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EUCALC

Explore sustainable European futures

EUCalc model / Pathways Explorer - release 2

D9.6

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Short Description
This document describes the EUCalc Transition Pathways Explorer web application and, in particular, the user interaction and functional design choices made when producing it.

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Statement of originality:

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

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Disclaimer

This document is supposed to describe Deliverable 9.5, which is the launch version of the Transition Pathways Explorer web application. The development of the EUCalc model, however, is not yet finalized. As a consequence, the results representation in the Transition Pathways Explorer is still in a transient state and the public call for evidence is still running. Hence, the development of the Transition Pathways Explorer has to be kept open until feedback is collected in order to guarantee a product that best suits user needs. This is also why the menu with a "FEEDBACK" button is open when arriving on the website.

This document, hence, describes an intermediate version of the Transition Pathways Explorer. Even though details will still change, the fundamental principles and layout/design choices can be described here.

The optimization of the Python code of the underlying EUCalc model, that is running on the server, is not yet finished. For the time being, a request sent by the Transition Pathways Explorer to the server is often only answered more than 100 seconds later. Remedies to this limit are being explored both with respect to model speed as well as to the notification of the user about the calculation time.

1 Executive Summary

This document presents Deliverable 9.6, the second release of the Transition Pathways Explorer, the online user interface to the European calculator model which is accessible at tool.european-calculator.eu. It describes the purpose, functional design, general layout, user interaction opportunities, results prioritization and display of the Transition Pathways Explorer (TPE) in its second version. The model itself is described in other Deliverables and documents, for example in the Cross-Sectoral Model description and documentation.

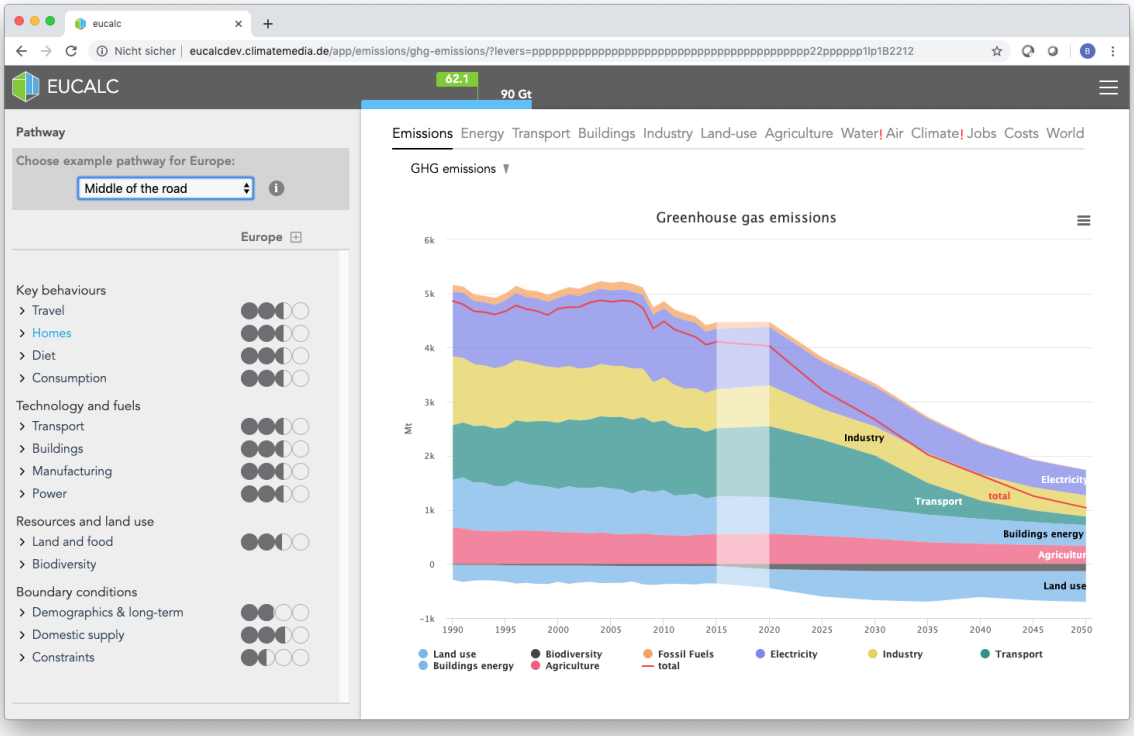

Figure 1 – The EUCalc Transition Pathways Explorer web application showing Greenhouse gas emissions from 1990 to 2050 set to the "Middle of the road" example pathway.

The TPE enables the user to explore the solution space for the European decarbonisation challenge. It is a web application that provides a simple interface to the EUCalc model. The user can design an individual emissions pathway for Europe by choosing ambition levels for all relevant decarbonisation sectors represented by levers. The tool then presents the consequences for energy supply and demand, system costs, land use and biodiversity, water availability, air pollution, employment, equity and transboundary effects for immediate insights into potential trade-offs and synergies of decision-making in different sectors.

Figure 2 – The Transition Pathways Explorer (indicated in the middle) is the interface between the EUCalc model (indicated on the left) and the user.

2 Purpose of the second release of the Transition Pathways Explorer

The general purpose of the TPE is to help guarantee that the outcome of the project can be influential in terms of having an impact on public policy making, civil society, and private sector decision making.

The consortium is trying to achieve this goal by maximising the usefulness and relevance of the EUCalc model and the Transition Pathways Explorer for the addressed target groups. The initial step to get to a demand-driven design was to understand the challenges, the members of these groups face, and the (political/strategical) levers they can set in motion to meet these challenges.

As has been assessed in various stakeholder interactions, such as informal end user consultations and demand analysis workshops in Potsdam and Brussels (see Deliverable 9.1 for details), policy makers want to use the tool to test impacts of (shadow) policies and identify areas of significant policy impact on emissions. Civil society organisations want to use the tool in their advocacy related efforts and activities. For the private sector the tool may assist with costing, technology choices, estimating the economic impacts of the transition and with the quantification of their role and contributions. All stakeholders emphasised the importance of transparency and clarity around assumptions and the meaning of terminology used. While striving to cater for as many of the stakeholder desires as possible, we also decided to not do so for some requests in order to safeguard the guiding principles of the modeling and presentation approaches.

3 User interaction and functional design choices

The target audience for the Transition Pathways Explorer comprises in large part decision makers that have limited time budgets. In order to respect this limitation, we designed the tool to be as clear, simple and user-friendly as possible, both with respect to content as well as to its presentation.

With "clear" we mean comprehensible and transparent. This is enforced by strictly separating in the presentation what is input to the EUCalc model and what are the results of the calculation, see section 3.3.

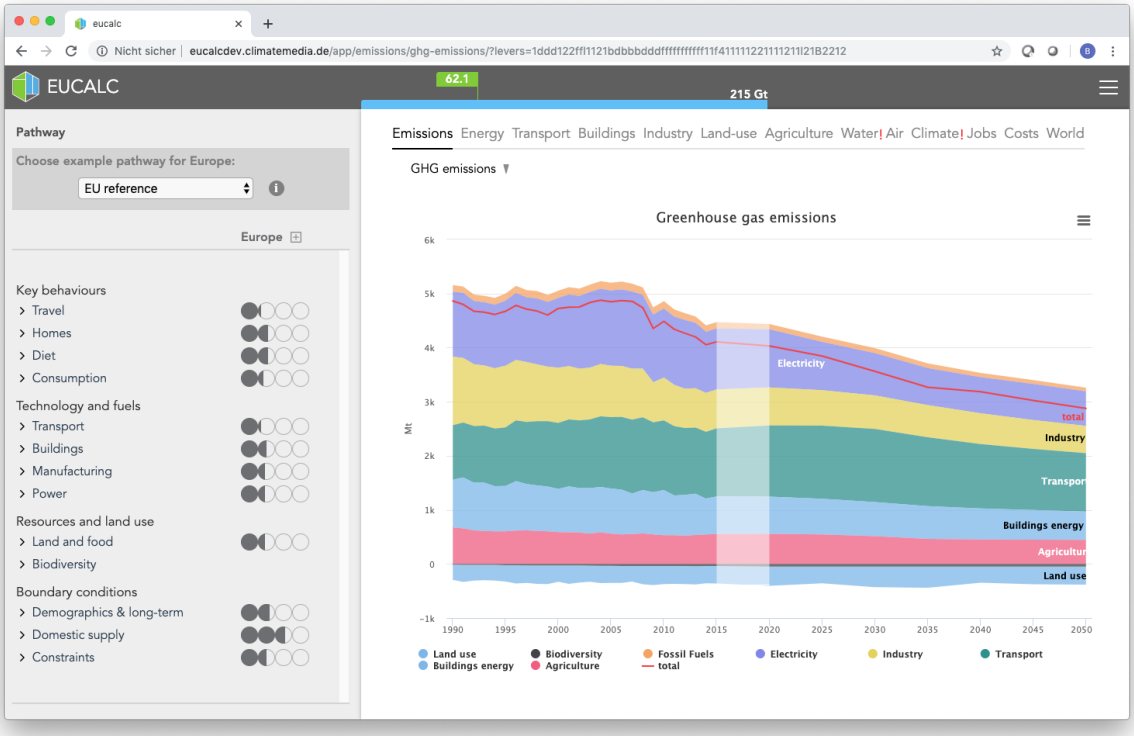

Figure 3 – Screenshot of the Transition Pathways Explorer showing the greenhouse gas emissions per sector "Emissions" output tab for the "EU reference" example pathway.

In order for users to perceive the interaction with the TPE as being "simple", even though the underlying model and the choice of inputs is rather complex, we strongly focus on initially representing only the most important aspects. The complexity of the model is hidden on first sight. Results graphs, that are preselected, show aggregated results. The full complexity is readily accessible at the appropriate place in the user interface, details are dynamically shown on demand (ref. section 3.4). Furthermore, instead of showing a bouquet of reduction targets and trajectories to be met, the application reduces "success" to complying with one number, staying below a set emission budget (ref. section 3.1).

By accounting for typical user behavior (ref. section 3.2) and by respecting common interaction metaphors, the application is intuitive and user-friendly.

The layout of the web application is designed to allow very different user interaction sequences. One of the most natural ones may be the following.

- Click through the intro pages to understand the challenge and the purpose of the web app
- Set a GHG budget for Europe
- Enter the main page of the app (and take a quick tour)
- Choose a predefined example transition pathway from the dropdown menu
- Examine consequences and potential trade-offs and synergies by looking at the output tabs
- Either design an individual pathway, compare different example pathways or zoom into a specific country
- Share interesting results

3.1 User sets a European GHG budget

After being introduced to the decarbonization challenge, the user is familiarized with the principle idea of the EUCalc model and the resulting opportunity for the user to choose ambition levels for a concise set of most influential "levers" (introduction is still to be developed).

In order to motivate the user to find a transition pathway that respects the goals agreed on in the Paris accord[1], we envisioned a feedback gauge that is always visible and that can synthesise success in that respect.

Which goal shall the user reach? This is the question that had to be answered to develop such a feedback gauge. Possible goals for a Pathways Explorer user are

- Get below a specific GHG emission curve (taken from the literature) that respects the 1.5° or 2° C threshold like in the following example.

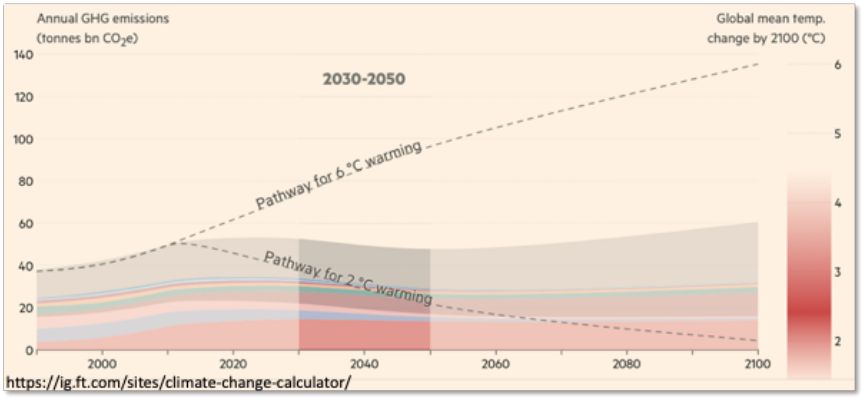

Figure 4 – The dashed lines indicate emission paths compatible with different warming in 2100. https://ig.ft.com/sites/climate-change-calculator/

[1]https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf

- Meet politically agreed decarbonisation milestones like in the following example.

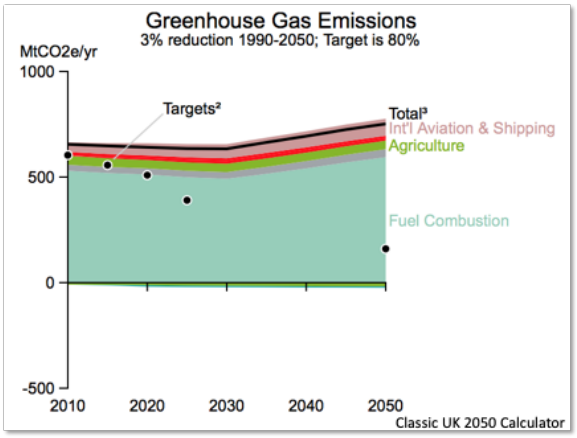

Figure 5 – The dots indicate reduction targets set politically until 2050. http://classic.2050.org.uk

- Reduce 80-95% of GHG emissions until 2050 (with respect to those in 1990) like in the following example.

Figure 6 – The yellow gauge on the right indicates the emission reduction in Belgium until 2050 with respect to 1990. The goal for the user is to get the bar between the green arrows, i.e. between 80 and 09% reduction. http://webtool.my2050.be

- Become net-zero until 2050.
- Undercut a specific carbon budget

While the first two options unnecessarily restrict the number of pathways considered as "successful", the third approach is considered insufficient for European countries from the current perspective. The goal to become net-zero is very timely. From a physical perspective, though, it neglects the fact that different decarbonisation speeds would lead to different cumulative emissions and, hence, to different amounts of warming[2].

[2] The evermore restricted time frame and the fact that the speed in which transformational change may occur may lead to a restricted set reduction pathways that can realistically comply with remaining budgets, which weakens this argument.

Figure 7 – Emissions versus time. Respecting the same reduction target at a specific point in time may lead to very different cumulative emissions (Graphic: REF Meyer-Ohlendorf, Nils; Voß, Philipp; Velten, Eike; Görlach, Benjamin: EU Greenhouse Gas Emission Budget: Implications for EU Climate Policies, 2018[3]).

The idea of a remaining GHG budget is simple and compatible with plausible fairness approaches. Nevertheless, it is not commonly used in general climate mitigation discourses. Depending on the international fairness approach applied, the European share of the budget may be small or even negative. In the latter case, carbon markets have to be explained, additionally. The budget approach has the advantage, though, to combine two things that are frequently incompatible: The concept is scientifically sound and easy to understand. The budget approach has, therefore, be chosen as the success measure for pathways set by the user in the TPE.

The last page of the introduction asks the user to choose a warming guard rail she or he does not want to exceed with the transition pathway to be chosen afterwards. A burning amber diagram exemplifies risks that come about with different levels of warming. With the help of these examples, the user can comprehend the difference it makes in terms of risk to stay below the threshold of 1.5°C or below 2°C above pre-industrial levels[4]. To guarantee staying below these thresholds with a given chance (66% is predefined here), the greenhouse gas emissions must not exceed a specific global greenhouse gas budget. The latter is defined as the maximal total amount of greenhouse gases (converted to cumulative CO_2 equivalents) that can still be emitted globally to have a chance to limit global warming to 2° or 1.5° C[5]. An additional choice, the user can influence if desired, is the approach of how the European share of this global budget is calculated. This is a question of fairness, than can be answered very differently, depending on the respective point of view. All different approaches discussed in the literature (REF Meinshausen) have in common that the remaining European share would be very small or even negative. For a detailed explanation of choice of approaches and of the methodology, please refer to Deliverable 1.2.

The progress in reaching the goal is always visible as a horizontal gauge in the header of the Transition Pathways Explorer web application as shown in the screenshot in Figure 8.

[3]https://www.ecologic.eu/sites/files/publication/2018/2120_eu_emission_budgets_ecologic_report20180124_final.pdf

[4] In case the 2° threshold is chosen, the user is informed that it may be impossible to "park" the climate at 2° (REF hothouse earth paper, Steffen et al. 8252–8259 | PNAS | August 14, 2018 | vol. 115 | no. 33)

[5] German Advisory Council on Global Change (WBGU) Special report: *Solving the climate dilemma: The budget approach*, Schellnhuber et al., 2009

Figure 8 – Screenshot from the TPE showing the chosen GHG budget (green flag) and the actual GHG emissions that are calculated by the model until 2100 for the set pathway (blue bar).

The global warming potential of the most important GHG emissions (CO_2, N_2O, CH_4, SO_2) are calculated using the emissions coming from the sectors to produce the „Carbon dioxide equivalency", i.e. the time-integrated radiative forcing described by CO_{2e}.

3.2 User experience is guided from left to right

The design of the web application highlights the results area with the white background on the center-right.

Most users, however, start looking at the top left of websites when they open as can be expected from users with a left–to-right reading direction. In order to be in accordance with this, the layout of the TPE also adopts a left-to-right arrangement. At the same time, this represents the EUCalc model workflow and suggests a sequence for the two major user interactions, namely

- choosing a pathway by setting ambition levels on the left and
- exploring the model output on the right.

Examining the alerts of overused resources and other warnings may then lead the user back to the ambition levels set by the levers on the left to reconsider and possibly change them.

This approach remedies a shortcoming of earlier calculators like the Global Calculator in which the user sets specific or example pathways at the bottom of the page to see the results on the top afterwards.

3.3 Presentation of input to the model and model results are clearly separated

Unlike one of the predecessors of the EUCalc project, the Global Calculator[6], the EUCalc Transition Pathways Explorer does not show graphs of (slightly modified) input parameters in the output panes. The clear decision was made to clearly separate input to the model and model results by graphical user interface design.

The data that is input to the EUCalc model is only shown when interacting with the lever pane on the left. Hovering over a lever name or a lever ambition level reveals short mouseover explanation texts as can be seen in Figure 9.

[6] the interface to the model is online here: http://tool.globalcalculator.org

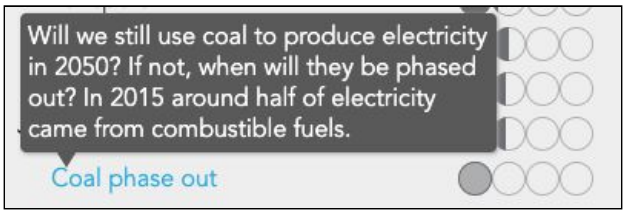

Figure 9 – Mouseover explanation text shown when hovering over the "Coal phase out" lever.

Clicking on the lever names opens the lever explanation panels. Those panels give details on what the lever is for, on the context, on things to consider and they give the full non-expert-readable descriptions of the levers ambition levels. The graph shows the temporal evolution of (one of the dimensions of) the ambition metric. At the end, every lever explanation links to the respective technical documentation.

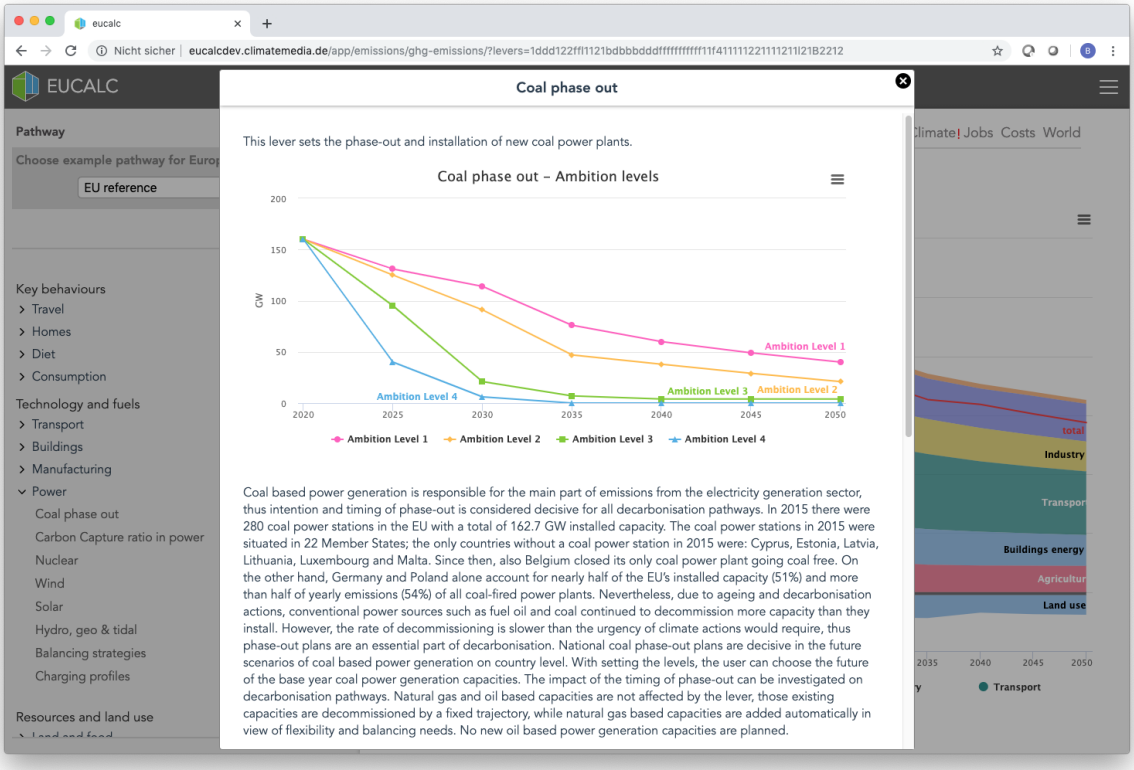

Figure 10 – Explanation of the "Coal phase out" lever shown in a modal window that can be opened by clicking on the lever name. The graph shows the assumed future temporal evolution of the installed coal capacity for the ambition levels 1 (pink curve) to 4 (light blue curve).

3.4 Details are revealed on demand

Already the choice of levers has been a strong reduction in detail. The 58 levers are assigned to lever groups that, on their part, belong to domains. On arrival on

the web application, the user can only see the names of the lever groups under four different domains headings. Clicking on a lever group name opens a drawer with the levers belonging to this group. Lever name and ambition level bubbles are equipped with concise descriptions that appear on mouse-over. Clicking on the lever name opens more detailed descriptions, see Figure 10 above.

Domain	Lever group	Lever
Key behaviours	Travel	Passenger distance
		Mode of transport
		Occupancy
		Car own or hire
	Homes	Living space per person
		Percentage of cooled living space
		Space cooling & heating
		Appliances owned
		Appliance use
	Diet	Calories consumed
		Type of diet
	Consumption	Use of paper and packaging
		Product substitution rate
		Food waste at consumption level
		Freight distance
Technology and fuels	Transport	Passenger efficiency
		Passenger technology
		Freight efficiency
		Freight technology
		Freight mode
		Freight utilization rate
		Fuel mix
	Buildings	Building envelope
		District heating share
		Technology and fuel share
		Heating and cooling efficiency
		Appliances efficiency
	Manufacturing	Material efficiency
		Material switch
		Technology efficiency
		Energy efficiency
		Fuel mix
		Carbon Capture in manufacturing
		Carbon Capture to fuel

	Power	Coal phase out
		Carbon Capture ratio in power
		Nuclear
		Wind
		Solar
		Hydro, geo & tidal
		Balancing strategies
		Charging profiles
Resources and land use	Land and food	Climate smart crop production
		Climate smart livestock
		Bioenergy capacity
		Alternative protein source
		Forestry practices
		Land management
		Hierarchy for biomass end-uses
	Biodiversity	Area set aside for nature...
		...from agriculture or forestry
Boundary conditions	Demographics & long-term	Population
		Urban population
		EU emissions after 2050
	Domestic supply	Food production
		Product manufacturing
		Material production
	Constraints	Global mitigation effort
		Discount factor

Table 1 – The 58 levers are grouped and put into domains. On arrival on the web application, the user can only see the names of the lever groups under four different domains headings.

The lever ambition level for all countries, EU28+Switzerland, at once can be set by clicking on an ambition level bubble. Decimal values are set by clicking several times. In order to set the ambition for a specific country differently from the rest of the countries, the user can choose that country from a dropdown menu to make a second set of ambition level bubbles appear in the lever pane.

If the ambition for individual member states changes, other countries do not automatically adapt to compensate for the additional emissions. We do not want to prescribe an algorithm how the rest of the EU reacts when a country's ambition is changed. This is left to a political negotiation process.

3.5 Restrictions/warnings

Certain sets of lever settings, i.e. pathways, can lead to warnings. A very high ambition level for the "Area set aside for nature…" lever can, for example, lead to

problems with the amount of land necessary for other uses. This would be indicated in the "Land use" tab via the "Land scarcity / deforestation" warning.

Warnings are shown with red exclamation marks behind the tab menu items. Tabs with a warning have a red box at the top when opened with the warning name. It can be expanded to expose more detailed information about the warning and, if applicable, about the most influential levers to remedy to the problem.

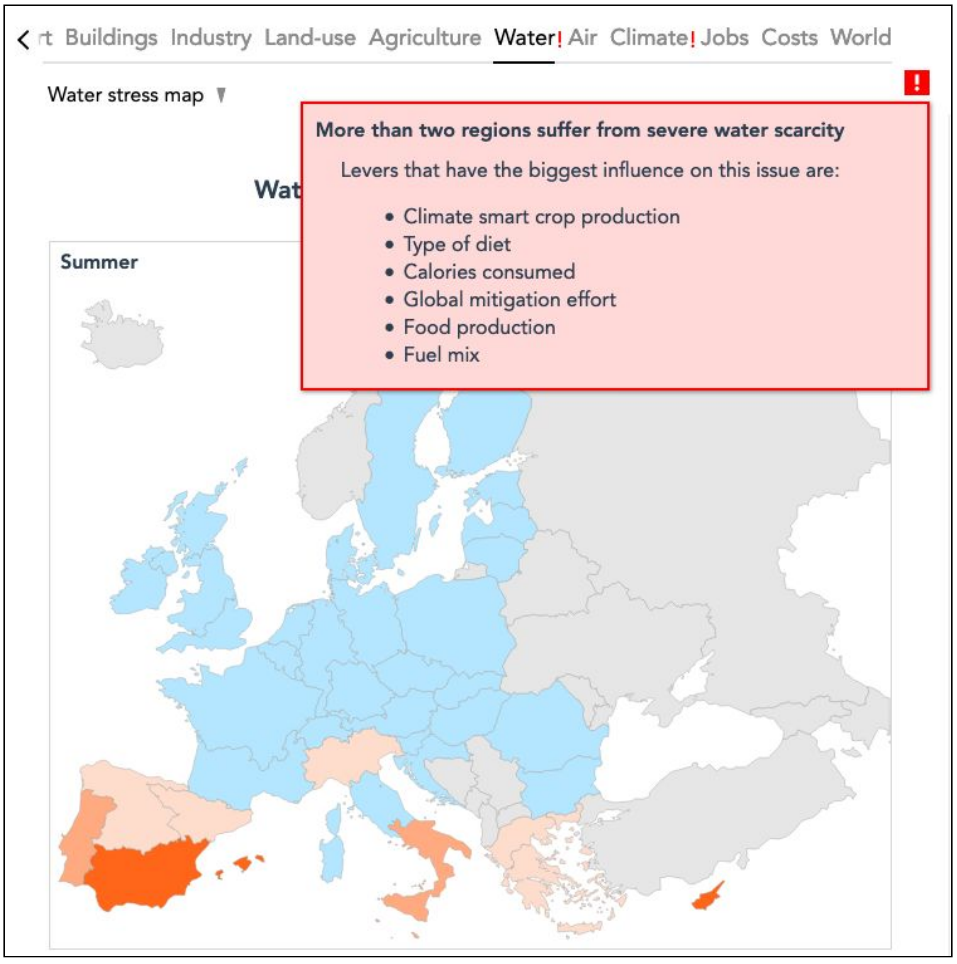

Figure 11 – TPE screenshot of the TPE showing the expanded warning sign in the output tab "Water" exposing more detailed information about the warning.

The levers with the strongest influence on remedying the problem will be highlighted in the lever pane on the left to guide user focus.

The table below shows the warnings that the Transition Pathways Explorer will feature. The ones marked in green are already implemented and active.

Warning name	Associated TPE output tab
Electricity oversupply	Energy (electricity)
Land scarcity / deforestation	Land
Water scarcity	Water

Drought risk	Climate
Flood risk	Climate
No equilibrium solution for pathway in GTAP	World
Air pollution	Air
Fossils scarcity	Minerals
Minerals scarcity	Minerals
High biofuels demand	Transport
High efuel demand	Transport

Table 2 – Warnings available in the Transition Pathways Explorer. The ones marked in green are already implemented and active.

3.6 Dimensions of ambition are implicitly represented

The notion of "ambition" has several dimensions, such as the start date of an intended change, the speed of deployment, and the share or penetration of the change. In the EUCalc model, these dimensions are all integrated to be represented by one number, the "ambition level". They are implicitly represented by the temporal curve shape of the share or penetration of the intended change.

These have been extensively co-created with almost 1000 stakeholders in countless workshops and other interactions.

3.7 Call for Evidence version of the TPE

Static versions of the Transition Pathways Explorer have been produced for the Calls for Evidence since the model calculation time was exceeding two minutes at that time. In order for the user to be able to play around with the tool and see changes in the results instantly, a storage backend was developed and fed with precalculated results for the example pathways that can be chosen from a dropdown menu. The lever settings of these pathways are shown by the ambition level bubbles, the levers can, however, not be set individually in that version.

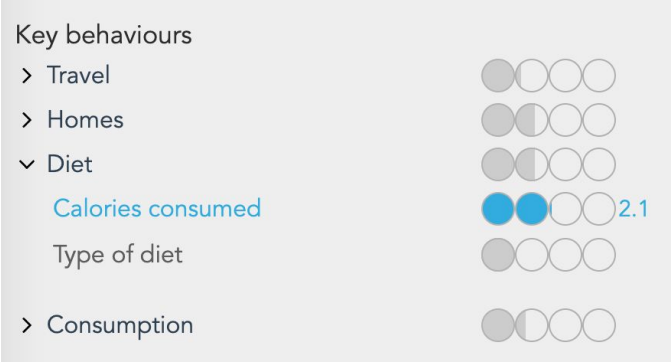

Figure 12 – The greyed out ambition level bubbles show the values set by the example pathways. The ambition level of individual levers can, however not be set by the user in the call for evidence version of the TPE.

Precalculating the results for all possible pathways is impossible due to the sheer amount. Even if we would only allow every lever to have only four possible (integer) ambition levels, and if we would further restrict the number of pathways by setting the ambition of every country to the same value, the TPE could still display the results of around 10^{34} different pathways[7].

3.8 Outlook

Introduction pages

We plan to produce both an on screen tour through the graphical user interface like those familiar from market leader cloud office software providers or as has been done in the Indian Calculator, see Figure 13, and, additionally an explanatory screencast that goes more into detail.

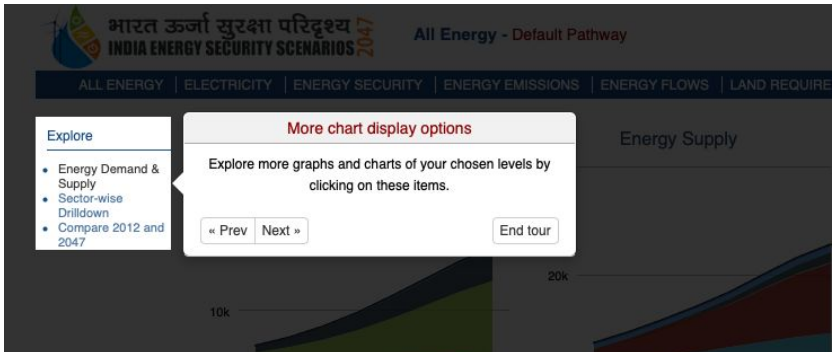

Figure 13 – On screen tour through the Indian Calculator user interface. Screenshot taken from http://iess2047.gov.in.

Audio-visual content

As soon as the model results are consolidated and main messages can be formulated, audio-visual content is going to be produced that will enrich and promote the EUCalc Transition Pathways Explorer by framing the main messages ("pathway narration").

Integration of call for evidence feedback

The call for evidence feedback will be carefully analysed and appraised to find the ideal set of enhancements to the TPE.

Calculation speed

At the current stage of development, the EUCalc model cannot provide „instant" results due to the complexity of the sectoral modules and their interactions. The calculation takes around 100 seconds to complete on the server. The calculation time of the final model version is decisive of the interaction design of the TPE. Ideas on how to accelerate the computation include the following.

[7] which is around a trillion times the number of stars in the visible universe

- calculate rough results (in less than a second) by shortcutting some KNIME flows to show preliminary graphs and re-run the same set of inputs through the full model (in less than a minute) to readjust the graphs
- Scenarios that the user have picked are by default stored in cache. A list of previous runs is available to the user if they want to go back to them.
- Equip the server back-end to be able to handle simultaneous requests and to be able to serve cached results while performing a model run. So that users with cached requests don't have to wait for any model run that happens in the background.

In case those ideas turn out to be impractical or impossible for any reason, the Transition Pathways Explorer will have to be adapted in order to avoid user frustration. Such adaptations could include

- what has been done for the call for evidence version: making the example scenario drop down box more apparent to invite the user to use it (all example scenarios are pre-calculated and the server can, hence, deliver instant results for them),
- greying out the lever positions until the user actively decides to use them to set an individual pathway,
- informing the user that running a custom scenario takes around one minute while picking from the scenario list is instantaneous