents were asked which parameters they changed in the 3rd scenario (Fig. 3.13.). Responses are visualised in a graph based on their correspondence to a category and frequency.


Fig. 3.13. Respondent answer distribution to the question "What parameters were changed in the model in Scenario 3?"

Most respondents admitted that they were not able to complete the task due to lack of time, knowledge and understanding of the functionality. However, those who managed to obtain results mostly used combined forms of green energy production. In Table 3.4. a summary for each municipality separately is outlined.

Table 3.4.

Parameters changed in each municipality in Scenario 3

| Gulbene | Tukums | Taurage | Mikolajki Pomorskie | Wejherowo | Tomelilla |
|---|---|---|---|---|---|
| 1) Solar collectors<br>2) Heat pump<br>3) Increased HPP capacity | 1) Combination of green energy technologies (solar, HPP, biomass, heat pump) | 1) Combination of green energy technologies (solar, HPP, biomass, heat pump)<br>2) Information campaign strength, expertise and knowledge<br>3) Increasing the intensity of the renovation information campaign | 1) Coal CHP off<br>2) Accumulation tanks<br>3) RES technologies | No answer | 1) Discount rate changed<br>2) Reduced production of non-renewable energy<br>3) Increased information campaign |

The model also includes a function to deploy energy storage technologies. Respondents were also asked whether they included these in their strategies (Fig. 3.14.). Responses are visualised in a graph based on their correspondence to a category and frequency.

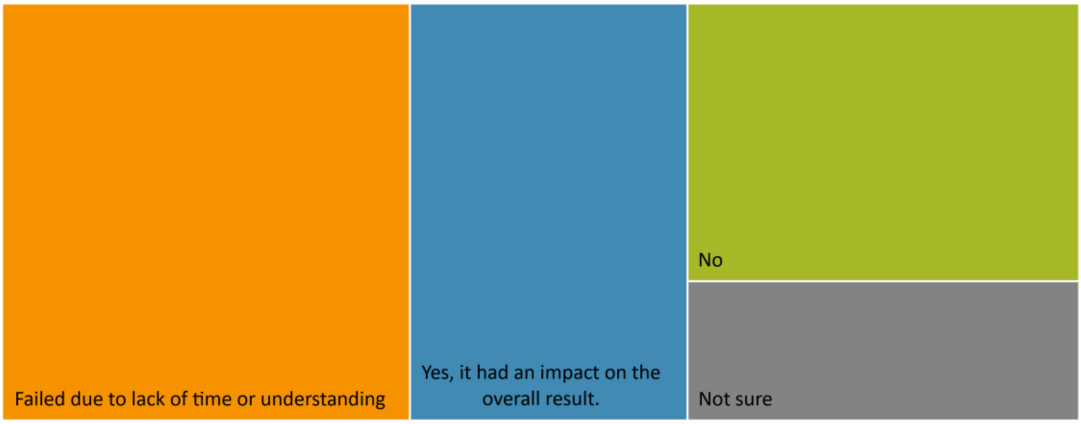



Fig. 3.14. Respondent answer distribution to the question “Did energy storage play a role in your scenarios? If yes, what role do you think it played in the scenarios you have modelled?”

Most respondents did not have an answer due to lack of time, knowledge and understanding of the functionality. However, those who responded felt that energy storage technologies were important in achieving a higher share of renewables and lower municipal system costs.

### *3.1.2.2 The overall evaluation of the experience*

To get a better impression of the tool from the perspective of users, participants were asked about the comprehensibility of the model. The distribution of responses to question "Was the tool understandable?" is shown below in Fig. 3.15.:

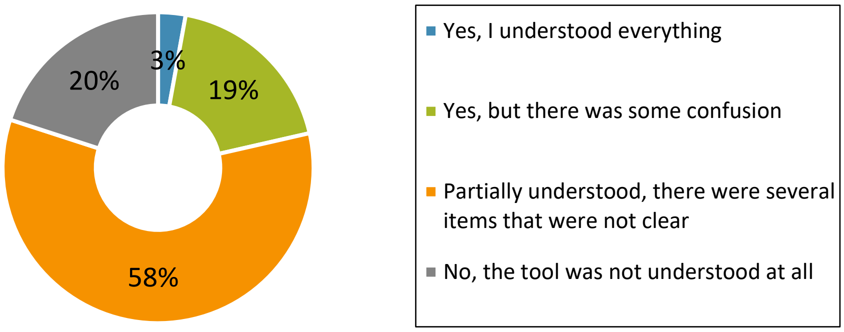



Fig. 3.15. Respondent answer distribution to the question "Was the tool understandable?"

The majority of respondents (58%) said that they understood partly the functionality of the tool, the second most common answer (20%) was that participants felt that the model was not easy to understand.

The distribution of responses to question "How would you rate the reliability of the results obtained by the modelling tool?" is shown below in Fig. 3.16:

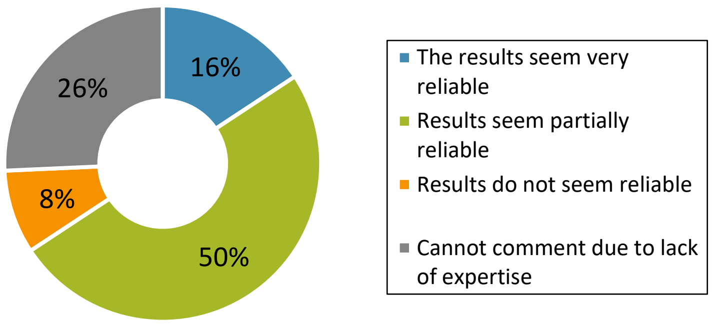



Fig. 3.16. Respondent answer distribution to the question "How would you rate the reliability of the results obtained by the modelling tool?"

Similar to the previous question, the majority of responses (50%) indicate that participants doubt the reliability of the model. 26% of people avoided a specific answer due to a lack of competence.

Participants were asked about the tool's comprehensibility (Fig. 3.17.). Responses are visualised in a graph based on their correspondence to a category and frequency.

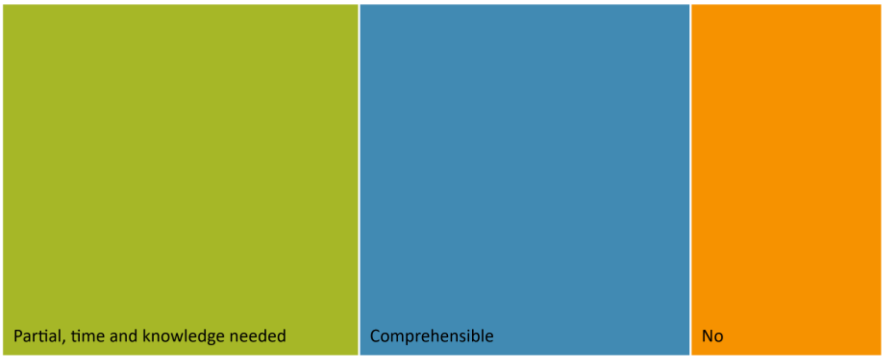



Fig. 3.17 Respondent answer distribution to the question "Were the data entry explanations and information messages on indicators in the tool clear? If not, please explain which headings were confusing?"

Consistent with the answers to the previous questions, most answers were that the tool is not very easy to understand and that the interface should be made simpler.

Moreover, respondents were asked about the possible end users of the tool. (Fig. 3.18.). Responses are visualised in a graph based on their correspondence to a category and frequency.

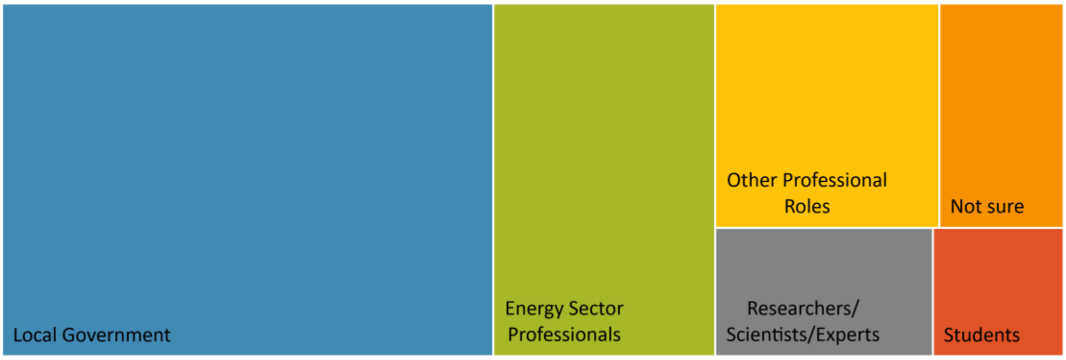



Fig. 3.18. Respondent answer distribution to the question "Who do you think would be the end users of this tool?"

Participants mainly agreed that the model would be useful for municipal and sector professionals and researchers who understand the sector and the parameters involved.

Finally, respondents were asked about possible improvements, suggestions to make the prototype more user-friendly (Fig. 3.19.).


Fig. 3.19. Respondent answer distribution to the question "What are your recommendations to improve the functionality of the tool?"

**Key takeaways**

- The possibility to delete unnecessary columns in the chart.
- Descriptive and clear user instructions.
- More time to understand in detail.
- Reset button not for input data but only for simulations.
- "It would be good if when entering a technology, its main parameters are also shown so that they do not have to be entered. Maybe the presentation of the tool itself should be rethought, talking more about the parameters. There are descriptions, but they are long and in very small print".
- Additional languages
- "It is difficult to know the value of capacity if you don't work with it on a daily basis"

# 3.2 Interactive workshop "Energy Sustainability Compass: The Role of Energy Storage in Future Energy Systems"

## 3.2.1 Description of the event

Riga Technical University organised an interactive workshop on "Energy Sustainability Compass: The Role of Energy Storage in Future Energy Systems", which took place on 17 May 2024 from 10:00 to 13:00 EEST. The event was organised as part of the Sustainable Energy Days, an initiative of the European Sustainable Energy Week. The event was organised in a hybrid format and offered the opportunity to participate on site at the premises of Riga Technical University and to join in online. A total of 83 participants registered for the event and completed the registration form. However, a total of around 67 participants attended the workshop, 43 of whom took part on site and 24 online. Table 3.5. outlines the program of the workshop.

During the event, participants were introduced to the role of energy storage in future energy systems and the benefits of energy modelling. There was also a demonstration of the energy modelling tool and a presentation of the local energy transition case study. Participants were then given guidance for the practical task on municipal energy modelling, including energy storage technologies. Afterwards, participants had time to work individually on completing the practical task with real case studies on simulating energy systems and analysing different pathways to low-carbon local energy systems. During the workshop participants were using Energy Equilibrium platform, energy modelling tool developed by the Interreg Baltic Sea Region project Energy Equilibrium. After the event, three participants were asked about their experiences of using the energy modelling tool during the workshop.


Fig. 3.20. Picture from the workshop "Energy Sustainability Compass: The Role of Energy Storage in Future Energy Systems"

The highlights from the event can be seen in this video: [https://www.youtube.com/watch?v=LLjrim-fKJpg&t=19s](https://www.youtube.com/watch?v=LLjrim-fKJpg&t=19s)

Table 3.5.

Program of the workshop

| Time | Topic | Presenter |
| --- | --- | --- |
| 10:00 – 10:30 | Registration for the workshop | M.sc.ing. Ingūna Brēmane, Riga Technical University |
| 10:30 – 10:45 | Introduction on the role of energy storage in future energy systems and benefits of energy modelling | M.sc.ing. Kristiāna Dolge, Riga Technical University |
| 10:45 – 11:00 | Demonstration of the energy modelling tool & presentation of the case study on the local energy transition | B.sc.ing. Ģirts Bohvalovs, Riga Technical University |
| 11:00 – 11:15 | Instructions about the practical task on municipal energy modelling opportunities, including energy storage technologies | M.sc.ing. Kristiāna Dolge & B.sc.ing. Ģirts Bohvalovs, Riga Technical University |
| 11:15 – 12:30 | Practical task on energy systems simulation and analysis of different pathways to low-carbon local energy systems | All participants |
| 12:30 – 13:00 | Reflection on the exercise and discussions on local energy transition challenges in integrating energy storage solutions | All participants |
| 13:00 – 14:00 | Lunch | All participants |

## 3.2.2 Main findings from the participant feedback survey

### *3.2.2.1 Outline of the results from the task*

The purpose of this survey was to gather feedback on the Energy Equilibrium platform presented during the workshop on 17/05/2024. First part of the survey analysis focused on summarizing the main outcomes of the piloting task.

First question summarized the distribution on which municipality the respondent represented in the task. Although the task providers tried to distribute the municipalities evenly among the respondents, it can be seen that tasks were mostly completed for Taurage.

The distribution of responses to question “Which municipal energy system did your group represent?” is shown below in Fig. 3.21.:

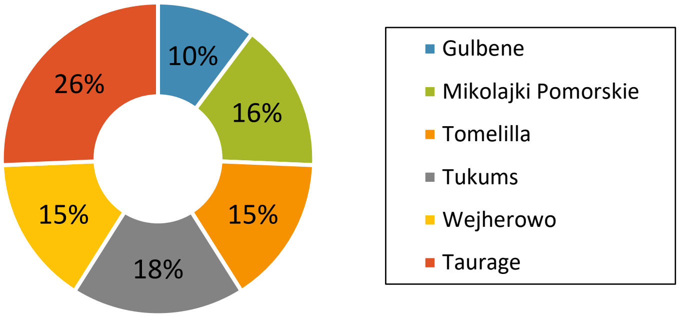
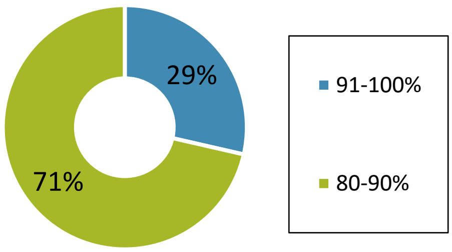



Fig. 3.21. Respondent answer distribution to the question “Which municipal energy system did your group represent?”

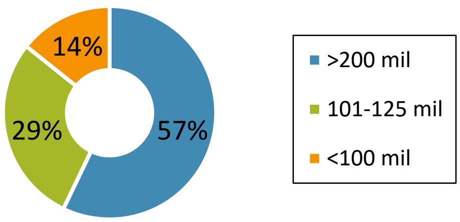
After the municipalities had been divided among the participants, a task was started, the first step of which was to determine from the terms of the task the initial share (%) of renewable energy sources (RES) in 2050 and the initial cost of a municipal system in 2050 in the specific municipality. To assess how well the participants understood the model functions, the model builders themselves performed the task and determined the correct value to compare the participants' results with. The following sections show the responses obtained from respondents for each municipality within the exercise and compared to the expected values.

## Tukums municipality

The distribution of responses for Tukums municipality is shown in Figure 3.22. The expected value for Tukums initial share (%) of renewable energy sources (RES) in 2050 was around 80%. In Figure 3.22. it can be seen that 71% of the participants' responses were in the region of this value, which is a good indicator. The initial cost of a municipal system in 2050 should have been 220 M. 57% of respondents provided value that was in this region.




a)

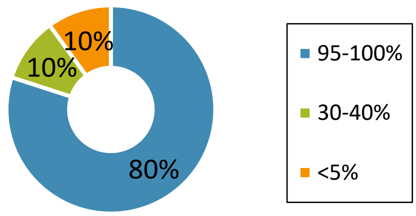



b)

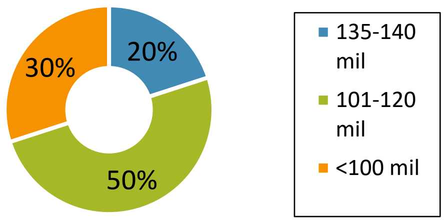
Fig. 3.22. a) Respondent answer distribution to the question “What is Tukums initial share (%) of renewable energy sources (RES) in 2050?”; b) Respondent answer distribution to the question “What is the initial cost of the municipal system in 2050?”

## Taurage municipality

The distribution of responses for Taurage municipality is shown in Figure 3.23. The estimated value of Taurage's initial share (%) of renewable energy sources (RES) in 2050 was around 23.2%. Only 10% of participants' responses were close to this value. The initial cost of a municipal system in 2050 should have been 3490 M. This value was obtained by no one.




a)




b)

Fig. 3.23. Respondent answer distribution to the question "What is Taurage initial share (%) of renewable energy sources (RES) in 2050?"; b) Respondent answer distribution to the question "What is the initial cost of the municipal system in 2050?"

## Wejherowo municipality

The distribution of responses for Wejherowo municipality is shown in Figure 3.24. The estimated value of Wejherowo's initial share (%) of renewable energy sources (RES) in 2050 was 0%. Most of the representatives obtained this value. The initial cost of a municipal system in 2050 should have been 158 M. All participants obtained this value.

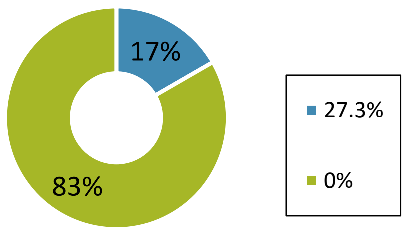
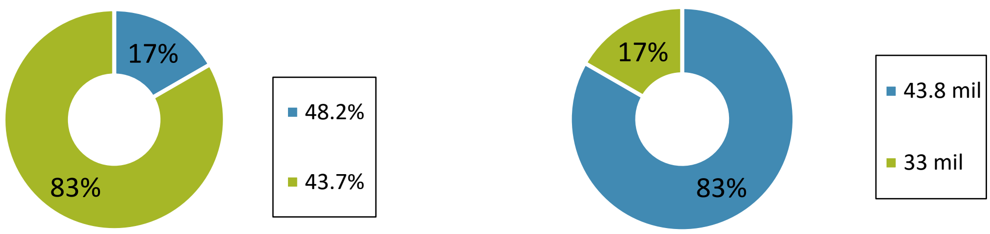



Fig. 3.24. Respondent answer distribution to the question "What is Wejherowo initial share (%) of renewable energy sources (RES) in 2050?"

## Mikolajki Pomorskie municipality

The distribution of responses for Mikolajki Pomorskie municipality is shown in Figure 3.25. The estimated value of Mikolajki Pomorskie initial share (%) of renewable energy sources (RES) in 2050 was around 23,5%. None of participants' responses were within this value. The initial cost of a municipal system in 2050 should have been 35,3M. 83% of participants got the results within the range of the correct value.

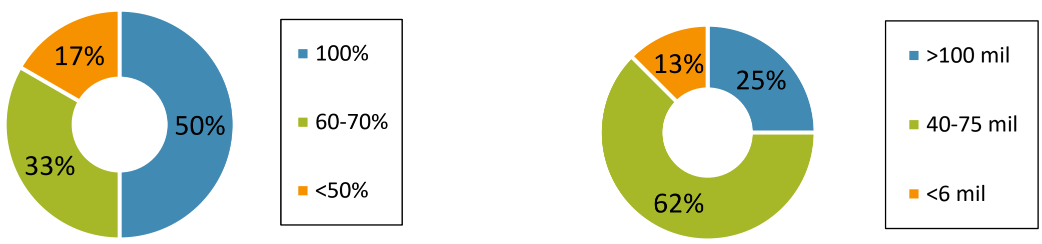



a) b)

Fig. 3.25. a) Respondent answer distribution to the question “What is Mikolajki Pomorskie initial share (%) of renewable energy sources (RES) in 2050?”; b) Respondent answer distribution to the question “What is the initial cost of the municipal system in 2050?”

## Tomelilla municipality

The distribution of responses for Tomelilla’ municipality is shown in Figure 3.26. The estimated value of Tomelilla’s initial share (%) of renewable energy sources (RES) in 2050 was around 99%. Figure 3.26. a) shows that 50% of participants' responses were close to this value. The initial cost of a municipal system in 2050 should have been 30,4 M. 62% of participants got the results around the correct value.

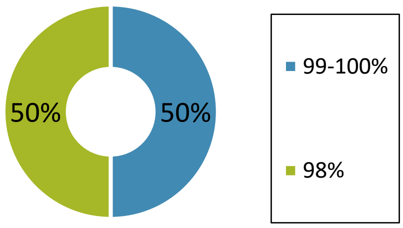



a) b)

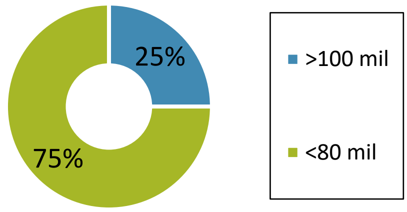
Fig. 3.26. a) Respondent answer distribution to the question “What is Tomelilla’s initial share (%) of renewable energy sources (RES) in 2050?”; b) Respondent answer distribution to the question “What is the initial cost of the municipal system in 2050?”

## Gulbene municipality

The distribution of responses for Gulbene municipality is shown in Figure 3.27. The estimated value of Gulbene initial share (%) of renewable energy sources (RES) in 2050 was around 98,9%. Figure 3.27. a) shows that all participants' responses were close to this value. The initial cost of a municipal system in 2050 should have been 57,8 M. 75% of participants got the results around the correct value.




a)




b)

Fig. 3.27. a) Respondent answer distribution to the question “What is Gulbene initial share (%) of renewable energy sources (RES) in 2050?”; b) Respondent answer distribution to the question “What is the initial cost of the municipal system in 2050?”

Next, respondents were asked about their preferred strategies for completing the task. In Table 3.6. the answers for all municipalities are summarised.

Table 3.6.

Strategies implemented in each municipality within the task

| Gulbene | Tukums | Taurage | Mikolajki Pomorskie | Wejherowo | Tomelilla |
|---|---|---|---|---|---|
| 1) Increase renewable energy capacity;<br>2) Transition to biomass and enhance CHP plants;<br>3) Implement energy storage solutions. | 1) Eliminate the use of natural gas;<br>2) Enhance energy storage and renewable energy production;<br>3) Promote energy efficiency and renovation. | 1) Increase the capacity of installed PV (Photovoltaic) and energy production technologies;<br>2) Add storage systems solutions;<br>3) Promote and support renewable energy technologies and efficiency. | 1) Increase renewable energy capacity;<br>2) Transition from coal to biomass;<br>3) Implement energy storage solutions and increase energy efficiency. | 1) Increase renewable energy integration;<br>2) Develop biomass and cogeneration plants;<br>3) Enhance energy efficiency and storage. | 1) Increase investments in renewable energy;<br>2) Enhance building efficiency and implement renovations;<br>3) Substitute fossil fuels with biomass and implement energy storage. |

Respondents were asked which parameters they changed in the first scenario. In Table 3.7. a summary for each municipality separately is outlined.

Table 3.7.

Parameters changed in each municipality in Scenario 1

| Gulbene | Tukums | Taurage | Mikolajki Pomorskie | Wejherowo | Tomelilla |
|---|---|---|---|---|---|
| 1) Maximizing utilization hours; 2) Long-term investment; 3) Diversification of energy sources. | 1)Eliminate the use of natural gas; 2) Increase capacity of renewable energy sources (PV, CHP); 3) Investments in various renewable energy technologies, such as PV Utility Sun and CHP biomass | 1) Increase the share of building renovations; 2) Implement community and stakeholder engagement; 3) Increase renewable energy production and storage. | 1) Investments in solar collectors 2) Replacing coal with biomass 3) Enhance energy efficiency through renovation. | 1) Enhance energy efficiency; 2) Phase out coal and natural Gas; 3) Increase renewable energy capacity. | 1) Invest in combined heat and power (CHP) technology; 2) Utilize a combination of technologies; 3) Introduce heat pump water electricity to substitute natural gas. |

Then, respondents were asked which parameters they changed in the 2nd scenario. In Table 3.8. a summary for each municipality separately is outlined.

Table 3.8.

Parameters changed in each municipality in Scenario 2

| Gulbene | Tukums | Taurage | Mikolajki Pomorskie | Wejherowo | Tomelilla |
|---|---|---|---|---|---|
| 1) Investments in a mix of renewable energy technologies | 1) Eliminate the use of natural gas boilers and addition of solar collectors with storage; 2) Information campaigns and psychological factors; 3) Increased building renovation. | 1) Invest in energy storage; 2) Implement biomass power plants and combined heat and power (CHP) systems; 3) Installation of solar collectors. | 1) Energy storage systems | 1) Invest in PV utility sun and collector solar sun systems; 2) Invest in a mix of renewable energy technologies such as solar (PV and collector), biomass, and thermal (wood pellet boiler). | 1) Increase renewable energy production and storage. |

Futhermore, respondents were asked which parameters they changed in the 3rd scenario. In Table 3.9. a summary for each municipality separately is outlined.

Table 3.9.

Parameters changed in each municipality in Scenario 3

| Gulbene | Tukums | Taurage | Mikolajki Pomorskie | Wejherowo | Tomelilla |
|---|---|---|---|---|---|
| 1) Increase in electricity storage capacity;<br>2) Expansion of solar PV capacity; | 1) Diversification and expansion of energy sources;<br>2) Increased share of renovated buildings, decreased electricity import tariff, and the addition of lithium-ion electricity storage. | 1) Renovation of buildings for energy efficiency;<br>2) Enhanced renewable energy production with CHP biomass and thermal storage. | 1) Increased solar PV capacity | 1) Removing coal and gas plants;<br>2) Increasing energy storage capacity | 1) Incorporating storage systems |

To actualise implementation of energy storage in municipalities, the use of such technologies was integrated into the scenarios (Fig. 3.28.). Participants were therefore asked whether they used these technologies and what benefits they noticed. Opinions on this matter were highly divided.

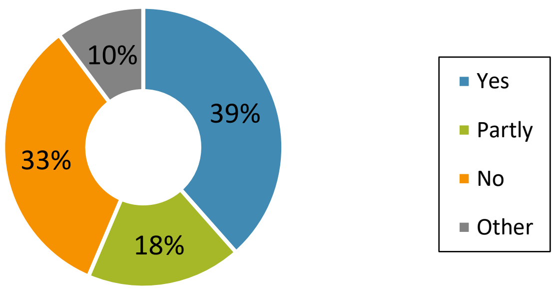



Fig. 3.28. Respondent answer distribution to the question "Did energy storage technologies play a role in your scenarios?"

Some answers to this question categorized as "others" included statements such as:

- No, not in the scenario I proposed;
- As the RE share was already 98%, the impact was low;
- I was unable to finish the task.

Additionaly participants were asked "What role do you think energy storage technologies played in the development scenarios you modelled?". Answers have been summarized below:

- Equalizes energy demand and consumption peak loads, optimizes and balances energy production;

- It allowed to increase the RES share in total energy balance and in the end also cut the costs;
- Energy storage played a major role in predating the consumption, from the look of the simulation the program considers various seasons, especially storing energy in season with less consumption to be use in season with higher energy consumption.
- As a big part of the energy demand is for heating, thermal energy storage helped in covering the peak heat load.
- It plays a high role if we want to fully eliminate non-renewable sources of energy;
- Helps utilise intermittent energy sources like solar more effectively.

#### *3.2.2.2 The overall evaluation of the experience*

To gain a comprehensive understanding of the respondents' backgrounds, participants were asked to specify their field of specialization area and age group.

The distribution of responses to question "Which sector/field do you represent?" is shown below in Fig. 3.29.:

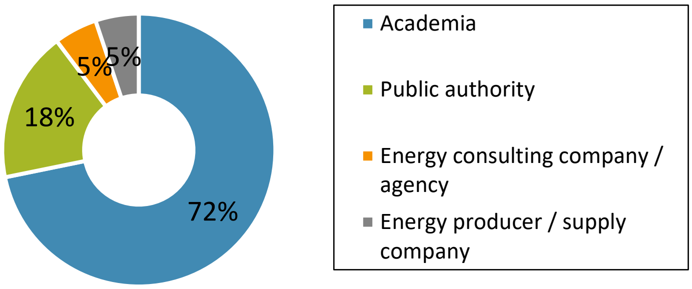



Fig. 3.29. Respondent answer distribution to the question "Which sector/field do you represent?"

Most respondents (72%) that participated in the workshop had an academic background.

The distribution of responses to question "What group of age are you?" is shown below in Fig. 3.30.:

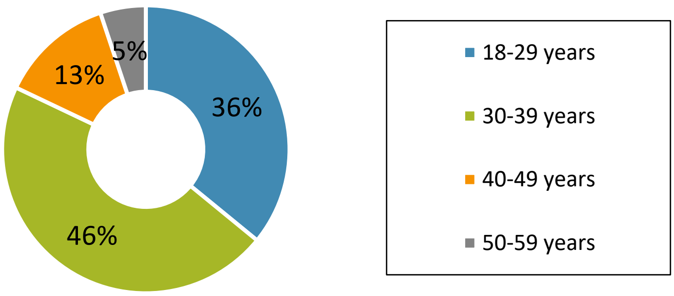



Fig. 3.30. Respondent answer distribution to the question "What group of age are you?"

The next section of questions included questions that would allow a better understanding of the tool user experience. To answer the question, participants had the option to indicate how much they agreed with the statement.

A question about the use of this tool on a regular basis was asked to understand to what extent the participants present see the use of the model in their professional daily life. The distribution of responses (Fig. 3.31.) shows a positive trend - the majority (49% neutral, 29% agree). The average rating given by participants to this statement was 3.3, which can be interpreted as a "neutral attitude" with a tendency towards agreeing.

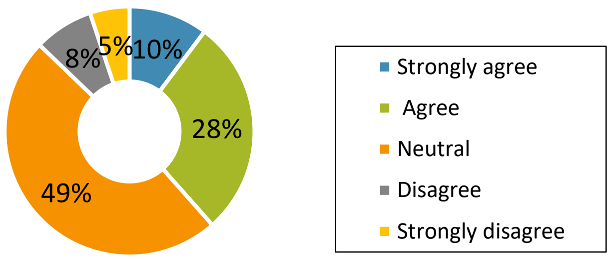



Fig. 3.31. Respondent answer distribution to the question "I can imagine using the tool on a regular basis"

In each of the pilots and model trials, participants identified a high degree of difficulty. In this exercise, 62% said that they did not feel that the model was unreasonably complex (Fig. 3.32.). The average rating submitted by participants on this statement was 2.4 - disagree.

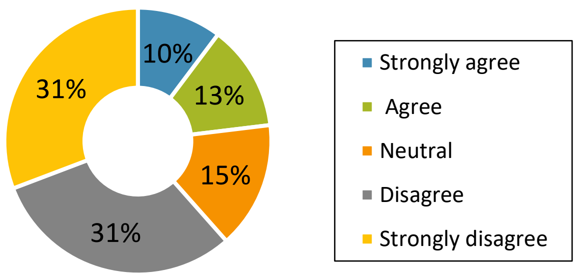



Fig. 3.32. Respondent answer distribution to the question "I find the tool unnecessarily complex"

Based on the previous question, it was asked whether participants found the model easy to use. Consistently, the majority consider it straightforward (Fig. 3.33.). The average rating given by participants to this statement was 3.4, which can be interpreted as a "neutral attitude" with a tendency towards agreeing.

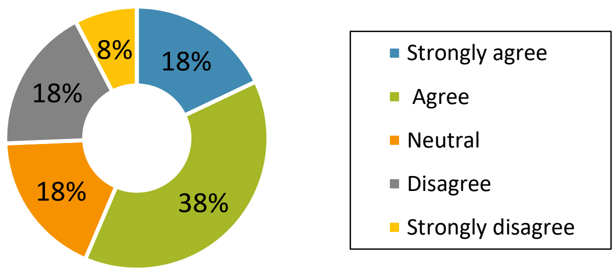



Fig. 3.33. Respondent answer distribution to the question "I find the tool is easy to use"

Although the tool's first page contains a tutorial video and the workshop moderators explained the functionality of the model in a step-by-step manner, participants were asked if there was a need for additional technical support. More than half felt that they would need help in using it (Fig. 3.34.). The average rating given by participants to this statement was 3.3, which can be interpreted as a "neutral attitude" with a tendency towards agreeing.

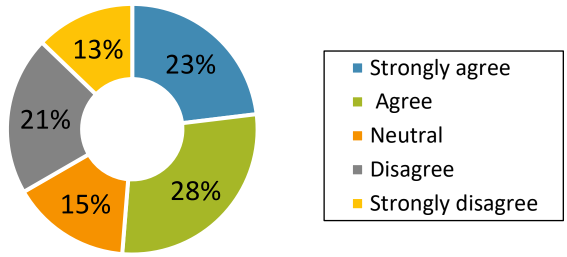



Fig. 3.34. Respondent answer distribution to the question “I think, I would need technical support while using the tool”

Regarding the tool's functionality, only 13% disagreed that its features are well integrated (Fig. 3.35.). The average rating given by participants to this statement was 3.7- neutral opinion with a tendency towards agreement.

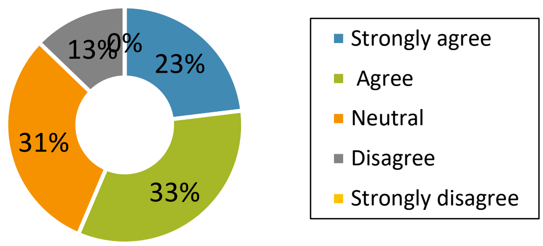



Fig. 3.35. Respondent answer distribution to the question “I find that the different functions of the tool are well integrated”

During the workshop some participants managed to find bugs, we are grateful for their identification and will address them. Hence about 3% strongly agreed that there are several inconsistencies in the model (Fig. 3.36.). A positive indicator is that more than half disagreed with this statement or felt neutral. The average rating submitted by participants on this statement was 2.4 - disagree.

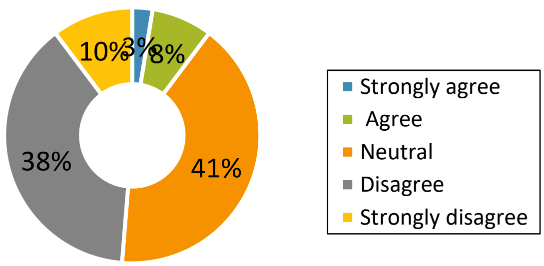



Fig. 3.36. Respondent answer distribution to the question “I find that there are too many inconsistencies in the tool”

Following the analysis of the previous surveys, a question was asked about how difficult the model seems to a first-time user. The distribution of answers shows a positive trend (Fig. 3.37.). This is probably since the participants are representatives of the field, actively working on these issues. For the municipality representatives it would most likely be difficult to use for the first time anyway even after improvements. The average rating given by participants to this statement was 3.1, which can be interpreted as a neutral opinion.

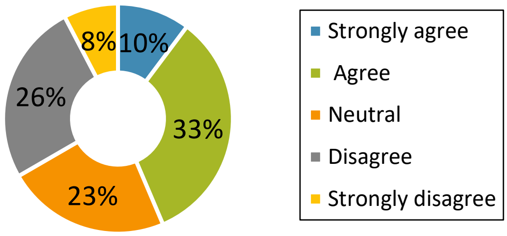



Fig. 3.37. Respondent answer distribution to the question "I can imagine that most people will know how to master the tool quickly"

After analysing the data provided in the survey, it can be concluded that the tool is not particularly complex to use (Fig. 3.38.). The average rating given by participants to this statement was 2.4- disagree.

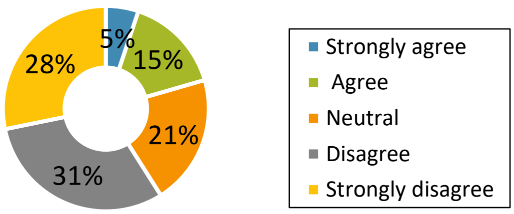



Fig. 3.38. Respondent answer distribution to the question "I find the tool's operation very complicated"

From a cyber security perspective, participants were asked how they felt about using this model. More than half said they felt safe (Fig. 3.39.). The average rating given by participants to this statement was 3.6- neutral opinion with a tendency towards agreement.

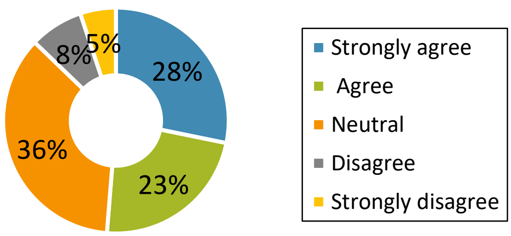



Fig. 3.39. Respondent answer distribution to the question "I felt very safe using the tool"

Previous surveys have raised the issue of the knowledge gap. Participants were therefore also asked for their opinion on this topic. The distribution of the answers shows that their existing knowledge and skills were in general sufficient to complete the workshop task (Fig. 3.40.). The average rating given by participants to this statement was 3, which can be interpreted as a neutral opinion.

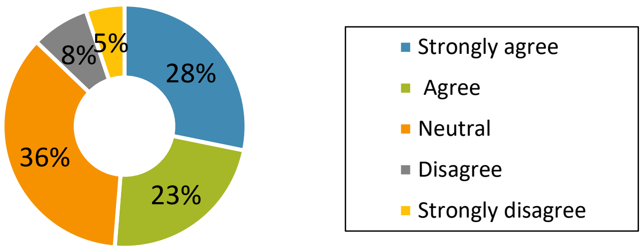



Fig. 3.40. Respondent answer distribution to the question “I needed to learn a lot of things before I could work with the tool properly”

From the questions above, an analysis of the responses to the questionnaire was carried out. The graph in Fig. 3.41. shows the average values obtained from the participants' answers to each specific question. A rating of 5 indicates strong agreement with the statement, while a rating of 1 indicates strong disagreement. Most participants gave an answer of 3 or 2, meaning that they were neutral or disagreed with the statement. From the mean values it can be concluded that out of all the statements, the most participants agreed with "I find that the different functions of the tool are well integrated". On the contrary, most disagreed with the statements about the expressed complexity of the tool.

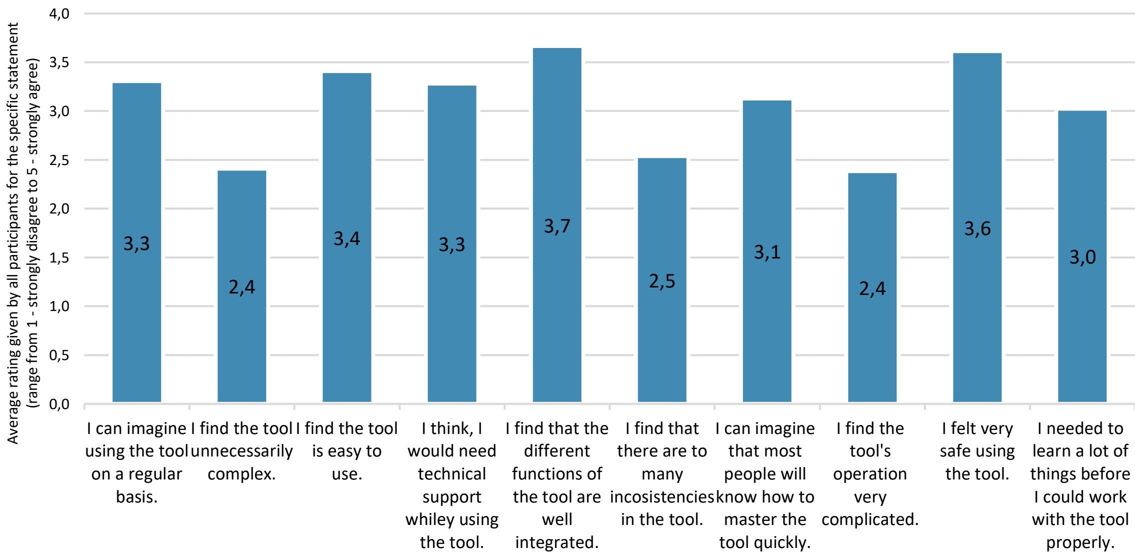



Fig. 3.41. Average values of participants' input on the statements

The most informative participant answers to the question “Do you have any specific suggestions, comments on how this tool could be improved?” are placed below:

- Need the possibility of writing the "Financing distribution, %" and resetting only specific simulations.
- Tool is very easy to use and understand, however I need to know more input data

- I loved the tool, but I feel that I don't have enough knowledge in the field of energy storage, as well as other missing information, that would help me understand the tool better.
- The tool seems to be very simple to use but the team needs to prepare manual or walkthrough process. Also, there is a need to provide some information about the parameters that are used in the simulation for users to have an idea.
- Could it be possible to have a reset button for the simulation runs. Now when running the simulations they all pile up in the same graph and the only way to clear the graph is to reset everything.
- Very cool tool. There were some uncertainties about the tool while I was doing this task, like, if I turned off the "use technology" but the values left the same as it was, then the tool it takes in account, so maybe this could be explained by the information button, to make it clearer but otherwise, nice job!
- It would be good if we can see the technologies we added to the system. Like a list of the current used technologies with their capacities
- I found out, that if municipality employees would use it, there were needed technical support and may be theoretical knowledge - possible as presentation before using it and so on.
- I have found a few small bugs, but the most valuable thing authors could do is add the option to save the baseline scenario. When you try to "play" with the data, you get many results quickly.

**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 data and graphs.

**Enhancements in Functionality:** Participants recommended improving the “reset” button.

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

**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.

# 3.3 Webinar on Energy Equilibrium second round of pilots on 24/05/2024

## 3.3.1 Description of the event

On 24 May 2024, the second round of the Energy Equilibrium Platform pilots was held for the project partners and their stakeholders. During the webinar, the latest version of the Energy Equilibrium platform was explored, demonstrating its improved features and functionalities. Participants had the opportunity to delve into hands-on exercises, simulating various development scenarios tailored to the specifics of each municipality. Table 3.10. outlines the program of the event.

Table 3.10.

Program of the webinar on Energy Equilibrium second round of pilots

| Time | Topic | Presenter |
|---|---|---|
| 11:00 – 10:15 | Opening remarks & reflection on 1st pilots | Project communications manager, M.sc.ing. Kristiāna Dolge, Riga Technical University |
| 11:15 – 11:30 | Municipality expectations from modelling | Adam Cenian, IMP PAN |
| 11:30 – 11:45 | Introduction to the new version of the model interface & import data | Research assistant B.sc.ing. Ģirts Bohvalovs, Riga Technical University |
| 11:45 – 12:45 | Exercises & hands on modelling | All participants |
| 12:45 – 13:00 | Short break | All participants |
| 13:00 – 13:30 | Reflection on the exercise & feedback. Discussion by all participants | All participants and IMP PAN, RTU - moderators |

During this webinar participants had the opportunity to use data import function of the Energy Equilibrium platform, enabling them to start modelling without manually placing the figures.

## 3.3.2 Main findings from the participant feedback survey

The purpose of this survey was to gather feedback on the Energy Equilibrium platform presented during the webinar on 24/05/2024.

#### *3.3.2.1 Outline of the results from the task*

First part of the survey analysis focused on summarizing the main outcomes of the piloting task. Although the task providers tried to distribute the municipalities evenly among the respondents, it can be seen that tasks were mostly completed for Tomellila municipality and Taurage municipality.

The distribution of responses to question "Which municipal energy system did your group represent?" is shown below in Fig. 3.42.:

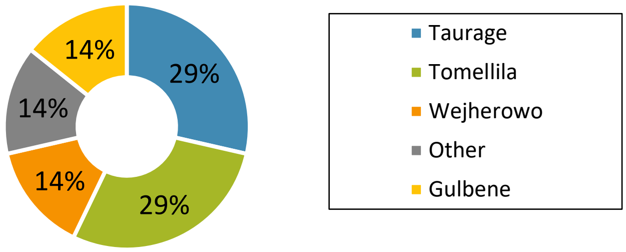
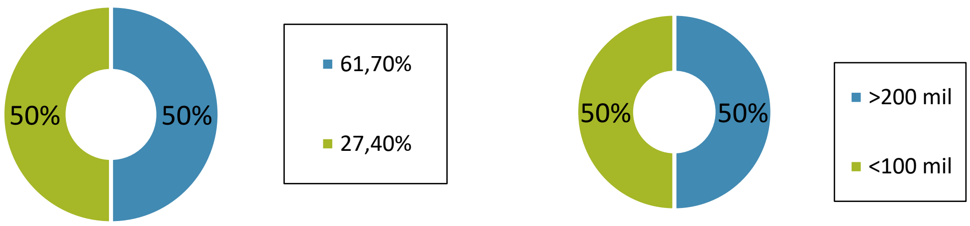



Fig. 3.42. Respondent answer distribution to the question Respondent answer distribution to the question "Which municipal energy system did your group represent?"

After the municipalities had been divided among the participants, a task was started, the first step of which was to determine from the terms of the task the initial share (%) of renewable energy sources (RES) in 2050 and the initial cost of a municipal system in 2050 in the specific municipality. To assess how well the participants understood the model functions, the model builders themselves performed the task and determined the correct value to compare the participants' results with. The following sections show the responses obtained from respondents for each municipality within the exercise and compared to the expected values.

## TAURAGE

The distribution of responses for Taurage municipality is shown in Figure 3.43. The estimated value of Taurage's initial share (%) of renewable energy sources (RES) in 2050 was around 23.2%.




a) b)

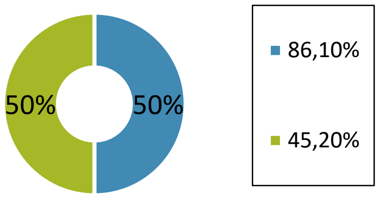
Fig. 3.43. a) Respondent answer distribution to the question "What is Taurage initial share (%) of renewable energy sources (RES) in 2050?"; b) Respondent answer distribution to the question "What is the initial cost of the municipal system in 2050?"

## Wejherowo

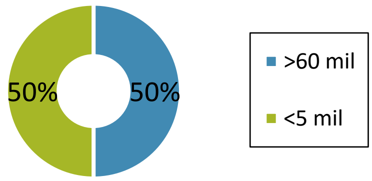
The estimated value of Wejherowo's initial share (%) of renewable energy sources (RES) in 2050 was 0%. There was only one participant doing the exercise for this exact municipality and he/she obtained the answer "4.33%", which is relatively close to the reference value - 0%.

## Tomelilla

The distribution of responses for Tomelilla' municipality is shown in Figure 3.44. The estimated value of Tomelilla's initial share (%) of renewable energy sources (RES) in 2050 was around 99%. Figure 3.44. shows that 50% of participants' responses were close to this value.




a)




b)

Fig. 3.44. a) Respondent answer distribution to the question "What is Tomelilla's initial share (%) of renewable energy sources (RES) in 2050?"; b) Respondent answer distribution to the question "What is the initial cost of the municipal system in 2050?"

## Gulbene

The estimated value of Gulbene initial share (%) of renewable energy sources (RES) in 2050 was around 98,9%. The one participant that did the exercise for this municipality did not get the value close to the real. The initial cost of a municipal system in 2050 should have been 57,8 M. Participant did not obtain this value.

Next, respondents were asked about their preferred strategies for completing the task. In Table 3.11. the answers for all municipalities are summarised.

Table 3.11.

Strategies implemented in each municipality within the task

| Gulbene | Other | Taurage | Wejherowo | Tomelilla |
|---|---|---|---|---|
| 1) Newly install PV Utility Sun 4MW in 2024 and Lithium-Ion Electricity Storage<br><br>2) Newly install PV Utility Sun 10MW in 2024, Heat Pump with planned capacity 30MW, CHP Biomass Woodchips 5MW and Lithium-Ion Electricity Storage<br><br>3) Recommissioning existing technologies. | 1) Wind energy. | 1) Installed of PV Utility, heat pumps and biomass boilers. | - | 1) Installed PV and wind energy capacities. |

Respondents were asked which parameters they changed in the first scenario. In Table 3.12. a summary for each municipality separately is outlined.

Table 3.12.

Parameters changed in each municipality in Scenario 1

| Gulbene | Other | Taurage | Wejherowo | Tomelilla |
|---|---|---|---|---|
| - | - | 1) Information campaign strength was increased till 20%, PV Utility Sun 10 MW installed in 2028. | - | 1) Installed 100 MW more solar power and 58 MW more wind power in 2024;<br><br>2) 29 MW installed on-shore wind, 10 MW PV. |

Respondents were also asked which parameters they changed in the 2nd scenario. In Table 3.13. a summary for each municipality separately is outlined.

Table 3.13.

Parameters changed in each municipality in Scenario 2

| Gulbene | Other | Taurage | Wejherowo | Tomelilla |
|---|---|---|---|---|
| - | - | 1) Information campaign strength was increased till 20%, PV Utility Sun in-stalled 10 MW in 2028; Heat Pump water electric-ity 5 MW in 2034. | - | 1) Installed 100 MW more solar power and 58 MW more wind power in 2024. Added 100 MWh storage of Lithium-Ion electricity.<br><br>2) Installed onshore wind |

Furthermore, respondents were asked which parameters they changed in the 3rd scenario. In Table 3.14. a summary for each municipality separately is outlined.

Table 3.14.

Parameters changed in each municipality in Scenario 3

| Gulbene | Other | Taurage | Wejherowo | Tomelilla |
|---|---|---|---|---|
| - | - | 1) Information cam-paign strength was increased till 20%, PV Utility Sun installed 10 MW in 2028; Heat Pump water electric-ity 5 MW in 2034; | - | 1) Installed onshore wind: 29 MW Planned newly installed capacity (installed onshore wind): 29 MW. Recommission.<br><br>2) Installed PV utility: 10 MW Planned newly installed capacity (installed onshore wind): 10 MW |

| | | | | |
|---|---|---|---|---|
| | | Boiler biomass wood-chips 30 MW in 2030. | | Recommission.<br><br>3) Energy storage technologies Lithium-Ion Electricity installed storage: 10 MWh<br>no recommission |

To actualise the implementation of energy storage in municipalities, the use of such technologies was integrated into the scenarios (Fig. 3.45.). Participants were therefore asked whether they used these technologies and what benefits they noticed. More than half of participants felt that energy storage did have an impact on the scenarios developed.

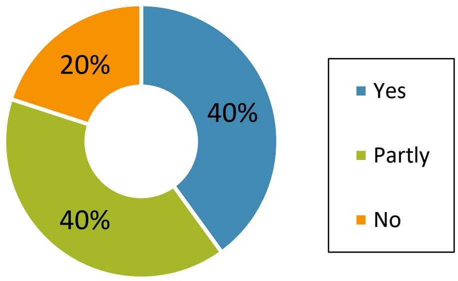



Fig. 3.45. Respondent answer distribution to the question "Did energy storage technologies play a role in your scenarios?"

### *3.3.2.2 The overall evaluation of the experience*

To gain a comprehensive understanding of the respondents' backgrounds, participants were asked to specify their field of specialization area and age group. The distribution of responses to question "Which sector/field do you represent?" is shown below in Fig. 3.46.:

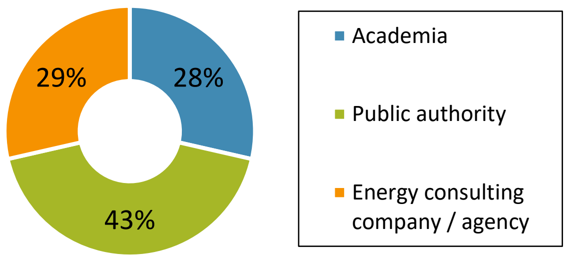



Fig. 3.46. Respondent answer distribution to the question "Which sector/field do you represent?"

Most respondents (43%) were public authority representatives.

The distribution of responses to question “What group of age are you?” is shown below in Fig. 3.47.:

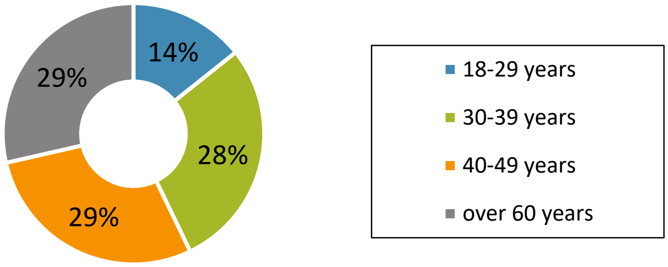



Fig. 3.47. Respondent answer distribution to the question “What group of age are you?”

The majority of participants were in their forties or over 60 years old.

The next section of questions included questions that would allow a better understanding of the tool user experience. To answer the question, participants had the option to indicate how much they agreed with the statement.

The distribution of responses (Fig. 3.48.) shows a positive trend (40% agree, 20% strongly agree). The average rating given by participants to the statement about using this tool regularly was 2.9, which can be interpreted as "neutral attitude".

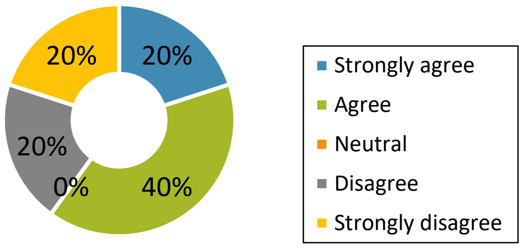



Fig. 3.48. Respondent answer distribution to the statement “I can imagine using the tool on a regular basis”

In each of the pilots and model trials, participants identified a high degree of difficulty. In this exercise, more than half agreed with the statement (Fig. 3.49.). The average rating given by participants to this statement was 3.4, which can be interpreted as a "neutral attitude" with a tendency towards agreeing.

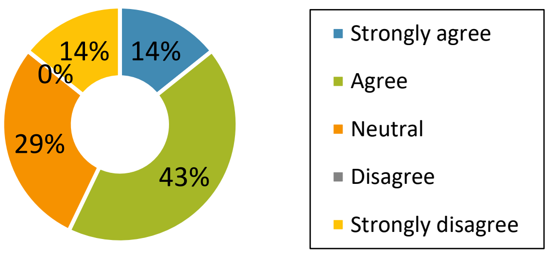



Fig. 3.49. Respondent answer distribution to the statement “I find the tool unnecessarily complex”

Based on the previous question, it was asked whether participants found the model easy to use. Consistently, the majority consider it difficult (Fig. 3.50.). The average rating submitted by participants on this statement was 2.4 - disagree.

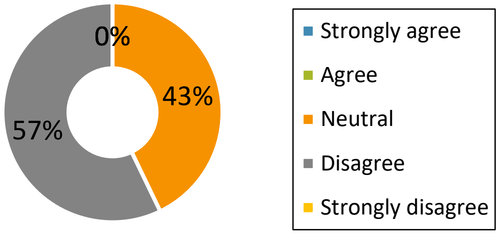



Fig. 3.50. Respondent answer distribution to the statement “I find the tool is easy to use”

Although the tool's first page contains a tutorial video and the workshop moderators explained the functionality of the model in a step-by-step manner, participants were asked if there was a need for additional technical support. More than half felt that they would need help in using it (Fig. 3.51.). The average rating given by participants to this statement was 4 - agreement.

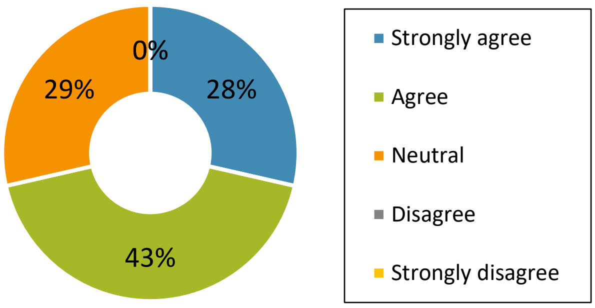



Fig. 3.51. Respondent answer distribution to the question “I think, I would need technical support while using the tool”

Regarding the tool's functionality, only 14% strongly disagreed that its features are well integrated (Fig. 3.52.). The average rating given by participants to this statement was 3.6- neutral opinion with a tendency towards agreement.

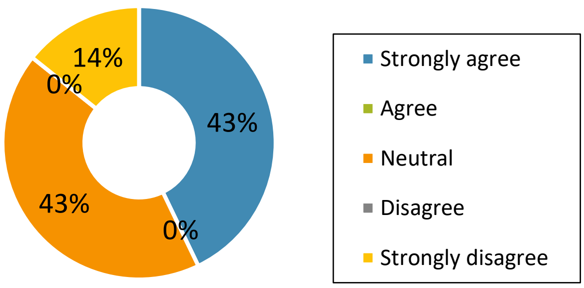



Fig. 3.52. Respondent answer distribution to the statement “I find that the different functions of the tool are well integrated”

During the workshop some participants managed to find bugs, we are grateful for their identification and will address them. Hence about 14% agreed that there are several inconsistencies in the model (Fig. 3.53.). The average rating given by participants to this statement was 2.4- disagree.

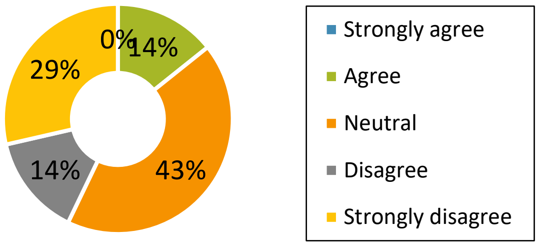



Fig. 3.53. Respondent answer distribution to the statement "I find that there are too many inconsistencies in the tool"

Following the analysis of the previous surveys, a question was asked about how difficult the model seems to a first-time user. The distribution of answers shows that for people that are not actively working in the field or have had an experience with a similar modelling tool will have difficulties using it (Fig. 3.54.). The average rating given by participants to this statement was 2.1- disagree.

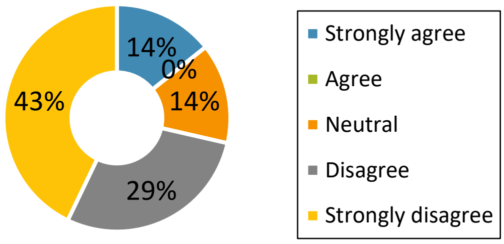



Fig. 3.54. Respondent answer distribution to the statement "I can imagine that most people will know how to master the tool quickly"

After analysing the data provided in the survey, it can be concluded that the tool can be complex to use for people without proper training (Fig. 3.55.). The average rating given by participants to this statement was 3, which can be interpreted as a neutral opinion.

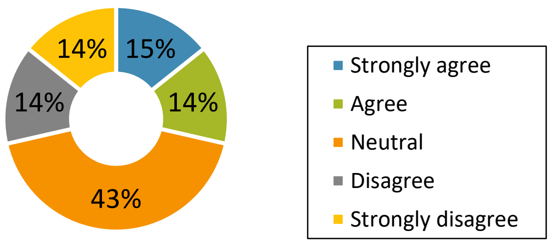



Fig. 3.55. Respondent answer distribution to the statement "I find the tool's operation very complicated"

From a cyber security perspective, participants were asked how they felt about using this model. The answers do not show a clear trend (Fig. 3.56.). The average rating given by participants to this statement was 3, which can be interpreted as a neutral opinion.

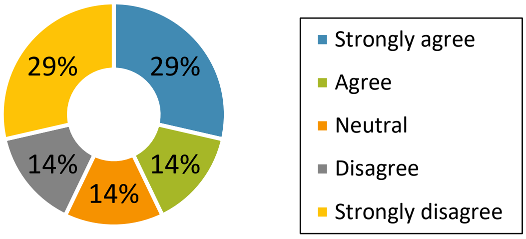



Fig. 3.56. Respondent answer distribution to the statement "I felt very safe using the tool"

Previous surveys have raised the issue of the knowledge gap. Participants were therefore also asked for their opinion on this topic. The distribution of the answers shows that more than half of respondents felt the need for additional training, tutorials to sufficiently use this tool. (Fig. 3.57.). The average rating given by participants to this statement was 4, indicating agreement with the statement.

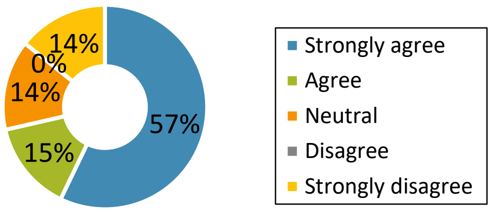



Fig. 3.57. Respondent answer distribution to the statement "I needed to learn a lot of things before I could work with the tool properly"

From the questions above, an analysis of the responses to the questionnaire was carried out. The graph in Fig. 3.58. shows the average values obtained from the participants' answers to each specific question. A rating of 5 indicates strong agreement with the statement, while a rating of 1 indicates strong disagreement. Most participants gave an answer of 3 or 2, meaning that they were neutral or disagreed with the statement. From the mean values it can be concluded that out of all the statements, the most participants agreed with statements that were about needing additional help, tool's complexity. On the contrary, most disagreed with "I can imagine that most people will know how to master the tool quickly".

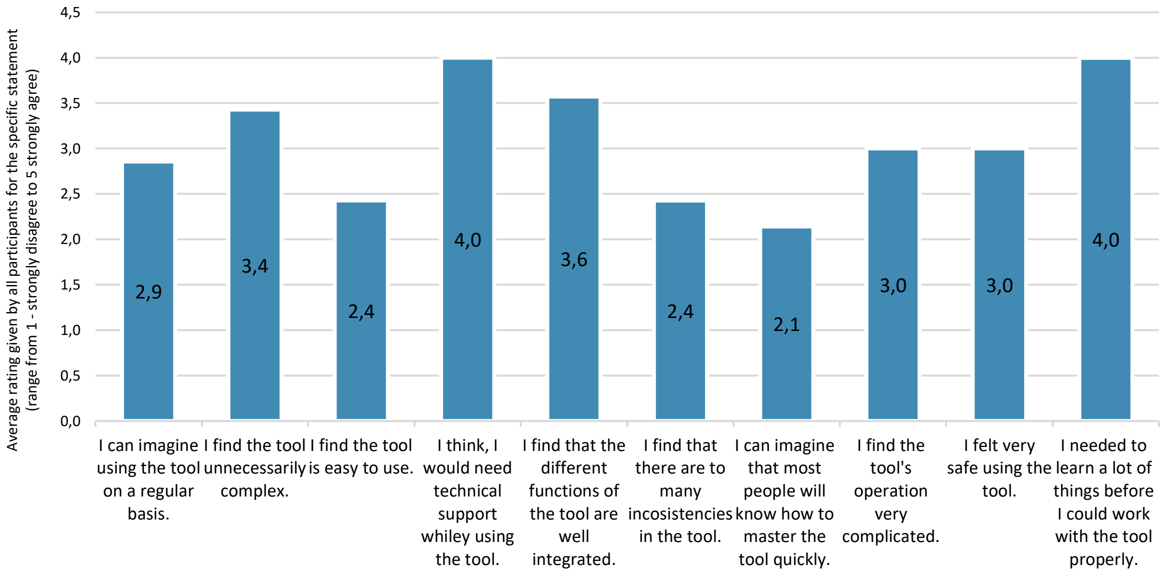



Fig. 3.58. Average values of participants' input on the statements

Additionaly participants were asked “What role do you think energy storage technologies played in the development scenarios you modelled?”. Answers have been summarized below:

- “It played a very little role. Although the cost increased significantly”;
- “Minor role”.

The main takeaways from participant answers to the question “Do you have any specific suggestions, comments on how this tool could be improved?” are placed below:

**Key takeaways**

**Multi-scenario and Multi-technology Comparisons:** Comparing different technological solutions is important as planned solutions may involve various technologies. Also having a graph with a single, final estimate might be sufficient.

**End-user Consideration:** Participants acknowledged that someone with more expertise in the field would likely find the tool more useful.

**Usability Issues:** There's a lack of ability to compare the impact of multiple technologies on the final result. It's necessary for participants to try and test the platform before using it effectively.

Finally, participants were asked for their opinion on the added value of the Energy Equilibrium platform and the possibility of it helping municipalities in their energy planning. Responses are summarized below.

“The platform offers high potential and valuable features, including the calculation of renewable energy share, cost estimation, and summaries of energy systems, which can be beneficial for municipalities, designers, researchers, and students. However, its full potential is currently underutilized due to either the user's lack of knowledge or the platform's complexity. Despite this, it allows for simulating different development scenarios, visualizing environmental impacts, and calculating system costs and payback times. Improvements in usability and understanding could further enhance its utility."

- "The tool has great potential for aiding municipalities in navigating various scenarios to choose the most cost-effective methods for long-term energy planning."
- "It can significantly benefit the energy planning process by helping to create future energy production plans, considering possible storage options, and adapting to changes in building numbers and energy consumption."
- "The platform is currently complex and requires substantial effort to understand, making it challenging for municipal staff to use."
- "With proper training, an energy manager could effectively utilize the tool to explain and justify decisions."

## 3.4 Webinar on the general piloting of the Energy Equilibrium platform

### 3.4.1 Description of the event

On May 31, 2024 webinar on Energy Equilibrium platform general piloting was held. During this interactive workshop-style webinar, participants had the chance to explore the Energy Equilibrium platform firsthand. Table 3.15 outlines the program of the event.

Table 3.15.

Program of webinar on Equilibrium platform general piloting

| Time | Topic | Presenter |
|---|---|---|
| 11:00 – 11:15 | Opening remarks & & short introduction about the project | Researcher, M.sc.ing. Kristiāna Dolge, Riga Technical University |
| 11:15 – 11:30 | Introduction to the model interface | Research assistant B.sc.ing. Ģirts Bohvalovs, Riga Technical University |
| 11:30 – 12:30 | Workshop exercise | All participants |
| 12:30 – 12:45 | Reflection on the exercise & feedback | Research assistant B.sc.ing. Ģirts Bohvalovs, Riga Technical University & Researcher, M.sc.ing. Kristiāna Dolge, Riga Technical University |
| 12:45 – 13:00 | Discussion | All participants |

Participants were instructed to continue modeling their case studies and scenarios using the Energy Equilibrium platform. The webinar served as a consultation and guidance session to assist them through their scenario development. Participants were encouraged to share their experiences and insights to help identify the most feasible opportunities for improving the platform.

### 3.4.2 Main findings from the participant feedback survey

The purpose of this survey was to gather feedback on the Energy Equilibrium platform presented during the webinar on 31/05/2024.

To gain a comprehensive understanding of the respondents' backgrounds, participants were asked to specify their field of specialization area and age group. Before the actual survey questions, respondents were asked to specify the organization represented by themselves. The answers are summarized in Fig. 3.59. below.

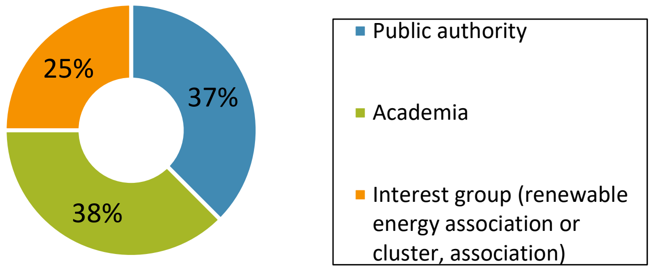



Fig. 3.59. Respondent answer distribution to the question Distribution or respondents according to main stakeholder groups of the project

Figure 3.59. illustrates that most participants were delegates from research organizations, constituting 38%. The second-largest group in attendance comprised representatives from municipalities, accounting for 37%.

The distribution of responses to question “What group of age are you?” is shown below in Fig. 3.60.:

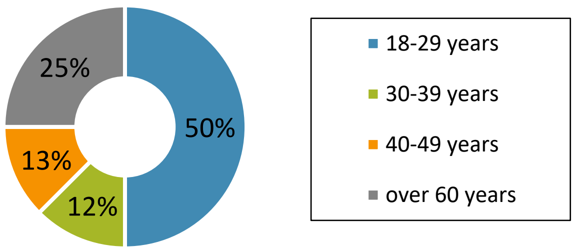



Fig. 3.60. Respondent answer distribution to the question “What group of age are you?”

Figure 3.60. illustrates that the majority of participants (50%) were in their twenties.

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. 3.61.).

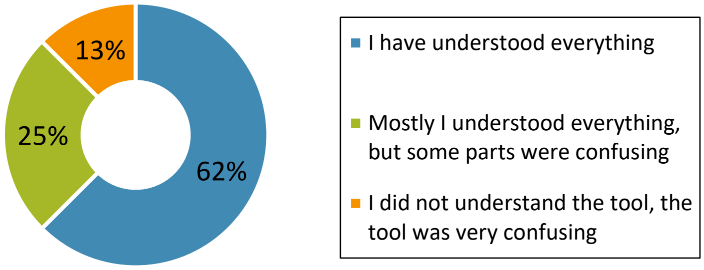



Fig. 3.61. Respondent answers on the level of tool’s understandability

A majority of respondents (62%) reported a complete understanding of the tool, suggesting that participant opinions and recommendations were considered, leading to enhanced user-friendliness in the tool. Additionally, 25% indicated that they generally grasped the content within the tool, though some sections posed confusion.

As participants were given a choice of how to use the model, the question was asked how exactly they did use the tool. The summary of the answers in Fig. 3.62. shows that most of them chose to use the model for specific case studies, for creating their own municipal scenarios, or simply to follow the instructions given by the workshop organisers. Responses are visualised in a graph based on their correspondence to a category and frequency.

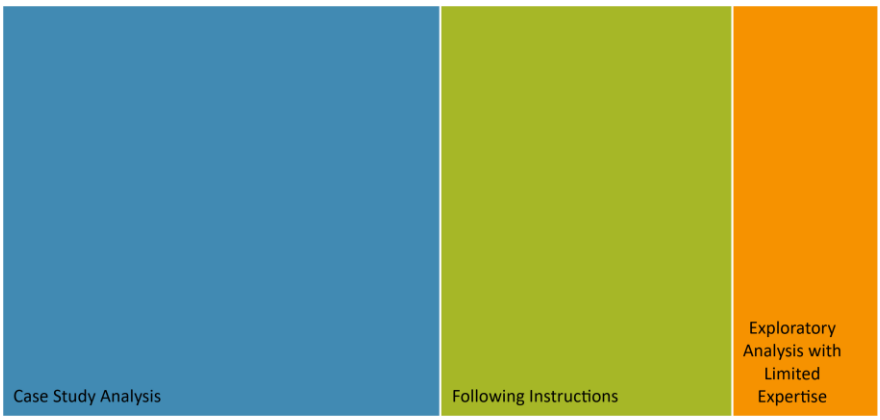



Fig. 3.62. Respondent answer distribution to the question “Describe what case studies did you model and what was the achieved result?”

The participants were also asked to provide insights on any aspects of the tool that caused confusion or were difficult to comprehend (Fig. 3.63.). Responses are visualised in a graph based on their correspondence to a category and frequency.


Fig. 3.63. 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:

- "It took some time for me to understand that the model was not applicable for the whole energy system of Tomelilla. I also noticed that I needed to do sector charts instead of for all sectors. One suggestion would be that the sector chart is shown automatically when you have selected a sector."
- "Sometimes there are two colours in the graph just defined as '1' and '2' which made the graph hard to understand."
- "It is confusing when you make 10 and more simulations, you can see all simulation results in for example Simulation results for the entire system 1. graph and others. Then it is complicated to understand graphic. Maybe it could be better to show only last 5 simulation results."
- "Part of Production, where the addition of several technologies does not show the impact of each on the final result."
- “The connection between different factors was sometimes hard to understand and realize. I did not really feel a connection between production, storage and renewable energy share percentage. ”

**<u>Key takeaways</u>**

**Understanding and Applicability of the Model:** Participants need more time and instruction to understand all the features and their nuances.

**User Interface and Graphical Representation:** 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.

**Impact Analysis and Clarity:** Lack of knowledge or insufficient indication in the tool of how parameters are related and influence each other.

To gather feedback on specific aspects of the tool that participants found confusing or difficult to comprehend they were asked: “Were there any challenges you encountered?”. (Fig. 3.64.). Responses are visualised in a graph based on their correspondence to a category and frequency.

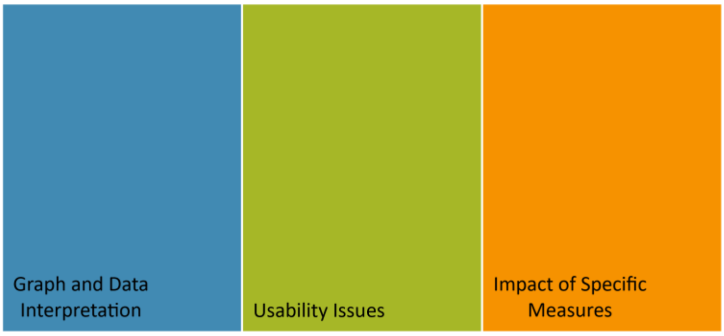



Fig. 3.64. Respondent answers on areas that may need improvement or clarification in terms of functionality

The main participant answers to the question are placed below:

- "It is difficult to compare the impact of the technologies used on the final result."
- "Growth of private electric cars (3) the growth of the number of electric public transport does not show the significant reduction of the use of diesel fuel, though in reality, public electric buses are replacing old diesel ones, which are used just occasionally (hired), but not used on a constant basis, and this can't be defined in the model."
- "Yes, e.g. problems with technical lifetime (I changed according to instructions, but it was not accepted) in the case of HAWT and PV."
- "I struggled to understand some graphs that did not show what units or categories they were displaying. It was also hard to interpret some graphs."
- "When clicking the reset button, I initially only wanted to reset the graphs to have a better overview (in the end I had like 90 graphs next to each other from simulating 90 times). But then all the data I typed in disappeared and I had to start from the beginning."
- "It is challenging to achieve 100% renewable energy in one of the sectors and in the whole county as a whole."

**Key takeaways**

**Graph and Data Interpretation:** The presentation of the graphs and their interpretability need to be improved.

**Usability Issues:** Participants managed to find some bugs, which were reported with a "report bugs" button, that the tool's developers will address.

**Impact of Specific Measures:** Lack of knowledge or insufficient indication in the tool of how parameters are related and influence each other.

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. 3.65.

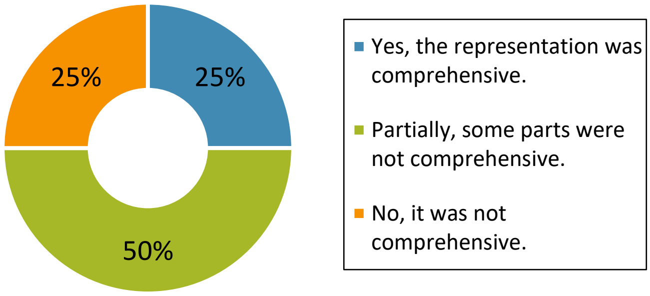



Fig. 3.65. Respondent answers on level of comprehensiveness of the tool

25% of respondents considered the tool's depiction to be thorough, while 50% believed that certain aspects of the tool were not comprehensive. However, one fourth of participants perceived it as not comprehensive. 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. 3.66.). Responses are visualised in a graph based on their correspondence to a category and frequency.

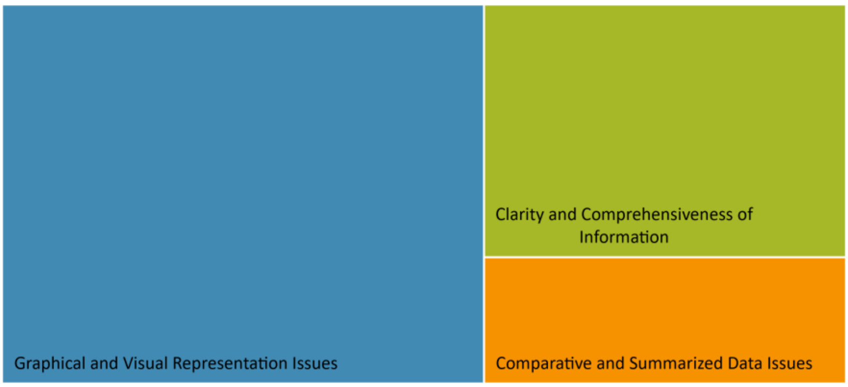



Fig. 3.66. Summary of the key responses on the information and results that lacked comprehensiveness.

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

- "Under 'production', it would also be good to define the difference between showing the 'sector' and showing the 'system'."
- "In Production page in simulation results for entire systems is unclear its results for all used technologies or just for one technology. For example, in emissions graph there are total emissions, but it would be interesting to know how much emissions are for each technology in one graph."
- "Some units were hidden by the 'reset' arrow which made it hard to see what data should be inputted."

- "It would be good to have value titles on the graphs, as in some cases they are confusing."
- "There are no clear results (these are summaries rather than simulations), including lack of tabular, how to compare it (lack of functionality to compare), and generally - talking about years after 2035 is a nonsense!"

**Key takeaways**

**Graphical and Visual Representation Issues:** Overall, the presentation of information was effective, but need to ensure that all axes include units, colour use specified.

**Clarity and Comprehensiveness of Information:** Simulations of results should provide additional information, explaining exactly what is shown and what data has been used.

**Comparative and Summarized Data Issues:** There should be a user-friendly solution for comparing the results for analysis.

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. 3.67.).

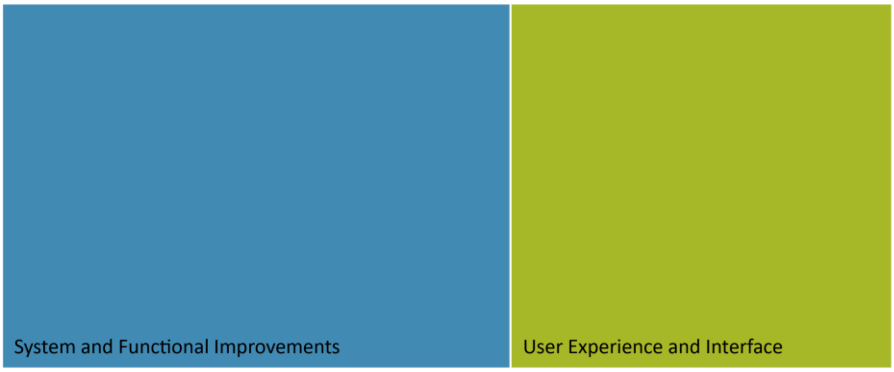



Fig. 3.67. Summary of the key responses on specific suggestions on the how the tool could be improved.

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

- "Sectors should constitute (one) system, not isolated systems."
- "Possibility to examine all combinations of (selected) energy sources, taking into account balancing and financial metrics (sorting solutions - a kind of quasi-optimization)."
- "Possibility to generate comprehensive calculation reports."
- "The tool should be more user-friendly and visual. How to enter data is more or less clear, but the display of the result is difficult to understand."
- I sometimes have a bit of a hard time understanding the connections the tool makes, and how the tool calculates the results. But this may also be because the connectivity of the different parameters itself is pretty complex. Maybe explanation could be implemented a bit more, to make it more user-friendly for people that haven't studied environmental research or technical studies or anything like that."

- "There are several graphs where transcripts do not appear in the legend (heat and electricity balance and emissions)."
- "I think the tool needs to specify more clearly how choosing a sector affects the results.”
- I would like the platform to have prompting questions, or maybe available examples. For example, on the first page of the platform, it asks you (for example... there are many cases you could explore) 1) What would happen to the renewable share if you built a new building? --> Try these steps and find out. And then it would lead you through the platform with small arrows that indicate where you can change input variables. And then the arrows would suggest which simulation results are interesting to look at."

<u>**Key takeaways**</u>

**System and Functional Improvements:** Improve functionality to allow the user to perform comparative analysis.

**User Experience and Interface:** The interface - data visualisation, simulations - needs to be improved. Addition of explanatory information should be considered.

# Appendices

## Appendix 1. Data input parameters for each municipality used for piloting task

### Gulbene municipality

| Indicator | Value |
|---|---|
| Initial share of renovated buildings, % | 52% |
| Total area of the buildings, m2 | 110107 |
| Other electricity consumption, MWh/yr | XX |
| Non-renovated building specific electricity consumption, kWh/m2/year | 26.5 |
| Non-Renovated building specific heat consumption, kWh/m2/year | 126.8 |
| Renovation electricity consumption decrease, % | 10% |
| Renovation heat consumption decrease, % | 25% |
| Financing distribution, % | 80% building subsidies<br>10% self-financing<br>10% loan fraction |
| Energy Efficiency and Renovation investment, EUR/m2 | 280 |
| Interest rate, % | 7 |
| Loan term, years | 15 |
| Information campaign strength, % | 10 |
| Expertise and Knowledge, % | 10 |
| Implementation and Technology, % | 10 |
| Psychological and Social Factors, % | 10 |
| Organizational and Leadership Support, % | 10 |
| Minimum Investment Payback Time, yr | 10 |
| Municipality population | 20 431 |
| People in the country | 1 934 379 |
| Discount rate, % | 7 |
| Electricity import tariff, EUR/MWh | 100 |
| Share of renewable energy in imported electricity, % | 53.5 |
| Imported electricity emission factor, tCO2/MWh | 0.182 |

| | Initially installed capacity, MW | Full-load production hours, hr/yr | Technical lifetime, yr |
|---|---|---|---|
| PV Utility Sun | 0.64 | 275 | 25 |
| HAWT Onshore Wind | 0.25 | 260 | 25 |

| | | | |
|---|---|---|---|
| CHP Biomass Wood Pellets | 4.4 | 6254 – electricity and heat | 25 |
| PowerPlant Hydro Water | 2.83 | 3329 | 50 |
| Boiler Biomass WoodChips | 15.6 | 2263 | 25 |

### Tukums municipality

| Indicator | Value |
|---|---|
| Initial share of renovated buildings, % | 34% |
| Total area of the buildings, m2 | 144095 |
| Non-renovated building specific electricity consumption, kWh/m2/year | 44.9 |
| Non-Renovated building specific heat consumption, kWh/m2/year | 147.6 |
| Renovation electricity consumption decrease, % | 10% |
| Renovation heat consumption decrease, % | 25% |
| Financing distribution, % | 80% building subsidies<br>10% self-financing<br>10% loan fraction |
| Energy Efficiency and Renovation investment, EUR/m2 | 280 |
| Interest rate, % | 7 |
| Loan term, years | 15 |
| Indicator | Value |
| Information campaign strength, % | 10 |
| Expertise and Knowledge, % | 10 |
| Implementation and Technology, % | 10 |
| Psychological and Social Factors, % | 10 |

| | |
|---|---|
| Organizational and Leadership Support, % | 10 |
| Minimum Investment Payback Time, yr | 10 |
| Discount rate, % | 7 |
| Electricity import tariff, EUR/MWh | 100 |

| | Initially installed capacity, MW | Full-load production hours, hr/yr | Technical lifetime, yr |
|---|---|---|---|
| PV Utility Sun | 4.28 | 266 | 25 |
| HAWT Onshore Wind | 0.005 | 95 | 25 |
| CHP Biomass Wood Pellets | 2.7 | 1157 – electricity and heat | 25 |
| PowerPlant Hydro Water | 0.69 | 1042 | 50 |
| Boiler Biomass WoodChips | 47.89 | 994 | 25 |
| Boiler Gas NaturalGas | 0.82 | 1068 | 25 |

### Taurage municipality

| Indicator | Value |
|---|---|
| Initial share of renovated buildings, % | 21% |
| Total area of the buildings, m2 | 691417 |
| Non-renovated building specific electricity consumption, kWh/m2/year | 5.5 |
| Non-Renovated building specific heat consumption, kWh/m2/year | 68.4 |
| Renovation electricity consumption decrease, % | 10% |
| Renovation heat consumption decrease, % | 25% |
| Financing distribution, % | 80% building subsidies<br>10% self-financing<br>10% loan fraction |
| Energy Efficiency and Renovation investment, EUR/m2 | 280 |

| | |
|---|---|
| Interest rate, % | 7 |
| Loan term, years | 15 |
| Information campaign strength, % | 10 |
| Expertise and Knowledge, % | 10 |
| Implementation and Technology, % | 10 |
| Psychological and Social Factors, % | 10 |
| Organizational and Leadership Support, % | 10 |
| Minimum Investment Payback Time, yr | 10 |
| Discount rate, % | 7 |
| Electricity import tariff, EUR/MWh | 100 |

| | Initially installed capacity, MW | Full-load production hours, hr/yr | Technical lifetime, yr |
|---|---|---|---|
| PV Utility Sun | 2.37 | 901 | 25 |
| HAWT Onshore Wind | 50.54 | 2113 | 25 |
| PowerPlant Hydro Water | 3 | 1673 | 50 |
| Boiler Biomass Wo-odPellets | 32.27 | 2345 | 25 |
| Boiler Gas Natural-Gas | 54.18 | 15 | 25 |

## Mikolajki Pomorskie municipality

| Indicator | Value |
|---|---|
| Initial share of renovated buildings, % | 100% |
| Total area of the buildings, m2 | 6077 |
| Non-renovated building specific electricity consumption, kWh/m2/year | 68 |
| Non-Renovated building specific heat consumption, kWh/m2/year | 145 |
| Renovation electricity consumption decrease, % | 10% |
| Renovation heat consumption decrease, % | 25% |
| Financing distribution, % | 80% building subsidies<br>10% self-financing<br>10% loan fraction |
| Energy Efficiency and Renovation investment, EUR/m2 | 280 |
| Interest rate, % | 7 |
| Loan term, years | 15 |
| Information campaign strength, % | 10 |
| Expertise and Knowledge, % | 10 |
| Implementation and Technology, % | 10 |
| Psychological and Social Factors, % | 10 |
| Organizational and Leadership Support, % | 10 |
| Minimum Investment Payback Time, yr | 10 |
| Discount rate, % | 7 |
| Electricity import tariff, EUR/MWh | 100 |

| | Initially installed capacity, MW | Full-load production hours, hr/yr | Technical lifetime, yr |
|---|---|---|---|
| PV Utility Sun | 7 | 257 | 25 |
| HAWT Onshore Wind | 38.1 | 3132 | 25 |
| CHP Extraction Coal | 7 | 3251 | 25 |

### Tomellila municipality

| Indicator | Value |
|---|---|
| Initial share of renovated buildings, % | 62.8 |
| Total area of the buildings, m2 | 45831 |
| Non-renovated building specific electricity consumption, kWh/m2/year | 62.2 |
| Non-Renovated building specific heat consumption, kWh/m2/year | 128 |
| Renovation electricity consumption decrease, % | 10% |
| Renovation heat consumption decrease, % | 25% |
| Financing distribution, % | 80% building subsidies<br>10% self-financing<br>10% loan fraction |
| Energy Efficiency and Renovation investment, EUR/m2 | 280 |
| Interest rate, % | 7 |
| Loan term, years | 15 |
| Information campaign strength, % | 10 |
| Expertise and Knowledge, % | 10 |
| Implementation and Technology, % | 10 |
| Psychological and Social Factors, % | 10 |
| Organizational and Leadership Support, % | 10 |
| Minimum Investment Payback Time, yr | 10 |
| Discount rate, % | 7 |
| Electricity import tariff, EUR/MWh | 100 |

| | Initially installed capacity, MW | Full-load production hours, hr/yr | Technical lifetime, yr |
|---|---|---|---|
| PV Utility Sun | 7 | 711 | 25 |
| HAWT Onshore Wind | 29 | 1721 | 25 |
| Boiler Biomass Wood Chips | 9 | 4756 | 25 |

### Wejherovo municipality

| Indicator | Value |
|---|---|
| Initial share of renovated buildings, % | 67 |
| Total area of the buildings, m2 | 51963 |
| Non-renovated building specific electricity consumption, kWh/m2/year | 126 |
| Non-Renovated building specific heat consumption, kWh/m2/year | 120 |
| Renovation electricity consumption decrease, % | 10% |
| Renovation heat consumption decrease, % | 25% |
| Financing distribution, % | 80% building subsidies<br>10% self-financing<br>10% loan fraction |
| Energy Efficiency and Renovation investment, EUR/m2 | 280 |
| Interest rate, % | 7 |
| Loan term, years | 15 |
| Information campaign strength, % | 10 |
| Expertise and Knowledge, % | 10 |
| Implementation and Technology, % | 10 |
| Psychological and Social Factors, % | 10 |
| Organizational and Leadership Support, % | 10 |
| Minimum Investment Payback Time, yr | 10 |

| | |
|---|---|
| Discount rate, % | 7 |
| Electricity import tariff, EUR/MWh | 100 |

| | Initially installed capacity, MW | Full-load production hours, hr/yr | Technical lifetime, yr |
|---|---|---|---|
| PowerPlant Condensing NaturalGas | 6.5 | 3594 | 25 |
| CHP Extraction Coal | 42.9 | 1968 – heat and electricity | 25 |