



● Support Energy Efficiency Deployment with the  
Multiple Impacts Calculation Tool

# D2.2 – Report on improvements to the MICATool

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## EXECUTIVE SUMMARY

This deliverable documents the conceptual, methodological, and technical enhancements implemented in the MICATool under the SEED MICAT project to improve accuracy, transparency, performance, and usability. Guided by continuous feedback from users and consortium partners, the tool now offers clearer workflows, stronger data foundations, and new analytical capabilities that better support decision-making and the Energy Efficiency First Principle.

Usability and results communication have been substantially improved. The interface now includes concise, context-aware info buttons and warnings, harmonised terminology, and enriched result descriptions with assumptions, sources, and caveats. A save/import function was implemented to preserve full configurations and enable reproducibility and team collaboration. In addition, user can now export the results in a structured Excel file, covering inputs and all result sections. Visualisation was redesigned with clearer bar charts, including interactive controls. Users can now compare multiple programmes side by side and assign a starting year per programme to align impacts over time and improve the accuracy of some indicators. The integration of global and advanced parameters and their modification by tool users has been streamlined and slightly simplified. A newly introduced option for a percentage-based allocation of total savings across improvement actions now supports different use-cases and improves the usability of the tool. The CBA was simplified to a single weighted value with sensitivity sliders, and work is underway to transition from NPV to Annuity to avoid horizon–lifetime inconsistencies.

The interplay of front and back end was simplified by removing the ex-post/ex-ante split and adopting a unified baseline that uses the latest Eurostat data for available years and PRIMES for the remainder with interpolation. Front-end migration was completed, accompanied by extensive bug fixes to improve stability.

Back-end advances expand data coverage and methodological robustness. Here, the MICATool database has been extended with new data sets, especially with regard to the renewables extension (e.g. displaced generation mixes, capacity factors, technology efficiencies, and costs). However, previously included data sets were also updated to close data gaps, increase the accuracy of the results and improve transparency (e.g. extension and update of air pollutant and emission factors as well as the respective morbidity and mortality factors, new default energy prices and investment costs, addition of default fuel switching values by sector). In order to ensure the tool works with the newest Eurostat data, some key data sets are regularly directly downloaded through the Eurostat API (Application Programming Interface). The FEC-to-PEC conversion was overhauled to a transparent two-step method using generation efficiencies and energy mixes. Reliability was strengthened through a server watchdog that auto-recovers crashed processes.

Last but not least, two new modules were introduced, expanding the tool's scope of application and possible approaches for its use.

Building on the MICAT methodology for energy efficiency, the renewable energy supply-side module quantifies Multiple Impacts for renewables by linking renewable energy production to impact factors/functions. In parallel to the energy-savings-based approach for efficiency, renewable generation is mapped to environmental, economic, and social impacts using technology-specific factors and time-dependent baselines.

The Policy Module integrates prior policy assessment work into the MICATool to enable consistent, transparent analysis of energy efficiency policies. The module establishes a standardised connection to two external data sources (MURE and ODYSSEE databases) and imports reported savings into the MICATool, to facilitate analysis of their multiple impacts and provide a starting point for using the tool when no own data is available.

Overall, the upgraded MICATool delivers more reliable, comparable, and user-friendly assessments of multiple impacts across efficiency and renewables.

## 1. INTRODUCTION

This report presents the conceptual and technical enhancements to the MICATool undertaken within the SEED MICAT project by November 2025. The general improvements focus on expanding and refining the tool's analytical capabilities, including the integration of new or revised data, the continuous bug fixing of the back end/calculations, and the incorporation of refined impact factors/functions to increase the accuracy of impact quantifications. Technical adjustments to the back-end target faster calculation performance and an increased stability of the tool, while front-end refinements aim to improve usability, user-friendliness, and the clarity of results. The report also documents new visualisation options added to support more intuitive insights, such as reworked charts and user guidance. During the first half of the project, a major focus was placed on usability and user guidance. We streamlined core workflows, improved navigation and terminology, and introduced contextual support such as tooltips and guided steps. Training material was published, accessibility and error messaging were enhanced, and user journeys were simplified.

These enhancements have been implemented iteratively throughout the project duration, guided by continuous feedback from tool users, consortium partners, and insights from other work packages (e.g. from workshops and training sessions). The objective is to deliver a more accurate, performant, and user-centric MICATool that better supports decision-making and stakeholder needs.

## 2. IMPROVEMENTS OF THE FRONT-END AND THE USABILITY OF THE MICATool

### 2.1 Implementation of additional info buttons and context dependent instructions

To reduce ambiguity and help users configure analyses correctly, we added prominent info buttons across the general input pages and parameter panels (see Figures 1–5). Each info button opens a concise, context-aware explanation covering what the input represents, why it matters, and how it affects the results. Where relevant, the info pop-ups link directly to the tool documentation, which provides methodological detail, definitions, units, and data sources to support deeper understanding (Figure 3). For global parameters, the info buttons clarify default values and/or expected inputs and explain how changing the parameter influences the model (e.g., potential interactions with the advanced parameters, see e.g. Figure 4).

Based on feedback, the content of the info boxes is continuously improved and adapted to constantly enhance the user-friendliness of the tool.

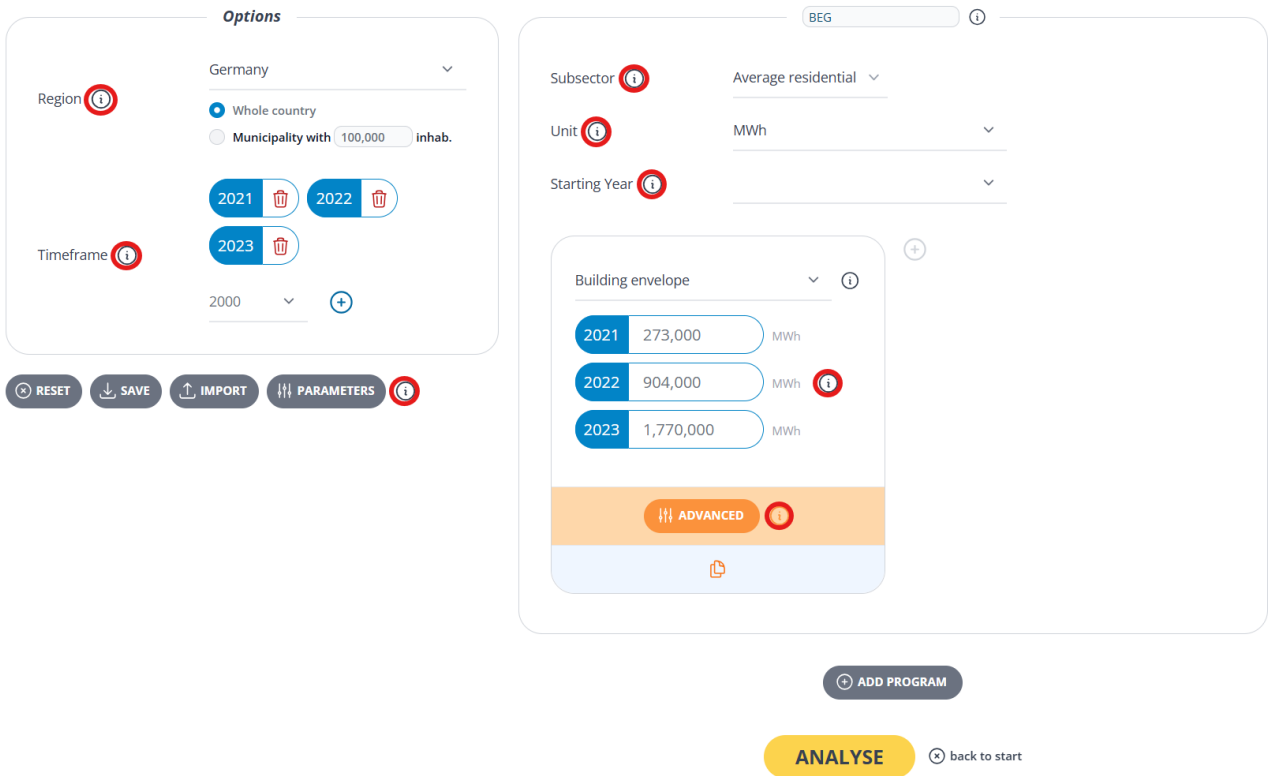


FIGURE 1 INFO BUTTONS ON THE GENERAL INPUT PAGE

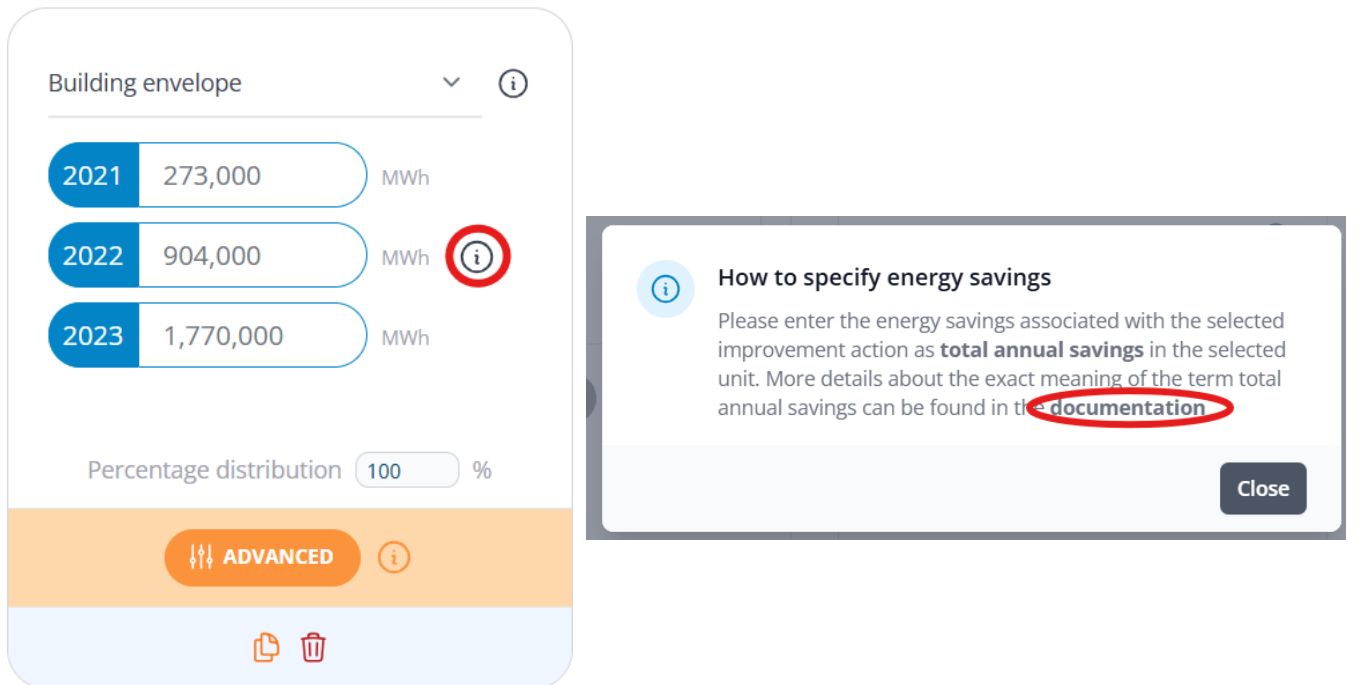


FIGURE 2 DETAILED INFO BUTTON EXAMPLE: SPECIFICATION OF ENERGY SAVINGS

## Accounting of energy savings and how to input them into the MICATool

Generally, energy savings can be accounted for in three different ways: new annual savings, total annual savings, and cumulative savings. The MICATool uses total annual savings, however, it makes sense to dive a little bit into the topic, in order to avoid confusion.

### New annual savings

New annual savings are the savings generated by measures implemented in the examined year.

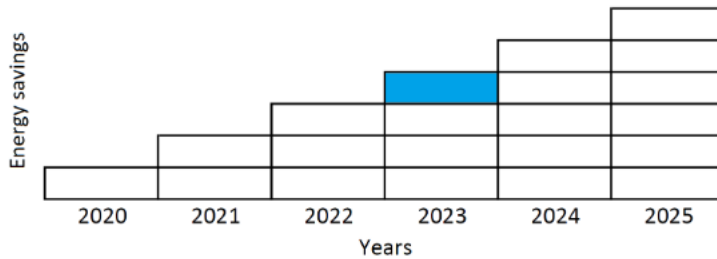


Figure 1: Schematic depiction of new annual savings in the exemplary year 2023.

### Total annual savings

In contrast to new annual savings, total annual savings take all savings into account that accrue in the examined year compared to a scenario in which the assessed energy efficiency measures have not been implemented. Thus, all savings generated in the examined year by older measures are also considered, as long as the lifetime of the measure is not over.

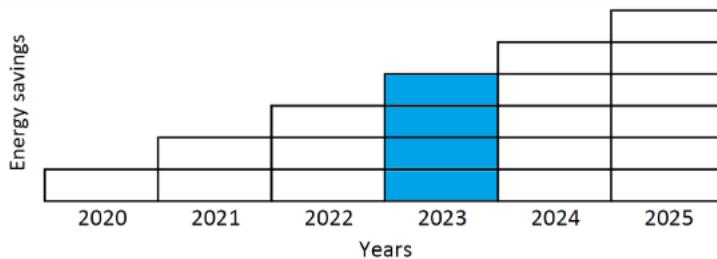


Figure 1: Schematic depiction of total annual savings in the exemplary year 2023.

### Cumulative savings

Cumulative savings consider all savings achieved since the inception of the assessed energy efficiency measures until the examined year in comparison to a scenario without these savings. Yet, savings are still only accounted within the measures' lifetime.

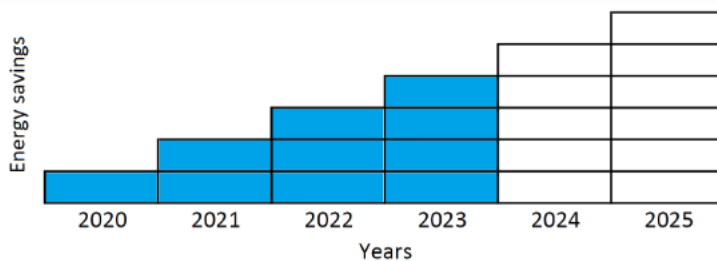


Figure 1: Schematic depiction of total annual savings in the exemplary year 2023.

FIGURE 3 EXAMPLE OF MORE DETAILED EXPLANATIONS FROM THE TOOL DOCUMENTATION LINKED TO THE INFO BUTTON

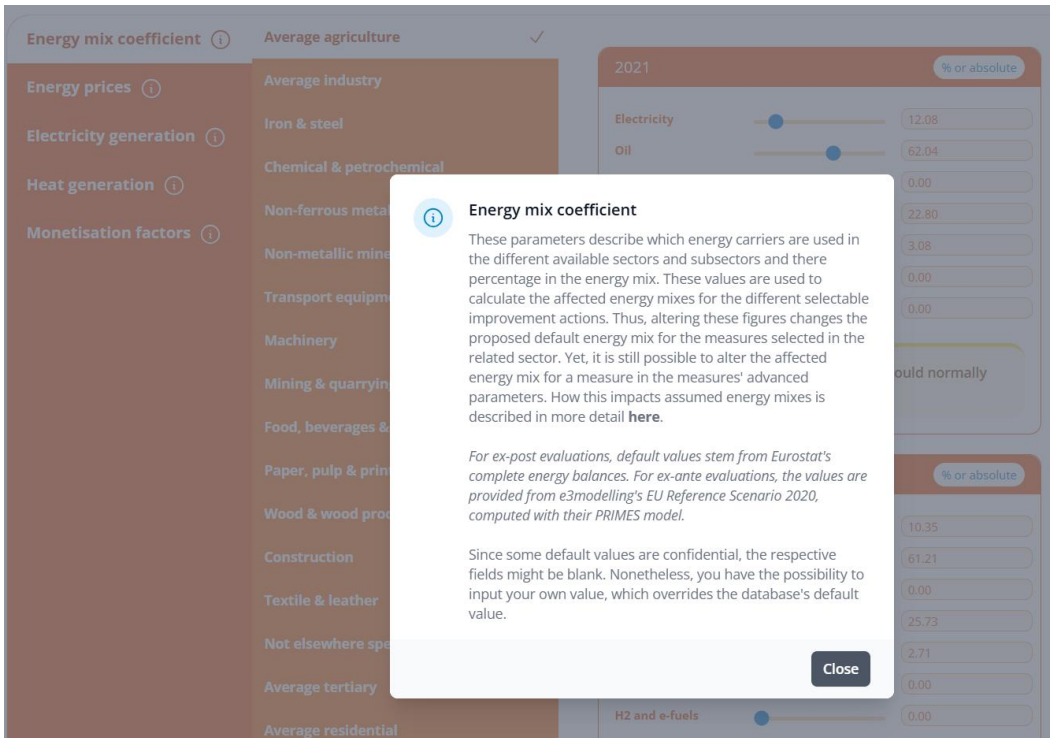


FIGURE 4 INFO BUTTON FOR THE GLOBAL PARAMETERS – EXAMPLE 1

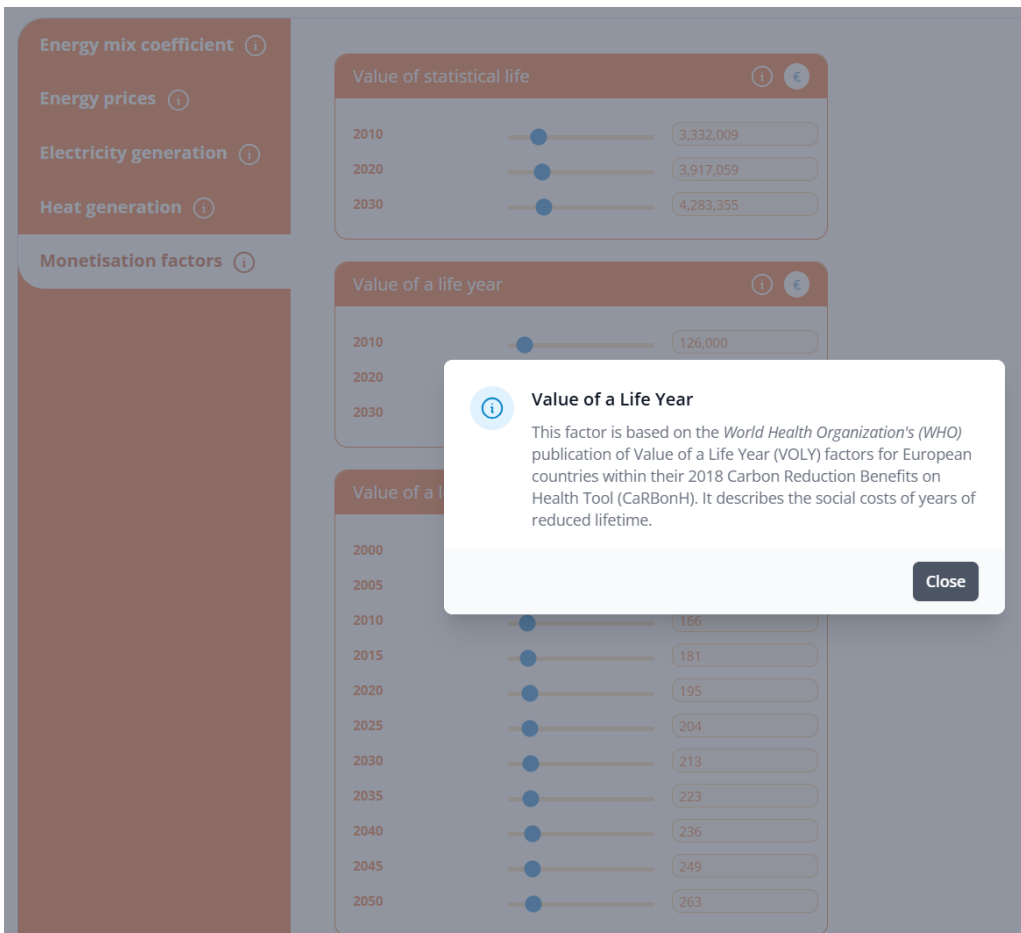


FIGURE 5 INFO BUTTON FOR THE GLOBAL PARAMETERS – EXAMPLE 2

Beyond static help via the info buttons, we introduced context-dependent information boxes that appear when users modify key inputs such as entered energy savings or a programme’s starting year (Figures 6–7). These messages alert users to potential inconsistencies (for example, to clarify the interplay between global and advanced parameters, or if advanced parameters should be reviewed because of a change in scope/provided entries). The guidance prioritises clarity and brevity, and provides concise instructions. Together, these enhancements reduce the learning curve, foster correct usage, and help users maintain internal consistency in their configurations without relying on external manuals.

i You have made changes to the advanced parameters in one or more programmes. Changes to the global parameters are only taken into account if the advanced parameters of the corresponding programmes are reset.

Energy mix coefficient i

Energy prices i

Electricity generation i

Heat generation i

Monetisation factors i

Average agriculture ✓

Average industry

Iron & steel

Chemical & petrochemical

Non-ferrous metals

Non-metallic minerals

Transport equipment

Machinery

Mining & quarrying

Food, beverages & tobacco

2021 % or absolute

Electricity	<input type="range"/>	12.08
Oil	<input type="range"/>	62.04
Coal	<input type="range"/>	0.00
Gas	<input type="range"/>	22.80
Biomass and Waste	<input type="range"/>	3.08
Heat	<input type="range"/>	0.00
H2 and e-fuels	<input type="range"/>	0.00

i The values of all energy carriers should normally sum up to 100%.

FIGURE 6 EXAMPLE OF CONTEXT RELATED USER GUIDANCE – GLOBAL PARAMETERS

**Options**

Region *i* Germany

Whole country  
 Municipality with 100,000 inhab.

Timeframe *i*

2021 *i* 2022 *i*

2023 *i*

2000 *i* +

RESET SAVE IMPORT PARAMETERS *i*

BEG *i*

Subsector *i* Average residential

Unit *i* MWh

Starting Year *i*

Building envelope *i* +

2021	273,000	MWh
2022	904,000	MWh <i>i</i>
2023	1,770,000	MWh

ADVANCED *i*

**Options**

Region *i* Germany

Whole country  
 Municipality with 100,000 inhab.

Timeframe *i*

2021 *i* 2022 *i*

2023 *i*

2000 *i* +

RESET SAVE IMPORT PARAMETERS *i*

BEG *i*

Subsector *i* Average residential

Unit *i* MWh

Starting Year *i* 2021

Building envelope *i* +

2021	273,000	MWh
2022	904,000	MWh <i>i</i>
2023	1,870,000	MWh

ADVANCED *i* *w*

The advanced parameters are based on your entries. The entries have changed. The parameters must be reset or checked accordingly.

FIGURE 7 EXAMPLE OF CONTEXT RELATED USER GUIDANCE – GENERAL INPUT PAGE (TOP: VIEW BEFORE CHANGES TO GENERAL INPUTS; BOTTOM: VIEW INCLUDING WARNING MESSAGE TO ADJUST ADVANCED PARAMETERS AFTER CHANGING SAVINGS AND STARTING YEAR)

## 2.2 Continuous improvements of the descriptions in the results section

To support accurate interpretation and communication of findings, we substantially enriched/reworked the descriptions accompanying each indicator and result view (Figures 8–9). Every indicator now features:

- A brief description that explains its meaning and scope, including:
  - Notes on underlying assumptions and data sources, with direct links to the calculation methodology and documentation to facilitate transparency and reproducibility.
  - Flags for caveats, such as reliance on proxy data, interpolation, or corresponding hints if indicators are more exploratory or informational in nature.

Terminology was harmonised across the results section to improve comparability between indicators and to ensure consistent interpretation. These improvements make results easier to understand for both technical and non-technical audiences and strengthen internal and external reporting.

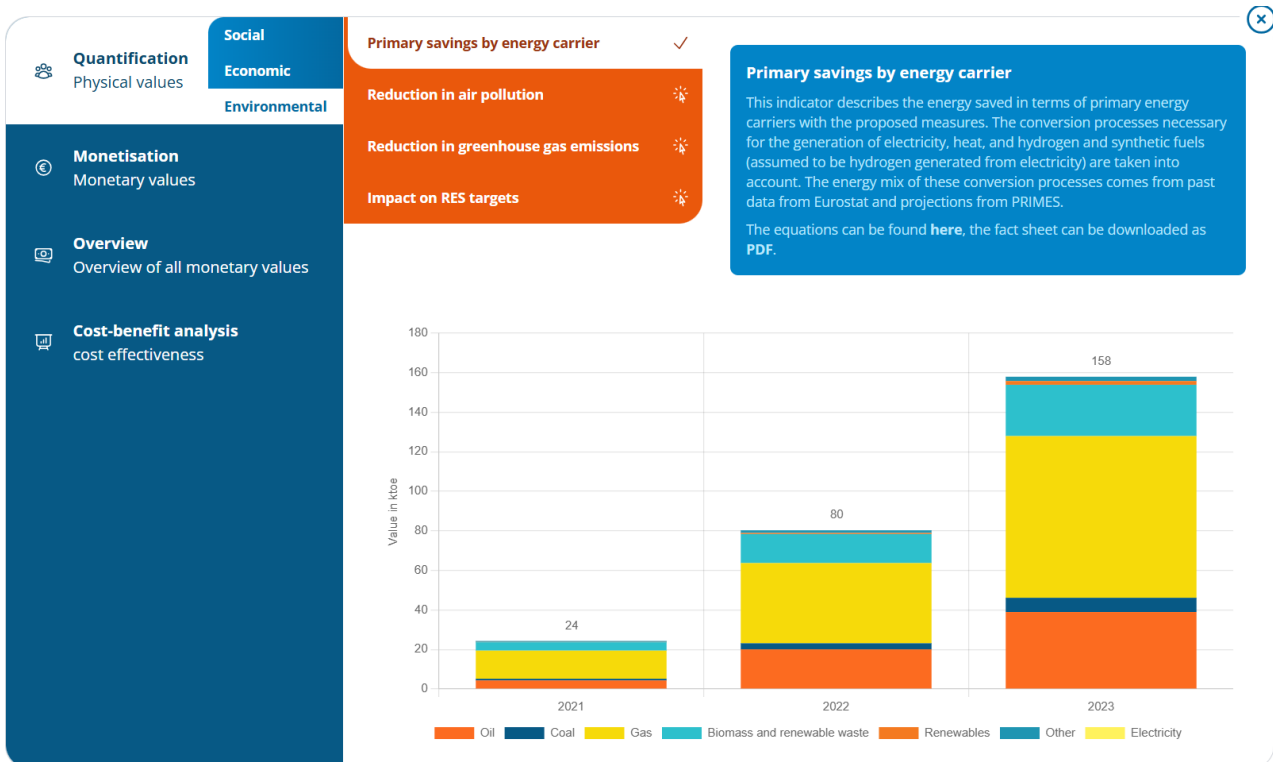


FIGURE 8 EXAMPLE OF A RESULT/INDICATOR DESCRIPTION

## Primary energy savings

The indicator "Primary savings by fuel" describes the savings accruing in terms of different energy carriers for primary energy consumption:

$$\Delta E_{P,pe,y} = \sum_u \sum_{ss} \Delta E_{P,pe,ss,a,y}$$

$\Delta E_{P,pe,y}$  = Primary savings by fuel (= total energy savings of an primary energy carrier in a given year)

$\Delta E_{P,pe,ss,a,y}$  = total energy savings of primary energy carrier *pe* for id\_action\_type *a* and subsector *ss* (from [here](#))

## Final energy savings

The "final energy savings" are currently not an indicator but are needed as interim result. The following calculation originally was part of the above.

$$\Delta E_{e,y} = \sum_u \sum_{ss} \Delta E_{e,ss,a,y}$$

$\Delta E_{e,y}$  = total energy savings for a final energy carrier in a given year

$\Delta E_{e,ss,a,y}$  = energy savings of final energy carrier *e* for id\_action\_type *a* and id\_subsector *ss* (from [here](#))

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PUBLISHING NOTES

FIGURE 9 EXAMPLE OF A RESULT/INDICATOR DESCRIPTION – LINKED INFORMATION ON THE CALCULATION METHODOLOGY

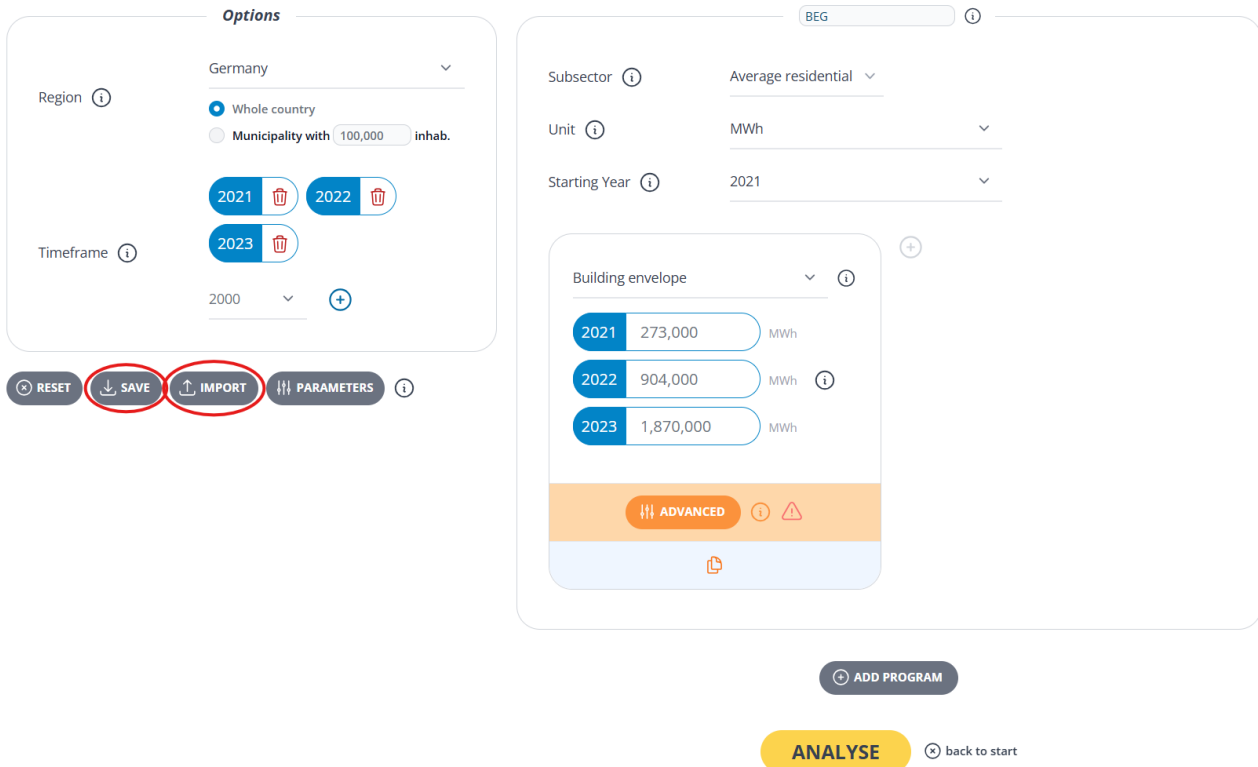
## 2.3 Implementation of the save and import function

We introduced a save and import function that enables users to preserve, share, and re-run complete analyses (Figure 10). When saving, the tool stores the full configuration—including programme inputs, global and advanced parameters, and selected options—into a machine-readable file. The resulting file can be re-imported to reproduce the exact setup, which supports team collaboration, iterative refinement, and usability.

An example input file for the analysis of a large building renovation programme in Germany (BEG) is referenced below to illustrate the use of the function. More information on this use case is provided in the training guideline of the tool: [https://micatool.eu/seed-micat-project-wAssets/docs/publications/SEED MICAT Training 202505-V2.pdf](https://micatool.eu/seed-micat-project-wAssets/docs/publications/SEED_MICAT_Training_202505-V2.pdf)

Example of input file for the analysis of the BEG in Germany can be found [here](#).

To summarize, this functionality reduces manual re-entry effort, prevents configuration drift, and facilitates comparative analyses across time and teams.



The screenshot shows the 'Options' panel on the left and the 'Building envelope' table on the right. The 'Options' panel includes a 'Region' dropdown set to 'Germany', radio buttons for 'Whole country' (selected) and 'Municipality with 100,000 inhab.', and a 'Timeframe' section with buttons for years 2021, 2022, and 2023, and a 'Timeframe' dropdown set to 2000. Below the options are buttons for 'RESET', 'SAVE', 'IMPORT', and 'PARAMETERS'. The 'Building envelope' table shows energy consumption in MWh for years 2021, 2022, and 2023. At the bottom, there are buttons for 'ADD PROGRAM', 'ANALYSE', and 'back to start'.

Year	Value (MWh)
2021	273,000
2022	904,000
2023	1,870,000

FIGURE 10 SAVE AND IMPORT FUNCTION

## 2.4 Implementation of the possibility to export the results as an Excel file

To streamline reporting and further analysis, results can now be exported directly to Excel (Figures 11–12). The exported workbook include the results in the same structure/logic as the online presentation of the results in the tool:

- An input sheet with the key inputs provided.
- One sheet for each of the different results sections: Quantification, Monetisation, Aggregation and CBA. These include the results (and respective units) for each indicator and all analyzed years.

Column naming conventions and ordering were standardised to simplify further processing (e.g., pivoting, charting).

This export option enables users to quickly integrate findings into presentations, internal reports or their own further analysis, and external deliverables.

Potential further improvements of the export function could include:

- An improved presentation of the results, including the visualisation.
- A metadata sheet summarising scenario settings, global/advanced parameter values, and the MICATool version to support traceability and documentation.

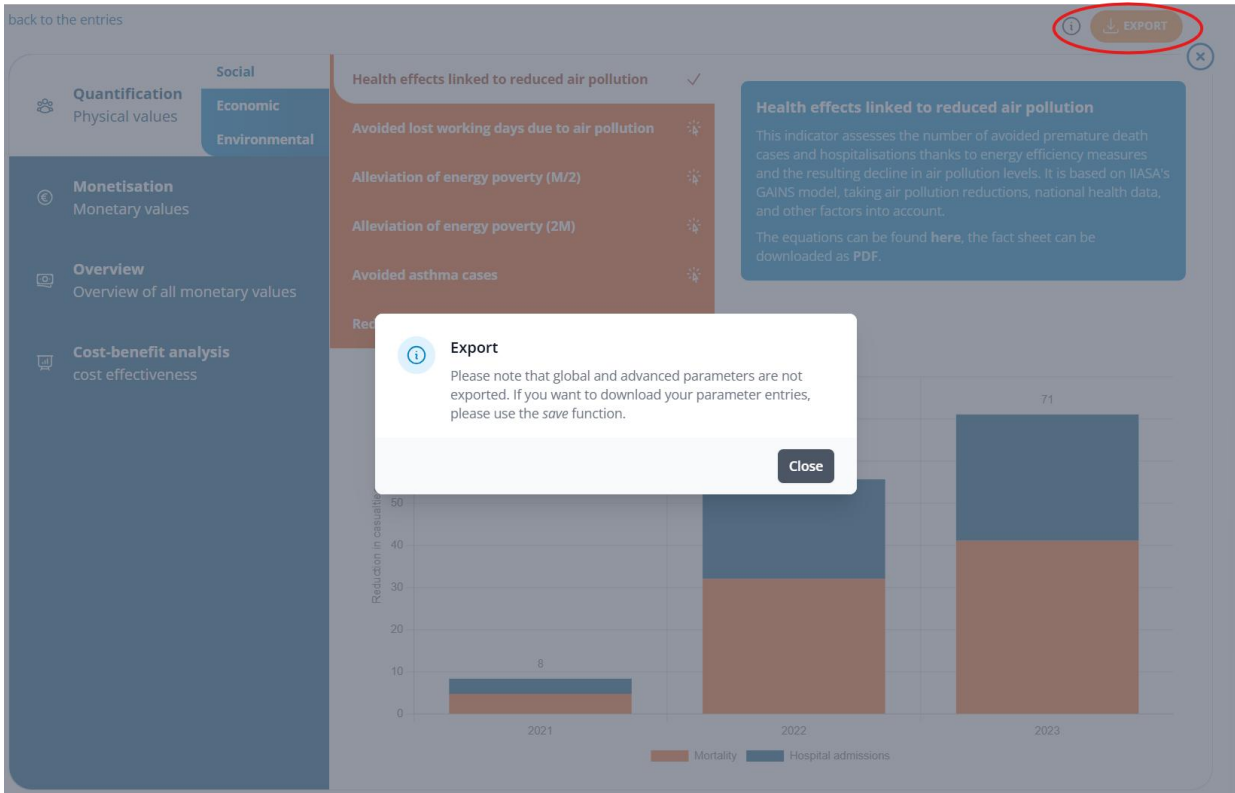


FIGURE 11 EXPORT OF RESULTS

	A	B	C	D	E	F
1	<b>[Social] Health effects linked to reduced air pollution</b>					
2	<i>Reduction in casualties</i>					
3		<b>2021</b>	<b>2022</b>	<b>2023</b>		
4	Mortality	0,727312117	2,554548453	4,667377902		
5	Hospital admissions	0,540884045	1,880143143	3,398144652		
6	Mortality	4,094793861	29,515772776	36,451681655		
7	Hospital admissions	3,045196986	21,723556563	26,539371673		
8	<b>Total</b>	<b>8,408187009</b>	<b>55,674020935</b>	<b>71,056575883</b>		
9						
10	<b>[Social] Avoided lost working days due to air pollution</b>					
11	<i>Avoided absences in days</i>					
12		<b>2021</b>	<b>2022</b>	<b>2023</b>		
13		256,782123656	882,609269423	1.576,171885212		
14		1.445,692762122	10.197,84714505	12.309,970889516		
15	<b>Total</b>	<b>1.702,474885778</b>	<b>11.080,456414473</b>	<b>13.886,142774728</b>		
16						
17	<b>[Social] Alleviation of energy poverty (M/2)</b>					
18	<i>People lifted out of energy poverty</i>					
19		<b>2021</b>	<b>2022</b>	<b>2023</b>		
20		1.172,995564369	14.584,201901125	27.441,754218381		
21		8.514,935256769	114.896,966044738	196.269,650588853		
22	<b>Total</b>	<b>9.687,930821138</b>	<b>129.481,167945862</b>	<b>223.711,404807234</b>		
23						
24	<b>[Social] Alleviation of energy poverty (2M)</b>					
25	<i>People lifted out of energy poverty</i>					

FIGURE 12 EXPORT OF RESULTS - EXPORTED EXCEL FILE

## 2.5 Improvement of the result graphs

We redesigned the visual presentation of results to make trends and comparisons easier to understand at a glance (Figures 13–14). Key features include:

- Transition from line charts to clearer bar charts for discrete annual or categorical comparisons, reducing visual clutter and aiding interpretation.
- Interactive controls to toggle stacking/ grouping, so users can focus on the most relevant sub-components.
- Tooltips that display exact values.

In addition, axis labels and titles were standardised, and the automatised scaling of the y-axis was improved to balance detail and clarity. The redesign prioritises interpretability for non-experts while preserving the analytical depth required by technical users.

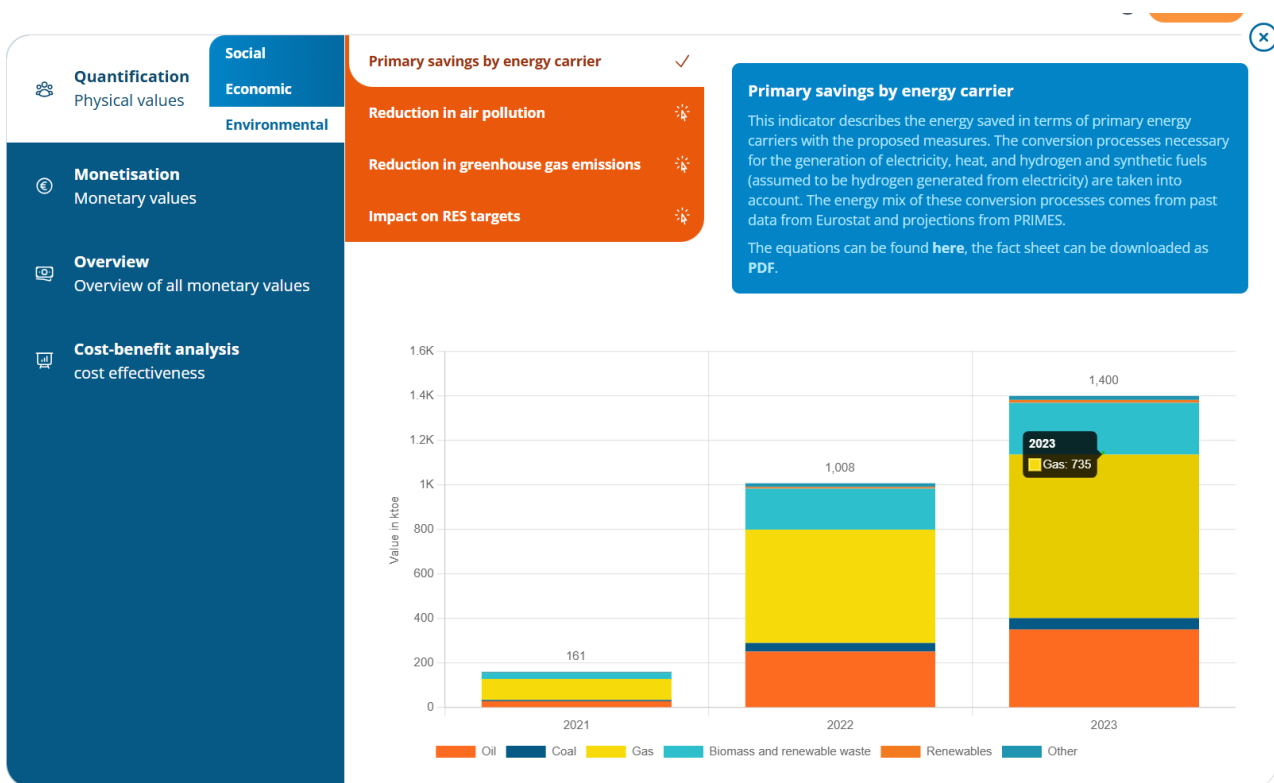


FIGURE 13 NEW PRESENTATION OF RESULTS (BAR CHARTS), INCLUDING DETAILED MOUSEOVER INFORMATION

[back to the entries](#)

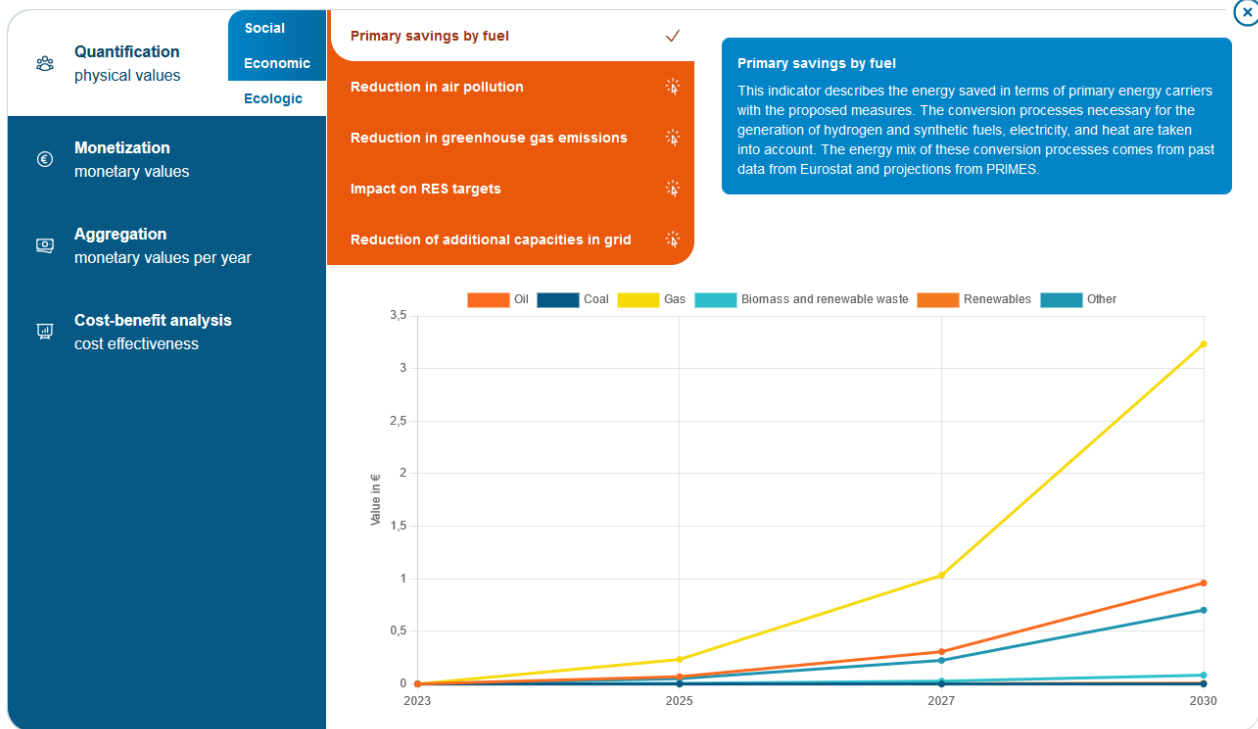


FIGURE 14 OLD PRESENTATION OF RESULTS (LINE CHARTS),

## 2.6 Possibility to directly compare the results of different programmes

The tool now enables side-by-side comparisons of multiple programmes within the same analysis workflow (Figures 15–20). Users can:

- Add one or more programmes and view both individual results and aggregated totals.
  - The results for all improvement actions included/analysed as part of one programme are aggregated in the results.
  - The results of two or more different programmes are displayed separately to be able to compare them.

This functionality supports evidence-based prioritisation, enabling users to identify which programmes deliver higher impacts under different criteria and assumptions. Therefore, it supports the analysis and comparison of different measures as required by the Energy Efficiency First Principle.

**Options**

Region: Germany

Whole country (selected) / Municipality with 100,000 inhab.

Timeframe: 2021, 2022, 2023 (selected), 2000

Buttons: RESET, SAVE, IMPORT, PARAMETERS

---

BEG\_1

Subsector: Average residential

Unit: MWh

Starting Year: [dropdown]

**Building envelope**

2021: 273,000 MWh

2022: 904,000 MWh

2023: 1,770,000 MWh

Percentage distribution: 100 %

ADVANCED

**Energy-efficient heating**

2021: 1,537,000 MWh

2022: 10,445,000 MWh

2023: 14,046,000 MWh

Percentage distribution: 0 %

ADVANCED

Buttons: ADD PROGRAM, ANALYSE, back to start

FIGURE 15 ONE PROGRAMME AS INPUT FOR THE TOOL



FIGURE 16 ONE PROGRAMME AS INPUT FOR THE TOOL – AGGREGATED RESULTS

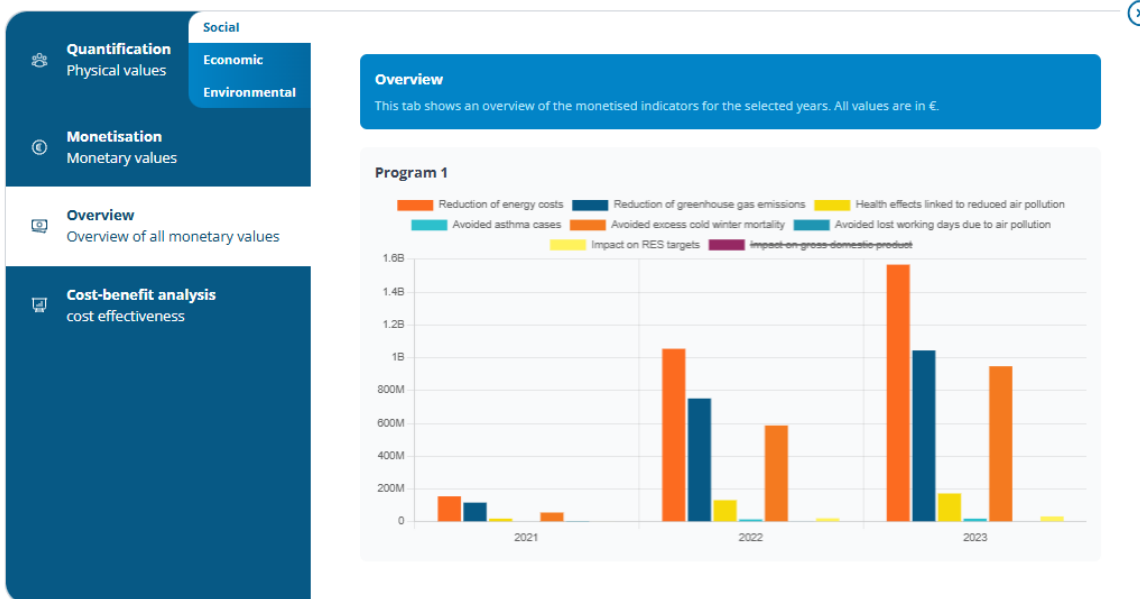


FIGURE 17 ONE PROGRAMME AS INPUT FOR THE TOOL – AGGREGATED OVERVIEW

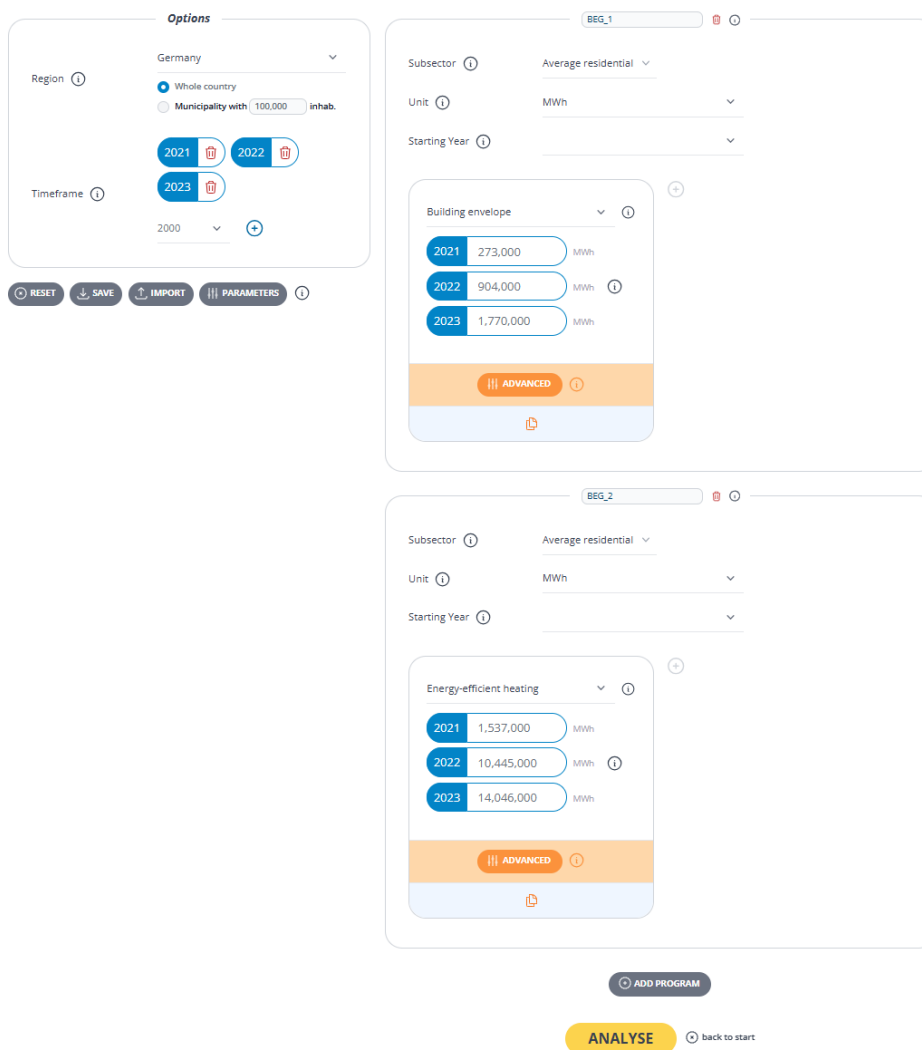


FIGURE 18 TWO PROGRAMMES AS INPUT FOR THE TOOL



FIGURE 19 TWO PROGRAMMES AS INPUT FOR THE TOOL - COMPARATIVE PRESENTATION OF THE RESULTS

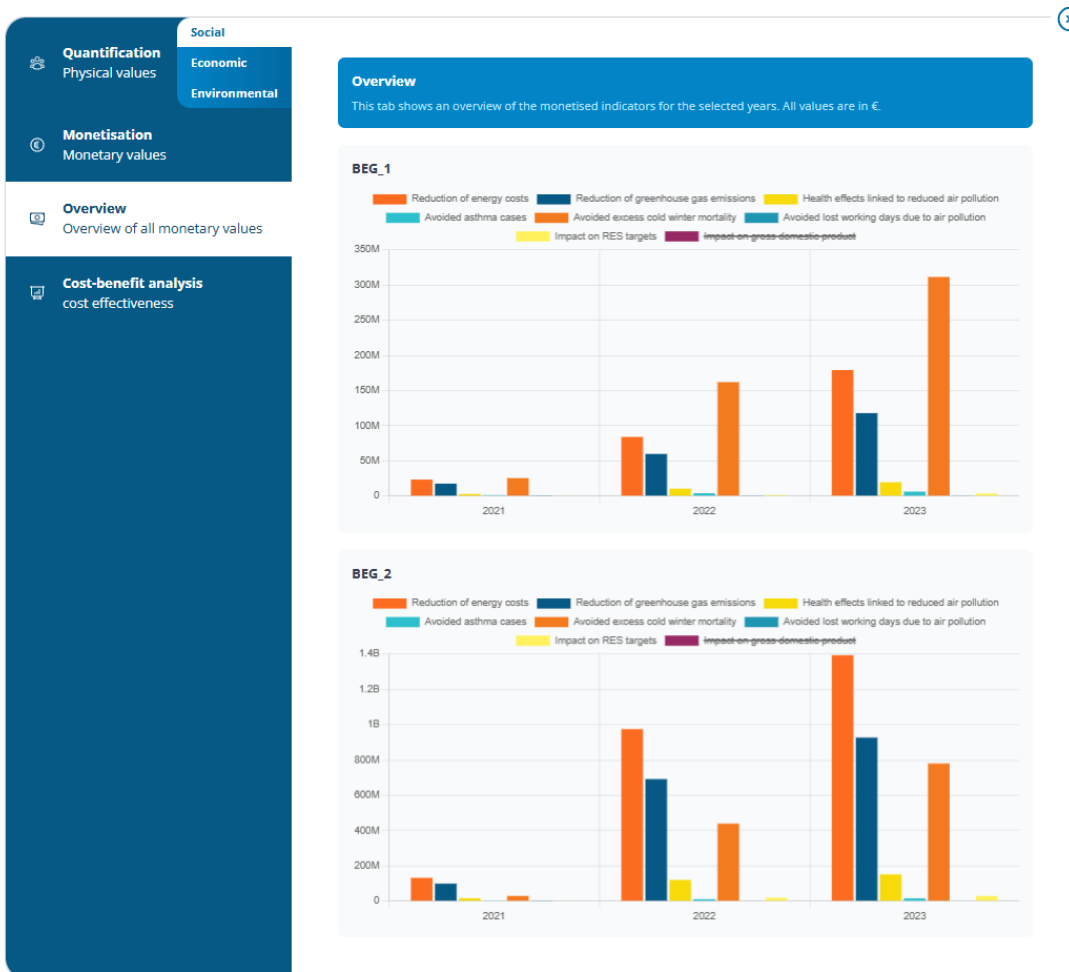


FIGURE 20 TWO PROGRAMMES AS INPUT FOR THE TOOL - COMPARATIVE PRESENTATION OF THE OVERVIEW

## 2.7 Improvements of the CBA

The CBA has been improved. For one, the previously available curves have been replaced by a single weighted value. These curves showed the NPV for the new annual savings implemented in each year but led to confusion among users. Thus, this has been condensed into one value instead, clarifying the meaning. Additionally, sliders for the discount rate, as well as multipliers for investment costs and energy costs, allow to assess the result's robustness under different circumstances.

Until now, the CBA used Net Present Value as main indicator, comparing the investments to discounted benefits accruing over a measure's lifetime. This has the complication, that benefits need be calculated over the whole lifetime, which is particularly problematic when a measure's lifetime surpasses the tool's assessment horizon of 2050. Thus, a switch to Annuity as main CBA indicator is currently carried out. Annuity compares the benefits of one year to the discounted investments for one year, implicitly assuming constant benefits over the measure's lifetime. Although this is not necessarily the case, this indicator causes fewer problems than the NPV approach.

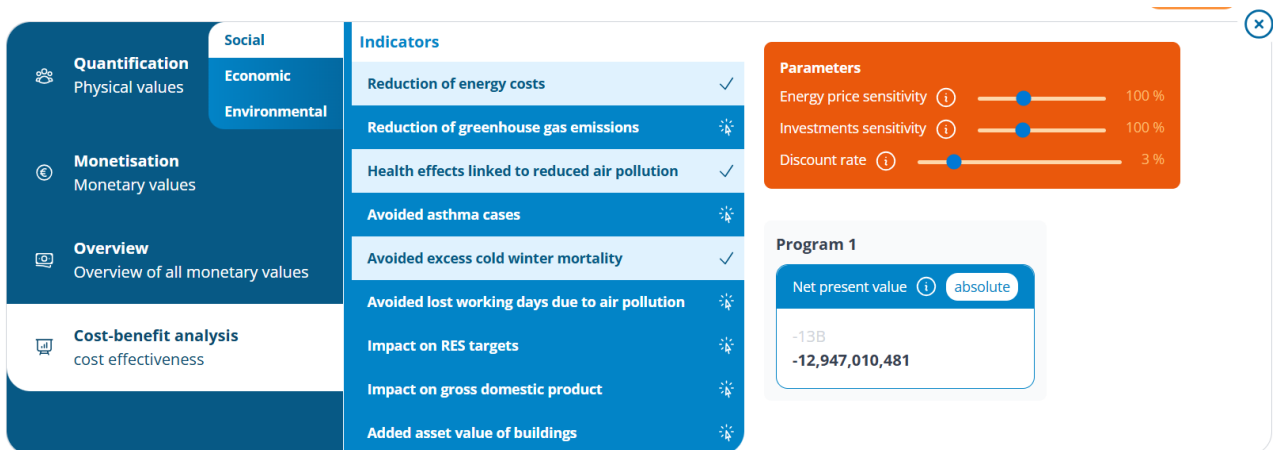
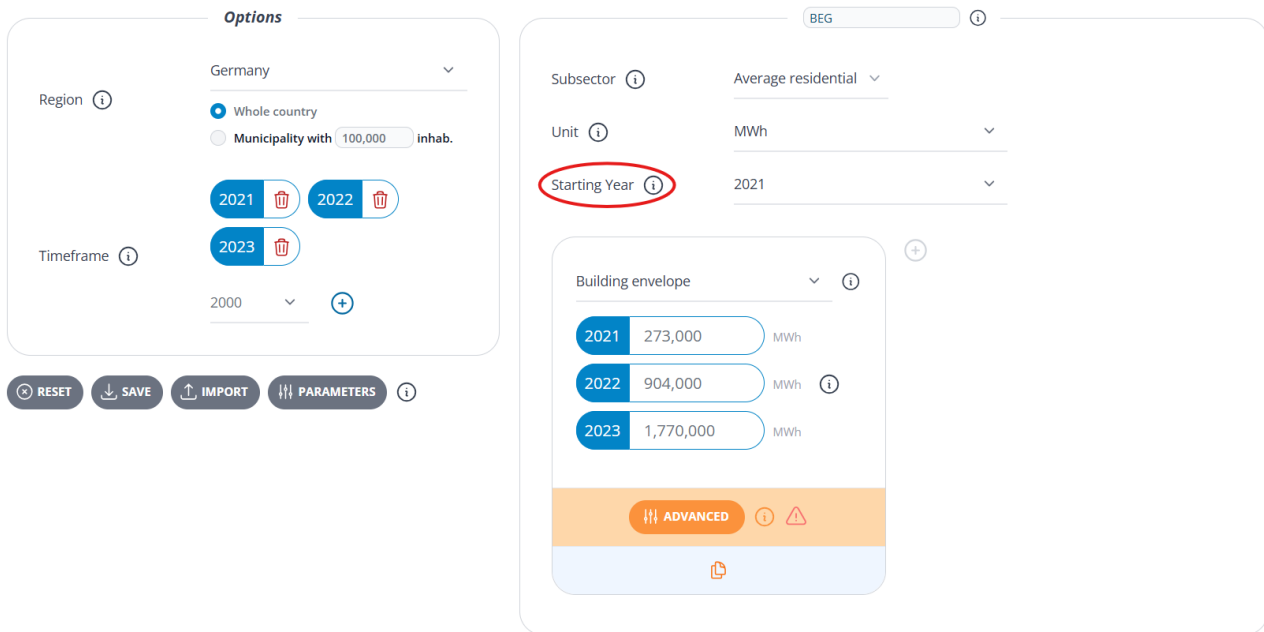


FIGURE 21 SIMPLIFIED CBA

## 2.8 Implementation of a starting year for each programme

Each programme now includes an explicit starting year to ensure correct temporal alignment of savings and impacts with the underlying data series (Figure 22).

This improvement enhances comparability across programmes introduced at different times and ensures impact quantification accurately reflects when measures begin to deliver savings (e.g. by taking the starting year into account for respective interpolations in the calculation – one example is the indicator “impact on GDP”, where the starting year is used to calculate the distribution of the investments over time).



**Options**

Region *i* Germany

Whole country  
Municipality with 100,000 inhab.

Timeframe *i*

2021 2022 2023

2000 +

RESET SAVE IMPORT PARAMETERS *i*

BEG *i*

Subsector *i* Average residential

Unit *i* MWh

Starting Year *i* 2021

Building envelope *i*

Year	Value	Unit
2021	273,000	MWh
2022	904,000	MWh <i>i</i>
2023	1,770,000	MWh

ADVANCED *i* ⚠

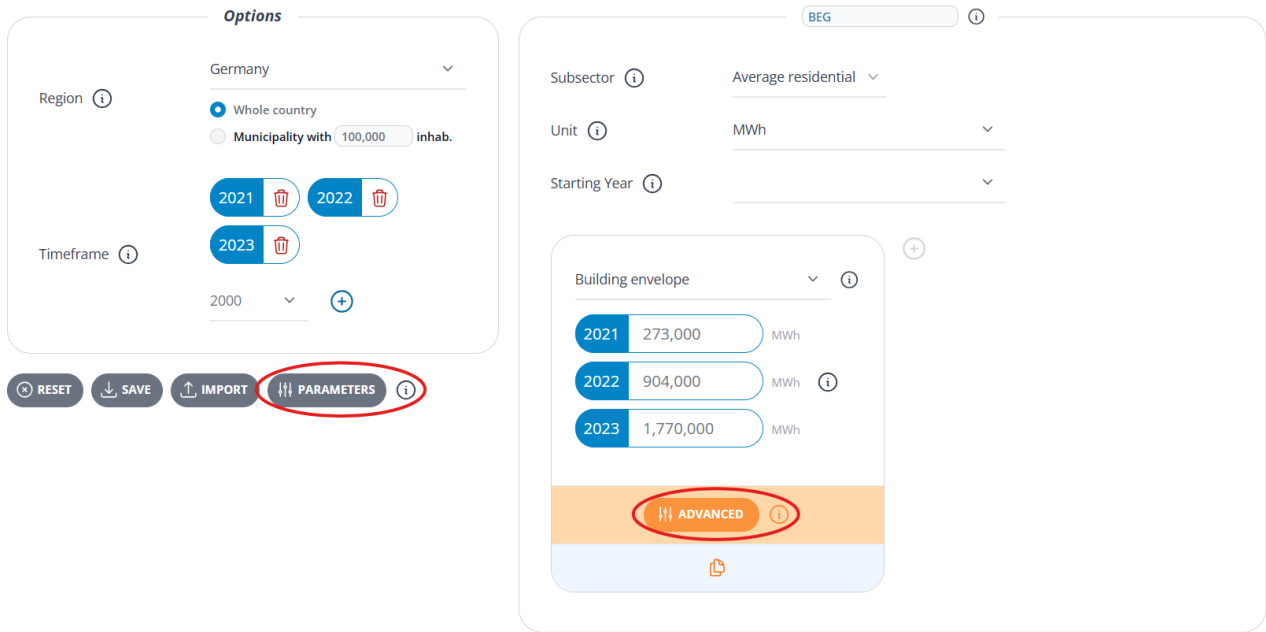
FIGURE 22 IMPLEMENTATION OF A STARTING YEAR FOR EACH PROGRAMME

## 2.9 Streamlining of the global and advanced parameters

Global and advanced parameters are accessible and adjustable by the user of the tool and are supplemented by a dedicated info button (containing explanations and important notes on their use) (Figure 23). While global parameters affect the analysis of all programmes (→ changed only once for the analysis of all programmes and improvement actions), advanced parameters only affect specific improvement actions (→ can be changed separately for each improvement action examined).

To improve the usability of the tool, global and advanced parameters were consolidated and streamlined (e.g. for most parameters only the years under investigation are displayed) to reduce setup time and risk of misconfiguration (Figures 23–25). Here, naming and units were harmonised, and context dependent user guidance helps prevent out-of-range values and inconsistent combinations (Figure 6).

Additional info buttons (Figure 23, see also chapter 2.1 for global parameter examples) provide short explanations for each parameter, including data sources and - if relevant - the implications of changing default values. The aim of this approach is to balance accessibility and flexibility, allowing both quick configuration and detailed customisation without overwhelming users directly.



**Global parameters**

These parameters define the context in which the assessed measures take place. Inter alia, this concerns energy prices, the energy mix used in electricity and heat generation, the employed monetisation factors or the energy mix in certain sectors and subsectors. Thus, these settings apply to all measures, unless specified otherwise in measures' advanced parameters.

The region and years for which these values can be input reflects the selection of **Region** and years in the prompt **Time frame**, respectively.

**Important:** Please note, that any changes are lost if you change the given region or time frame.

Close

**Advanced parameters**

These parameters merely pertain to the corresponding measure. More information can be found **here**.

**Important:** Please note, that any changes are lost if you change the given region, time frame, subsector or improvement.

Close

FIGURE 23 INTEGRATION OF GLOBAL AND ADVANCED PARAMETERS INTO THE FRONT END

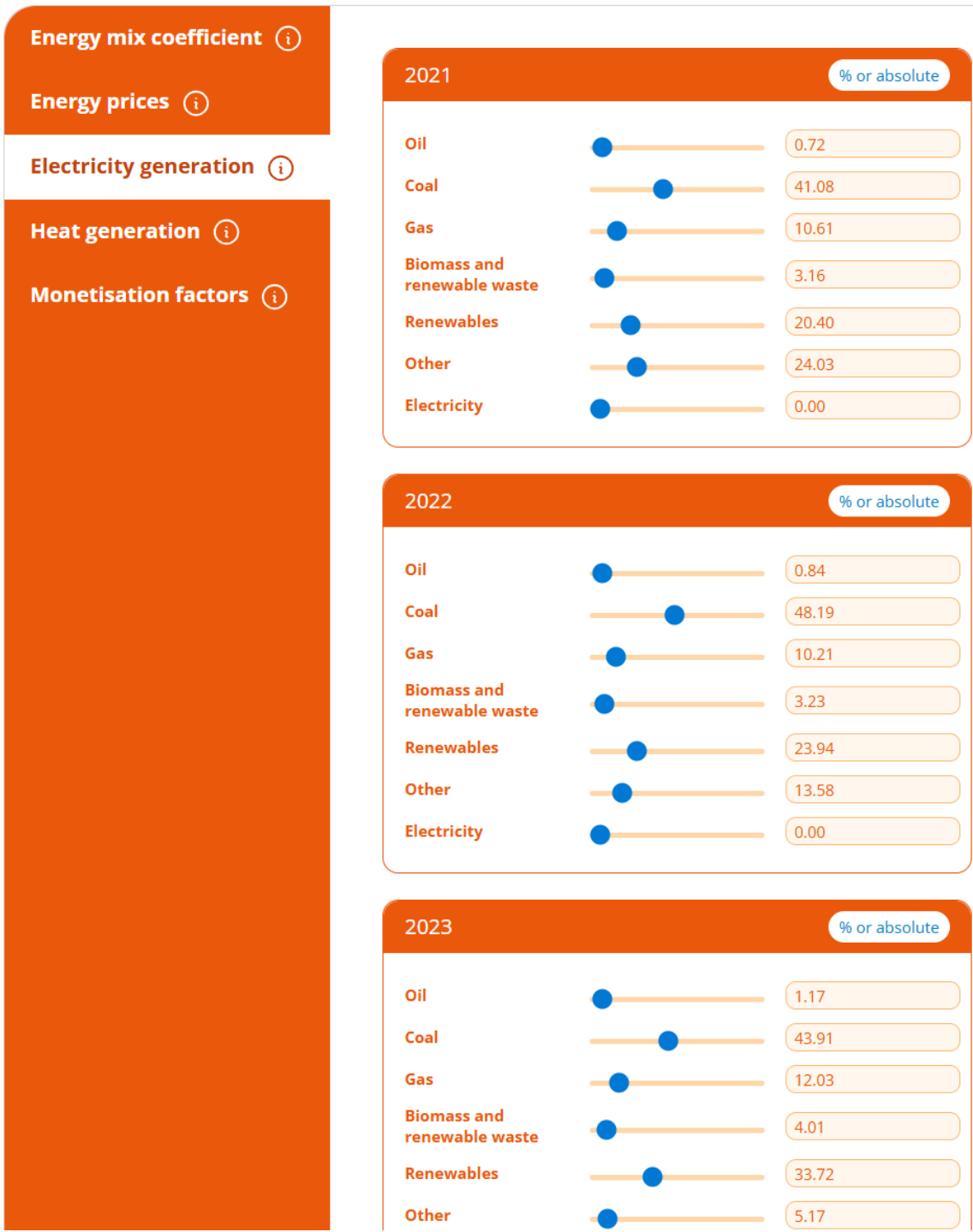


FIGURE 24 SIMPLIFIED GLOBAL PARAMETERS

Main | BEG — Average residential — Building envelope insulation (Windows, insulation, etc)

Affected Fuels

Residential

Year	Share of electricity among affected (%)	Share of oil among affected (%)	Share of coal among affected (%)	Share of gas among affected (%)	Share of biomass and waste among affected (%)	Share of heat among affected (%)
2021	2.00	18.00	1.00	54.00	16.00	9.00
2022	2.00	25.00	1.00	46.00	17.00	9.00
2023	3.00	25.00	1.00	47.00	15.00	9.00

**Share of electricity among affected**

This value specifies the share of final energy carrier electricity among all energy carriers saved by the implemented improvement action. Instead of %, the values can also be entered as shares or absolute values if this is easier, as long as you remain consistent.

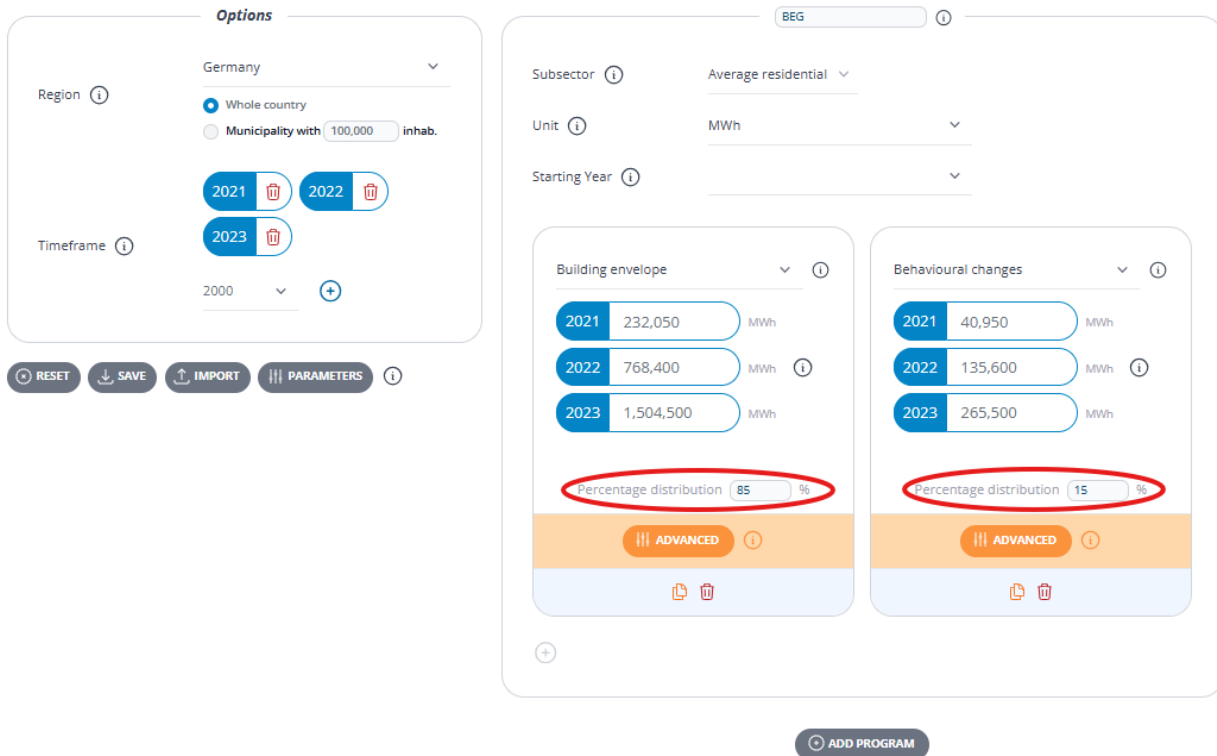
When provided, this overrides the default value, calculated following **this logic**. *The data feeding this calculation stem from Eurostat's Complete Energy Balances for ex-post and from PRIMES' EU Reference Scenario 2020 for ex-ante, as well as a range of past model runs, to account for the specific improvement action and how its energy mix typically relates to the subsectoral energy mix.*

Close

FIGURE 25 SIMPLIFIED AND STREAMLINED ADVANCED PARAMETERS WITH EXTENDED INFORMATION BUTTONS

## 2.10 Implementation of the option to apply a percentage distribution of savings across various improvement actions

To simplify data entry and support different approaches to using the tool, users can now allocate total energy savings to various improvement measures based on percentage distributions (Figure 26). This facilitates, for example, the analysis of different ‘scenarios’ to compare how different distributions affect the results and enables more detailed planning and sensitivity analysis.



**Options**

Region <sup>i</sup> Germany <sup>v</sup>

Whole country  
 Municipality with 100,000 inhab.

Timeframe <sup>i</sup>

2021 <sup>i</sup> 2022 <sup>i</sup>  
 2023 <sup>i</sup>  
 2000 <sup>v</sup> <sup>+</sup>

RESET SAVE IMPORT PARAMETERS <sup>i</sup>

**Parameters**

BEG <sup>i</sup>

Subsector <sup>i</sup> Average residential <sup>v</sup>

Unit <sup>i</sup> MWh <sup>v</sup>

Starting Year <sup>i</sup> <sup>v</sup>

**Building envelope** <sup>v</sup> <sup>i</sup>

2021	232,050	MWh
2022	768,400	MWh <sup>i</sup>
2023	1,504,500	MWh

Percentage distribution 85 %

**Behavioural changes** <sup>v</sup> <sup>i</sup>

2021	40,950	MWh
2022	135,600	MWh <sup>i</sup>
2023	265,500	MWh

Percentage distribution 15 %

ADVANCED <sup>i</sup> ADVANCED <sup>i</sup>

ADD PROGRAM

FIGURE 26 PERCENTAGE DISTRIBUTION OF SAVINGS ACROSS VARIOUS IMPROVEMENT ACTIONS

### 3. IMPROVEMENTS OF THE INTERPLAY OF THE FRONT AND BACK END

#### 3.1 Streamlining of the ex-post and ex-ante modes of the tool

In order to simplify the inputs of measures in the tool, the differentiation between ex-post and ex-ante has been lifted. This distinction led to confusion with many users, since older ex-ante assessments made for periods that are now in the past would have fallen under ex-post in the tool. A key reason to have it in the first place was the different reference baseline, with the former being based on Eurostat and the latter on PRIMES' EU Reference Scenario 2020. Moreover, this now better allows for the quantification of measures implemented in periods covered by Eurostat as well as in periods with PRIMES data.

The MICATool now uses the latest available data from Eurostat for all available years, with the rest covered with PRIMES data, interpolated accordingly.

**Select your use case**

Time frame ⓘ **PAST** (ex-post) **FUTURE** (ex-ante)

Region ⓘ European Union

Unit ⓘ ktoe (kilo tonne of oil equivalent)

**START** **LEARN MORE**

**Select your use case**

Region ⓘ European Union

Timeframe ⓘ 2015 2020 2025

2000 +

**START** **LEARN MORE**

FIGURE 27 SIMPLIFICATION OF THE EX-ANTE/EX-POST MODES

## 3.2 Finalisation of the transfer of the front end

After moving to a new more accessible and inviting front-end at the end of the MICAT project, major bugfixing and extension of functions were necessary in the first two quarters of the SEED MICAT project to root out all issues and have a working version. As a result, the popup warning of unexpected tool behaviour has been removed.

## 4. MAJOR IMPROVEMENTS OF THE BACK-END

### 4.1 Data extensions and updates

On the one hand, the MICATool database has been extended with new data to enable developed additional functions. This concerns mainly the renewables extension, which required data on a variety of aspects:

- efficiency of electricity, heat and hydrogen generation with different methods
- typically substituted electricity generation by different renewable technologies
- hydrogen generation energy mix
- capacity factors of renewable technologies
- efficiency of renewable technologies
- investment and operative costs of renewables

On the other hand, also some previously available data has been updated. This concerns air pollution coefficients and emissions factors, which have been updated and extended to provide coefficients for each way of generating electricity and heat, not only a national average. Thus, user changes in energy mixes are reflected in emission figures and related health effects. In addition, also the related morbidity and mortality factors were updated/extended.

Default investment costs (per energy saved and per improvement action) and default energy prices have been updated with new data provided by e3m, based on PRIMES. This has allowed to move energy prices from the confidential to the public database, meaning that default values can now be shown to users in the tool. Furthermore, GDP and employment coefficients have been expanded to renewables, to reflect the impact of their installation. Finally, default fuel switch values for each sector have been specified, which allows users without own data to carry out calculations relying on default values.

To allow for a strong softlink/streamlining with the PRIMES model (see also Task 3.1 of the project) as many of the new/updated data sets as possible were derived based on PRIMES. This includes:

- efficiency of electricity, heat and hydrogen generation with different methods (partly)
- typically substituted electricity generation by different renewable technologies
- capacity factors of renewable technologies (partly, heat based on different sources)
- efficiency of renewable technologies

- investment and operative costs of renewables
- default energy prices
- default investment costs
- GDP and employment coefficients

## 4.2 Connection with Eurostat

In order to ensure the tool works with the newest Eurostat data, "Complete energy balances" as well as "Population unable to keep home adequately warm by poverty status" are regularly directly downloaded through the Eurostat API (Application Programming Interface).

In the future, it is planned to extend the number of datasets directly updated through Eurostat's API. However, several datasets are currently preprocessed manually before being imported into the MICAT database, which needs to be codified. Thus, this process takes a while and is planned for the months to come.

## 4.3 Major update of the FEC to PEC calculation methodology

The calculation of primary energy savings has been changed. This has three reasons: to use data that is more tangible for users to replace with their own, to better reflect the ways in which hydrogen can be generated, and to prepare the tool for the integration of renewables (which would have been extremely cumbersome with the old approach).

Previously, this conversion was done by calculating the national average input of each primary energy carrier in an average energy unit of electricity and heat. These coefficients, which were not widely available elsewhere for tool users to improve results' accuracy, were then multiplied with saved electricity and heat. This has now been changed to an two-step approach, including the efficiency of electricity, heat, and hydrogen generation, combined with typical national energy mixes for their generation. More details about this change can be found in the [documentation](#).

## 4.4 Fixing of server crash issue

In the past, there were frequent issues with the server having a minor crash. As a result, the dropdowns in the tool would not show any selection possibilities, requiring someone at Fraunhofer to restart the related process. This has been resolved by running a programme, constantly verifying the state of the server instance and restarting the process in case it is not properly running.

# 5. INTRODUCTION OF NEW MODULES

To extend the analytical scope of the MICATool beyond energy-efficiency programmes and to better reflect stakeholder needs, two new modules were designed and implemented: the renewable energy (RE) supply side module and the Policy module. Both were developed iteratively, including testing, feedback, and technical reviews within the consortium. The modules follow the same design

principles as the core tool—transparent methods, clear user guidance, robust defaults with editable parameters, and full reproducibility via save/import and Excel export. They integrate seamlessly with existing inputs, the global and advanced parameters, and all result views, including the CBA, and export functions.

## 5.1 RE supply side module

The RE supply side module extends the MICATool beyond energy efficiency to the second pillar of the energy transformation: renewable energy sources and related climate-neutral options (e.g., hydrogen-based carriers and e-fuels). Building on the MICAT methodology for energy efficiency, the module quantifies Multiple Impacts for renewables by linking renewable energy production to impact factors/functions. In parallel to the energy-savings-based approach for efficiency, renewable generation is mapped to environmental, economic, and social impacts using technology-specific factors and time-dependent baselines.

A core objective is to capture both the positive Multiple Impacts of renewables and the avoided negative impacts of fossil energy use. For example, reductions in local air pollutants and greenhouse gas emissions are quantified by comparing renewable generation against displaced fossil fuel use.

Because renewables and energy efficiency increasingly interact—sometimes synergistically, sometimes in competition—the RE supply side module supports consistent scenario assessment across both pillars. Users can compare and combine efficiency measures with renewable deployment to understand how the Multiple Impacts shift under larger penetrations of low-carbon supply. This enables evidence-based assessments of where energy efficiency outperforms supply-side options in terms of Multiple Impacts, thereby strengthening the analytical basis for the Energy Efficiency First Principle.

In practice, the module:

- Applies impact factors/functions that link renewable generation to multiple impact categories (e.g., GHG and air pollutant reductions, economic and social co-benefits).
- Quantifies avoided negative impacts from fossil energy sources
- Aligns with MICATool baselines and methods to ensure comparability with energy efficiency module of the tool.
- Supports combined and comparative analyses to evaluate different options and measures towards climate neutrality holistically.

For a seamless integration of the new module (Figure 28) and a consistent and as simple as possible user experience across both modules, the new module was implemented in a manner completely analogous to the energy efficiency module in terms of its logic and operation (including the inputs as well as the presentation of the results).

For a detailed description of the underlying methodology, please refer to Deliverable 2.1. Detailed instructions on how to use the new module will be included in an update of the MICATool training guideline.

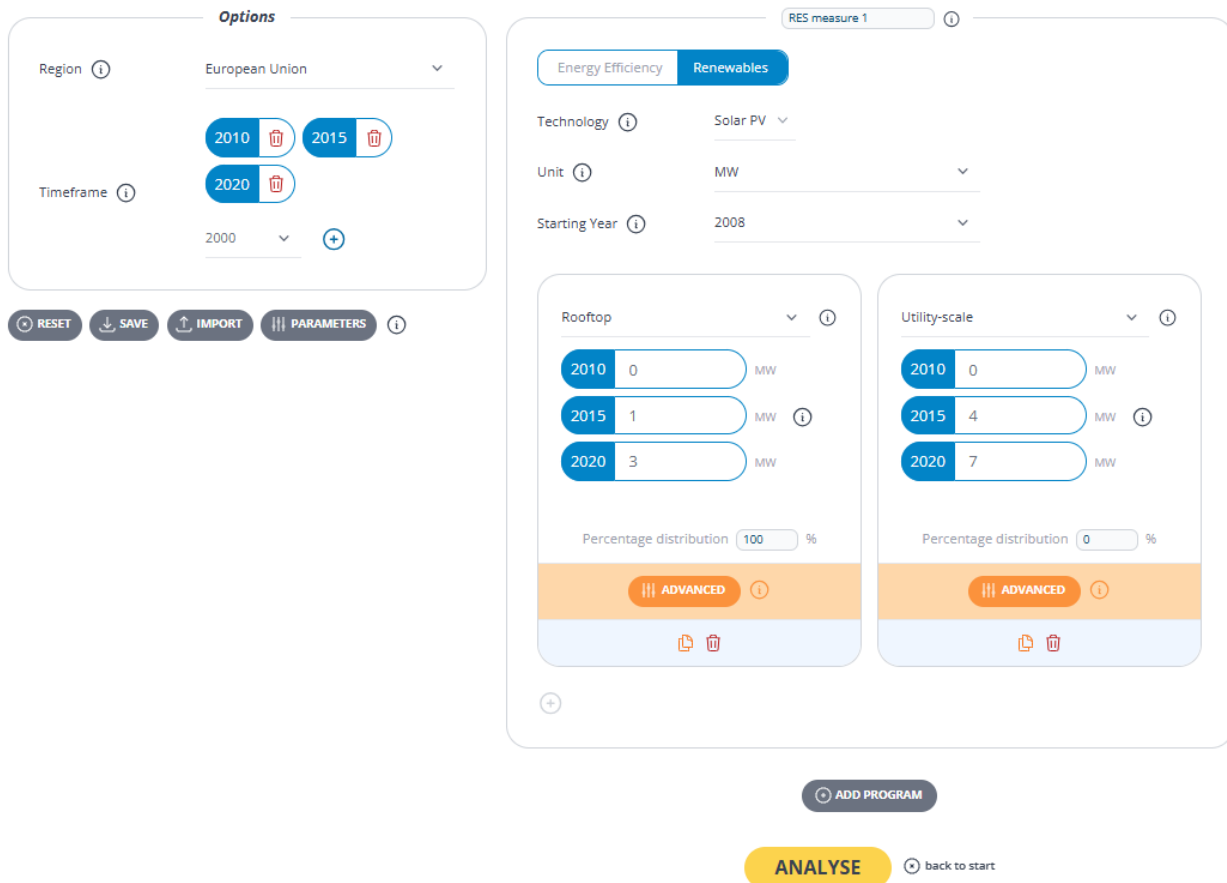


FIGURE 28 INTEGRATION OF THE RE SUPPLY SIDE-MODULE

## 5.2 Policy module

The Policy Module integrates prior policy assessment work into the MICATool to enable consistent, transparent analysis of energy efficiency policies. The module establishes a standardised connection to external data sources and imports reported savings into the MICATool, to facilitate the respective analysis of their multiple impacts (Figure 29).

Data integration for the policy module focuses on two sources:

- [MURE](#): Connected via an API, allowing direct import and assessment of quantified energy efficiency measures.
- [ODYSSEE](#): Top-down energy efficiency savings (by country, year, and sector) are integrated through a manual import process, as no API is currently available.

Within the module, imported policy information and savings are mapped to SEED MICAT categories and inputs (country, sector, time frame). However, since the allocation of savings to the various improvement actions (or their distribution across several different actions, if applicable) is not

stored in the two databases, this must be supplemented by the users. The general workflow for the two different modi of the module are shown in Figure 30-35 (MURE) and Figure 36-37 (ODYSSEE).

Further extensions of the module try to implement a "gap filling measure mode" which shall support stakeholder in the analysis of potential new measures (based on existing ones from other countries) which could help to fulfill saving targets.

## Assess the impacts of any energy efficiency project

Build your own suitable use case or scenario with your own values and receive a comprehensive multiple impact analysis.

Select your use case

Region ⓘ European Union

Timeframe ⓘ 2015 2020 2025

2000 +

START

LEARN MORE

Do you want to select data from a predefined use case?

Assess the impacts of past energy savings or specific policies

The statistical data of past energy savings originates from the ODYSSEE database, whereas the predefined real policies with provided energy savings stem from the MURE database. Both have been developed and maintained in the course of the long-running ODYSSEE-MURE EU-Project

START WITH STATISTICAL DATA ODYSSEE

START WITH A POLICY MURE

FIGURE 29 INTEGRATION OF THE POLICY MODULE

## Assess the impacts of past energy savings or specific policies

Browse through statistical data of past energy savings from the ODYSSEE database or predefined policies and measures with provided energy savings from the MURE database and analyse their multiple impacts.

Select a policy from MURE

Sector ⓘ Household

Country ⓘ Estonia

Starting date (optional) ⓘ 2013

Measure ⓘ Renovation of private houses 2014-2020

START

LEARN MORE

Do you want to use your own inputs?

DESELECT MURE

FIGURE 30 INTEGRATION OF THE POLICY MODULE – MURE EXAMPLE STEP 1

**Select a policy from MURE**

Sector ⓘ **Household**

Country ⓘ **Estonia**

Measure ⓘ **Renovation of private houses 2014-2020**

↻ RESET
↓ SAVE
↑ IMPORT
⋮ PARAMETERS ⓘ

**Renovation of private hou** ⓘ

Subsector ⓘ **Average residential** ▾

Unit ⓘ **PJ** ▾

Starting Year ⓘ **2016** ▾

Select improvement ▾ ⓘ

2016	0.000030	PJ
2017	0.008340	PJ
2018	0.015330	PJ
2019	0.021850	PJ ⓘ
2020	0.031290	PJ
2030	0.040400	PJ

⋮ ADVANCED ⓘ

📄

FIGURE 31 32INTEGRATION OF THE POLICY MODULE – MURE EXAMPLE STEP 2

**Select a policy from MURE**

Sector ⓘ	Household
Country ⓘ	Estonia
Measure ⓘ	Renovation of private houses 2014-2020

⌂ RESET
↓ SAVE
↑ IMPORT
⋮ PARAMETERS ⓘ

**Renovation of private hou ⓘ**

Subsector ⓘ	Average residential ▾
Unit ⓘ	PJ ▾
Starting Year ⓘ	2016 ▾

**Building envelope** ▾ ⓘ

2016	0.000012	PJ
2017	0.003336	PJ
2018	0.006132	PJ
2019	0.008740	PJ ⓘ
2020	0.012516	PJ
2030	0.016160	PJ

Percentage distribution  %

⋮ ADVANCED ⓘ

📄 🗑️

**Energy-efficient heating** ▾ ⓘ

2016	0.000018	PJ
2017	0.005004	PJ
2018	0.009198	PJ
2019	0.013110	PJ ⓘ
2020	0.018774	PJ
2030	0.024240	PJ

Percentage distribution  %

⋮ ADVANCED ⓘ

📄 🗑️

+

FIGURE 33 34 INTEGRATION OF THE POLICY MODULE – MURE EXAMPLE STEP 3



FIGURE 35 36 INTEGRATION OF THE POLICY MODULE – MURE EXAMPLE STEP 4

## Assess the impacts of past energy savings or specific policies

Browse through statistical data of past energy savings from the **ODYSSEE** database or predefined policies and measures with provided energy savings from the **MURE** database and analyse their multiple impacts.

Select statistical data from **ODYSSEE**

Sector <sup>i</sup>	Household <sup>v</sup>
Country <sup>i</sup>	Finland <sup>v</sup>
Starting year <sup>i</sup>	2019 <sup>v</sup>
End year <sup>i</sup>	2022 <sup>v</sup>

**START** **LEARN MORE**

Do you want to use your own inputs?

**DESELECT ODYSSEE**

FIGURE 37 INTEGRATION OF THE POLICY MODULE – ODYSSEE EXAMPLE STEP 1

Select statistical data from ODYSSEE

Sector ⓘ Household  
 Country ⓘ Finland

RESET SAVE IMPORT PARAMETERS ⓘ

Top-down EE savings ⓘ

Subsector ⓘ Average residential ▾  
 Unit ⓘ ktoe (kilo tonne of oil equivalent) ▾  
 Starting Year ⓘ ▾

Select improvement ⓘ +

2019	310	ktoe
2020	370	ktoe
2021	410	ktoe
2022	470	ktoe

ADVANCED ⓘ

ANALYSE ⓘ back to start

FIGURE 38 INTEGRATION OF THE POLICY MODULE – ODYSSEE EXAMPLE STEP 2

## 6. CONTINUOUS BUGFIXING

The following table provides an overview of further minor improvements and bug fixes that have been implemented in the tool.

**Table 1. Overview of minor improvements and bug fixes**

Bug or improvement	Affected part of the tool	Description
bug	general	<ul style="list-style-type: none"> <li>Results are not displayed reliably</li> </ul>
improvement	inputs	<ul style="list-style-type: none"> <li>Add a possibility to save and import the inputs</li> </ul>
improvement	general	<ul style="list-style-type: none"> <li>Add an output EXCEL with the results which can be downloaded</li> </ul>
improvement	general	<ul style="list-style-type: none"> <li>Adjust presentation of values for better readability (number of decimal places, ...)</li> </ul>
improvement	inputs	<ul style="list-style-type: none"> <li>Options- Time frame: PAST/FUTURE should be a toggle switch</li> </ul>
bug	inputs	<ul style="list-style-type: none"> <li>Years available incorrect, not always correct depending on ex-post/ex-ante selection</li> </ul>
improvement	global parameters	<ul style="list-style-type: none"> <li>"Only past values 2000 to 2020 can be adjusted -&gt; future is missing</li> <li>The years that were selected in the General Inputs under Time frame should always be displayed here</li> </ul>
improvement	global parameters	Fuel split coefficients: <ul style="list-style-type: none"> <li>add info button</li> <li>in percentage, add unit</li> </ul>
improvement	global parameters	Energy prices: <ul style="list-style-type: none"> <li>add info button</li> <li>add unit and show only two decimals</li> </ul>
improvement	global parameters	Electricity generation: <ul style="list-style-type: none"> <li>add info button</li> <li>in percentage, add unit</li> <li>adjust infobox accordingly</li> </ul>
improvement	global parameters	Heat generation: <ul style="list-style-type: none"> <li>add info button</li> <li>in percentage, add unit</li> </ul>

		<ul style="list-style-type: none"> <li>• adjust infobox accordingly</li> </ul>
improvement	global parameters	<p>Monetisation:</p> <ul style="list-style-type: none"> <li>• add info buttons</li> <li>• €/ktoe oder €/MWh</li> <li>• adjust infobox accordingly</li> </ul>
improvement	inputs	<ul style="list-style-type: none"> <li>• Add info button for the savings (which savings should be specified? Total annual savings)</li> <li>• Add general info button for the "Programme box"</li> <li>• For subsector selection: Emphasize main sectors (average agriculture, average industry, average tertiary, average residential, average transport). Delete "Average" from designations</li> <li>• Display the unit to be entered again (depending on the selection under Options - Unit)</li> </ul>
improvement	advanced parameters	<ul style="list-style-type: none"> <li>• Only display relevant tabs (fuel switch only for fuel switch measures, residential only for average residential measures)</li> <li>• Add info buttons for all parameters</li> <li>• Show percentages instead of absolute figures</li> <li>• Investment costs in million €</li> <li>• adjust ranges (e.g. for % only 1 - 100)</li> <li>• Always display "Fuel switch: Share of XY among removed" next to "Share of XY among installed" for all energy sources</li> <li>• Max. 2 decimal places for all parameters</li> </ul>
bug	general results	<ul style="list-style-type: none"> <li>• Results charts only ever show 2010 to 2020</li> </ul>
improvement	quantification results	<ul style="list-style-type: none"> <li>• The M/2 indicator is currently called 2/M</li> <li>• Some of the axis labels and the data format do not make much sense: make units, values etc. readable and consistent (also for monetisation)</li> </ul>
bug	general	<ul style="list-style-type: none"> <li>• The backend connection from the frontend failed.</li> </ul>
improvement	results - overview	<ul style="list-style-type: none"> <li>• Add info box</li> <li>• Make selection and deselection of parameters clearer</li> </ul>
bug	general results	<ul style="list-style-type: none"> <li>• wrong results for impact on GDP</li> </ul>

bug	general results	<ul style="list-style-type: none"> <li>wrong results for additional employment</li> </ul>
bug	general results	<ul style="list-style-type: none"> <li>wrong results for energy intensity</li> </ul>
bug	general results	<ul style="list-style-type: none"> <li>wrong results for import dependency</li> </ul>
improvement	general	<ul style="list-style-type: none"> <li>add data sources in the info buttons where feasible</li> </ul>
improvement	inputs	<ul style="list-style-type: none"> <li>add the possibility to distribute energy savings via percentages across different improvement actions</li> </ul>
improvement	general	<ul style="list-style-type: none"> <li>streamline the data format (english)</li> </ul>
bug	general	<ul style="list-style-type: none"> <li>resolve issues regarding the cache (user shall always access the newest version of the tool)</li> </ul>
bug	policy module	<ul style="list-style-type: none"> <li>Odyssee and Mure connection: improve filter option and the display of the measure titles</li> <li>Mure connection: import name of the selected measure as programme name</li> </ul>
bug	global parameters	<ul style="list-style-type: none"> <li>Energy mix coefficients are not displayed correctly</li> </ul>
bug	global parameters	<ul style="list-style-type: none"> <li>Heat generation parameters are not displayed correctly</li> </ul>
bug	global parameters	<ul style="list-style-type: none"> <li>Energy costs are not displayed correctly</li> </ul>
bug	global parameters	<ul style="list-style-type: none"> <li>Not all years are displayed for the monetisation factors</li> </ul>
Improvement	descriptions and info buttons	<ul style="list-style-type: none"> <li>Adjust information and description texts based on user feedback for better comprehensibility.</li> <li>Adjust indicator label for better comprehensibility</li> </ul>
bug	advanced parameters	<ul style="list-style-type: none"> <li>Average renovation rent premium: here, the value appears to be doubled everywhere. The default value would be 4%. The description should also be adjusted: 'The default value stems from a review of existing pertinent studies, although data availability is quite scarce.'</li> </ul>
bug	general	<ul style="list-style-type: none"> <li>Analyse: The following error message often appears, even when all parameters and data have been reset to default values: 'We are sorry. Your request could not be processed. Details: Input for division contains NaN values. Please get in touch.'</li> </ul>
bug	advanced parameters	<ul style="list-style-type: none"> <li>Adjustment of annual renovation rate not possible</li> </ul>
Improvement	results	<ul style="list-style-type: none"> <li>Impact on import dependency and on energy intensity: should rather be presented as negative values</li> </ul>

bug	results	<ul style="list-style-type: none"> <li>• Incorrect axis labels are displayed</li> <li>• Improve automatic scaling of axes</li> </ul>
bug	general	<ul style="list-style-type: none"> <li>• Dropdown menus are not functioning</li> </ul>
bug	general	<ul style="list-style-type: none"> <li>• server connection failed</li> </ul>
bug	advanced parameter	<ul style="list-style-type: none"> <li>• user inputs are not saved correctly</li> </ul>
improvement	general	<ul style="list-style-type: none"> <li>• improve design and usability of the landing page (e.g. more information on the policy module)</li> </ul>
bug	advanced parameter	<ul style="list-style-type: none"> <li>• Advanced parameters can not be saved</li> </ul>
bug	general	<ul style="list-style-type: none"> <li>• changed global parameters are not taken into account in the calculations</li> </ul>
bug	general	<ul style="list-style-type: none"> <li>• Fix interplay between global and advanced parameters (advanced parameters should override corresponding global parameters)</li> </ul>
bug	general	<ul style="list-style-type: none"> <li>• If you have two or more improvement actions in a programme, the results are no longer displayed in the overview.</li> <li>• If you have two or more improvement actions in a programme, many indicators in the results display strange information (results are shifted to the wrong years).</li> </ul>
improvement	results - overview	<ul style="list-style-type: none"> <li>• Display overview separately for each programme</li> </ul>
bug	general	<ul style="list-style-type: none"> <li>• CBA only partially displayed</li> </ul>
bug	results	<ul style="list-style-type: none"> <li>• Energy costs are shown in the results in € instead of in million €.</li> </ul>
bug	general	<ul style="list-style-type: none"> <li>• New error: Factor tables must have the same year columns</li> </ul>
bug	results	<ul style="list-style-type: none"> <li>• Exported results file can not be opened</li> </ul>
<b>+ numerous follow-up issues and bugs</b>		

# SEED MICAT PARTNERS

