LEAP-IBC Training Guide

How to: i) Enter data; ii) Create emission scenarios; iii) View outputs

The Long Range Energy Alternatives Planning system-Integrated Benefits Calculator (LEAP-IBC) is a tool that can be used to calculate human health, vegetation and climate benefits for a target country resulting from addressing short-lived climate pollutants (SLCPs). Using activity data and emissions factors, LEAP-IBC first calculates emission inventories for current and future years, then uses these emissions to estimate the resultant atmospheric concentrations of fine particulate matter (PM$_{2.5}$) and ozone (O$_3$) in the target country. Finally, the impacts on human health (e.g. change in premature mortality), vegetation (crop yield loss), and climate (temperature change in 4 latitudinal bands) are calculated.

Emission scenarios can also be constructed, based on predicted or potential changes in human activities which change air pollutant emissions in a country, such as the implementation of a SLCP reduction policy (e.g. a policy to decrease the black carbon (BC) emissions from diesel vehicles). LEAP-IBC then calculates the projected air pollutant emissions, resultant PM$_{2.5}$ and O$_3$ pollutant concentrations, and the health, vegetation and climate impacts for this emission scenario, which can then be compared to the baseline scenario emissions (without the implementation of the policy) to determine the resulting health, vegetation and climate benefits/disbenefits of the policy in the target country.

This document is a guide for entering input data into LEAP-IBC, including the country-specific data required for calculation of impacts, as well as activity data and emission factors for different emission source sectors. Also covered is how scenarios can be created in LEAP-IBC to describe how future emissions might change for a particular policy. Finally, this guide shows users how to view useful outputs from LEAP-IBC, including emissions totals, and health, vegetation and climate impacts.
1 The LEAP-IBC interface

- The LEAP-IBC interface is shown below. LEAP-IBC is a series of folders within which you can enter data and view results. Each area of the LEAP-IBC interface is described below.
- 1. Toolbar with menus for creating and saving projects, altering parameters etc.
- 2. Tabs which select between data input mode and viewing results mode.
- 3. Folders which contain the input data, activity and emission factor data for each source sector and the impact results once calculated.
- 4. Panel where input data is viewed and changed.
- 5. Panel which shows plots summarising input data, emissions and impacts. Other tabs on this panel allow you to view tables of output data, write notes (e.g. references for emission factor), and input equations.
2 Entering data in LEAP-IBC

Data is entered in LEAP-IBC by selecting a folder in Panel 3. The variables stored in this folder are displayed in Panel 4, where updated values can be entered. The following list shows how to populate the folders with data to calculate emissions inventory and impacts for a target country.

1. **Select ‘Analysis’ mode:** Click the ‘Analysis’ button on the far left vertical panel (Panel 2).

2. **Select ‘Current Accounts’:** Above Panel 4 there is a drop down menu called ‘Scenario’. This menu lets you choose which scenario you will enter data for. First, you need to enter data for the start year (currently 2005). To do this select ‘Current Accounts’.

3. **Entering country-specific input data:** The ‘Key Assumptions’ folder is where statistics required to calculate emissions and impacts are entered such as GDP and population etc. The Blank LEAP-IBC country template provided includes this data for the specified target country, but it can be changed if more accurate information is available.
   - **Select ‘Key Assumptions’**: Panel 3 will display the sub-folders within ‘Key Assumptions’, which include ‘GDP’, ‘ValueAdded’ and ‘Benefits Calculator Inputs’. Panel 4 will display the variables which can be changed in ‘Key Assumptions’ (but not those stored in subfolders). In the ‘Key Assumptions’ folder, the Population is set to xxxxx thousand people (see below), but can be changed by clicking on the value in Panel 4, entering a new number and pressing enter. There is also the option to select whether LEAP-IBC calculates emissions from transport using a simple or detailed method.
Click on sub-folders: In the ‘Key Assumptions’ folder, clicking on each sub-folder will display the variables which can be entered in Panel 4. Each variable is changed as outlined above, by clicking on it in Panel 4, entering the new value, and pressing enter. In the ‘GDP’ subfolder, the GDP for the country can be added. In the ‘Benefits Calculator Inputs’ folder, variables required to calculate health and vegetation impacts are entered.

- Folders with multiple tabs: For many of the folders in LEAP-IBC, there are multiple ‘tabs’ where data can be entered. The ‘Value Added’ folder in ‘Key Assumptions’ is an example of a folder with two tabs. The variables in the ‘Value Added’ sub-folder determine the contribution of agriculture, industry and services to the target country’s economy. The two tabs are called ‘Absolute value added’ and ‘Key Assumptions’. By clicking on each tab, the variables stored within it are displayed in Panel 4, in this case agriculture, services and industry variables for both tabs. In the ‘Key Assumptions’ tab, the variables are calculated by LEAP-IBC using an equation shown in Panel 4 (see below). The equation calculates the proportion of the country’s economy accounted for by agriculture, services and industry. The user does not need to alter these equations. The ‘absolute value added’ tab is where the value of each of the economic sectors is input in monetary value (US$). These variables are linked to the equations in the ‘Key Assumptions’ tab, which are updated when the values in the ‘Absolute value added’ tab are changed.
4. **Inputting emissions data:** The ‘Demand’, and ‘Non-energy’ folders contain sub-folders for the source sectors which are used to calculate the country emissions inventory. The information required for each source sector is different, but it is input in the same way. In general an activity variable(s) is required (e.g. number of vehicles, amount of fuel consumed by the sector), as well as an emission factor which quantifies the emissions of each pollutant for each unit of activity.

- **Demand:** The sub-folders within ‘Demand’ are for source sectors associated with the combustion of fuels. There are six categories within which the source sectors are grouped. For example within ‘Manufacturing and Construction’ there is ‘Iron and Steel’ and ‘Combustion Other Industries’. In each category the fuel types used are listed.

- **Entering Activity Data:** In the ‘Manufacturing and Construction’ folder, click on ‘Iron and Steel’, and then ‘Baseline’. There will be six tabs that can be selected in Panel 4. Only two are needed for entering data: ‘Total Consumption’ and ‘Fuel Share’.

  - **Total Consumption:** In this tab the total energy consumption in the sector in the start year, expressed in tonnes of oil equivalents (TOE), is entered in Panel 4.
- **Fuel Share:** In this tab, the percentage of each fuel type used in the source sector should be entered. The total must equal 100% which is why the fuel share for Electricity is the ‘Remainder(100)’ expression. This means that the percentage of Electricity used is 100 minus the sum of the fuel share of all other fuel types.

- **Entering Emission Factor Data:** Default emission factors are provided for each pollutant for each fuel type, and these should only be changed if better emission factors are available. Pollutant emission factors for a fuel type are shown in Panel 4 by clicking on the fuel type in Panel 3.
  - **Click on a fuel type:** e.g. Coke Oven Gas
  - **Select ‘Environmental Loading’ tab:** This tab contains the emission factors. For example, the default emission factor for carbon dioxide is 44.4 metric tonnes per TJ of energy consumed. These values can be changed if better information is available.
    - The emission factor is followed by a ‘?’ and a letter. Any text after the ‘?’ is not read by LEAP-IBC and is for information only. This letter corresponds to the reference source for the default emission factor. The ‘Notes’ tab in Panel 5, then lists the reference sources for the default emission factors and any other relevant information. The user may also add their own information into the Notes tab. For example, if the default emission factor is replaced with a more relevant, local emission factor, then the reference source for the new factor should be recorded here (to remind the user what they did and to inform any future ‘quality assurance’ checks by someone else).
- **Other Demand source sectors**: The information required for the other source sectors in the Demand folder is exactly the same as for ‘Iron and Steel’. For each source sector, the user enters the ‘Total consumption’, and the ‘Fuel Share’. The default emission factors are then viewed or changed by clicking on a fuel type and selecting the environmental loading tab. See the example below for Residential → Cooking:

1. Select source sector
2. Enter total fuel consumption
3. Enter fuel share
4. Click fuel type and select ‘Environmental Loading’ tab to view emission factors
- **Non-Energy**: The ‘Non-Energy’ folder mainly contains source sectors that are not associated with fossil fuel combustion (the exception being ‘Detailed transport’). As with the ‘Demand’ source sectors, activity data and emission factors are required to calculate emissions. However, the non-energy source sectors are diverse, and the information required often differs.
- **Example: Fugitive emissions from production of Coke in traditional ovens**:
  - **Select the correct folder**: Non-Energy → Fugitive → Coke → Traditional
  - **Input activity data**: In this case, the activity variable is the annual production (in tonnes) of coke in traditional ovens. This is input by selecting the ‘Coke Production in traditional ovens tab’, and entering the data in Panel 4.
- **Emission factors:** The default emission factors are viewed (and replaced with better factors if available) by selecting the ‘Emission Factor’ tab in the Traditional folder. The notes page shows where the emission factors came from, and can be used to reference updated emission factors added by the user.

- **Non-Energy Effect Loading:** Each source sector in the ‘Non-Energy’ folder has a ‘Non-Energy Effect Loading’ tab which contains the equations used to calculate the emissions for from the activity and emission data. **The user should not change these equations.**
  - For the other ‘Non-Energy’ source sectors, there are tabs for the activity data, and the emission factors. The data in entered in exactly the same way as above.
5. **Baseline scenario**: The next step is to create the Baseline scenario which describes how the emissions will change from 2005 (the ‘Current Accounts’ year) to 2030 for the baseline. The Baseline scenario is used for comparison with other scenarios, e.g. the implementation of a policy. For the Baseline scenario, we need to outline how the variables in the ‘Key Assumptions’, ‘Demand’, and Non-Energy’ folders will vary between 2005 and 2030.

   - **Select baseline scenario**: Above Panel 4, the scenario menu should be changed from ‘Current Accounts’ to ‘Baseline’.

   - **Select folder of interest**: For example, select the GDP sub-folder with ‘Key Assumptions’ folder. As shown below, in Panel 4 the 2005 ‘Current Accounts’ value is displayed but can’t be changed. The ‘Expression’ window is used to input how the variable will change between 2005 and 2030. For GDP, the expression `Growth(4%)` which has been entered means that the GDP will increase by 4% every year between 2005 and 2030. For all the country-specific data in ‘Key Assumptions’, as well as the activity data in ‘Demand’ and ‘Non-Energy’ source sectors, an expression should be entered.

   - **Expressions**:  
     - **Variable remains constant**: If the variable does not change between 2005 and 2030 enter in the expression the same value as the current accounts value.
- **Linear Interpolation**: Use `Interp(2030, XXX)` to interpolate between the 2005 value, and a specified value (XXX) for the variable in 2030. In the example below, the population for each year is calculated from a linear interpolation between the 2005 value (140,588 thousand people) and 2030 (175,000 people).

![Linear Interpolation Example](image)

- **Percentage change**: Use `Growth(XXX%)` to specify the % increase or decrease per year between 2005 and 2030.

![Percentage Change Example](image)

- **Change at same rate as a Key Assumption**: Use ‘GrowthAs’ to link growth from 2005 to 2030 with a chosen Key Assumption. For example, to link growth in fuel use for cooking to the population growth rate, use `GrowthAs(Key\Population)`.

![Change at Same Rate Example](image)

- **Input data for individual years**: The value of a variable can be input individually for each year, or for blocks of years. Using the `Interp(Year, Value, Year, Value …)` expression as shown below, data can be entered for individual years, and the values for the years in between will be interpolated. In the example the values 2005-2010, 2010-2015, and 2015-2030 are interpolated.

![Input Data Example](image)
3 Creating scenarios in LEAP-IBC

A key feature of LEAP-IBC is the ability to create scenarios which describe the changes that would occur due to the implementation of a mitigation policy, or other changes in human activities within a country. A mitigation scenario is created in the same way as the baseline scenario. You need to specify how the activity data for a country will change between 2005 and 2030.

1. Creating a scenario:
   - Select General → Scenarios from the toolbar (Panel 1).
   - The Scenarios window has one scenario listed already, the baseline scenario. The expressions for the baseline scenario have already been entered.
   - Creating a new scenario: To describe, for example, a policy which reduces the number of diesel vehicles, first click baseline, and then click the green plus sign in the top left corner. Enter the name of the scenario, e.g. ‘Clean Diesel Vehicles’, and click OK. The scenario now appears in the left hand panel underneath baseline. The values of every variable in the newly created scenario are inherited from (i.e. the same as in) the baseline. You just need to change the variables in the source sectors affected by the policy in the scenario.
o Entering scenario-specific data:

- **Select scenario** from the scenario menu. Click on the scenario which you want to enter data for, e.g. Clean Diesel Vehicles.

- **Select a source sector** which the policy implemented in this scenario affects. For clean diesel vehicles this is the road transport sector.

- **Use Expressions** to change the variables between 2005 and 2030. For clean diesel vehicles, it is the fuel share that is affected by the policy, and between 2005 and 2030 the diesel fuel share decreases from 65.6% in 2005 to 0% in 2030. The proportion of diesel vehicles for years between 2005 and 2030 is calculated from linear interpolation (hence the expression is $\text{Interp}(2030,0)$). The plot in Panel 5 shows how the fuel share changes between gasoline, diesel and natural gas between 2005 and 2030. In the Baseline scenario the fuel share for diesel is 65.6% for all years. If the scenarios affect other variables, expressions are entered in the same way. All the variables not changed in the scenario are the same as in the baseline.
4 Running LEAP-IBC

1. Before running LEAP-IBC:
   - Select General → Basic Parameters from the toolbar
     - **Select Years**: ‘Results every’ selects how often results are calculated for, e.g. every 1, 5 or 10 years between 2005 and 2030. The more frequent the longer it takes LEAP-IBC to run. Every 5 years is generally a good balance.
   - Select General → Scenarios from the toolbar
     - **Select Scenarios**: If you create multiple scenarios for different policies then you can select which ones are run by LEAP-IBC. Tick the box of the scenarios you want to calculate. In the example below, the Baseline, Clean Cookstoves, Clean Diesel Vehicles and Mitigation scenarios are all selected.

2. **Run LEAP-IBC**: Click the ‘Results’ icon in the far left hand panel (Panel 1). LEAP-IBC will ask if you want to calculate results, click yes.
5 Viewing output from LEAP-IBC

1. **Results interface:** The ‘Results’ interface is slightly different to the ‘Analysis’ interface. The toolbar (Panel 1), mode tabs (Panel 2) and folders (Panel 3) are the same as in ‘Analysis’ mode. Panel 5 has been expanded, and Panel 4, where data was entered, has been replaced with a series of menus which are used to select which outputs to display in Panel 5 as Charts (select Charts tab) or Tables (select Tables tab).

2. **Viewing emissions**
   - **Select scenario:** When you select ‘Results’ from Panel 2, the Baseline scenario will already be selected in the menu in Panel 4. You can use the scenario menu in Panel 4 to select different scenarios, including the policy scenarios which have been created.
Select folder: Select the sub-folder within ‘Demand’ or ‘Non-energy’ for the source sector you want to view emissions for, e.g. Demand → Transport.

Select output: The menu in Panel 4 is used to select the ‘effect’ you want to view. Selecting ‘Environment’ from this menu shows the different pollutants which can be selected. For example, selecting Nitrogen Oxides (NOx) will display the NOx emissions from the Transport source sector in Panel 5.
- **Viewing outputs:** Outputs are shown in Panel 5. When ‘Chart’ is selected, a plot such as the one below for Transport is shown.
  - The NOx emissions for transport are separated into the contribution to total transport NOx emissions for each sub-folder, i.e. Road Transport, Railways and Shipping. LEAP-IBC always separates emissions into contributions from sub-folders one level below the selected folder.
  - Additionally, if a policy scenario is selected (e.g. Clean Diesel Vehicles), then the avoided emissions (versus baseline scenario) can be shown by selecting ‘AbsoluteValues’ and ‘Avoided vs. Baseline’ in the drop-down menus above Panel 5 (see green outline box below). When this is done, white boxes on the bar chart show the emissions avoided due to the policy.
  - The toolbar on the right hand side of the plot (see red outline box below) can be used to customise the figure. For example, the plot can be changed to a pie chart or the bars can be plotted side by side rather than stacked. The data can also be quickly exported to Powerpoint or Excel.
3. Viewing Impacts:
   - **Select scenario:** Use the same procedure as for viewing emissions.
   - **Select folder:** All the impacts calculated in LEAP-IBC are stored in the ‘Indicators’ folder. The sub-folders within ‘Indicators’ store the impacts on deaths, crop loss, radiative forcing and temperature change separately.
   - **Viewing outputs:** To view an output simply select the relevant folder.
     - **Deaths:** Selecting the deaths folder displays the total premature deaths separated into the contribution from PM$_{2.5}$ (red bar) and from O$_3$ (green bar). The avoided deaths in a particular policy scenario are shown by the white box.
       - Selecting either the ‘PM2p5’ (=PM$_{2.5}$) or ‘Ozone’ subfolders will display the premature deaths due to each pollutant, separated into the contribution from national and rest of the world emissions.
     - **Crop Loss:** Selecting the ‘Crop Loss’ folder displays the total crop loss for 4 crops (rice, wheat, soy and maize). Selecting the sub-folder for each crop displays crop loss for that crop separated into contributions from national and rest of the world emissions.
     - **Radiative Forcing:** Selecting the ‘Radiative Forcing’ folder displays the Radiative Forcing due to emissions from the Target country separated into RF due to CO$_2$, O$_3$ and aerosol.
     - **Temperature Change:** Displays the equilibrium temperature change in 4 latitudinal bands due to the RF resulting from the target country emissions. Clicking on each latitudinal band region displays the equilibrium temperature change in that region separated into contribution from CO$_2$, O$_3$ and aerosol. **(Note:** Select the ‘Side by Side’ bar chart display option – due not use the ‘Stacked’ chart option).