The Regulatory Assistance Project

The E3-India Model

Technical model manual, Volume 2:
Installation Guide

cambridge econometrics
clarity from complexity

This volume (2) is part of a 9-volume series covering the E3-India model

June 2017

Cambridge Econometrics
Cambridge, UK

info@camecon.com
www.camecon.com

Cambridge Econometrics' mission is to provide rigorous, accessible and relevant independent economic analysis to support strategic planners and policy-makers in business and government, doing work that we are interested in and can be proud of.

Cambridge Econometrics Limited is owned by a charitable body,
the Cambridge Trust for New Thinking in Economics.
www.neweconomicthinking.org

Authorisation and Version History

Version	Date	Authorised for release by	Description
1.0	17/06/17	Hector Pollitt	First version, Volume 2.

Contents

Page

1 Guide to Running E3-India

1.1 Getting started

This volume describes the steps required to install and run the model. We start with a general overview in this section and then describe how to run the model using the graphical interface. The model itself and the graphical interface come as a single package and are designed specifically to work together.

Installation

E3-India is set up to run on a PC running Windows version 8 or higher[1]. There are otherwise no specific computer requirements but the software works best in Google Chrome, and we highly recommend using Chrome as a platform for the software. The model has also been tested in Microsoft Edge but it does not operate in older versions of Internet Explorer.

The Manager software is provided as part of a package for the E3-India model. It collates all E3-India model inputs into one place, enabling users to make changes directly to the input files or to load files that have been edited elsewhere (e.g. using other text editor software) and viewing the model results.

Getting started

To get started:

1. Download the software to the directory C:\E3-India on your local drive.
2. In the C:\E3-india\ directory, launch the shortcut *manager.exe*.

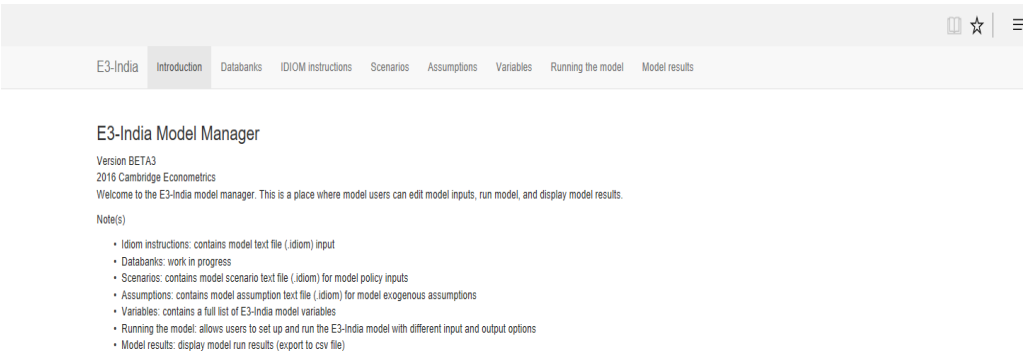
This will launch the E3-India Model Manager software in your default internet browser. The link may be copied into another browser window, so it is not necessary to set Chrome as your default browser.

1.2 The E3-India Manager interface

The Manager software collates all E3-India model inputs into one place, enabling users to make changes directly to the input files or to load files that have been edited elsewhere. It is also used for viewing the model results.

Figure 1-1 shows an image of the software on start-up.

Figure 1-1: Image of the software on start-up



[1] Most of the testing has been carried out using Windows 10.

The software contains seven main tabs, which are described in Table 1.1.

Many of the tabs link to other files that are installed on your local drive.

Table 1.1: The main tabs in the Manager

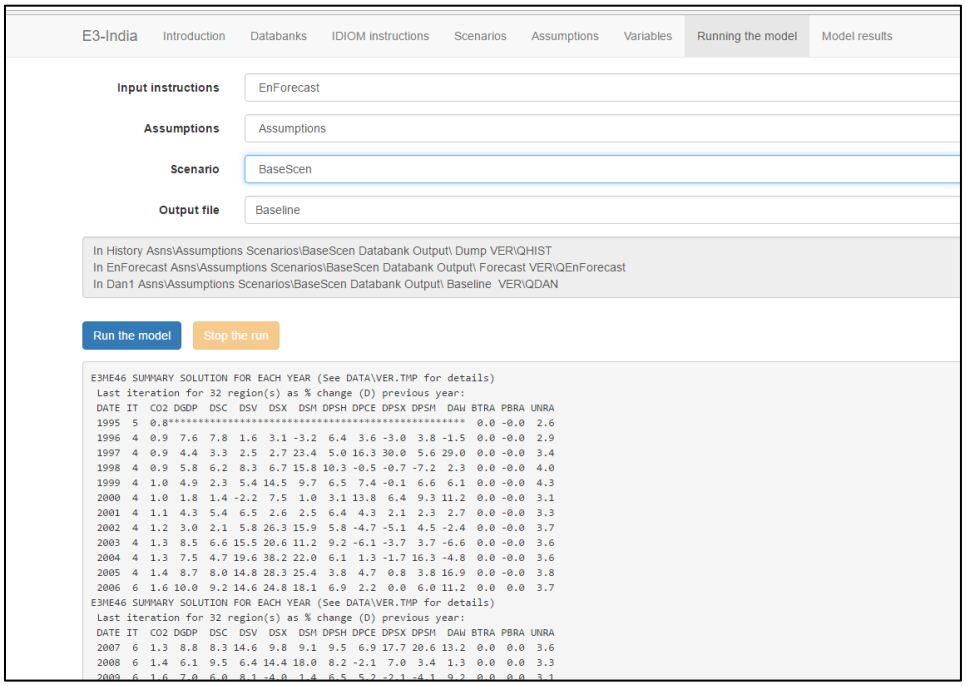
Tab:	Description:
Databanks	(under development) – A future option to modify the model databanks.
Instructions (original files in c:\e3-india\In\)	The instructions files include the commands to set up and run the model (see below). More complex scenarios can be assessed by modifying the instructions files. On installation, E3-India has a pre-loaded set of files. There are further options to modify, duplicate and delete files.
Scenarios (original files in c:\e3-india\In\Scenario\)	The scenario files include a set of policy options that can be entered directly in the Manager. On installation, there is a baseline option and some test cases. Modifications can be made here.
Assumptions (original files in c:\e3-india\In\Asns\)	The assumptions file includes a set of forward-looking assumptions that are necessary for the model to run. These assumptions can be modified here.
Variables	A list of the main E3-India variables for reference.
Running the model	Here the user can set up and run the model, entering the choice of scenario and assumption input files and choosing a name for the output file.
Model results	This tab allows the user to view and compare model results, and to produce charts and tables with the option to export model results for further analysis.

There are three input files that are used every time the model is run:

- Instruction file: This file contains the code that sets up and operates the model. It offers a much wider range of options for potential scenarios but does require a basic knowledge of the IDIOM scripting language that is used. Advanced users typically work extensively with the instruction file.
- Scenario file: This contains a set of policy inputs, including carbon taxes and energy taxes, that can be modified easily without any programming.
- Assumptions file: This contains exogenous assumptions such as commodity prices, world growth rates, state tax rates and government spending. These can also be modified easily without any programming required.

A set of baseline inputs is provided: EnForecast.idiom (instruction file), Assumptions.idiom (assumption file) and BaseScen.idiom (scenario file).

Figure 1-2: Image of the model baseline using the provided inputs



It is recommended not to delete the baseline input files, but to instead duplicate these files, make changes to the duplicates and save them under different names for scenario analysis.

Running the model for the first time

It is recommended to have a set of baseline results first for comparison with future scenario results. To run the baseline:

1. Go to Running the model tab.
2. Select the default baseline inputs from the list: EnForecast.idiom (instruction file), Assumptions.idiom (assumption file) and BaseScen.idiom (scenario file).
3. Type in a name to be given to the output of this run e.g. ‘baseline’.
4. Click ‘run the model’ button and wait until it finishes.

Setting up scenarios

To set up and run scenarios after the baseline:

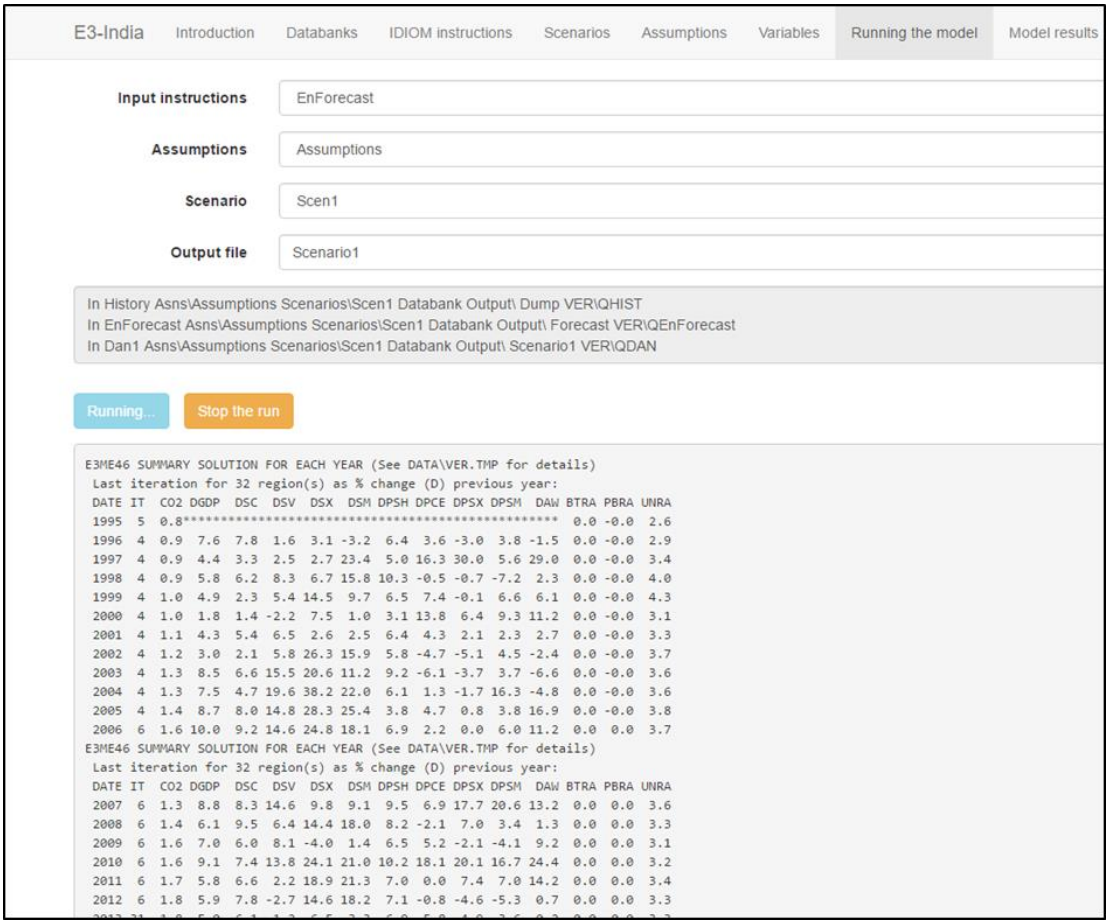
1. Go to the relevant tab to make the change (assumptions, scenarios or instructions)
2. Make a copy of the default input file by pressing the duplicate button and entering a new file name for it.
3. Make changes to the new file.
4. Click save once finished.

5. Follow step 1-4 of running the baseline above but make sure to select the relevant input files and provide a different name for results file.

Alternatively, steps 2 to 4 can be carried out outside the Manager by making a copy of the original input files and editing them manually using a standard text editor software package (e.g. Windows Notepad).

Note: output files are automatically saved to the C:\e3-india\output folder.

Figure 1-3: Image of a model scenario



Every time the user runs the model, three run sequences are automatically called (see command lines below). These lines are the model executables. The model runs over history first (to e.g. generate lagged variables), the forecast period (from the EnForecast script) and in a separate routine to print out the results (from the Dan1 script).

Figure 1-4: The three stages of running the model

```
In History Asns\Assumptions Scenarios\BaseScen Databank Output\ Dump VER\QHIST
In EnForecast Asns\Assumptions Scenarios\BaseScen Databank Output\ Forecast VER\QEnForecast
In Dan1 Asns\Assumptions Scenarios\BaseScen Databank Output\ Baseline VER\QDAN
```

The display box summarises key model variables as the model solves for each year of solution. It provides a quick overview of the model solution while the

model is running. A full set of the model results can be accessed once the model has finished running.

Figure 1-5: Display when the model is running

```
E3ME46 SUMMARY SOLUTION FOR EACH YEAR (See DATA\VER.TMP for details)
 Last iteration for 32 region(s) as % change (D) previous year:
 DATE IT  CO2 DGDP  DSC  DSV  DSX  DSM DPSH DPCE DPSX DPSM  DAW BTRA PBRA UNRA
 1995  4  0.8*************************************************  0.0 -0.0  1.6
 1996  4  0.9  7.6  8.4  9.5  3.1 -5.4  7.2  4.9 -4.4  3.8 -1.5  0.0 -0.0  1.8
 1997  4  0.9  4.4  0.9 12.7  2.7 19.4  4.5 27.3 19.0  2.4 29.0  0.0 -0.0  2.0
 1998  4  0.9  5.8  5.1 23.1  6.7 19.0 10.6 -2.0 -2.4 -8.7  2.3  0.0 -0.0  2.5
 1999  4  1.0  4.9 -5.2 32.1 14.5  8.8  6.5  3.4  0.7  6.9  6.1  0.0 -0.0  2.7
 2000  4  1.0  1.8-10.8 17.0  7.5 -6.6  3.0  9.0  2.4  7.4 11.2  0.0 -0.0  1.9
 2001  4  1.1  4.3 40.0 18.7  2.6  0.3  6.6  2.3 -0.3  1.3  2.7  0.0 -0.0  2.0
 2002  4  1.2  3.0 37.5  7.5 26.3 16.3  5.6 -5.3 -1.9  6.5 -2.4  0.0 -0.0  2.3
 2003  4  1.3  8.5 23.2-10.7 20.6 21.6  9.3 -6.7 10.2  7.2 -6.6  0.0 -0.0  2.3
 2004  4  1.3  7.5-21.3  0.7 38.2 29.3  6.0 -2.2  7.0 19.7 -4.8  0.0 -0.0  2.3
 2005  4  1.4  8.7  2.1  9.3 28.3 29.8  3.9  5.1  3.5  3.7 16.9  0.0 -0.0  2.4
 2006  6  1.6 10.0  5.7 12.1 24.8 23.3  7.0  1.8  5.4  6.0 11.2  0.0  0.0  2.3
E3ME46 SUMMARY SOLUTION FOR EACH YEAR (See DATA\VER.TMP for details)
 Last iteration for 32 region(s) as % change (D) previous year:
 DATE IT  CO2 DGDP  DSC  DSV  DSX  DSM DPSH DPCE DPSX DPSM  DAW BTRA PBRA UNRA
 2007  6  1.3  8.8  8.4 -4.3  9.8 12.3  9.3  6.3 21.5 21.7 13.2  0.0  0.0  2.3
 2008  6  1.4  6.1 19.7 13.6 14.4 20.6  8.2 -2.5  9.5  4.3  1.3  0.0  0.0  2.1
 2009  6  1.6  7.0 13.9 25.3 -4.0 -2.5  6.4  2.4 -7.4 -4.9  9.2  0.0  0.0  2.0
 2010  6  1.6  9.1 -8.6 14.6 24.1 21.1 10.1 20.5 21.6 16.1 24.4  0.0  0.0  2.1
 2011  6  1.7  5.8 23.9 -0.3 18.9 20.9  6.8 -0.3  7.2  7.6 14.2  0.0  0.0  2.2
 2012  6  1.8  5.9 19.4 15.1 14.6 19.1  7.1 -1.1 -4.9 -5.8  0.7  0.0  0.0  2.1
 2013 32  1.8  5.0  6.1  1.3  6.5 -3.3  6.8  5.8 -2.9 -3.9  0.2  0.0  0.0  2.2
 2014 25  1.9  7.8  6.0  4.4  1.3  4.6  1.6  1.2  3.0  1.8  4.8  0.0  0.0  2.2
 2015 23  1.9  6.2  6.4  5.7  2.5  4.7  1.6  1.2  3.0  1.8  5.0  0.0  0.0  2.2
 2016 27  1.9  6.2  6.0  7.1  2.7  4.5  1.7  1.2  3.1  1.8  5.2  0.0  0.0  2.2
 2017 27  1.9  6.2  6.0  7.2  2.5  4.4  1.6  1.1  3.1  1.8  3.6  0.0  0.0  2.2
 2018 30  2.0  6.2  6.1  7.2  2.6  4.3  1.7  1.2  3.1  1.8  4.1  0.0  0.0  2.1
 2019 38  2.0  6.2  6.1  7.2  2.7  4.2  1.6  1.1  3.1  1.8  4.4  0.0  0.0  2.1
 2020 26  2.0  6.2  5.9  7.3  2.4  4.5  1.9  1.4  3.1  1.8  4.1  0.0  0.0  2.1
 2021 34  2.0  6.6  5.3  7.1  4.4  3.1  1.9  1.4  3.1  2.0  3.5  0.0  0.0  2.1
 2022 46  2.1  6.6  5.2  7.1  4.4  3.1  1.9  1.4  3.1  2.0  3.5  0.0  0.0  2.0
 2023 33  2.1  6.6  5.2  7.1  4.4  3.1  2.0  1.4  3.2  2.0  3.5  0.0  0.0  2.0
```

Table 1.2: The variables displayed while the model is running

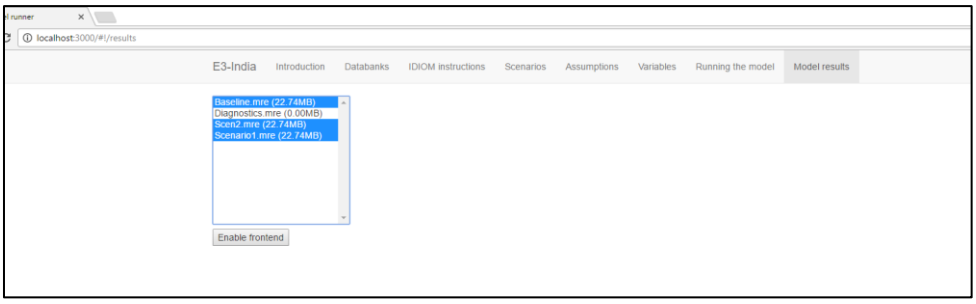
Code	Description	Unit
CO2	CO_2	CO_2 equivalent billion tonnes of carbon
DGDP	GDP	Year on year growth
DSC	Consumption	Year on year growth
DSV	Investment	Year on year growth
DSX	Exports	Year on year growth
DSM	Import	Year on year growth
DPSH	Industrial prices	Year on year growth
DPCE	Consumer prices	Year on year growth
DPSX	Export prices	Year on year growth
DPSM	Import prices	Year on year growth
DAW	Average Wage Rates	Year on year growth
BTRA	Trade balance	Percent
PBRA	Public balance	Percent
UNRA	Unemployment rate	Rate

Once the model finishes running, the output from the model run is saved in the C:\E3-India\Output folder. The output file is saved under a text (.mre) format which the Manager software translates into graphical format, allowing the user to inspect the model results in detail.

The Manager software automatically lists all the files with a .mre extension in the C:\E3-India\Output folder and users can select which sets of results to display.

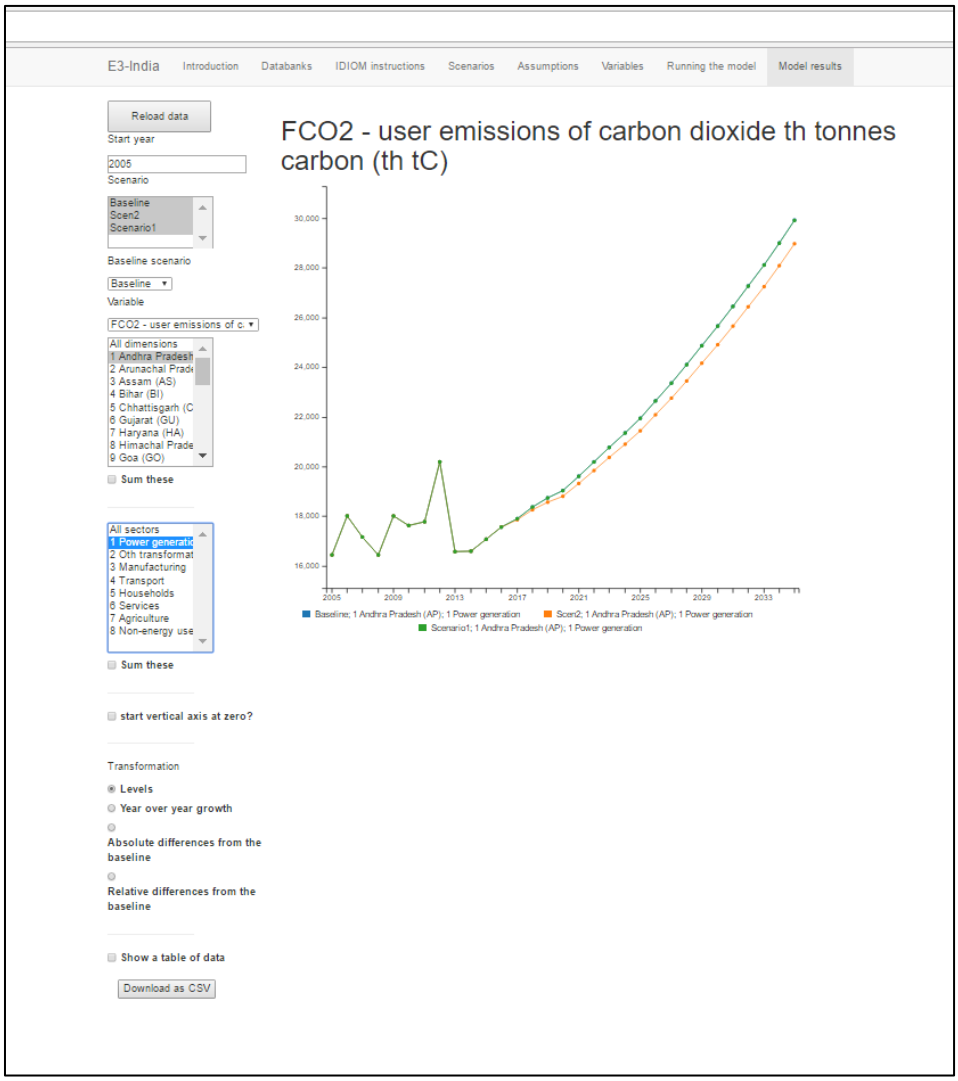
To select the results to display go to the Model Results tab. If the latest model run does not appear in the list, refresh the page as you would normally do in the internet browser. Select the results from the model runs that you wish to inspect and click on the 'Enable frontend' button.

Figure 1-6: Selecting sets of model results



To view the model results, select the relevant scenario(s), variable and dimensions to display.

Figure 1-7: Example of model output

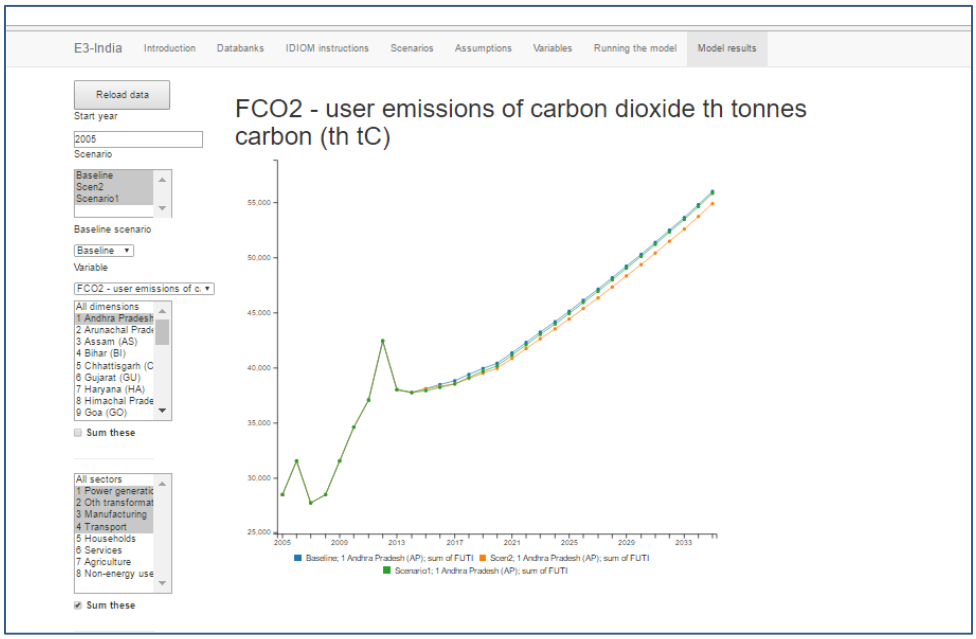


To compare scenario results against a baseline, select the baseline in the baseline drop down list (this can be any file). Choose the scenario, variable and dimensions to display.

Users can choose whether to view results in levels, absolute differences from baseline, relative difference from baseline, or year-on-year growth by selecting the relevant options in the bottom-left corner.

Additionally, users can select more than one sector or state to display simultaneously on the chart (by shift-clicking or control-clicking). There is an option to sum the dimensions selected, which is useful for checking aggregate results.

Figure 1-8: Example of comparing results against baseline



To export results, select '*Show a table of data'* and a table containing data will appear at the bottom of the page. Click '*download data as csv'* to export this table to .csv file. Alternatively, users can copy and paste the table to a spreadsheet package manually.

Users can browse through the full set of results from a model run. To rerun the model, return to the previous tabs. To look at the results from a different set of model runs, click on '*reload data'* button.

2 The E3-India Test Scenarios

2.1 Introduction

We provide a set of pre-loaded model input files that were used in testing the E3-India. Table 2.1 provides an overview.

Table 2.1: Overview of example scenarios

Run	Description	Instruction file	Assumptions file	Scenario file
Baseline	E3-India baseline	EnForecast	Assumptions	BaseScen
S1	Exogenous investment	EnTest1	Assumptions	BaseScen
S2	Income tax	EnForecast	Assump1	BaseScen
S3	Energy tax	EnForecast	Assumptions	Scen1
S4	Carbon tax	EnForecast	Assumptions	Scen2
S5	S4+ revenue recycling (employers' SSC)	EnForecast	Assumptions	Scen3
S6	S4+ revenue recycling (income tax)	EnForecast	Assumptions	Scen4
S7	S4+ revenue recycling (VAT)	EnForecast	Assumptions	Scen5
S8	Energy efficiency	EnTest4	Assumptions	BaseScen
S9	Feeds-in-Tariff	EnTest2	Assumptions	BaseScen
S10	Renewable subsidies	EnTest3	Assumptions	BaseScen
S11	Exogenous oil price	EnForecast	Assump2	BaseScen
S12	Removing Electricity Price Subsidies to households	EnForecast	Assumptions	Scen6

To run the scenarios, select the pre-loaded input files accordingly in the options in **Running the model** tab. Then give the output file names for each run (e.g. S1,S2,… S11,S12). Click the run model button.

Please refer to main E3-India -Testing Scenarios document for more information.

Note making use of text editors

The input files that appear in the E3-India Manager software are text files that can be edited outside the E3-India Manager software environment using any text editor software. This may be preferred if the input requirements are complex. Another useful tip is to use some text editor software to highlight the differences of the two input files.

However it must be noted that, if editing these files outside the Manager software, the model input.idiom files require text formatting to be exactly the same as the default file provided.

2.1 Test scenario 1: Investment

Scenario description

Exogenous investment in 18.Other business Services sector from 2016 onward (10% of existing investment)

Model inputs

Variable	Description	Unit	Input file
KRX(18,all)	Exogenous investment by sector and by region	2010 million rupees	EnTest1 (Idiom instruction file)

Scenario main impacts

Variable	Description	Impacts (compared to BAU)
RSK (KR*)	Investment	Increase
RSQ (QR*)	Industry output	Increase
REMP (YRE*)	Industry employment	Increase overall but some decrease (substitution effect between capital and labour)
RSX (QRX*)	Industry export	Increase (demand from other regions + technology impacts)
RSM (QRM*)	Industry import	Increase (demand for other region goods/services)

* denotes sectoral variable

2.2 Test scenario 2: Income tax

Scenario description

Increase average income tax rate in region 1 Andhra Paresh from 23% to 30% from 2017 onward (note further income tax testing for all regions are included in another test scenario – using revenues from carbon tax to reduce income tax in all regions).

Model inputs

Variable	Description	Unit	Input file
RDTX (11 TAX_DIRECT)	Average direct income tax rate	% of wages and salaries	Assump1 (assumption file)

Scenario main impacts

Variable	Description	Impacts (compared to BAU)
RRPD	Gross real disposable income (i.e. income after tax)	Decrease
RSC	Consumer spending	Decrease
GDP	GDP	Decrease
REMP (YRE*)	Employment	Decrease
RSQ (QR*)	Industry output	Decrease (especially services sector which are highly related to consumer spending)

* denotes sectoral variable

2.3 Test scenario 3: Energy tax

Scenario description

Tax of 400 rupees per tonne of oil equivalent to all energy users of all fuels.

Model inputs

Variable	Description	Unit	Input file
RTEA	Energy tax rate 2001-2035	Rupees/toe	Scen1 (scenario)
FEDS	Switch for fuel user coverage	1 = full coverage	Scen1 (scenario)
JEDS	Switch for fuel type coverage	1 = full coverage	Scen1 (scenario)

Scenario main impacts

Variable	Description	Impacts (compared to BAU)
RFU (FR0*)	Total fuel demand	Decrease
FRET*	Electricity demand	Decrease (substitution with other fuels)
FRCT*	Coal demand	Decrease (substitution with other fuels)
FROT*	Oil demand	Decrease (substitution with other fuels)
FRGT*	Gas demand	Decrease (substitution with other fuels)
RCO2 (FCO2)	CO2 emissions	Decrease
PRSC (PCR*)	Average consumer price index	Increase (due to tax)
RSC (CR*)	Consumer spending	Decrease (less disposable income)
RSX (QRX*)	Export	Mostly decrease (from higher energy price but relative to other states so there are competitiveness effects from internal trade)
RSM (QRM*)	Import	Mostly decrease from lowered domestic demand and imports of energy
RGDP	GDP	+/- depending on scale of import reduction (improvement to GDP)

* denotes sectoral variable

2.4 Test scenario 4: Carbon tax

Scenario description

Tax of 400 rupees per tonne of carbon (note not CO_2) to all energy users of all fuels. Note assuming no revenue recycling. All revenues are used to reduce government deficit.

Model inputs

Variable	Description	Unit	Input file
RTCA	Carbon tax rate, 2001-2035	Rupees/tonne of carbon	Scen2 (scenario)
FEDS	Switch for fuel user coverage	1 = full coverage	Scen2 (scenario)
JEDS	Switch for fuel type coverage	1 = full coverage	Scen2 (scenario)

Scenario main impacts

Variable	Description	Impacts (compared to BAU)
RCO2 (FCO2)	CO2 emissions	Decrease
RFU (FR0*)	Total fuel demand	Decrease
FRET*	Electricity demand	+/- (substitution with other fuels)
FRCT*	Coal demand	Decrease (substitution with other fuels)
FROT*	Oil demand	Decrease (substitution with other fuels)
FRGT*	Gas demand	Decrease (substitution with other fuels e.g. coal to gas)
MJEF*	Fuels demand by PG	Fossil fuels decrease
MEWG*	Power sector generation by technologies	Fossil fuels decrease/ possibly small increase in renewable shares but not drastic due to small CO_2 tax
METC*	Localised costs of electricity as seen by investors by technologies (including carbon costs + policies)	Fossil fuels costs increase
PYH(9,all)*	Electricity price (sector 9)	Increase
PRSC (PCR*)	Average consumer price index	Increase (due to tax and higher electricity price)
RSC (CR*)	Consumer spending	Decrease (less disposable income)
RSX (QRX*)	Export	Mostly decrease (from higher energy price but relative to other states so there are competitiveness effects from internal trade)
RSM (QRM*)	Import	Mostly decrease from lowered domestic demand and imports of energy

RGDP	GDP	+/- depending on scale of import reduction (improvement to GDP)
* denotes sectoral variable		

Figure 2-1: The impact of the carbon/energy tax on prices and wage rates

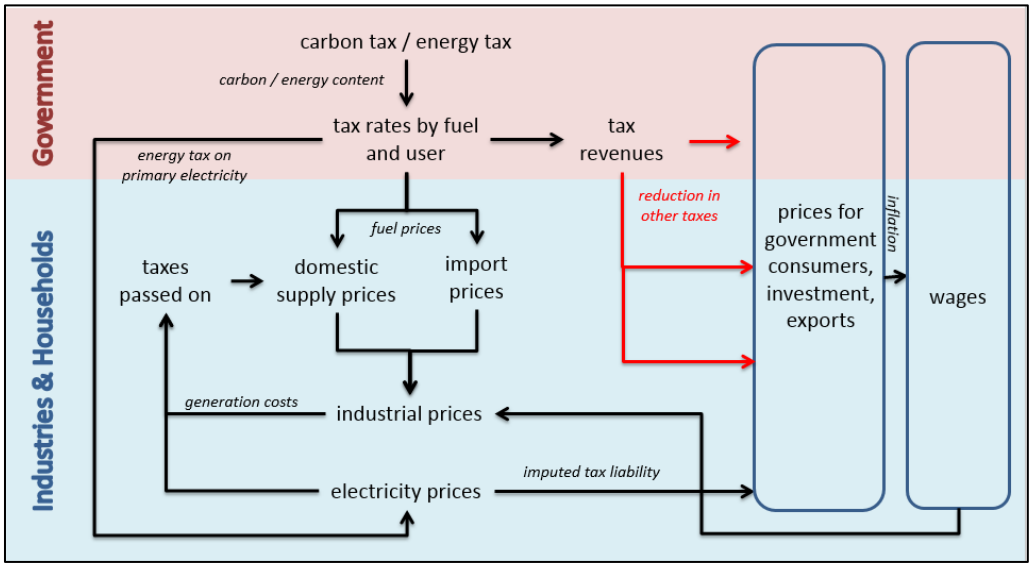
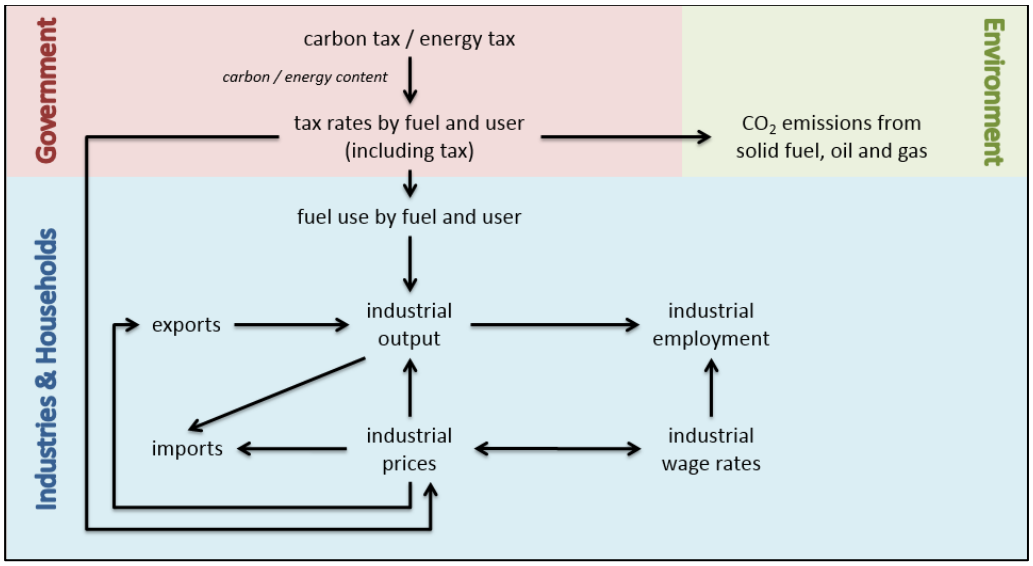


Figure 2-2: The impact of the carbon/energy tax on fuel use, CO_2 emissions and industrial employment



2.5 Test scenario 5: Carbon tax+revenue recycling (employers' social security tax)

Scenario description

Same tax as previously (400 rupees per tonne of carbon) to all energy users of all fuels. All revenues from carbon tax used to reduce employers' social security contribution within the region.

Model inputs

Variable	Description	Unit	Input file
RTCA	Carbon tax rate, 2001-2035	Rupees/tonne of carbon	Scen3(scenario)
FEDS	Switch for fuel user coverage	1 = full coverage	Scen3 (scenario)
JEDS	Switch for fuel type coverage	1 = full coverage	Scen3 (scenario)
RRTE	Proportion of energy tax and carbon tax to reduce employers'SSC by	1 = 100%	Scen3 (scenario)

Scenario main impacts

In addition to the carbon tax scenario.

Variable	Description	Impacts (compared to the carbon tax with no revenue recycling scenario)
RCTT	Total revenues from carbon tax (m rupees)	Increase (tax rate x CO2 emissions)
RERR	Employers social security contribution rates	Decrease
REMP (YRE*)	Employment	Increase (direct impact from lowering labour costs to firms)
RGDP	GDP	Increase
RSC (CR*)	Consumer spending	Increase
RWS (YRWS*)	Total wages and salaries	Increase
RRDP	Real disposable income	Increase
PYH	Industry prices	Decrease (reduction in labour unit cost) but not all costs will pass through to final price

* denotes sectoral variable

2.6 Test scenario 6: Carbon tax+revenue recycling (income tax)

Scenario description

Same tax as previously (400 rupees per tonne of carbon) to all energy users of all fuels. All revenues from carbon tax used to reduce direct tax (income tax) within the region.

Model inputs

Variable	Description	Unit	Input file
RTCA	Carbon tax rate, 2001-2035	Rupees/tonne of carbon	Scen4(scenario)
FEDS	Switch for fuel user coverage	1 = full coverage	Scen4 (scenario)
JEDS	Switch for fuel type coverage	1 = full coverage	Scen4 (scenario)
RRTR	Proportion of energy tax and carbon tax to reduce direct tax by	1 = 100%	Scen4 (scenario)

Scenario main impacts

In addition to the carbon tax scenario.

Variable	Description	Impacts (compared to the carbon tax with no revenue recycling scenario)
RCTT	Total revenues from carbon tax (m rupees)	Increase (tax rate x CO2 emissions)
RDTR	Direct tax rates	Decrease
RRDP	Real disposable income (income after tax)	Increase
RSC (CR*)	Consumer spending	Increase
RGDP	GDP	Increase
REMP (YRE*)	Employment	Increase (secondary impact from higher GDP)

* denotes sectoral variable

2.7 Test scenario 7: Carbon tax+revenue recycling (VAT)

Scenario description

Same tax as previously (400 rupees per tonne of carbon) to all energy users of all fuels. All revenues from carbon tax used to reduce VAT within the region.

Model inputs

Variable	Description	Unit	Input file
RTCA	Carbon tax rate, 2001-2035	Rupees/tonne of carbon	Scen5(scenario)
FEDS	Switch for fuel user coverage	1 = full coverage	Scen5 (scenario)
JEDS	Switch for fuel type coverage	1 = full coverage	Scen5 (scenario)
RRVT	Proportion of energy tax and carbon tax to reduce VAT by	1 = 100%	Scen5 (scenario)

Scenario main impacts

In addition to the carbon tax scenario.

Variable	Description	Impacts (compared to the carbon tax with no revenue recycling scenario)
RCTT	Total revenues from carbon tax (m rupees)	Increase (tax rate x CO2 emissions)
RSVT	VAT rates	Decrease
PRSC (PCR*)	Consumer price index	Decrease
RSC (CR*)	Consumer spending	Increase
RGDP	GDP	Increase
REMP (YRE*)	Employment	Increase (secondary impact from higher GDP)

* denotes sectoral variable

2.8 Test scenario 8: Energy efficiency (savings + investment)

Scenario description

10% energy savings in the use of coal by manufacturing sector in all regions. Manufacturing investment increase approximately $1m (60 m rupees) per 6,000 toe (source: estimated from IEA WEIO and WEO publications). Investment paid for by manufacturing (increase in cost to the sector).

Model inputs

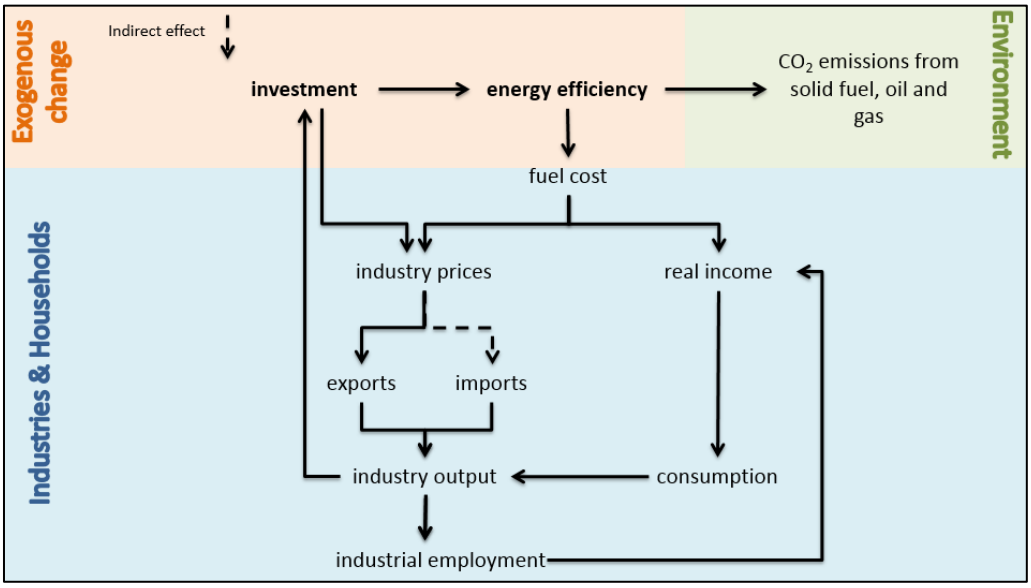
Variable	Description	Unit	Input file
FRCH(3,all)	Exogenous change in coal demand by manufacturing (fuel user 3)	Thousand TOE	EnTest4.idiom (IDIOM Instruction file)
KRX(8,all)	Exogenous change in investment by manufacturing sector (industry 8)	2010 m rupees	EnTest4.idiom (IDIOM Instruction file)
YRUX(8,all)	Exogenous increase in costs to manufacturing (get added to total unit cost)	Entered as m rupees and get converted to unit cost in model	EnTest4.idiom (IDIOM Instruction file)

Scenario main impacts

Variable	Description	Impacts (compared to BAU)
FRCT	Coal demand	Decrease
FR0	Total energy demand	Decrease
FCO2	CO2	Decrease
RSK (KR*)	Investment	Increase
RGDP	GDP	Increase
YRUC*	Unit costs of industry	Increase
PYH*	Industry price	Increase by less than costs
Other++		

* denotes sectoral variable

Figure 2-3: The main economic interactions of energy efficiency



2.9 Test scenario 9: Feeds-in-tariff

Scenario description

Feed-in-tariff for renewables technologies in FTT-power: -110% difference between levelised costs and electricity price.
Technology included: Tidal (15), Large Hydro(16), Onshore(17) , Offshore(18), CSP(20) note Solar PV (19) already have FIT in the baseline.
Example

LCOE of solar is $140/MWh, Electricity price is around $50/MWh
FIT is (140-50) *-1.1 = - $99/MWh
Cost to investor become 140-99 = $41/MWh
making small profit ($50-$41 = $9/MWh).

Note that FIT rate of -110% doesn't make all technologies profitable depending on difference between costs and price of that technology

Model inputs

Variable	Description	Unit	Input file
MEFI	Feed-in-tariff by power technology by region	% difference between levelised cost and electricity price	EnTest2.idiom (IDIOM Instruction file)

Scenario main impacts

Variable	Description	Impacts (compared to BAU)
METC*	Localised costs of electricity as seen by investors by technologies (including carbon costs + policies)	Decrease in technologies with FIT
MEWK*	Power sector capacities by technologies by region	Renewable shares increase (but there will be substitution due to differences in final LCOE)
MEWG*	Power sector generations by technologies by region	Renewable shares increase (but there will be substitution due to differences in final LCOE)
MWIY	Power sector investment in new capacity	Renewable increase (but fossil fuels could decrease)
MJEP*/PFRE*	Price of energy/Price of electricity	Electricity price increase to pay for FIT
FRET*	Electricity demand	Reduce from higher electricity price
PRSC	Consumer price index	Increase from higher electricity price
RSC (CR*)	Consumer spending	Decrease
RSK (KR*)	Investment	Higher investment by electricity sector (feedback from FTT)

RGDP	GDP	+/- depending on scale of RSC and RSK impacts
Other++		
* denotes sectoral variable		

2.10 Test scenario 10: Renewable subsidies

Scenario description

Subsidies for renewables technologies in FTT-power: 50% of investment costs of technologies
Technology included: Tidal (15), Large Hydro(16), Onshore(17) , Offshore(18), Geothermal(21)
Note(s): we assumed government paid for the subsidies but not raise taxes in response (i.e. through bigger budget deficit). This assumption can easily be change to achieve revenue neutrality.

Model inputs

Variable	Description	Unit	Input file
MEWT	FTT subsidies by power technology by region	% of investment cost of technology	EnTest3.idiom (IDIOM Instruction file)

Scenario main impacts

Variable	Description	Impacts (compared to BAU)
METC*	Localised costs of electricity as seen by investors by technologies (including carbon costs + policies)	Decrease in technologies with subsidies
MEWK*	Power sector capacities by technologies by region	Renewable shares increase (but there will be substitution due to differences in final LCOE)
MEWG*	Power sector generations by technologies by region	Renewable shares increase (but there will be substitution due to differences in final LCOE)
MWIY	Power sector investment in new capacity	Renewable increase (but fossil fuels could decrease)
MJEP*/ PFRE*	Price of energy /Price of electricity	Electricity price decrease because of subsidies
FRET*	Electricity demand	Higher from lower electricity price
PRSC (PCR*)	Consumer price index	Decrease from lower electricity price (although average could be positive due to higher economic activity)
RSC (CR*)	Consumer spending	Increase
RSK (KR*)	Investment	Higher investment by electricity sector (feedback from FTT)
RGDP	GDP	Increase from investment and possibly lower price (but could be negative once we start changing assumption about revenue neutrality)

* denotes sectoral variable

2.11 Test scenario 11: Exogenous oil price

Scenario description

Increase exogenous global oil price assumption – instead of growing at 3% pa between 2016-2020 let assume it is growing at 4% pa instead.
Note(s): Global energy price assumptions are in pa growth rate and derived from the latest IEA World Energy Outlook publication (current policies scenario).

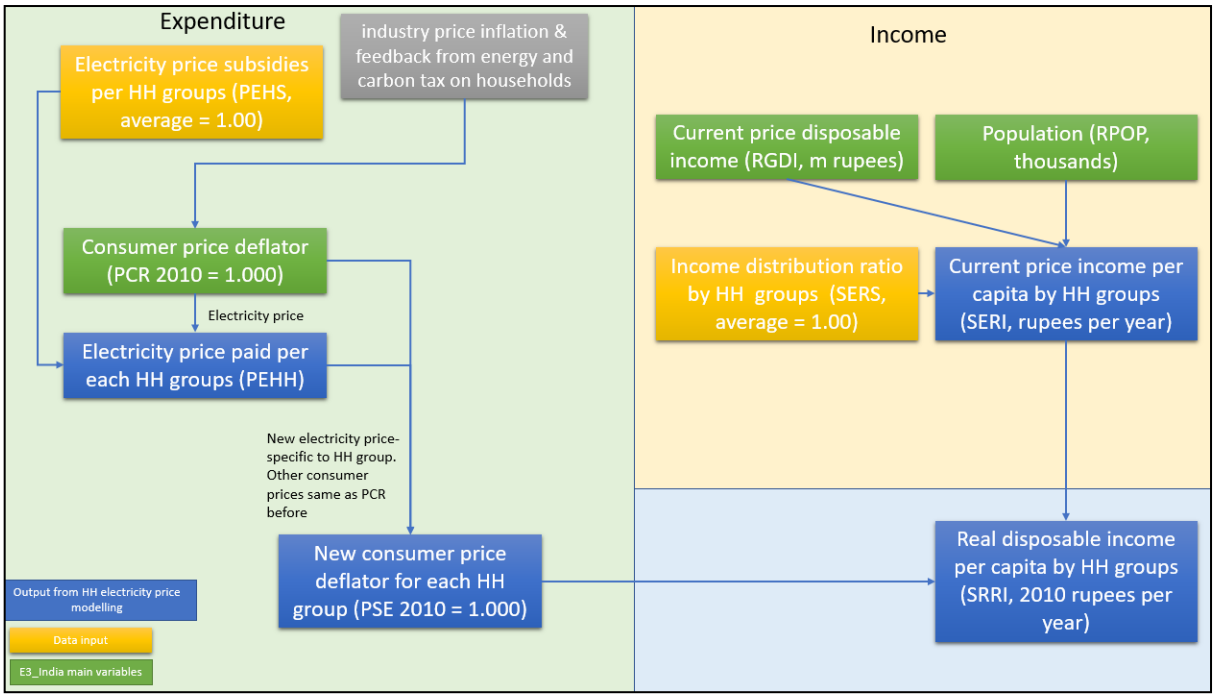
Model inputs

Variable	Description	Unit	Input file
PMF (CPRICE_BRENT_OIL)	Price of import groups in $ (2005 =1.00)	Index	Assump2.idiom (assumption file)

Scenario main impacts

Variable	Description	Impacts (compared to BAU)
PFRO*	Oil price by fuel users	Increase from higher Brent oil price assumption
PFR0*	Average price of energy by users	Increase as oil price increases
RFU (FR0*)	Total fuel demand	Decrease
FROT*	Oil demand	Decrease
RCO2 (FCO2*)	CO2 emissions	Decrease
RGDP	GDP	Increase or decrease depending on which impacts are larger – reduction in oil imports or impacts from higher price on consumption
RSM (QRM)	Imports	Oil import decrease
RSC (CR)	Consumer spending	Decrease due to higher price lead to reduction in real disposable income

* denotes sectoral variable


Expenditure
Electricity price subsidies per HH groups (PEHS, average = 1.00)
industry price inflation & feedback from energy and carbon tax on households
Consumer price deflator (PCR 2010 = 1.000)
Electricity price
Electricity price paid per each HH groups (PEHH)
New electricity price-specific to HH group. Other consumer prices same as PCR before
New consumer price deflator for each HH group (PSE 2010 = 1.000)
Output from HH electricity price modelling
Data input
E3_India main variables
Income
Current price disposable income (RGDI, m rupees)
Population (RPOP, thousands)
Income distribution ratio by HH groups (SERS, average = 1.00)
Current price income per capita by HH groups (SERI, rupees per year)
Real disposable income per capita by HH groups (SRRI, 2010 rupees per year)

2.12 Test scenario 12: Removing Electricity Price Subsidies to households

Scenario description

Removing electricity price subsidies for each State to look at impacts on various types of households.
Note- subsidy is treated as negative tax in E3_India so a scenario to remove electricity subsidies implies a positive electricity tax on household's consumption of electricity.
The E3_India's energy users classification are

- 1 Power generation
- 2 Other transformation
- 3 Manufacturing
- 4 Transport
- 5 Households
- 6 Services
- 7 Agriculture
- 8 Non-energy used

For electricity use, the model includes modelling of electricity price subsidies to different household types. This provides results on household's income distribution from changes in electricity taxation and subsidies. The figure below demonstrates how income distributions, measured by changes in real disposable income by household groups, are affected from changes in electricity prices.

It should be noted that due to lack of time series data, the model doesn't include price-elasticity of electricity demand for each group types of households. Users need to work out the equivalent average electricity price increase for the whole households group and use these values as electricity tax on the household groups. The variable PEHS[2], electricity price subsidies by households, enables users to adjust the subsidy rates to provide distributional impacts (no feedback to the rest of the model).

Model inputs

Variable	Description	Unit	Input file
RTEA	Energy tax rate 2001-2035 (5000 rupees/toe)	Rupees/toe	Scen6 (scenario)
FEDS	Switch for fuel user coverage (only households)	1 = full coverage	Scen6 (scenario)
JEDS	Switch for fuel type coverage (only electricity)	1 = full coverage	Scen6 (scenario)
PESH	Households implied price of electricity subsidies	1.00 = no subsidies,	Scen6 (scenario)

[2] Baseline PEHS is estimated from a) electricity price per consumption unit by state https://www.bijlibachao.com/news/domestic-electricity-lt-tariff-slabs-and-rates-for-all-states-in-india-in-2016.html and b) household electricity consumption by states, quintiles and rural/urban https://openknowledge.worldbank.org/bitstream/handle/10986/20538/926480PUB0978100Box385381B00PUBLIC0.pdf?sequence=1&isAllowed=y

	(removed all subsidies in the baseline – set to 1 for all groups)	0.8 = 20% subsidies

Scenario main impacts

Variable	Description	Impacts (compared to BAU)
FRET*	Electricity demand from households	Decrease
RFU (FR0*)	Total fuel demand	Decrease or there might be substitution between fuels
PRSC (PCR*)	Average consumer price index	Increase (due to electricity tax)
RSC (CR*)	Consumer spending	Decrease (less disposable income)
RGDP	GDP	Small decrease from reduction in consumer demand
SRRI*	Real disposable income by households	Household groups that are more vulnerable (e.g. low income) are worse off than other groups

* denotes sectoral variable

Appendix A Model Classifications

E3-India Classifications

Regions

1 Andhra Pradesh
2 Arunachal Pradesh
3 Assam
4 Bihar
5 Chhattisgarh
6 Gujarat
7 Haryana
8 Himachal Pradesh
9 Goa
10 Jammu & Kashmir
11 Jharkhand
12 Karnataka
13 Kerala
14 Madhya Pradesh
15 Maharashtra
16 Manipur
17 Meghalaya
18 Mizoram
19 Nagaland
20 Orissa
21 Punjab
22 Rajasthan
23 Sikkim
24 Tamil Nadu
25 Tripura
26 Uttar Pradesh
27 Uttarakhand
28 West Bengal
29 Andaman & Nicobar
30 Chandigarh
31 Delhi
32 Puducherry

Sectors

1 Agriculture
2 Forestry & Logging
3 Fishing
4 Coal Extraction
5 Oil Extraction
6 Gas Extraction
7 Non-Energy Mining
8 Manufacturing
9 Electricity
10 Gas
11 Water
12 Construction
13 Transport & Storage
14 Communication
15 Trade, Hotels & Restaurants
16 Banking & Insurance
17 Real Estate
18 Other Business Services
19 Public Administration
20 Other Services

Fuel Users

1 Power generation
2 Other transformation
3 Manufacturing
4 Transport
5 Households
6 Services
7 Agriculture
8 Non-energy used

Fuels

1 Coal
2 Oil
3 Natural Gas
4 Electricity
5 Biomass

E3-India Classifications

Consumers' Expenditure

1 Food
2 Drink
3 Tobacco
4 Clothing etc.
5 Rent
6 Water etc.
7 Electricity
8 Gas
9 Liquid fuels
10 Other fuels
11 Durable goods
12 Other consumables
13 Medical
14 Transport services
15 Other services
16 Recreational
17 Unallocated

Government sectors

1 Defence
2 Education
3 Health
4 Other
5 Unallocated

Labour Groups

1 Male 15-19
2 Male 20-24
3 Male 25-29
4 Male 30-34
5 Male 35-39
6 Male 40-44
7 Male 44-49
8 Male 50-54
9 Male 55-59
10 Male 60-64
11 Male 65+
12 Female 15-19
13 Female 20-24
14 Female 25-29
15 Female 30-34
16 Female 35-39
17 Female 40-44
18 Female 45-49
19 Female 50-54
20 Female 55-59
21 Female 60-64
22 Female 65+
23 Total 15-19
24 Total 20-24
25 Total 25-29
26 Total 30-34
27 Total 35-39
28 Total 40-44
29 Total 45-49
30 Total 50-54
31 Total 55-59
32 Total 60-64
33 Total 65+

Population groups

1 Male Children
2 Male 15-19
3 Male 20-24
4 Male 25-29
5 Male 30-34
6 Male 35-39
7 Male 40-44
8 Male 44-49
9 Male 50-54
10 Male 55-59
11 Male 60-64
12 Male OAPs
13 Female Children
14 Female 15-19
15 Female 20-24
16 Female 25-29
17 Female 30-34
18 Female 35-39
19 Female 40-44
20 Female 45-49
21 Female 50-54
22 Female 55-59
23 Female 60-64
24 Female OAPs