BIO4EEB Platform

How to make Multi Criteria Analysis

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Make Multi Criteria Analysis in BIO4EEB platform

In this report you will find instructions on how a user can make Multi Criteria Analysis (MCA) on the BIO4EEB platform.

1. From the **Homepage** the user can **navigate** to the '**Multi Criteria Analysis**' dedicated page from the top menu as shown in Figure 1 below.

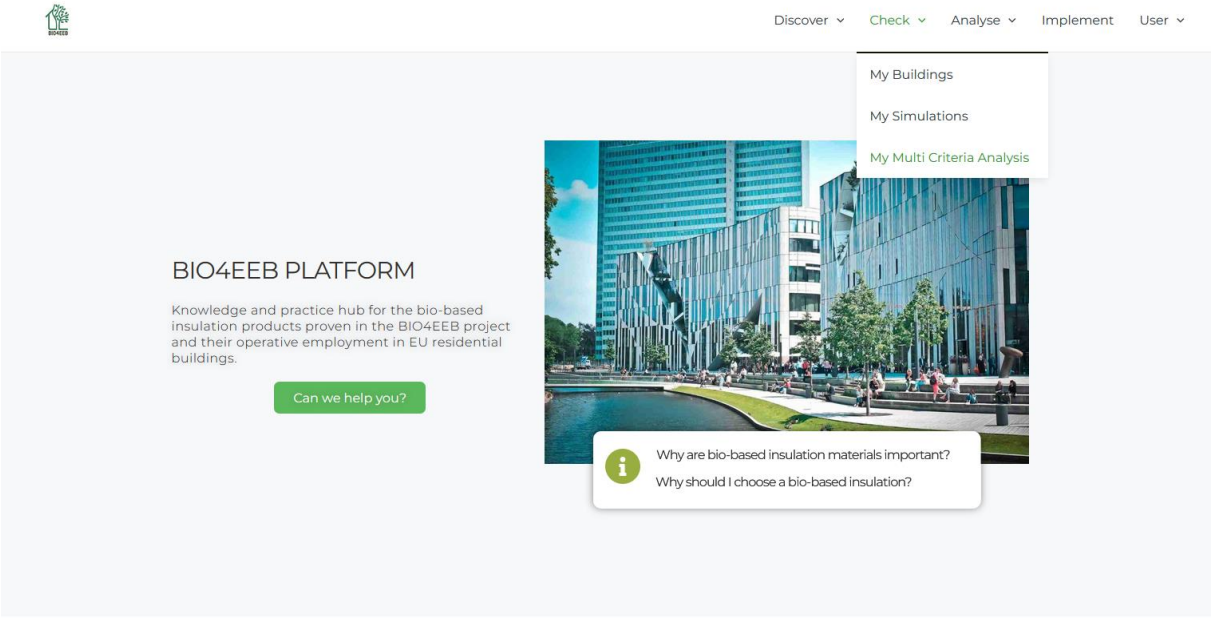

Figure 1: Navigation to the MCA page from the homepage.

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2. **List of MCA page**. In figure 2, the user can see 3 sections. The top left sections show a table with the buildings related to the listed MCA in the bottom. On the top right a table with quick links helps the user navigate through the platform faster.

   On the bottom the user sees a List of MCA that has been created by the user or by other users if the access were to be public.

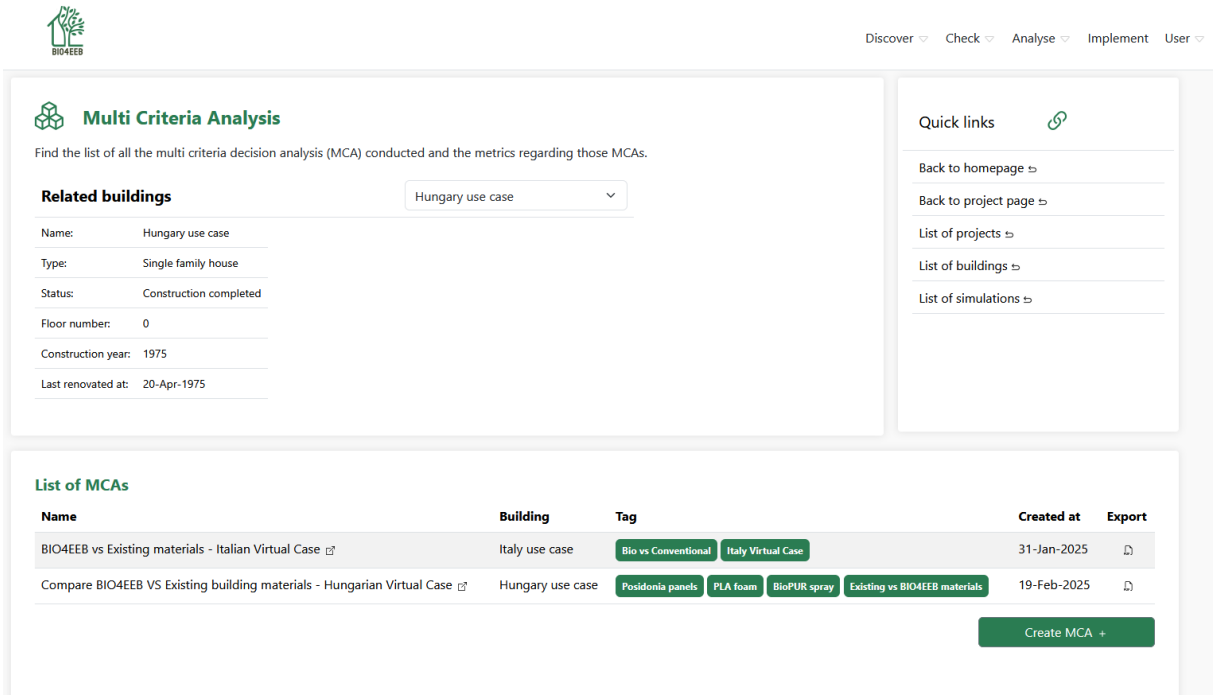

Figure 2: List of MCA and export functionality.

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3. **Create a new MCA**. In figure 3, you can see the page shown when the user creates an MCA. The page starts with an explanation block which can be hidden by the user by clicking on the switch 'hide main block' on the right-side bar.

   Below the explanation block the first block of input form is shown. Each block can be toggled from the top right-side bar where all steps are listed and clickable. Below these steps on the right-sidebar you can see a table 'Status'. This table changes throughout the process depending on the input data of the user. If a block of inputs is complete the status will change accordingly.

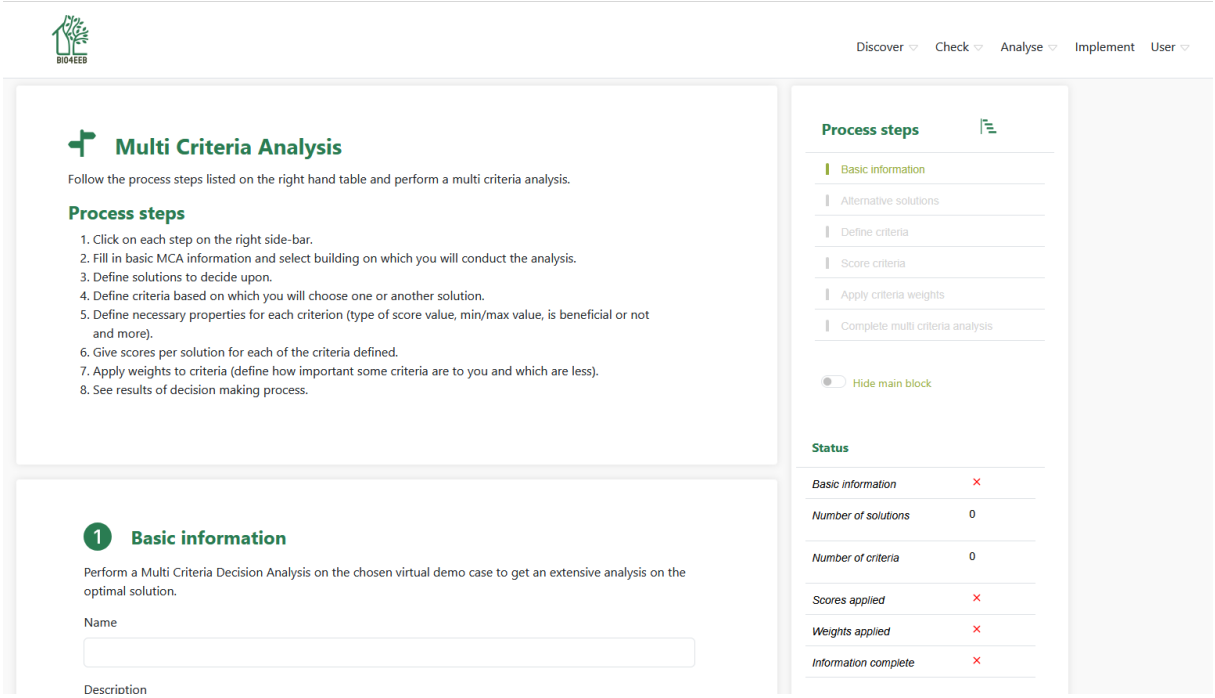

Figure 3: Create MCA entrance page with explanation block.

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4. **Create MCA– Basic information block**. In this block the user needs to give some basic information to the created MCA.

   The user should give a name which describes the purpose of the MCA shortly. Give a description for more information when you seek the results again. Tags can help the user filter the MCA in the table. They are optional but can help in identifying the correct MCA if there is a lot being done. Lastly, the user needs to select one of the 3 Virtual buildings.

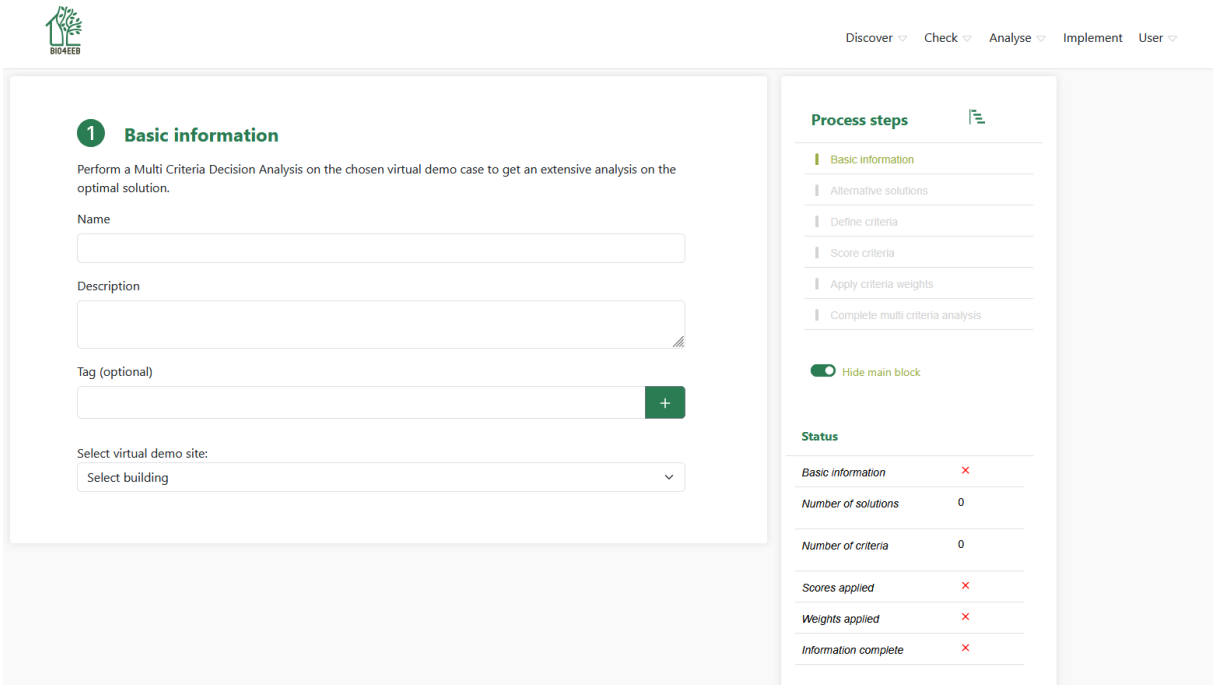

Figure 4: Create MCA – basic information block.

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5. Figure 5 shows an **example** of the filled **Basic information block**. The MCA is about comparing the existing situation of the Belgian virtual case with renovated building using BIO4EEB mix materials. You can see that the status table has been changed. A check symbol has appeared next to the respective step.

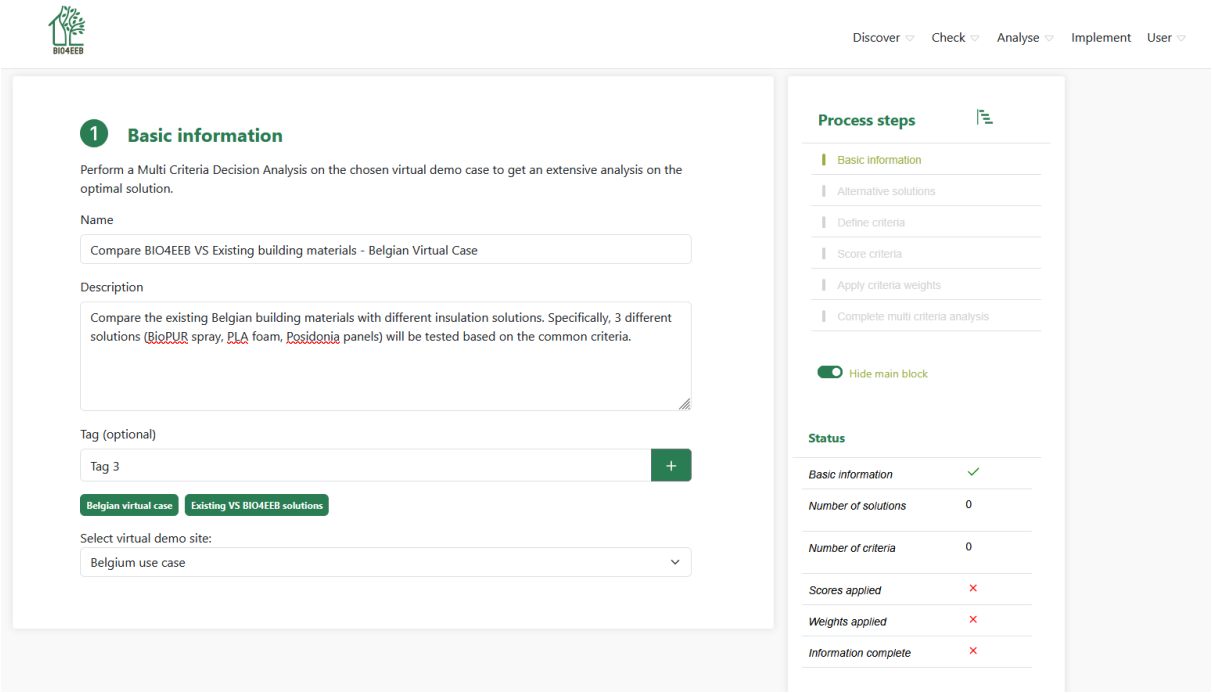

Figure 5: Example data filled in the basic information block.

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6. The second block of information needed for the MCA is defining the **alternative solutions** to be compared with. The minimum number of solutions to be defined is 2. Only then will the user be able to complete the MCA analysis.

   To define an alternative solution the user needs to give a name, a description and give the solution configuration of the building. The latter describes the solutions that will be used for the insulation of the Walls, Floors, Roof and windows. In this way we define an alternative solution.

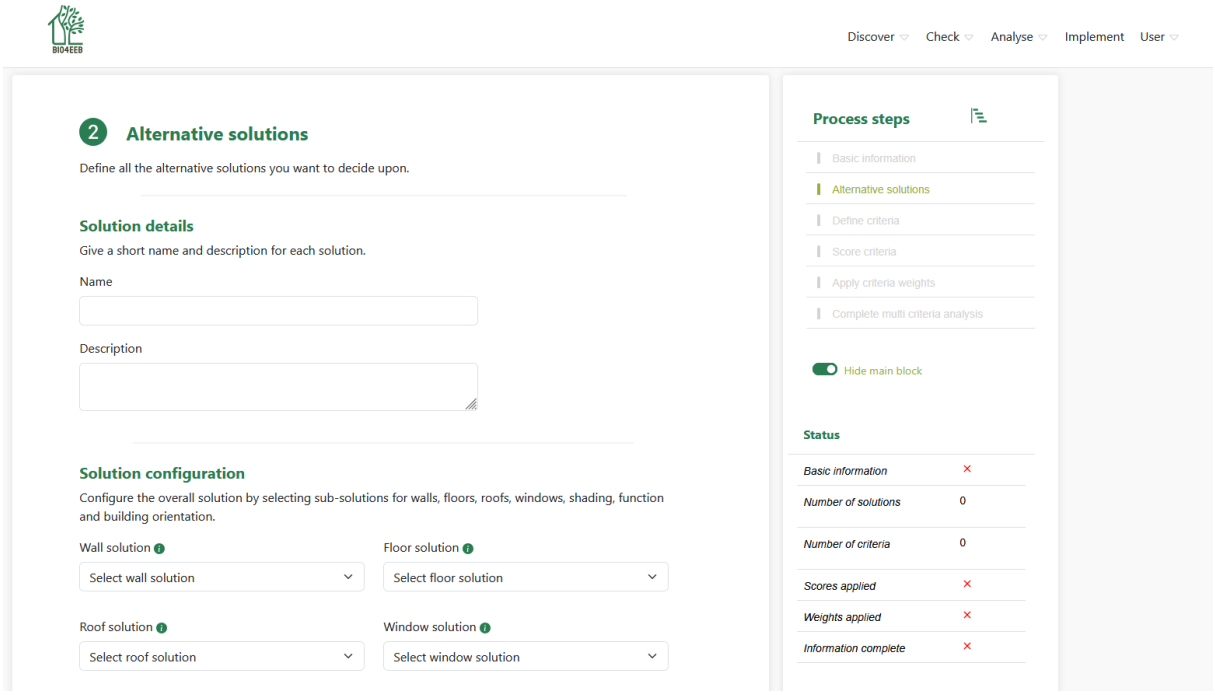

Figure 6: Alternative solutions input block.

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7. Figure 7 shows an **example of defining a solution**. In this case the solution describes the existing Wall, Floor, Roof and Window situation of the Belgian virtual case. In addition to completing the solution definition the user must add properties such as Shading, Orientation and occupant behavior type. When filled out the user can click on the 'Add solution' button. The solution record will be shown in a table below.

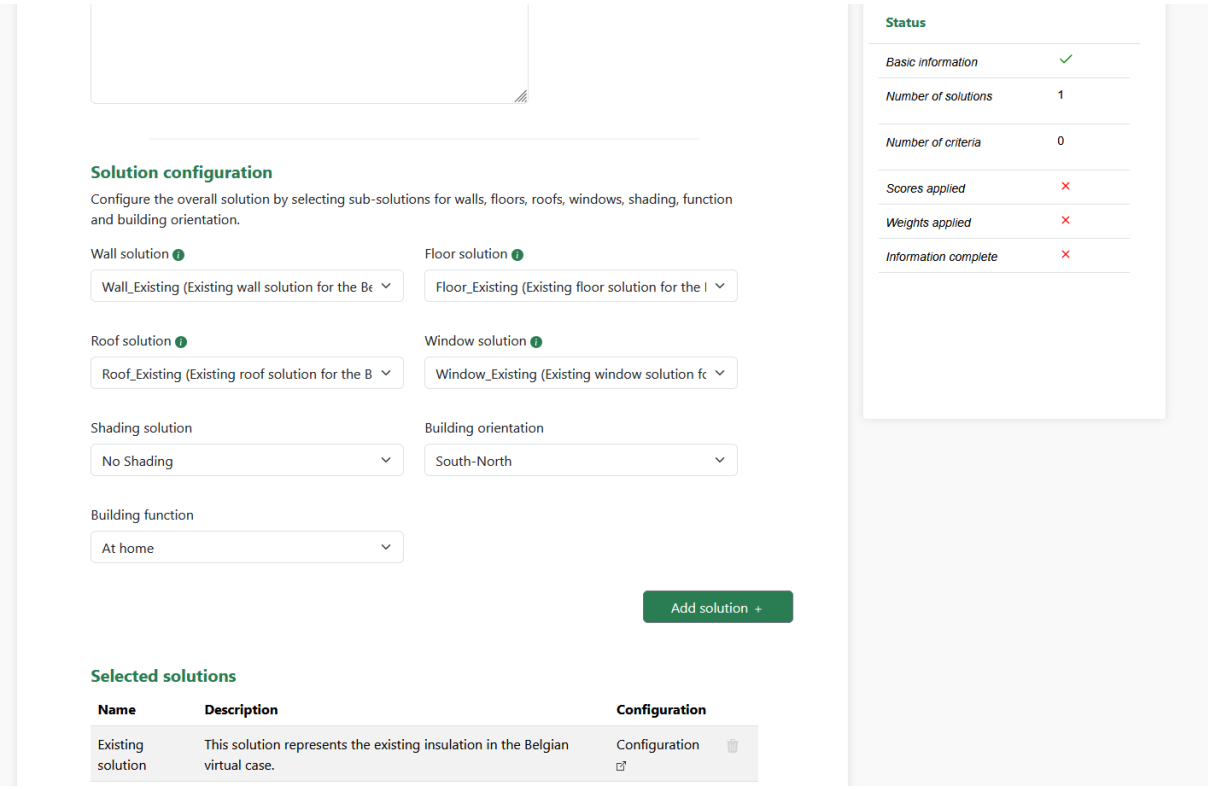

Figure 7: Insulation solutions example to be simulated

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8. Figure 8 shows an example of the 2nd solution to be compared with the Existing Belgian case. As you can see, for the Walls Posidonia Panels are used, for the floors the PLA foam and for the roof the BioPUR spray is used. For the window the KLIMA-PUR low emissive glass is used.

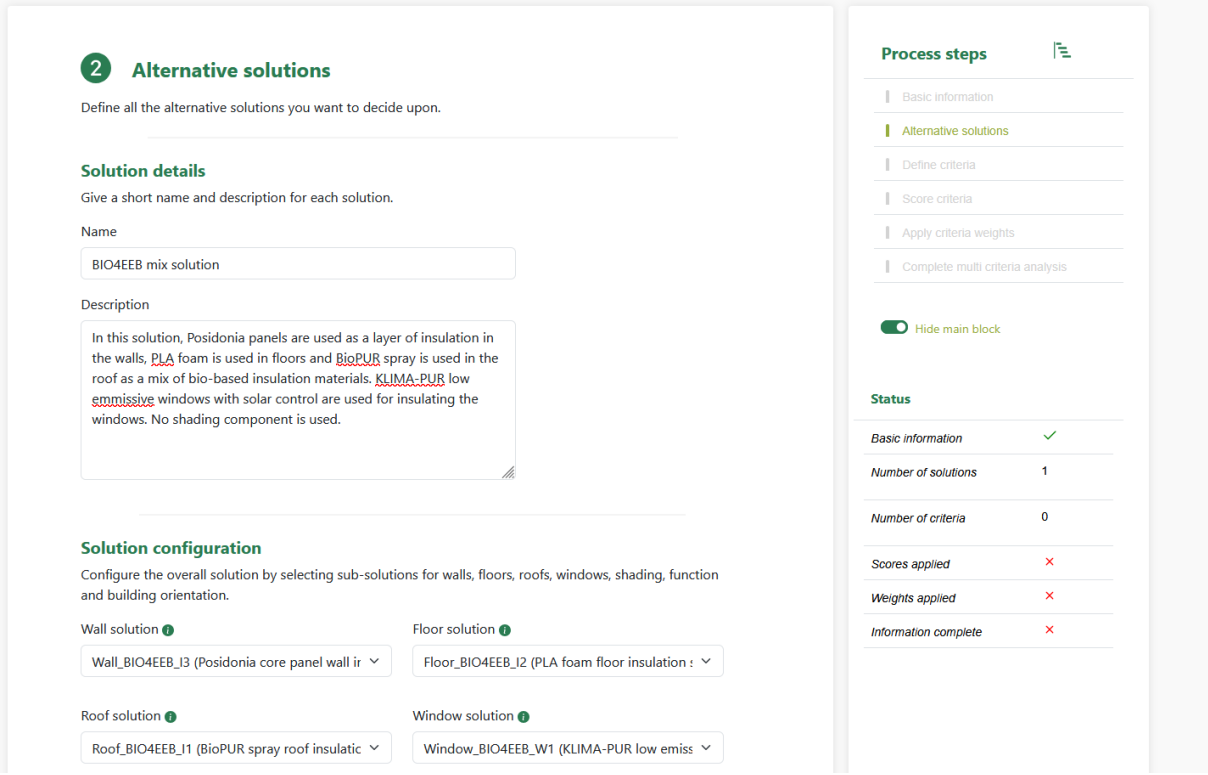

Figure 8: Example data for defining the second alternative solution.

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9. The user can click on the solution table configuration column to check again what data was filled for the respective solution. The window pops up as shown in Figure 9.

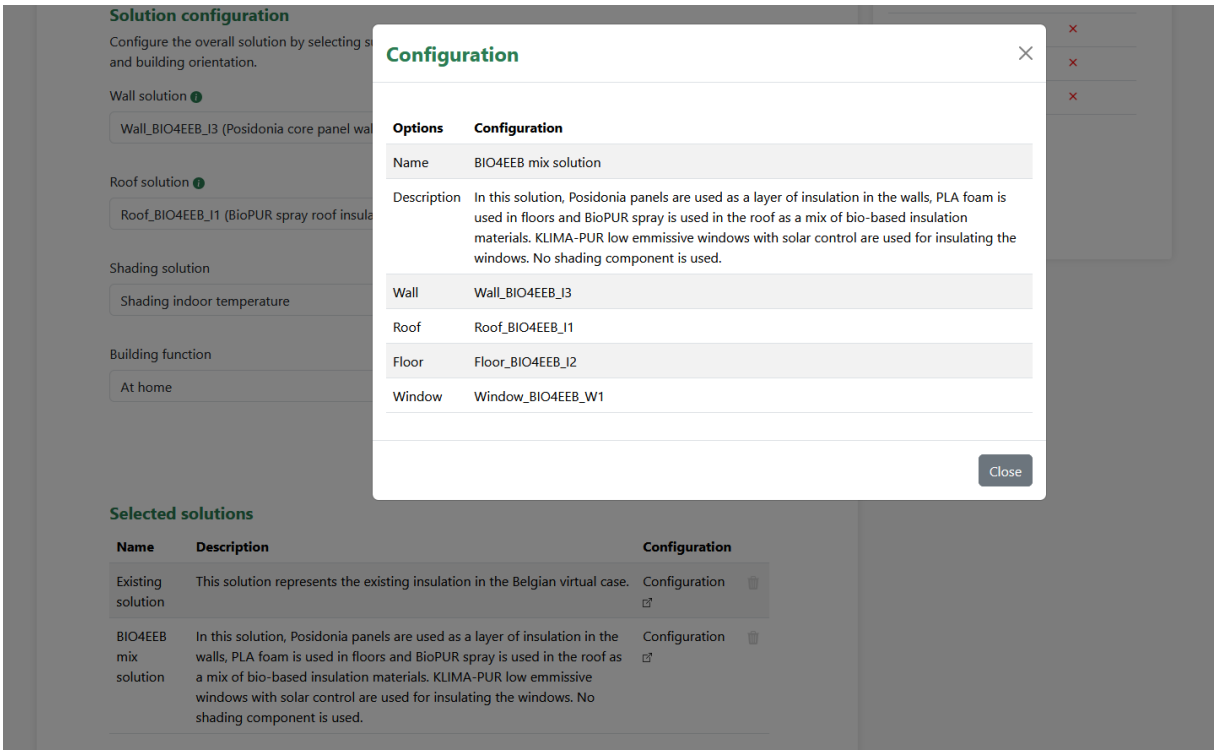

Figure 9: Popup window with the configuration of the respective solution.

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10. The third step is defining the **criteria** for which we choose the best alternative solution. The user has 2 options at this stage. One is selecting the most common criteria (defined by the consortium) which will make the process much easier and faster. The other option is defining all the criteria manually by filling in the input form and adding as many criteria as desired.

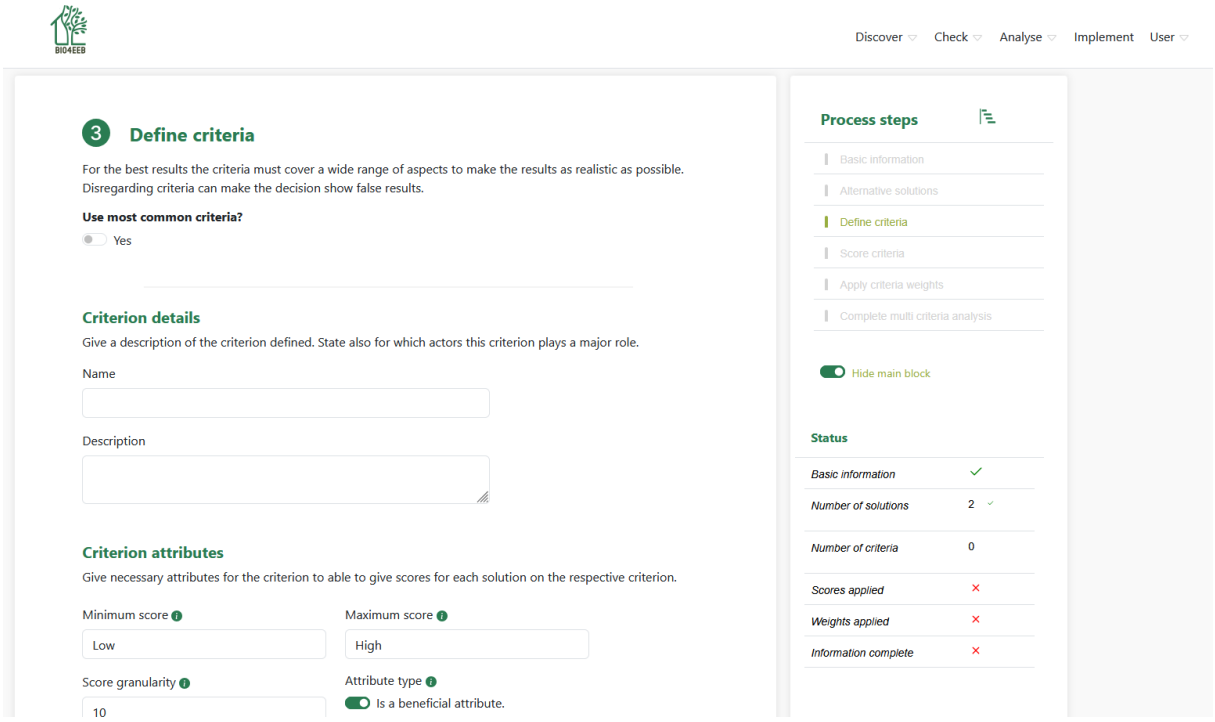

Figure 10: Defining criteria step.

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11. In this example we choose the most **common criteria** for simplicity reasons. These are Costs, Aesthetic appeal, Energy demand and occupant comfort. 2 of them are beneficial (Aesthetic appeal and Comfort) and 2 are non-beneficial (Costs and Energy demand). Beneficial criteria are the ones for which a high score is beneficial while a low score is not a good indicator. On the other hand, non-beneficial criteria are the ones for which a high score is NOT beneficial. So, a high score means a lower score in the decision-making process for that specific solution.

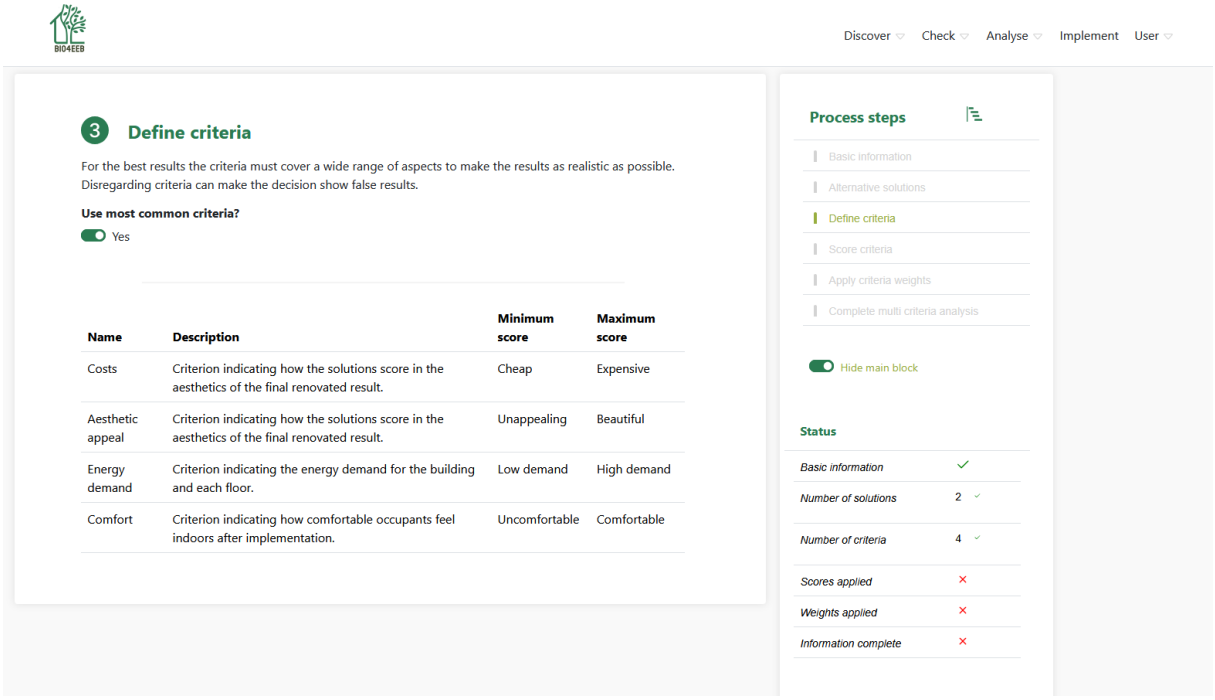

Figure 11: Most common criteria.

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12. The next step is to give **scores** to each criterion for each of the solutions defined. Figure 12 shows the scores given for the 2 solutions defined previously.

    As seen for the existing solution of the Belgian Virtual case we give high costs, low aesthetic appeal, high energy demand and low comfort. So, in general low scores for all criteria. For the renovation solution we will give lower costs, higher aesthetic appeal, low energy demand and high comfort.

    Imagine this scenario with more alternative solutions and more criteria. Then the process of decision making will become more complex and thus the tool will be more useful. In this example it's easy to see which solution is better but for simplicity and explanation purposes we reduce the number of solutions and criteria.

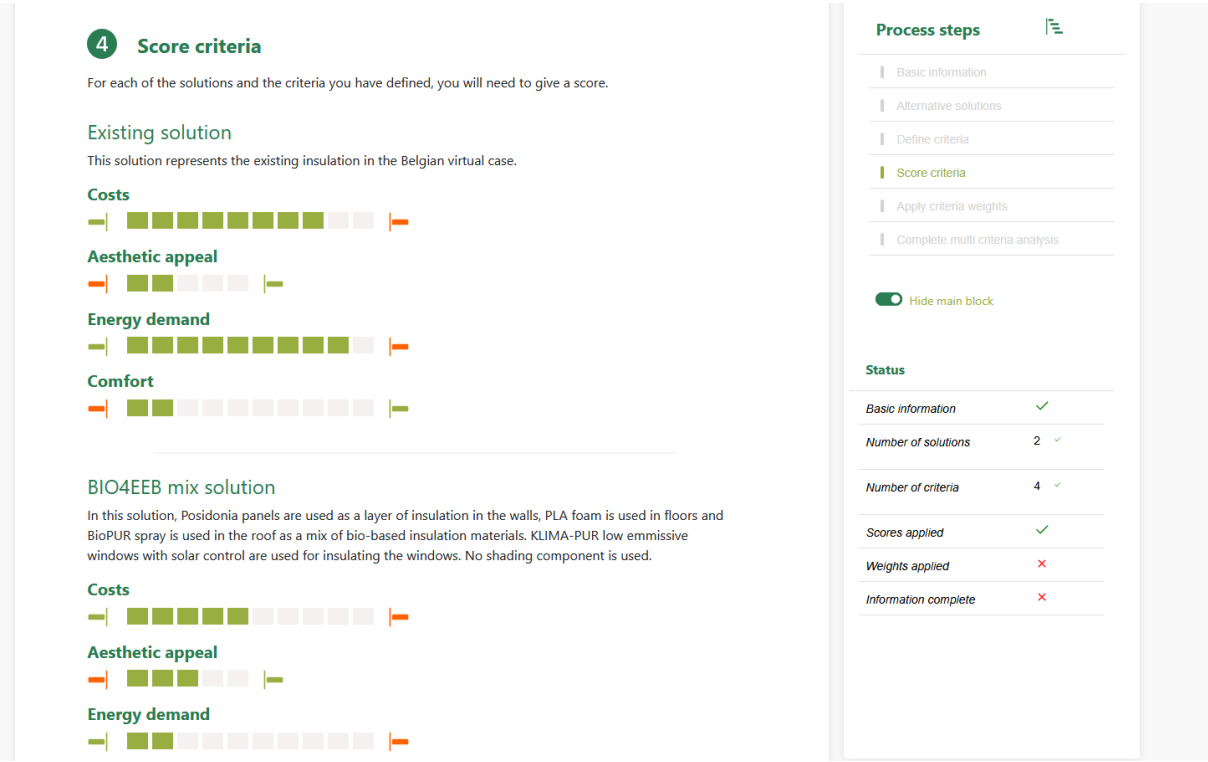

Figure 12: Scoring the criteria for each solution defined.

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13. The next step is to define the **weights for each criterion**. The methodology used for the MCA is the weighted sum methodology. Therefore, the user needs to give weight to each criterion in a percentage. Figure 13 shows the percentages given for each of the criteria defined in the previous steps.

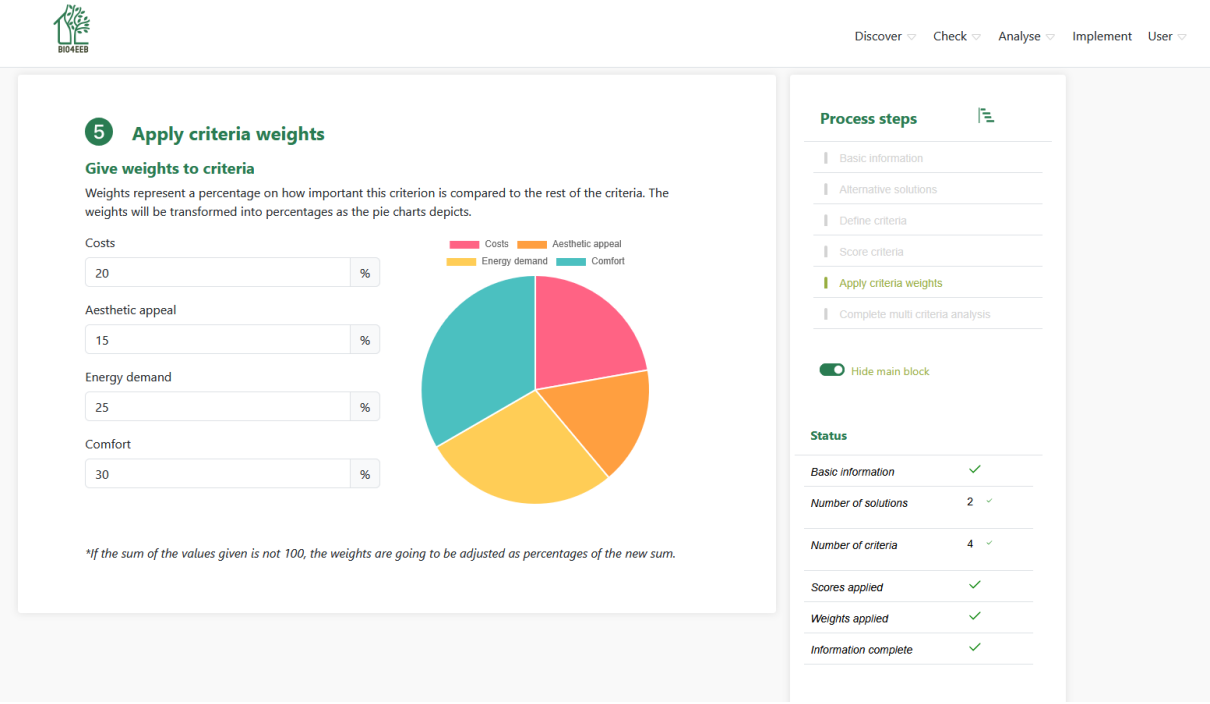

Figure 13: Giving weights to each of the criteria defined previously.

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14. The final step just shows all the input given by the user in a **summary table**. No input is required in this step. You can see that the status table on the right-hand side is filled with checks for each step. Only if all data is filled, the 'Run MCA' button is activated.

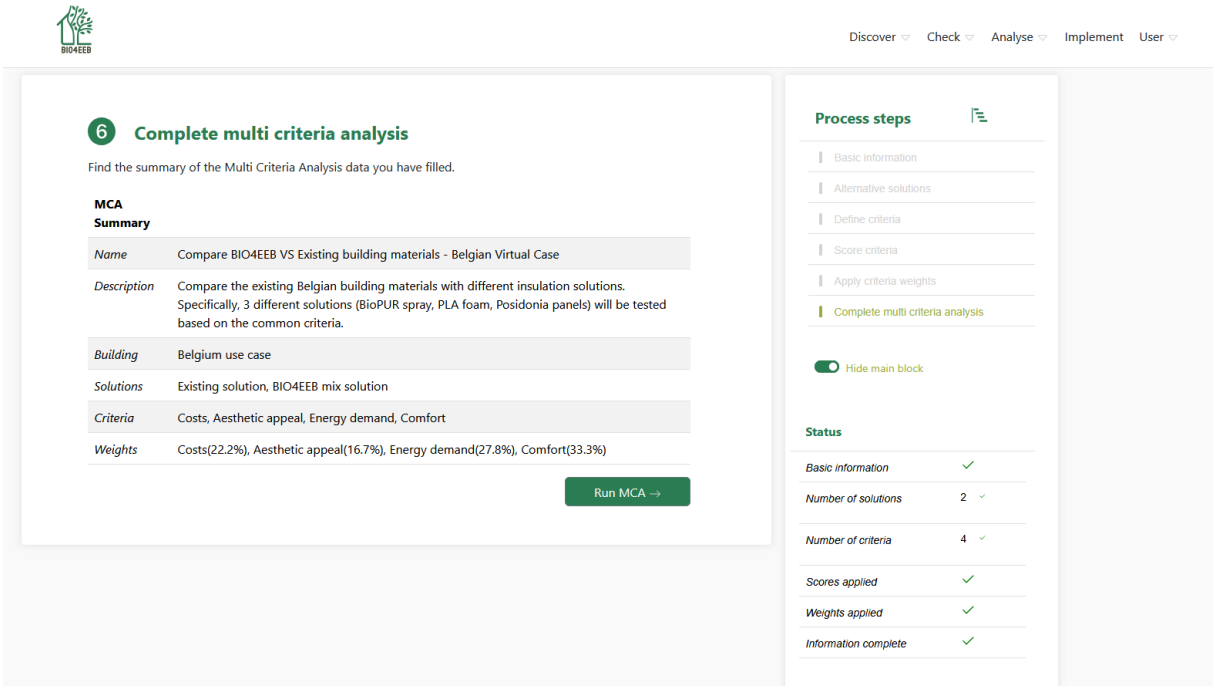

Figure 14: MCA summary table and 'Run MCA' button.

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15. After running the MCA, the user can check the results. The **results page** when opened shows 2 tables on the left (top one shows general information about the building and bottom one has quick links for navigation purposes).

    On the right-hand side, the 2 alternative solutions are shown in 2 different tabs (in this case the solutions are 2 but there can be more). Clicking on these tabs, the user can see the building configuration that has been chosen as a solution. Figure 15 shows the first solution we defined above which represents the existing materials in the Belgian virtual case.

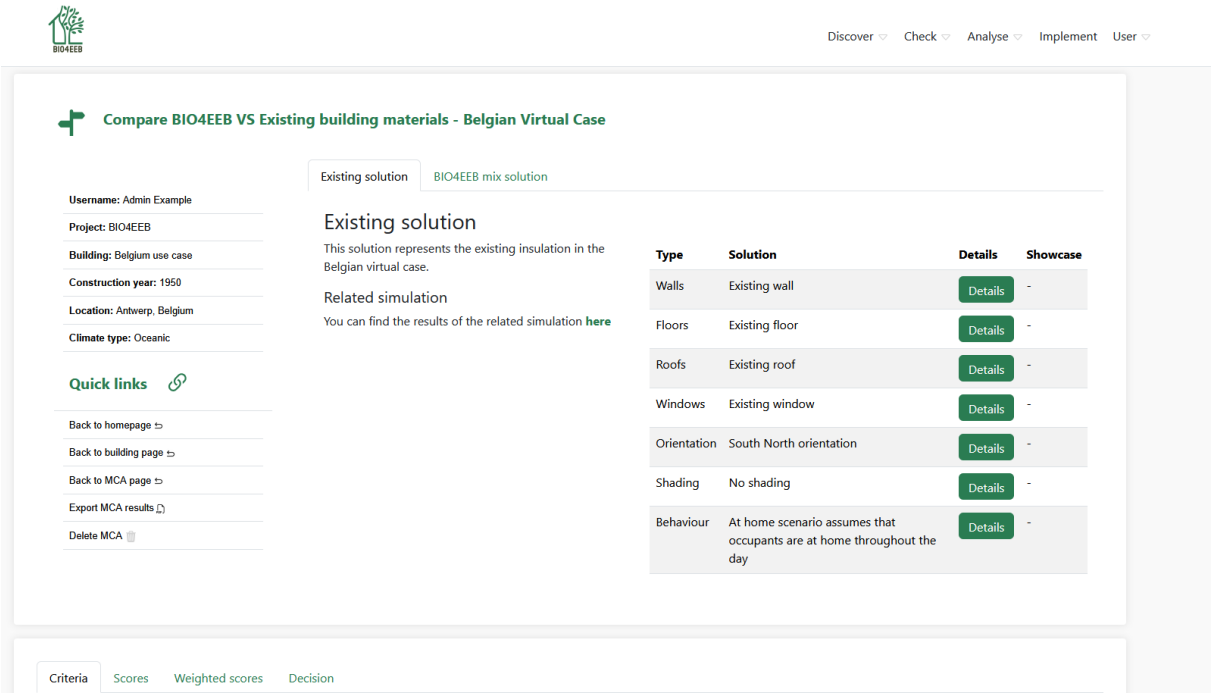

Figure 15: MCA results page. Tabs representing the defined solutions.

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16. Figure 16 depicts the second solution we have defined when creating the MCA. This solution represents the BIO4EEB materials for the Walls (Posidonia panels), Floors (PLA Foam), Roof (BioPUR spray) and windows (KLIMA PUR low emissive glass).

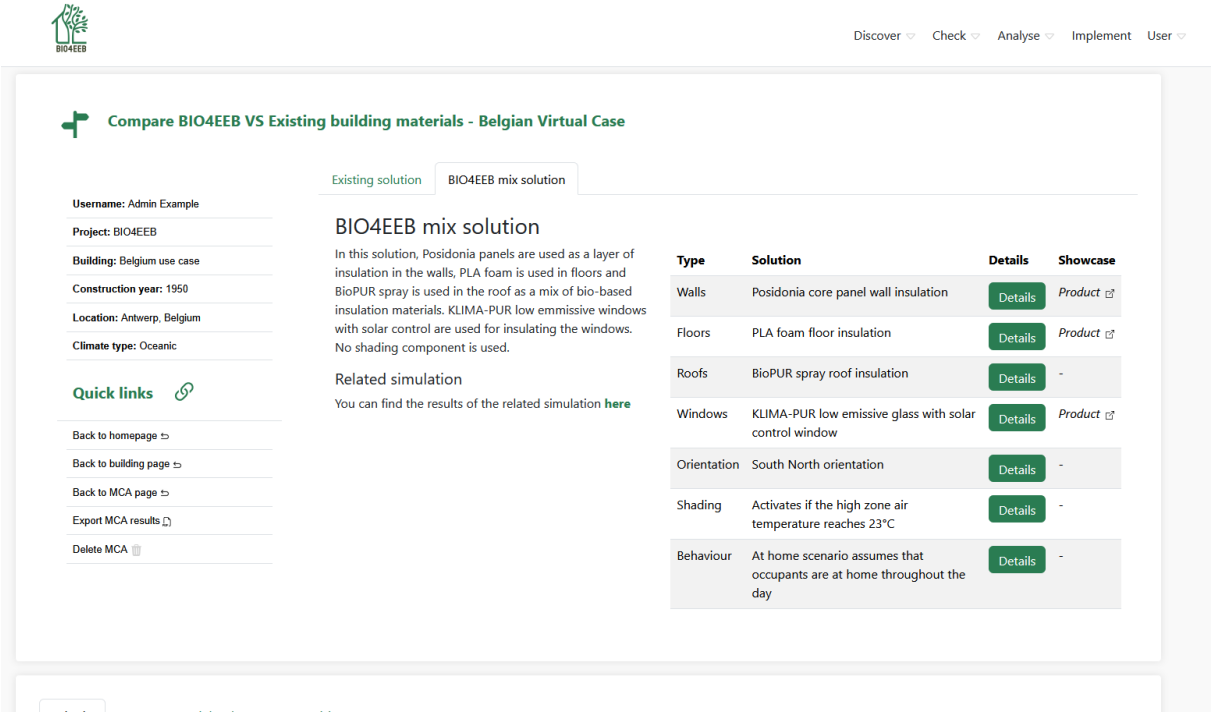

Figure 16: MCA results page. The second solution defined.

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17. Scrolling down the user sees 4 tabs. The first tab shows the **distribution of weights** defined in the creation (as shown in Figure 17) and below that all the scores per criterion are shown.

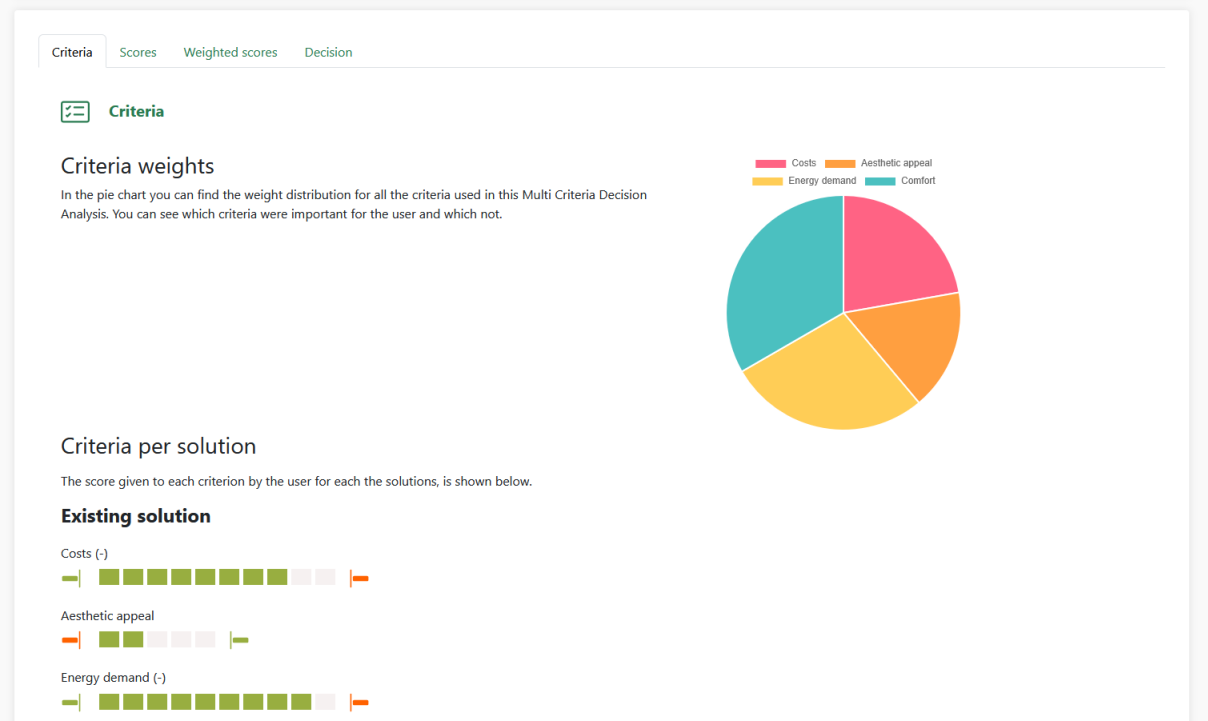

Figure 17: Weight distribution and scores per criterion per solution.

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18. Figure 18 depicts the rest of the **scores** given by the user during the creation of the MCA.

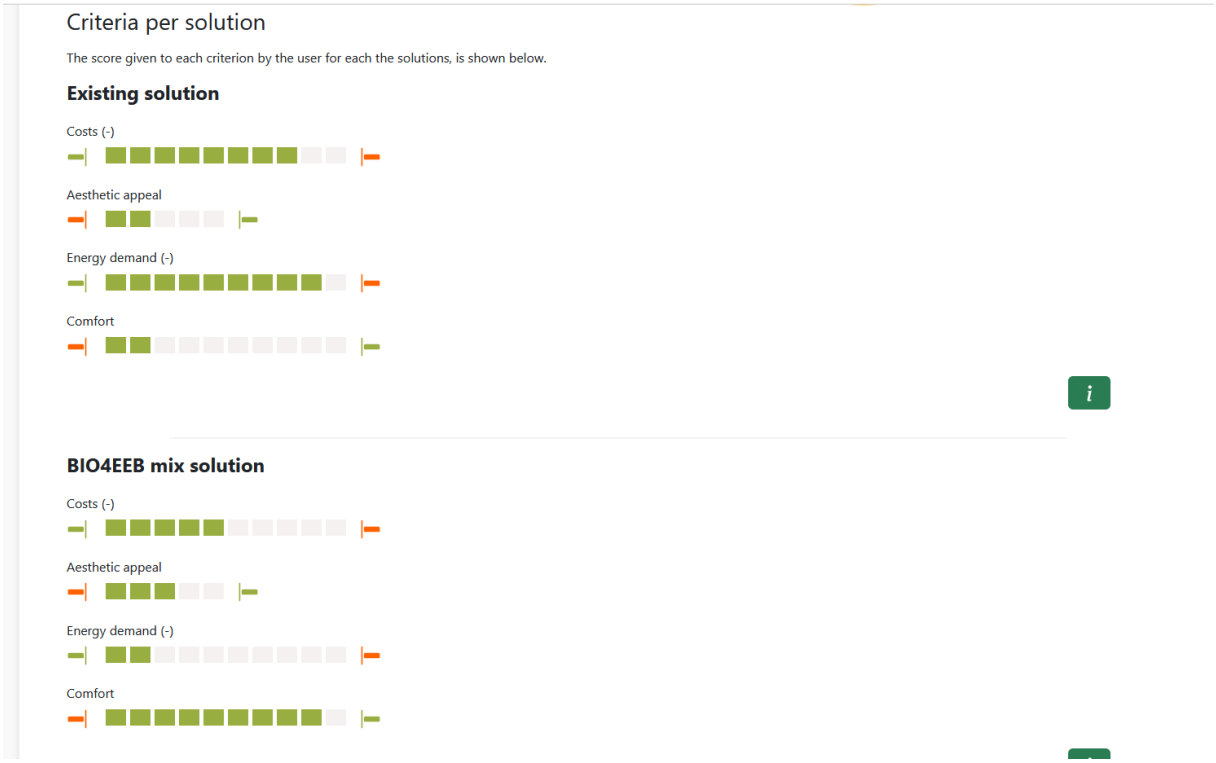

Figure 18: Scores per criterion and per solution.

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19. The user can press the information button on the bottom right if more information is required regarding the criteria used in the MCA.

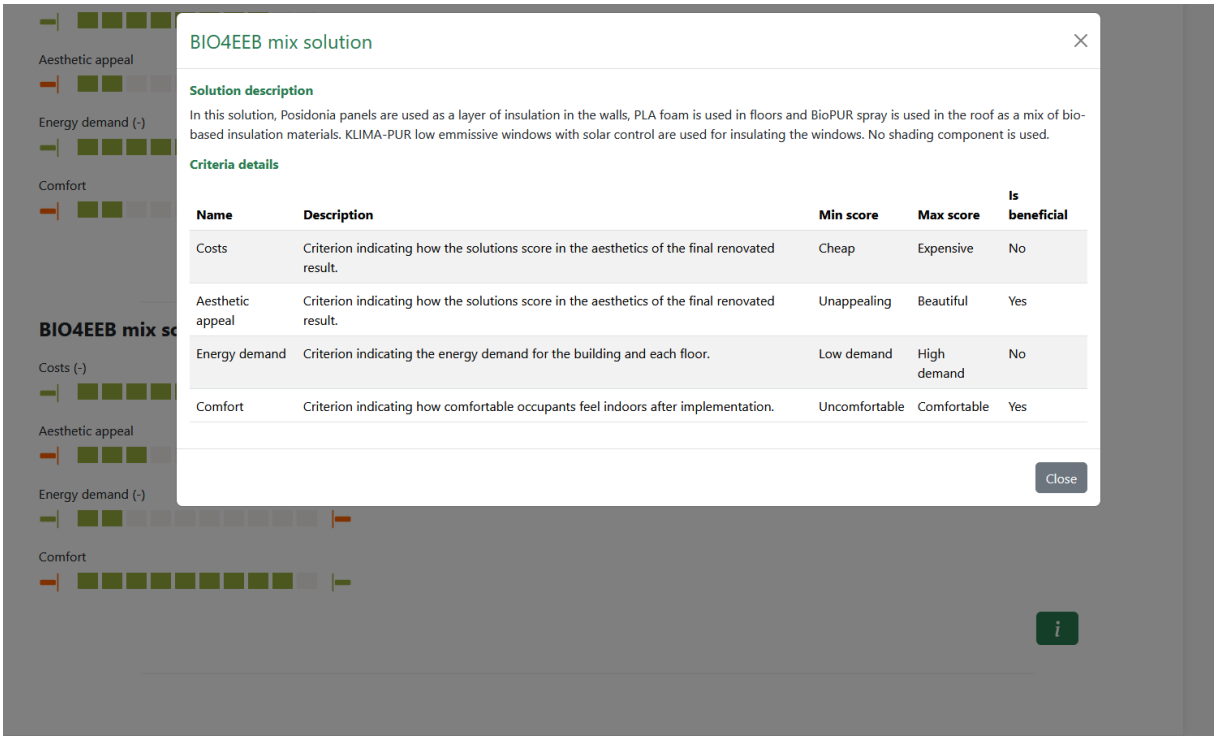

Figure 19: Information popup regarding the criteria used in the MCA.

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20. The next tab of the final **MCA results** shows the intermediate steps done by the **weighted sum methodology** to come to the final decision.

    Specifically, 2 tables are shown. The first organizes the criteria in the first column and the criteria in the rest of the columns. In the cells you can see the scores given. In the second table you can see the **normalized scores**. Depending on the criteria the normalized score is calculated differently. This depends on the fact that one criterion is beneficial and the other not. The idea here is to normalize the data to make the data for each criterion comparable to each other. If not done it would be impossible to compare criteria accepting very high scores compared to another criterion.

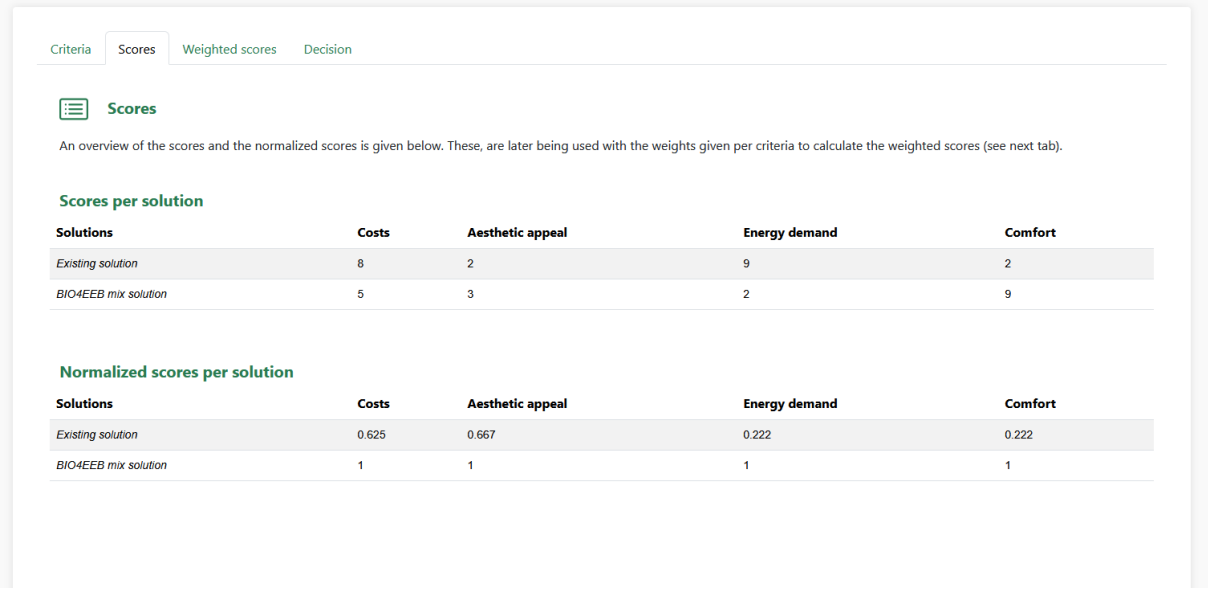

Figure 20: Normalization of scores.

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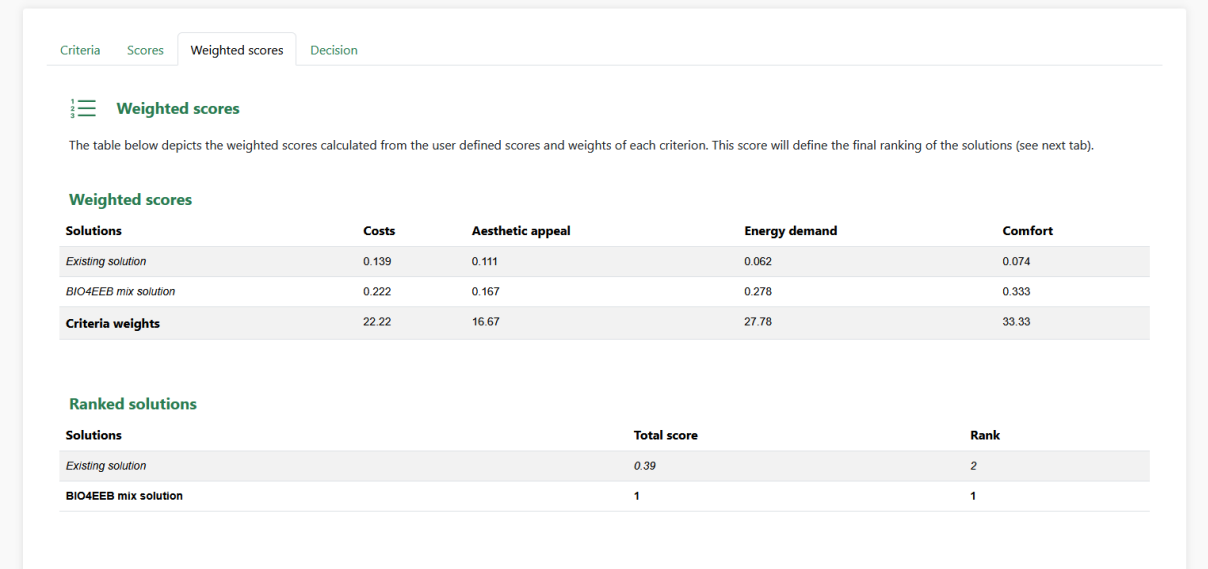
21. In figure 21, we also consider the weights given. In the top table you can see the criteria weights in the bottom row of the table in a percentage. For each criterion we multiplied the percentage of the weight with each normalized value.



Criteria | Scores | Weighted scores | Decision

Weighted scores

The table below depicts the weighted scores calculated from the user defined scores and weights of each criterion. This score will define the final ranking of the solutions (see next tab).

Weighted scores

Solutions	Costs	Aesthetic appeal	Energy demand	Comfort
Existing solution	0.139	0.111	0.062	0.074
BIO4EEB mix solution	0.222	0.167	0.278	0.333
Criteria weights	22.22	16.67	27.78	33.33

Ranked solutions

Solutions	Total score	Rank
Existing solution	*0.39*	*2*
BIO4EEB mix solution	**1**	**1**

Figure 21: Calculating weighted normalized scores.

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22. The final tab shows the **'Decision'** results of the MCA. On the left-hand side we see a table with the **total performance score** calculated from the MCA methodology. We can see in this example that the BIO4EEB solution performs better than the existing solution. Imagine this process with multiple solutions (5) and more criteria. Then the MCA will create more complex and valuable decisions.

    On the right-hand side we see a **radar chart** showing in a different way what scores were given by the user to each criterion for each solution. The color indicates the solution, and the shape indicates the scores. This is only useful to get a clearer picture of why one solution performed better than the other.

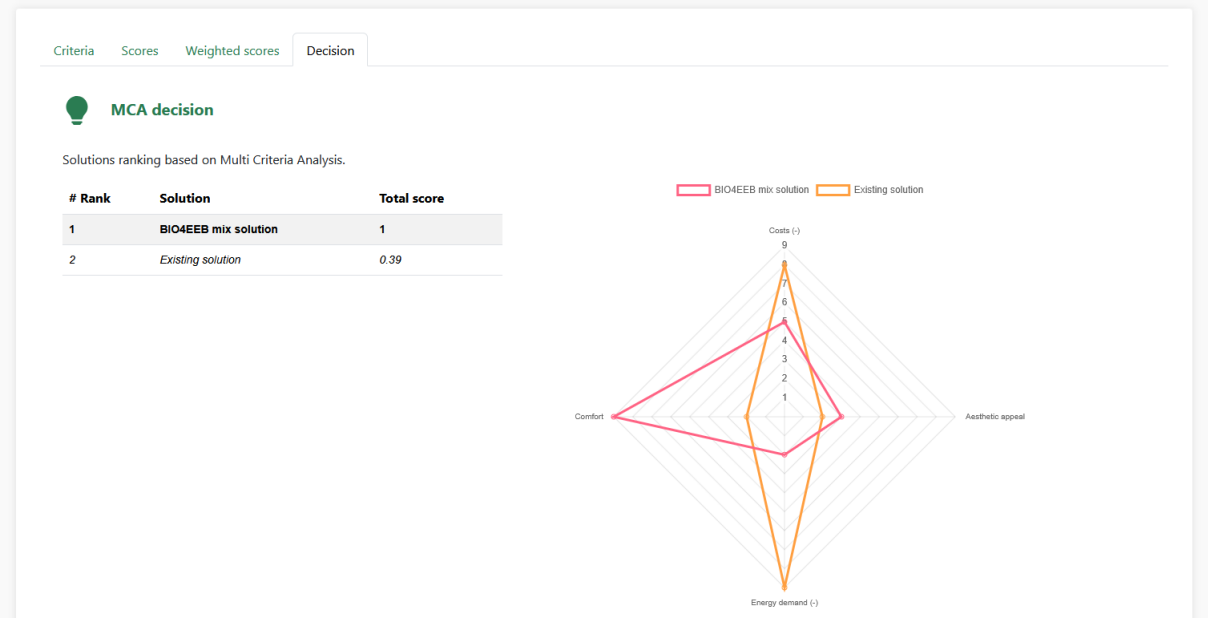

Figure 22: Decision results. Final performance score and radar chart.

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23. Below the radar chart there is one more bubble chart which shows the score in y-Axis and the criteria in the x-Axis. The bubbles show the score given for each solution (separated by color) and the size of the bubble indicates also the weight given by the user.

    This is also a helpful way to show the user why one solution may have scored better than the other. In both charts each solution can be toggled away and back in. This is to make the charts more readable in case there are too many solutions being compared.

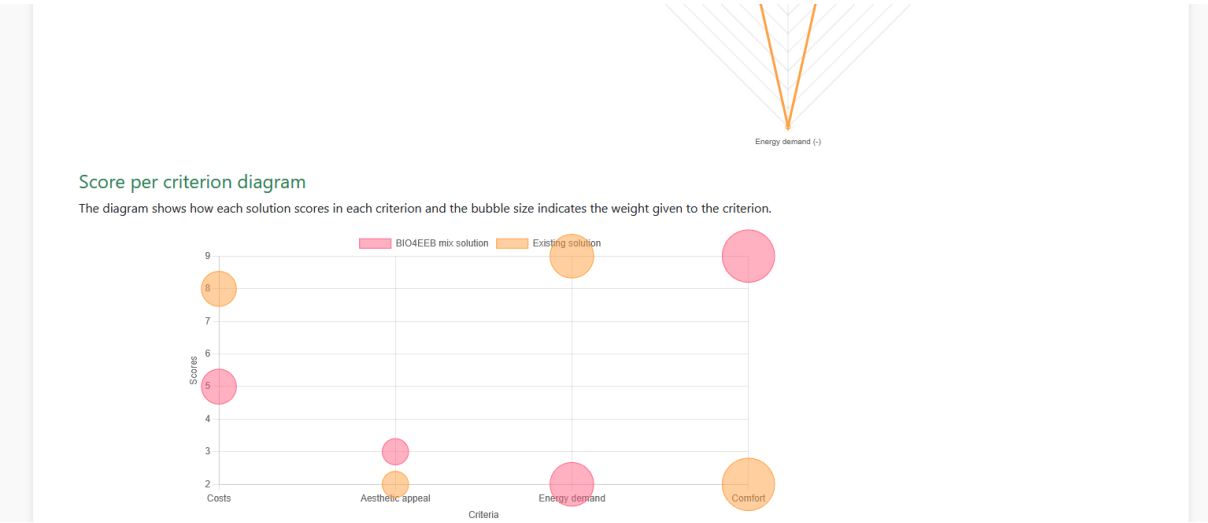

Figure 23: MCA results - Bubble chart.

In conclusion, the MCA is a tool to help the user find which solution is performing the best. The user is responsible for interpreting the results and deciding which solution is the optimal.

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