Creating a pathway in the Global Calculator

This document sets out guidance for producing an example pathway for the Global Calculator. This could be a brand new pathway produced from scratch, or re-creating a pathway that was originally generated through another process (e.g. produced from a model such as TIMES).

Structure of this paper:

- Guidance for producing a new pathway: 1 page version
- Guidance for producing a new pathway: 4 page version
- Guidance for re-creating an existing pathway in the Global Calculator

Guidance for producing a new pathway: 1 page version

Guidance for creating a pathway

1. **Set the levers.** Click on the boxes to set each lever. Each lever has four boxes, defined as described below. Some users take an example pathway as a starting point and improve the lever choices from there.
2. **Check cumulative emissions.** If you want to create a pathway consistent with international commitments to limit global mean temperature increase to 2C, then keep cumulative emissions below the line for a 50% chance of achieving this.
3. **Check warnings.** Potential problems with your pathway are highlighted in red in the warnings panel. Hover over the icons to view suggested solutions.

Also see "how to" video (2 mins) and more detailed how to guide.

Guidance for creating a new pathway: 4 page version

The Global Calculator tool is controlled using a number of levers. These appear on the bottom half of the screen. The user creates a pathway by clicking on the levers. The top half of the screen shows you information about the pathway, often in the form of graphs. There are many different tabs along the top that you can click on to see the implications of the pathway on different sectors or outcomes.
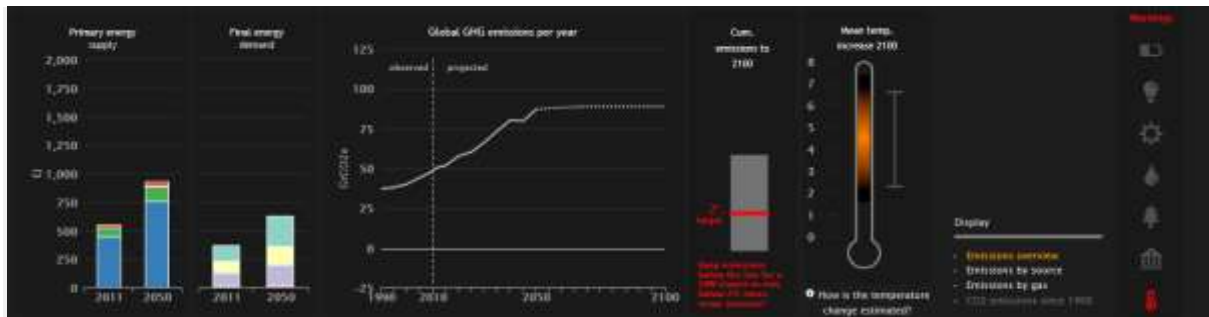

The graphs available on the overview tab

When you open the tool, you are taken to the overview tab. This gives you the headline information about the current pathway, with primary energy supply, final energy demand, and emissions graphs. The tool also contains a thermometer, so you can see the change in global mean temperature that the current pathway would produce in the year 2100. There are other tabs which include information on energy supply and demand by sector, lifestyle, costs, resources (land use patterns and fossil fuel consumption/reserves) and the climate. There are many graphs so it's good to look at what is available under each heading at the top.

The levers

The Global Calculator has a number of levers that affect the greenhouse gas emissions that are produced in various sectors (for example, in transport, manufacturing and buildings) from now until the year 2050. You control the calculator using these levers – for example you can choose to build nuclear power stations, reduce the distance people travel by car, or change people's diets.

The first view has 14 grouped levers, split by lifestyle (left section), technology and fuels (middle section) and land, demographics and long terms (right section). These look as follows:
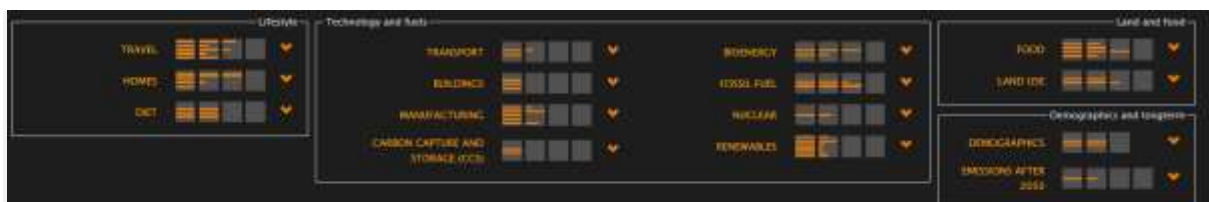
The grouped levers, as they appear when you launch the tool. Clicking the orange arrows expands the list to reveal more.

You can expand the levers by clicking on the down arrow next to each of the 14 grouped lever names. This will give you more control on what happens within sectors, for example under

"transport" in the "technology and fuels" section, you can choose to not deploy electric vehicles, but to make non-electric vehicles more efficient.

All the levers, which are visible once the grouped levers have been expanded.

For each lever you have a number of options to choose from – most will have four possible "levels" labeled 1, 2, 3 and 4. These relate to the amount of effort being used to tackle climate change, ranging from minimal effort to an extraordinarily ambitious and extreme level of effort. This allows the user to see the range of what is possible in the future. Each level has been set by consulting experts from around the world.
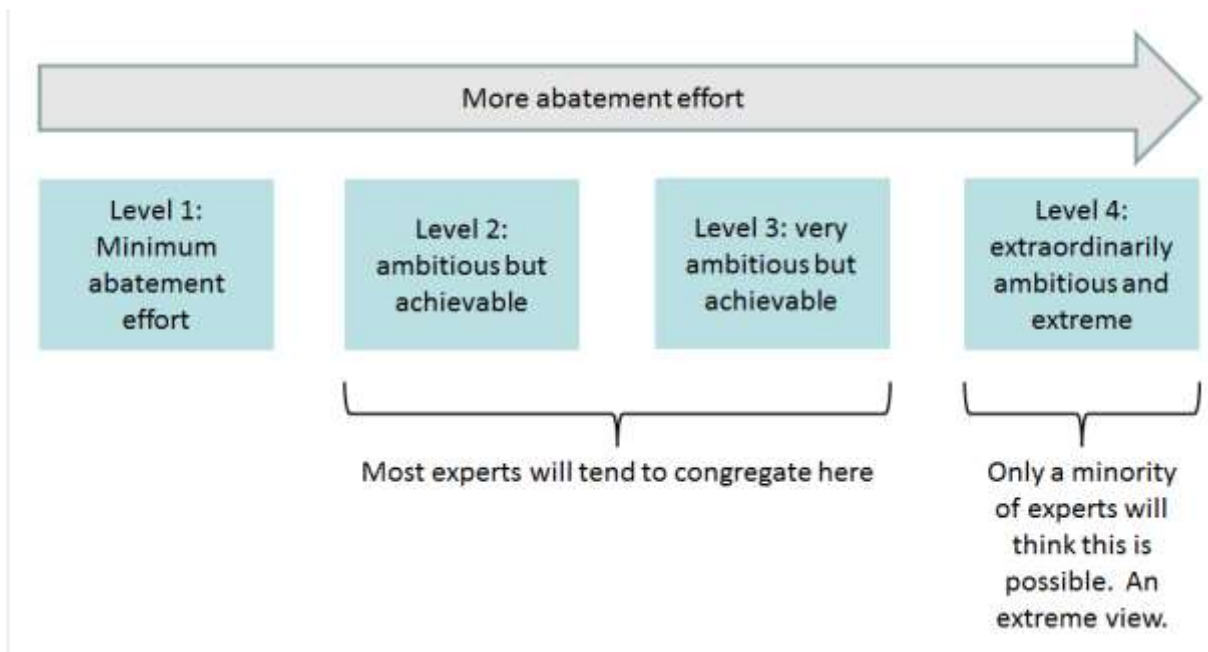

Diagram showing the meaning of levels 1 to 4

You can choose which level you want for a lever by clicking on the boxes next to it. The level selected is indicated by white shading. You do not just have to choose between the whole numbers 1, 2, 3 and 4, but can select levels between. To do this, click on the square multiple times, and you will step down 0.1 each time. For example, to set a lever to level 1.8, click on the level 2 square three times to step down from 2, then to 1.9 and then 1.8.

If you hover over the level buttons, you can see a summary description of what the levels mean. For more information about the lever, click on the lever name (e.g. "passenger distance") and you will open up a full description giving background information, graphs and more detail about levels 1 to 4 for this lever.
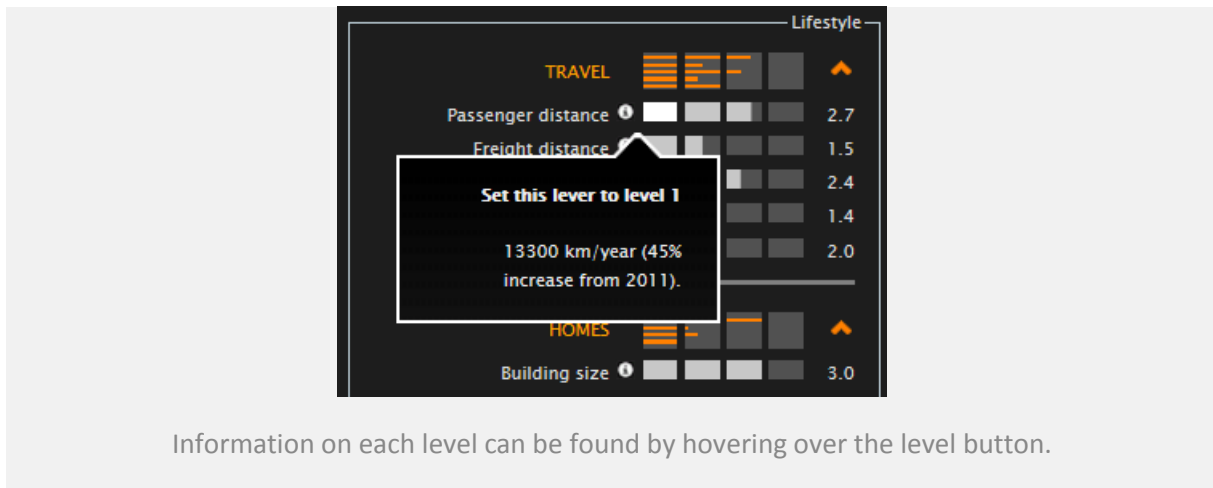
Information on each level can be found by hovering over the level button.

You can choose any combination of lever choices to create a "pathway" and then explore the implications. For example, regional climate impacts or cumulative fossil fuel consumption.

Warnings

Potential problems with your pathway are flagged up as warning indicators (see below). The icons illustrated will flash red if there is a problem. An explanation of the problem and ideas for how you could fix it is provided when you mouse over.   So to improve your pathway, you should aim to have no red warning lights (or at the very least, be aware of the warning and recognise what it tells you about your pathway).
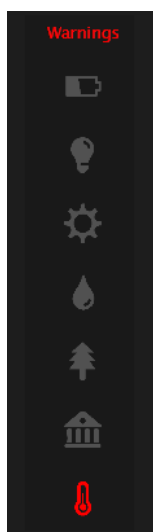
What main methodological issues should I be aware of?

The following methodological issues in the Global Calculator should also be known before attempting to map an example pathway.

1. The Calculator is user driven - the user is responsible for specifying physical things, such as distance travelled. There are broadly no feedbacks between sectors or choices.
2. The model matches electricity supply to demand if the user undersupplies electricity from their choices. Any shortfall is met by electricity from power plants without carbon capture and storage
3. The model produces fossil fuels to meet the demand for hydrocarbons above that which is supplied by bioenergy (the demand for hydrocarbons and bioenergy supply are both driven by the user)
4. The manufacturing sector "produces" the materials for the vehicles, appliances, buildings and fertilisers that are demanded in the user's pathway. So if you increase travel demand, then more cars are needed, and these are "produced" by the manufacturing sector. This increases the demand for steel and chemicals for plastic.
5. The user can chose whole numbers (1,2, 3 or 4), but decimal places (1.2, 1.3 etc) provide a closer match. Double click a level to reduce it by 0.1. The Calculator simply interpolates between levels by the corresponding decimal place, e.g. if level 1 is 10, and level 2 is 20, then level 1.6 chooses 16.

How does your pathway compare to others?

Users often want to check how their pathway compares to other example pathways in the tool. An easy way to do this is by clicking on "compare" at the top right of the screen. This opens up a summary table of key metrics for your pathway, alongside other example pathways.

URL for your pathway

To generate the unique URL for your pathway, click on "share" (top right hand side) and copy/paste the URL.

Guidance for re-creating an existing pathway in the Global Calculator

If you have a pathway produced through another process (for example, from a model such as TIMES), it is possible to re-create it in the Global Calculator.

To re-create your pathway, you need to consider:

- **The outcome**: do you care more about matching energy, emissions, physical implications (number of cars, installed capacity of wind etc) or some other consequence? Sometimes you can't match all implications at once because of fixed assumptions in the tool which differ to other models. For example, you may be able to match the primary energy supply from wind, but not the installed capacity of wind, because the capacity factor of wind is a fixed assumption in the Global Calculator, which may differ to the assumption in your scenario.
- **The key metric:** when you pull a lever, it can "drive" multiple things. For example, the "mode" lever determines passenger mode and freight mode simultaneously. This is done to limit the overall number of levers. You should choose the metric you are trying to match – in this case, do you want to match passenger mode or freight mode, or get both roughly right?
- **The time frame**: do you care more about matching the implication in a given year (e.g. 2050 or 2030) or matching the trend over a certain period (e.g. 2040 to 2050)?

Once you've made your decision about what implications you want to match and when you want them to match, you may still find it difficult to do this perfectly. This paper considers that matching across all implication within around 5-10% to be a good match. Remember that mapping scenarios into the Global Calculator is not an exact science and it may be difficult if your scenario or underlying model / analysis is different.

My model / analysis is partial – can I still map a pathway?

Yes. Sometimes you may have a model that is different in coverage to the Global Calculator. Here are some issues you should keep in mind:

- The Global Calculator covers all global emissions and energy – do you have a scenario which also covers all energy and emissions?
- The Global Calculator breaks down the world into sectors, each modelled at a global level – do you have outputs in compatible categories?
- The model begins in 2011 and energy implications are modelled up to 2050 – do you have a scenario up to 2050?

Where existing scenarios are not structured in the same way as the Calculator, you have to make a judgement about how to set the levers that address the other energy or emissions in a way which is consistent with the broad philosophy or "state of the world" in your underlying scenario. For example, the IEA don't model food supply in their scenarios, so the choices were set to give emissions and warming consistent with their overall scenarios (e.g. higher deforestation in the 6 degree scenario vs the 2 degree scenario).

How to find the implications you are trying to match

When you are trying to match an implication from an existing scenario (for example, final energy demand for transport) you should be able to find most of the data you will need in the webtool. However, confident users, or those who wish to match on implications not shown in the webtool,

can use the spreadsheet (please see the "spreadsheet user guide" for more information on where various implications are reported). Note that you can load a scenario from the webtool into the spreadsheet as follows:

- Click "share" at the top right of the webtool
- Highlight and "copy" the lever choices
- "Paste" the lever choices into the "user inputs" sheet in the spreadsheet
- Press "F9" to recalculate the spreadsheet. This can take around one minute owing to the size of the spreadsheet. Do this whenever you change a lever setting and you want to see the result

As you make your settings, try going to the relevant sector outputs. You can dig deeper by clicking on the sector-specific tabs at the top of the page. Here you will find out more about the impact your choices are making. For example:

- for the food levers, try looking at the resources tab to see how land use is affected
- for your lifestyle choices, look at the lifestyle tab and compare how people live in 2011 and 2050
- for your electricity supply choices, click on the electricity tab to view more detail about the electricity mix and the installed capacity.

Worked example: mapping the IEA's 2 degree scenario

This section explains the process by which the "levers" in the Global Calculator were "pulled" to try to get roughly the same energy implications as the IEA's 2DS – the order is important because of the methodological issues explained above. This should provide a useful guide for anyone else attempting to map their own scenario into the webtool.

Note that the final 2, 4 and 6DS pathways have not been signed off by the IEA.

The Global Calculator pulled the levers in the following order to re-create the IEA 2DS (more detail in table 1 below):-

i. "Demographics"
ii. "Lifestyle" levers – set to match physical implications as closely as possible for the year 2050 (car ownership, appliance ownership, building size).
iii. "Technology and fuel" (except the fossil fuel levers): set to roughly match the corresponding primary energy supply and final energy demand in 2050 in the IEA scenarios for these sectors. An attempt was made to match the implications by sub sector (e.g. freight / passenger) and by energy type (e.g. liquid hydrocarbons / electricity). Manufacturing levers were pulled after the levers in (ii) above because the levers in (ii) drive some manufacturing output (e.g. cement for buildings).
iv. Land, food and bioenergy levers were pulled to simultaneously (a) supply the bioenergy in the corresponding IEA scenarios and (b) to cause total emissions to achieve a global mean temperature rise consistent with that in the corresponding IEA scenario
v. The storage lever was pulled to roughly show the greater storage requirements under the 2DS vs the 4DS vs the 6DS
vi. CCS levers were pulled to roughly reduce emissions from thermal power by the same amount in 2050 as in their analysis
vii. Fossil fuel efficiency and power split levers we pulled to finally match on fossil fuel primary energy in 2050

viii.   The "emissions post 2050" lever was pulled last in order to achieve the rough level of
        warming in the scenario being mapped

Table 1: The order and reasons behind the IEA 2DS lever choices

Lever	How the level was decided to match the IEA 2DS 2050 value
Population	Set using UN central scenario as used by IEA
Urbanisation	Set using UN central scenario as used by IEA
Passenger distance	Set so total passenger distance increases by broadly the same per cent
Freight	Set so total freight tonne-km increases by broadly the same per cent
Mode	Set so the proportion of passenger km by cars falls by broadly the same per cent
Occupancy and load	Set so the average car occupancy is the same (i.e. did not match freight load)
Car own or hire	Set so the number of cars in 2050 is roughly the same (i.e. did not seek to match stock of other vehicles)
Efficiency	Set so total energy demand for transport is roughly the same
Electrification	Set so electricity demand for transport is roughly the same
Building size	Set so the per cent increase in total floor area is broadly the same
• Lighting cooking and appliance use • Building insulation • Temperature, cooking & lighting technology • Appliance efficiency	Overall it's difficult to match energy and physical implications across buildings sub-sectors as one lever (Lighting cooking and appliance use) drives multiple things. Total buildings energy demand broadly matches and the number of appliances increases in broadly the same way
Product lifespan & demand	Set so vehicles last as long as do most appliances
Design, material switch & recycling	Set to not reduce industry output
Carbon capture and storage (power)	Set to match roughly same Gt CO2 captured in 2050
Nuclear	Set to broadly match primary energy supply
Wind	Set to broadly match primary energy supply
Hydroelectric	Set to broadly match primary energy supply

Marine	Set to broadly match primary energy supply
Solar	Set to broadly match primary energy supply
Geothermal	Set to broadly match primary energy supply
Storage	Set to reflect a similar "ambition" to the other renewables levers
Iron, steel & aluminium	Set to match energy demand after other levers as closely as possible whilst trying to match overall industry energy demand
Chemicals	Set to match energy demand after other levers as closely as possible whilst trying to match overall industry energy demand
Paper and other	Set to match energy demand after other levers as closely as possible whilst trying to match overall industry energy demand
Cement	Set to match energy demand after other levers as closely as possible whilst trying to match overall industry energy demand
Carbon capture and storage (ind.)	Set to match roughly same Gt CO2 captured in 2050
Calories Consumed	FAO forecast
Meat Consumed	FAO forecast
Meat type	FAO forecast
Crop Yields	Set to allow high bio supply and low emissions
Land use efficiency	90% of land is needed owing to benefits of co-cropping etc (Alexandratos, cropping intensity increases from 88% to 92%)
Livestock intensification	Set to allow high bio supply and low emissions
Extensive livestock yields	Set to allow high bio supply and low emissions
Surplus land	Mostly used for forest to avoid oversupply of bioenergy
Wastes and residues	Set to show waste collection for bioenergy and to decrease land area for food, in order to free land for bioenergy
Bioenergy yields	Set high to get close to 2DS biosupply without having higher than level 3
Solid or Liquid	Set to roughly match biofuels supply for transport
Coal / oil / gas	Set to roughly match the per cent of fossil fuel power

	from gas
Fossil fuel efficiency	Set to broadly match overall primary energy supply of fossil fuels
Emissions trajectory	Set so that post-2050 emissions continue to fall to be consistent with the 2 degree target