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**Euro South Mediterranean Initiative:
Climate Resilient Societies
Supported by Low Carbon Economies**



Long-range Energy Alternatives Planning System (LEAP) & Greenhouse Gas (GHG) Modelling



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the ClimaEast project



ClimaEast

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FOREWORD

The Mediterranean region has been identified as a climate change hotspot by the Intergovernmental Panel on Climate Change (IPCC). Most countries in the region are already experiencing rising temperature, increasing water scarcity, rising frequency of droughts and forest fires, as well as growing rates of desertification. A common understanding is thus emerging in the region that fighting climate change is essential, by employing both mitigation and adaptation measures. These may also open new opportunities for further economic development, particularly those associated with low-carbon options.

The EU-funded ClimaSouth project supports climate change mitigation and adaptation in 9 Southern Mediterranean partner countries: Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Palestine and Tunisia. The project assists partner countries and their administrations in transitioning towards low-carbon societies while building climate resilience and promoting opportunities for sustainable economic growth and employment. The project also supports South-South cooperation and information-sharing on climate change issues within the region, as well as closer dialogue and partnership with the European Union.

As part of its efforts to enhance climate change strategic planning, the ClimaSouth project is producing a series of handbooks tailored to the needs of the Southern Mediterranean region. The key users targeted include relevant government departments at operational and policy levels, climate change units and committees, decision makers, me-

teorological services and members of local government, the private sector and civil society. The ClimaSouth handbooks are based on peer-to-peer seminars hosted by the project, which are designed to support national administrations in the development and implementation of climate change policy; they further help stakeholders in the region to engage more effectively in the global climate change framework.

After the Handbook on GHG Inventories, this fourth handbook reflects the content presented and discussions that took place during a ClimaSouth seminar entitled “Long-range Energy Alternatives Planning System (LEAP) & Greenhouse Gas (GHG) Modelling”. We hope the handbook will contribute to improving the knowledge of policy-makers and technicians alike on these issues, and will assist them in addressing future concerns.

May your reading be informative and interesting.

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CLIMASOUTH HANDBOOKS

- Handbook N. 1: Building Capacity & Mainstreaming Climate Change Policy
- Handbook N. 2: Improving Climate Information
- Handbook N. 3: An Introduction to Greenhouse Gas Inventories and MRV
- Handbook N. 4: Long-range Energy Alternatives Planning System (LEAP) & Greenhouse Gas (GHG) Modelling
- Handbook N. 5: Low-Emission Development Strategy (LEDS)
- Handbook N. 6: Downscaling Climate Modelling for High-Resolution Climate Information and Impact Assessment
- Handbook N. 7: Connecting Downscaling, Impacts and Adaptation: A Summary

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LIST OF ACRONYMS

CIHEAM	International Centre for Advanced Mediterranean Agronomic Studies
CHP	Combined Heat and Power
CH4	Methane
CO2	Carbon dioxide
DECC	Department of Energy and Climate Change
EDGAR	Electronic Data Gathering, Analysis and Retrieval
ENP	European Neighbourhood Policy
GDP	Groiss Domestic Product
GHG	Greenhouse Gas
GWP	Global Warming Potential
HCFCs	Hydrochlorofluorocarbons
HFCs	Hydro fluorocarbons
HTSPE	Absorbed by DAI (Development Alternatives Inc.)
IEA	International Energy Agency
INDC	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
JRC	Joint Research Centre (European Commission)
LEAP	Long-range Energy Alternatives Planning System
LPG	Liquefied petroleum gas
MEDPRO	Mediterranean Prospects
MER	Market Exchange Rates

MRV	Measuring, Reporting and Verification
NAMA	Nationally Appropriate Mitigation Actions
N2O	Nitrous oxide
OPEERA	Open Source tool for the simulation of energy demand and supply scenarios towards 2050
PBL	Netherlands Environmental Assessment Agency
SEI	Stockholm Environment Institute
SF6	Sulfur hexafluoride
UNFCCC	Framework Convention on Climate Change
WDI	World Development Indicators
WEC	World Energy Council

1. INTRODUCTION

On November 10-14, 2014, the ClimaSouth project (managed by the Agriconsulting Consortium) and the ClimaEast project (managed by the HTSPE Consortium) jointly organised a GHG modelling seminar at the CIHEAM¹ training centre in Bari (Italy). This seminar allowed the following 12 ENP countries to work together:

- Algeria, Egypt, Israel, Lebanon, Morocco, and Palestine for ClimaSouth, and;
- Armenia, Belarus, Republic of Moldova, Ukraine, Georgia and Azerbaijan for ClimaEast.

The seminar first offered an initial day of introduction on the topic of GHG mitigation assessment and an overall global policy context briefing, with the presentation of 3 examples of national GHG modelling: Belgium (practical presentation of their 2050 Road map), Azerbaijan and Tunisia.

The next four days were devoted to hands-on training on GHG modelling with the LEAP software system for 2 representatives from each of the 12 countries, with the technical support of the Stockholm Environment Institute (SEI) on 'LEAP' (Long-range Energy Alternatives Planning System), a "Tool for Energy Planning and GHG Mitigation Assessment". The training showed how to (1) model national energy systems; (2) assess the GHG emissions associated

with these systems; (3) create and compare alternative baseline and mitigation scenarios; and (4) assess the costs and benefits of alternative policies and measures. In the final two days of the workshop, participants were provided with **"starter" data sets** for LEAP in their own countries and were asked to review the data, methods and assumptions, developing an initial set of scenarios.



¹ <http://www.iamb.it/>

2. NATIONAL CASE STUDIES

Belgium

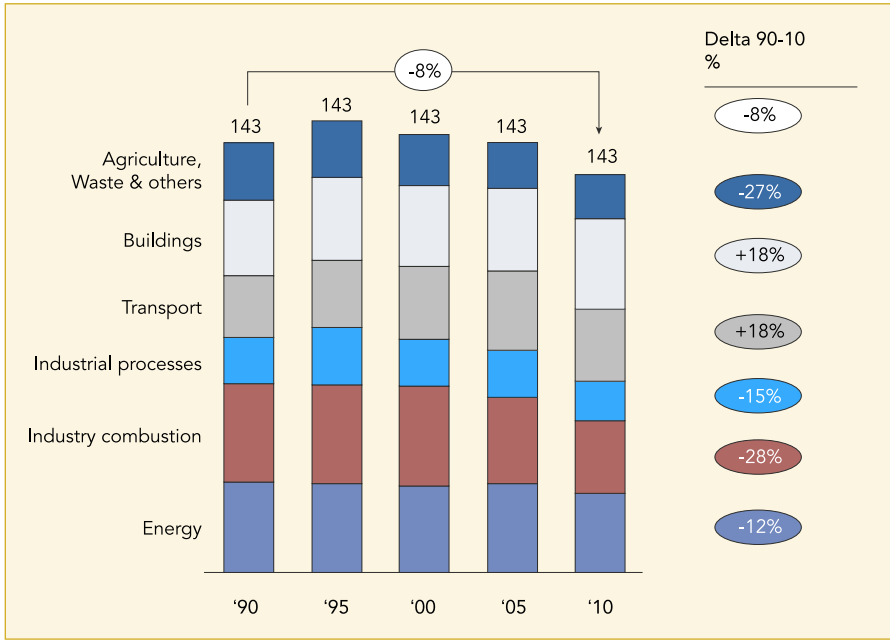
As a first step, a sectoral approach was used to understand what types and levels of change are technically possible in each area. For each emission-reduction lever identified in each of these sectors, a range of ambition levels was established so that a wide variety of potential futures could be tested.

These levers and the possible ambition levels related to them are the basis of the Belgian version of the OPEERA2 model, developed to construct possible pathways to 2050. OPEERA is an “Expert-Driven” model developed with the Department of Energy and Climate Change (DECC) of the United Kingdom (further described below). The approach looks not only at 2050 as an end point, but also at the sequence of changes that would need to occur over the next 40 years.

Many other analyses and studies already exist based on a variety of methodologies and covering different scopes (by sector, region, or country; at the European or global level, etc.). Besides a thorough literature review, the study builds extensively on thematic workshops and intensive discussions with a large number of experts in businesses, NGOs, technical fields, and academia. The study pays particular attention to existing Belgian work. More than a hundred experts were also consulted on several occasions, especially with respect to the ambition levels feasible for each reduction lever.

The study also built on comments from stakeholders to better identify and understand the key implications for Belgium of a move to a low-carbon society.

The source for historical emissions is Belgium’s National Inventory Report, or NIR, which captures current (and historic) GHG emissions in Belgium for the different emission sources. This inventory contains greenhouse gas emission estimates for the period 1990 to 2010 for Belgium, and describes the methodology on which the estimates are based.



Source: Belgium GHG Emissions Inventory.

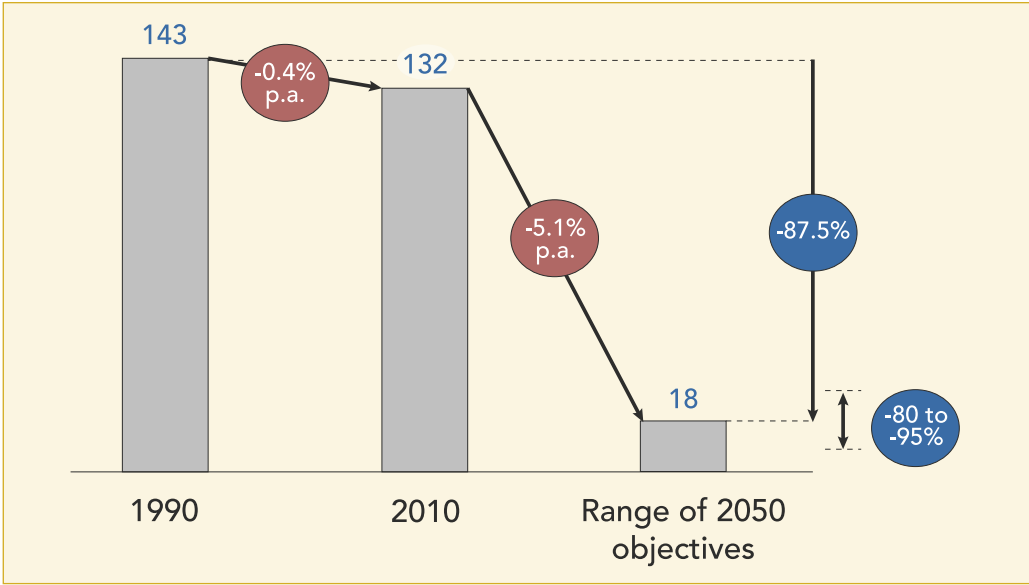
This study analyses various scenarios to achieve significant GHG reduction objectives. The scenarios imply drastic changes on the part of all actors in society. They require a clear political vision and a consistent framework, allowing all stakeholders to engage in the low-carbon transition while managing the many uncertainties of a 40-year time horizon.

The study shows that, if managed correctly, the low-carbon scenarios fall within the same cost range as the reference scenario: large investments in energy efficiency, infrastructure, flexibility, renewable energy and interconnections are compensated by lower fuel expenses. It clearly demonstrates that energy savings in all sectors continue to be of central importance and that the transition can be made possible through early investments financed by later fossil fuel savings, placing the question of financing at the heart of the debate.

A low-carbon transition offers opportunities and some ‘no regret measures’, such as renovating buildings, developing the energy infrastructure, or strengthening energy efficiency. However, critical barriers could make the transition difficult; therefore, moving to a low-carbon society must come about in a coordinated way, in order to properly manage competitiveness issues, ensure security of supply and provide the necessary conditions for a just transition. The directions taken by other regions and countries need to be taken into account, as their decisions will affect the availability of resources, prices and the development of technology and will therefore influence the context in which a Belgian low-carbon transition will take place.

This study aims to provide stepping stones to initiate a profound societal debate on orienting our economy and society towards low-carbon development, while identifying common ground, no regret measures and essential milestones. The different scenarios are meant to identify and outline the changes required and their main implications, and provide some answers. They also illustrate the need for further work on complementary topics such as macro-economic implications, employment and training, competitiveness, financing, co-benefits, etc. This complementary work will be important in identifying which pathway to 2050 is most desirable and deliverable.

Source: Climact & VITO, 2013 Scenarios for a Low-Carbon Belgium by 2050



Belgium GHG emissions, MtCO₂e per year

Source: Belgium GHG Emissions Inventory.

Tunisia

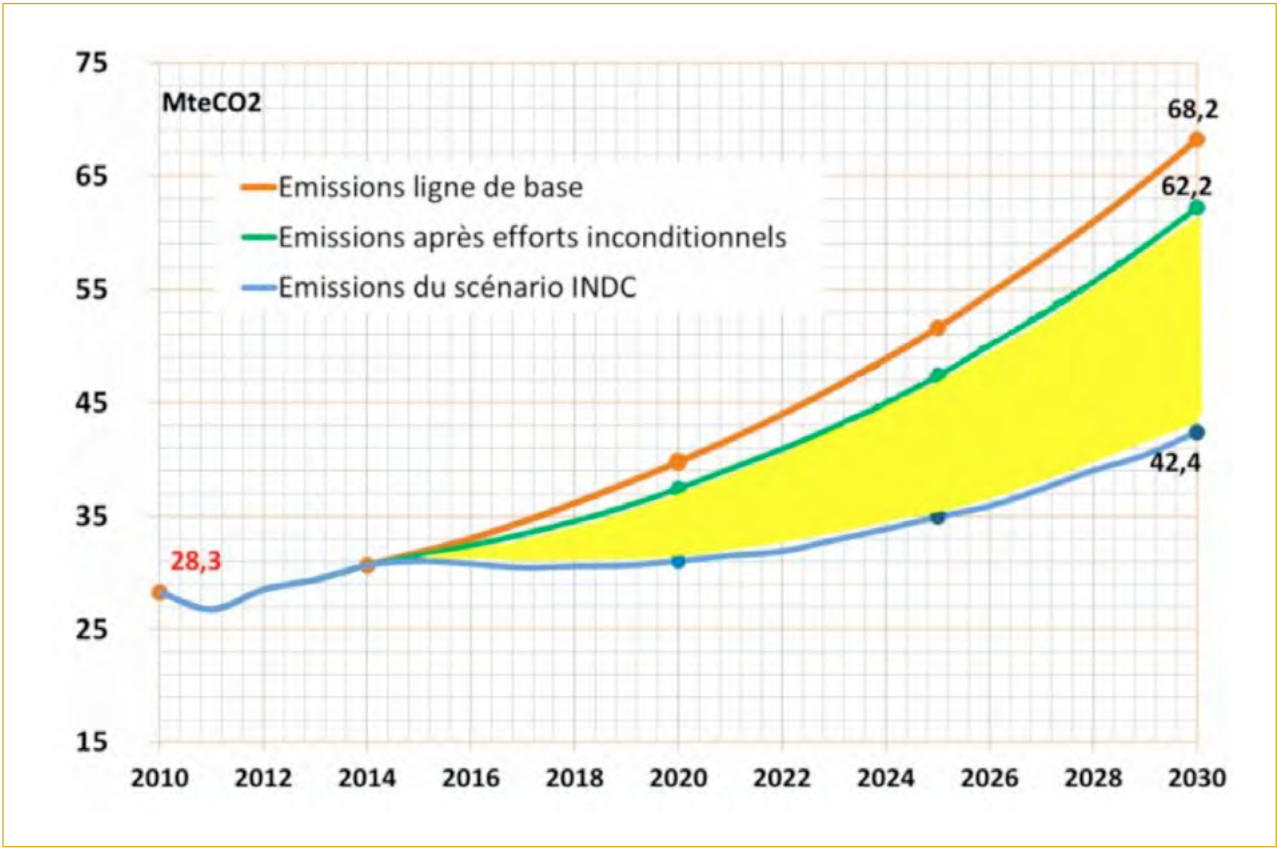
The approaches for calculating greenhouse gas emissions derive directly from the 2006 IPCC guidelines. The emissions calculation is based on estimated activity data, which is deduced from a simulation model using the following approaches:

- **Energy sector:** Emissions are assessed in the baseline scenario, mainly using a bottom-up approach based on modelling the final energy demand by sector and by type of energy, using the MEDPRO prediction model. This then allows primary energy demand to be predicted per energy type on the basis of hypothetical parameter changes in the electricity sector (specific consumption, losses and mix). The baseline scenario already includes a mitigation component since it corresponds to an average decrease in primary energy intensity on the order of 1 per cent per year for the period 2010-2030. The baseline emissions are being evaluated, year by year, from 2010 to 2030, by applying the sectoral approach of the 2006 IPCC guidelines very carefully (activity data and emission factors by sector and by energy product). This sectoral approach covers CO₂, CH₄ and N₂O. Annual baseline emissions are then expressed in tons of CO₂ equivalent. This approach should make it easier to cross-check the results of this baseline against future greenhouse gas inventories which will be carried out under the MRV system in Tunisia.
- **Industrial processes:** Emissions assessments for the baseline scenario mainly draw on the results of the ce-

ment sector (NAMA 5). For other process sources, the simulations are based either on the relationship with GDP or on the principle of a fixed production value.

- **Forestry and other land use:** The baseline assumes continuation of the reforestation trend and conservation measures typically pursued by the Directorate-General for Forestry, as well as the same rate of progress in arboriculture. This trend scenario will therefore consolidate the status of this source of emission/absorption as a net absorber.
- **Agriculture:** The baseline assumes that current trends in given agricultural practices will continue, while including four mitigation actions depending on the current or planned rate (including poultry dung in composting processes, biological agriculture, stepping up the role of legumes in arable crops and optimizing the use of synthetic mineral fertilizers).
- **Waste - Solid waste:** The baseline assumes that current waste management practices will continue, with waste being buried in controlled landfills. The baseline incorporates the emission reductions of the two Ministry of Sustainable Development degasification projects.
- **Waste water treatment:** The baseline assumes that current sanitation practices will continue until 2030, but with particular efforts made towards energy efficiency.

The following graph shows the respective trajectories of greenhouse gas emissions for the base-line, the unconditional national effort and the INDC scenario.



Source: Ministry of Environment and Sustainable Development of the Republic of Tunisia, Intended Nationally Determined Contribution (INDC)

3. LEAP TRAINING

LEAP² is a widely-used software tool for energy policy analysis and climate change mitigation assessment developed at SEI, which has been adopted by over 24,000 users and many hundreds of organizations in more than 190 countries worldwide. Its users include government agencies, academia, non-governmental organizations, consulting companies, and energy utilities. It has been used at different scales, ranging from cities and states to national, regional and global applications. LEAP is especially widely applied as a tool for national GHG mitigation assessment as a part of national commitments to report to the U.N. Framework Convention on Climate Change (UNFCCC). More information on LEAP is available here: www.energycommunity.org.

The aim of the training was to build capacity within these countries to develop integrated scenario-based climate mitigation assessments so as to advance the ability to assess and report on the climate mitigation potential, particularly with regards to these countries’ obligations to the UNFCCC. More specifically, the training was intended as a first phase of work to help countries assess current and likely future GHG emissions, including emissions reductions and costs and benefits resulting from proposed mitigation policies and measures.

² Dr. Heaps, a senior scientist in SEI’s climate and energy research programme and the lead designer of LEAP, was the lead trainer.

The four-day training programme consisted of:

- **Lectures** that gave participants a thorough grounding in GHG mitigation, including principles, key steps and a review of the various modelling tools available, as well as a detailed introduction to the capabilities of the LEAP modelling system. Issues covered included energy demand assessment, energy supply (transformation) assessment and calculation of GHG emissions, scenario analysis and cost-benefit analysis. Issues examined in more depth included end-use analysis, electricity sector capacity-expansion and dispatch modelling.
- **Hands-on Computer Exercises** covering all of these topics that gave participants the opportunity to practice the techniques learned in lectures within the LEAP modelling tool.
- **Review of Data Availability** on the types of data structures, and methods that would be feasible for mitigation assessment in participating countries.
- **Provision and Review of National Starter Data Sets:** On the final day of the workshop, participants were provided with “starter” data sets for LEAP, developed by SEI, for their respective countries (for all countries except Palestine for which, unfortunately, no readily available international data exists). These data sets are intended to serve as a useful starting point for analyses by developing-country experts involved in climate change mitigation analysis. Each data set represents a

single country and covers energy and non-energy-sector emissions, both for historical data (for 1990-2009) and for a relatively simple draft baseline scenario which runs from 2010 to 2040. The data sets include aggregate historical data on energy consumption, production, energy-sector emissions and non-energy-sector emissions, and are based on a range of international data sources, including data from the IEA, the World Bank, the IPCC, the UN, the WEC and PBL’s EDGAR database. It is important to note that the data sets are only intended as a starting point for analysis, and are not to be considered as finalized projections. Users of the data sets need to check, refine and correct data—typically by using their own, superior, locally available data. Participants were given the opportunity to review these data sets, including the methods and assumptions and data contained therein, and it is hoped that the data sets can be the basis for further work that can be done in-country after the workshop.

BOX 1. What is LEAP?

The Stockholm Environment Institute (SEI) has developed national-scale data sets for use within SEI’s LEAP software for energy planning and climate change mitigation. These data sets are prepared to serve as a useful starting point for analyses by developing country experts involved in climate change mitigation analysis.

Each data set represents a single country and covers energy and non-energy-sector emissions, both for historical data (for 1990-2009) and for a relatively simple draft baseline scenario which runs from 2010 to 2040.

An important caveat is that these data sets are intended only as a **starting point** for analysis. The data they contain are based only on readily available and regularly maintained *international sources* of data. Country experts should review the data, assumptions and methods contained in them. For most counties, better local data will be available and superior assumptions can be made based on the knowledge of national experts. Together, these can be used to refine and correct this first draft of the data sets.

Key Information

- National-level data sets for use with LEAP.
- Available to qualified developing-country energy analysts and to organizations involved in the UNDP LECB project.
- Include aggregate historical data on energy consumption, production, energy-sector emissions and non-energysector emissions.
- Based on a range of international data sources, including data from the IEA, the World Bank, the IPCC, the UN, the WEC and the PBL’s EDGAR database.
- Includes simplified baseline projections to 2040.
- Intended only as a starting point for analysis: not intended as finalized projections. Countries will need to check, refine and correct data—typically by using their own, superior, locally available data.
- Each data set is provided as a single “.leap” data file, which can be opened directly in LEAP.

4. KEY DATA SOURCES

Macroeconomic and Demographic Data

Each data set includes demographic and macroeconomic data drawn respectively from the latest UN population prospects report (UN, 2010) and the World Bank’s World Development Indicators (World Bank, 2012).

The population data include both national historical population estimates (going back in most cases to 1970) as well as medium-variant projections to 2100.

A variety of variables have been extracted from the World Bank WDI database, including historical estimates of GDP, estimated both in terms of market exchange rates (MER) and purchasing power parity (PPP). In both cases, the data are specified in constant international dollars. In addition to overall GDP estimates, the WDI also provides historical data on how the GDP is the sum of the economic value from the agriculture, industry and service sectors. These data are used to calculate the historical value-added shares for these three “macro sectors”, which are later used in LEAP to help forecast energy use and emissions in the agriculture, industry and service sectors.

Energy Data

Each data set includes a comprehensive picture of historical energy demand and supply from 1990 to 2009, based

on the IEA’s database of World Energy Balances (2011)³. The energy data includes information on final energy consumption by fuel in each major demand sector (households, industry, transport, services, agriculture, and non-energy/non-specified uses). On the supply side, the data sets include information on distribution losses, own use, heat production, electricity generation, CHP production and oil refining. These energy-supply sectors exist only in certain countries, so will not appear in countries where they are not relevant. In some countries, other conversion sectors are important, such as charcoal making, gas works, and liquefaction. Energy use and emissions from these sectors are not covered in these data sets. The data sets also include historical data describing statistical differences between demand and supply data, a summary of the sources of primary energy supply (indigenous production, imports and exports), as well as a summary of the annual change in stock of major fuels.

Data on different fuels is provided in terms of the simplified fuel categories used in the IEA’s less detailed energy balances. These aggregate fuel categories are not always ideal either for energy analysis or for GHG emissions calculations. For example, they do not distinguish among gasoline, kerosene, LPG, diesel, etc., but instead include only a single fuel type covering all oil products. Similarly, they do not distinguish among key renewable energy sources (e.g.,

³ In some cases the data set includes time-series data going back further. For example, the IEA energy data goes back to 1970.

wind vs. solar) nor do they distinguish between wood, charcoal and other traditional biofuels (which are often of key importance in many developing countries). Nevertheless, the IEA data should serve as a good overall summary of how energy is consumed and produced in each country. Countries may wish to revise and refine the data where better information is available.

The data on energy consumption and production from the IEA are supplemented by additional data (where available) on the national reserves of the major fossil fuels (coal, oil and gas), taken from the World Energy Council's 2007 survey of energy resources. Note, however, that data on reserves for many countries are not available. Note that our baseline scenario has no explicit projections of these values, so reserves are assumed to decline as they are consumed in future years under the scenario.

Emissions Data

Information on energy consumption and production is coupled with the IPCC's standard Tier 1 energy-sector emission factors (IPCC, 1996), which give estimates of the emissions of different gases, including all the major greenhouse gases (carbon dioxide, methane, and nitrous oxide), along with other major local air pollutants such as sulphur dioxide and carbon monoxide. These emission factors are specified per unit of fuel combusted (typically specified in terms of tonnes of pollutants per TJ of fuel combusted) for each major fuel type within each major sector of the economy (industry, residential and commercial, transport, electricity generation, etc.). While these Tier 1 emission factors do not distinguish among differ-

ent energy technologies and so would not be suitable for a detailed assessment of local air pollutants, they are sufficient to provide a good initial calculation of energy-sector GHG emissions.

These energy-sector GHG emission calculations are supplemented by data on non-energy-sector GHG sources and sinks. All of these data are directly extracted from **V4.1 of the EDGAR database** developed at JRC/PBL in the Netherlands (JRC/PBL, 2010). The EDGAR database covers emissions of all GHGs and its non-energy-sector data is organized into the following sectors: industrial processes, solvent and other product use, agriculture, land-use change and forestry, waste, other energy (i.e., emissions not covered in the earlier LEAP calculations) and other miscellaneous categories. The EDGAR data included in LEAP covers all GHGs, including CO₂, methane, N₂O and the high-GWP gases such as HFCs, HCFCs, and SF₆. For more details on the coverage of the EDGAR database, please refer to its documentation here: <http://edgar.jrc.ec.europa.eu>.

The overall global warming potential (GWP) calculated in LEAP uses the GWP values specified in the IPCC's Fourth Assessment Report (FAR). These values for the three major gases are as follows: CO₂ = 1 TCO₂e/T; CH₄ = 25 TCO₂e/T; N₂O = 298 TCO₂e/T. Note, however, that for national communications purposes, countries are recommended by the UNFCCC to continue using the GWP values from the second assessment report of 1, 21 and 310 TCO₂e/T, respectively. Countries may wish to edit the values in LEAP (in the General: Effects screen) if they wish to make these data sets more consistent with their national communications. For most countries, making such a change will have only a tiny effect on calculated results.

5. LEAP IN BRIEF

LEAP, the **Long range Energy Alternatives Planning System**, is a widely-used software tool for energy policy analysis and climate change mitigation assessment developed at the Stockholm Environment Institute (SEI).

LEAP is an integrated modelling tool that can be used to track energy consumption, production and resource extraction in all sectors of an economy. It can be used to account for both energy-sector and non-energy-sector greenhouse gas (GHG) emission sources and sinks. In addition to tracking GHGs, LEAP can also be used to analyze emissions of local and regional air pollutants and to perform cost-benefit assessments of scenarios.

LEAP is not a model of a particular energy system, but rather a tool that can be used to create models of different energy systems, where each requires its own unique data structures. It supports a range of different modelling methodologies. On the demand side, it supports bottom-up/end-use accounting techniques and top-down/macro-economic modelling. On the supply side, it provides a range of accounting and simulation methodologies, as well as optimization modelling capabilities .

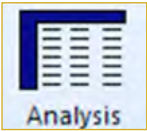
LEAP’s modelling operates at two conceptual levels. At one level, LEAP’s built-in calculations handle all of the non-controversial energy and emissions accounting calculations. At the second level, users enter spreadsheet-like expressions that can be used to specify time-varying data or to create multi-variable models.

LEAP’s main screen consists of 8 major “views”, each of which lets you examine different aspects of an energy system. The **View Bar** located on the left of the screen lets you switch among these views. Here are the three most important views:

- The **Analysis View** is where you enter or view data and construct your models and scenarios.
- The **Results View** is where you examine the outcomes of the various scenarios as graphs and tables. Use the **Favourites** menu to view some of the saved charts and tables that summarize the baseline results for your country.
- The **Energy Balance view** lets you see results in the form of a standard format energy balance. This is one of key places you should look. Try to compare the energy balance produced by LEAP in your country data set to a published energy balance for your own country.

The Analysis View

The **Analysis View** (shown below) contains a number of controls. On the left is a tree in which you view or edit your data structures. On the right are two linked panes. At the top is a table in which you edit or view data and modelling relationships. Below it is an area containing charts and tables that summarize the data you entered above. Above the data table is a toolbar that lets you switch among dif-



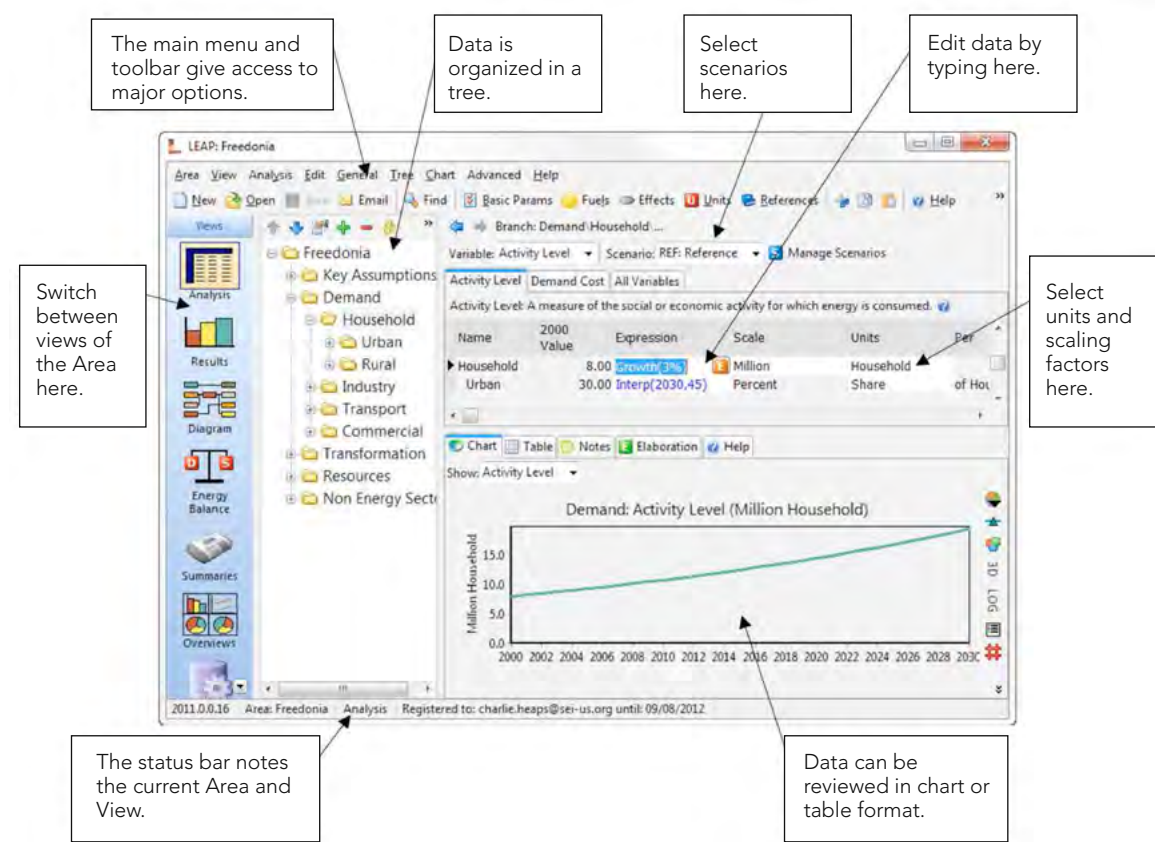
ferent scenarios or select different types of data to edit. The topmost toolbar gives access to standard commands such as saving data, creating new areas, and accessing the supporting fuels, effects (pollutants), units and references databases.

The main parts of the **Analysis View** are described in more detail below:

- Tree:** the tree is the place where you organize your data for both the demand and supply (Transformation) analyses. In most respects, the tree works just like the ones in standard Windows tools such as Windows Explorer. You can expand and collapse the tree outline by clicking on the +/- symbols.

The tree contains different types of branches. The type of a branch depends on its context (for example, whether it is part of your demand or transformation data structure, or whether it is one the variables added under the "Key Assumptions" branch. Different branch icons indicate different types of branches:

- Category branches** are used mainly for the hierarchical organization of data in the tree.
- Technology branches** contain data on the actual technologies that consume, produce and convert energy.
- Key Assumption branches** are where you create your own independent variables, such as macroeconomic or demographic indicators. These variables can then be referred to in expressions under other branches.





Fuel branches are found under the Resources tree branch. They also appear under each Transformation module, representing the **Output Fuels** produced by the module and the **Auxiliary** and **Feedstock Fuels** consumed by the module.



Environmental loading branches represent the various pollutants emitted by energy demand and transformation technologies.

- **Data Table:** The Analysis View contains two panes to the right of the tree. The top pane is a table in which you can view and edit the data associated with the variables at each branch in the tree. As you click on different branches in the tree, the data screen shows the data associated with branches at, and immediately below, the branch in the tree. At the top of the table is a set of “tabs” giving access to the different variables associated with each branch. The tabs you see depend on which part of the tree you are viewing.
- **Chart/Table/Notes:** The lower pane shows a chart or a table that shows the result of the expressions entered above. Look at the Notes tab to see documentation for the data and equations in each country data set.


The Results View

The Results View is the main place in LEAP for seeing the results of your scenario. Tabs at the top of the Results View let you switch between chart and table formats, and you can use the on-screen selection boxes in the Results view to select a huge number of different reports. The **Show** selection box lets you choose different types of results, such

as energy demands, primary requirements, or global warming potential. The selection boxes attached to the chart’s **X axis** and **Legend** let you select different dimensions to be displayed. For example, for an energy demand chart, you might decide to show years on the X axis and fuels on the legend for a particular scenario. Alternatively, you might decide to show results for different scenarios by selecting the scenarios dimension in the chart’s legend. You can also change the units in which charts are presented. To do this, click the Unit button on left axis of a chart. The Results view also includes the same Tree you work with in the Analysis View. As you click on different branches in the tree, LEAP will show you the results for the subset of branches below the branch you clicked on. To reduce complexity, the more advanced reporting options are hidden by default. To display these options, click on the **More** button.

Key LEAP Terminology

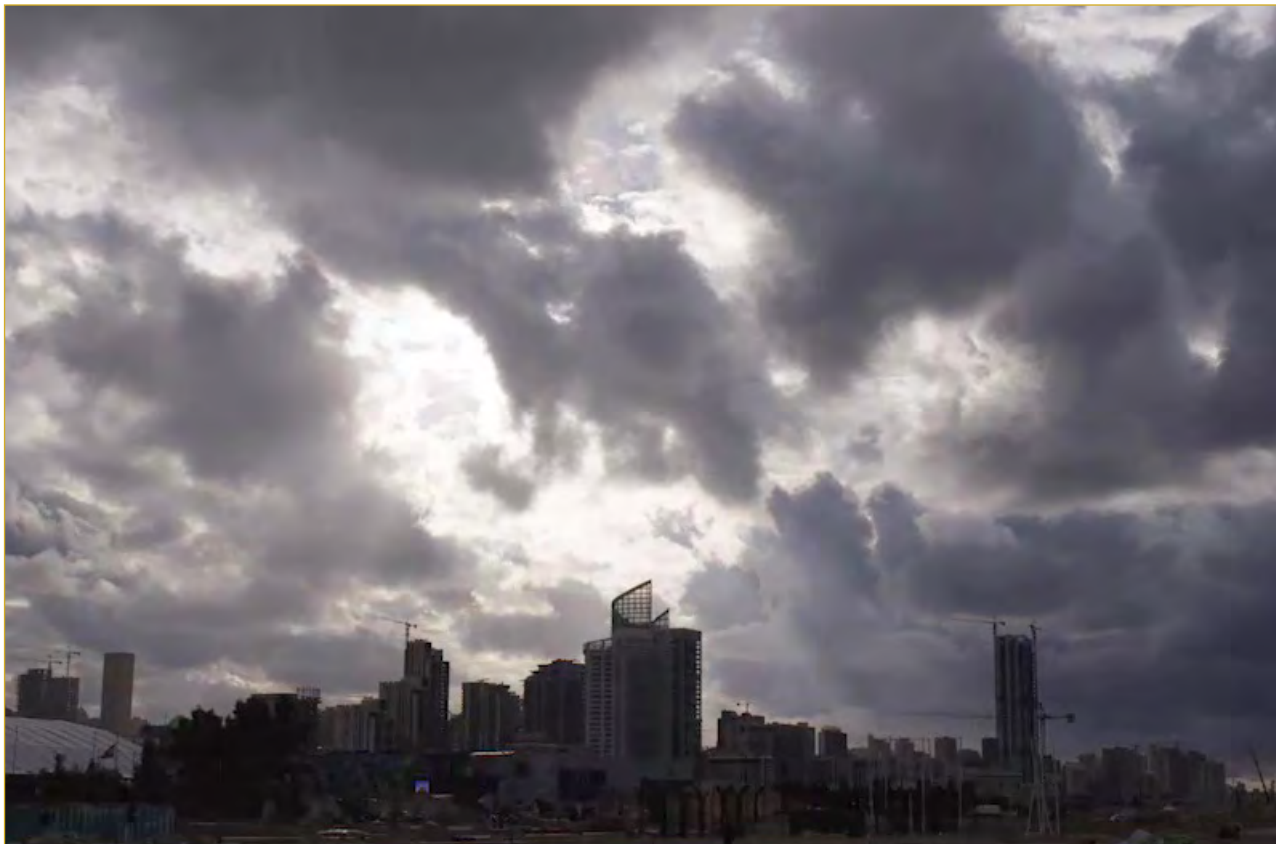
To help you more quickly understand the following model documentation, it is important to understand some of the terminology used in LEAP. Here is a quick guide to the most important terms:

- **Area:** a complete set of data. In this project, each country is represented as a separate area. Each area can be backed up to an individual .leap data file ().
- **Current Accounts:** All of the historical data in the model from the **Base Year** to the year immediately before the **First Scenario Year**. In this project, we have chosen 1990 as the Base Year. The First Scenario Year is 2010.
- **Scenario:** One consistent set of data describing how a

country (Area) evolves from the First Scenario Year to the **End Year** of the study. In this project the End Year is set to 2040 and we have provided one scenario named **Baseline**. Typically a study consists of at least one base-line scenario plus various counter-factual policy or mitigation scenarios.

Tip: It is important not to confuse “Baseline” with “Base Year”.

- **Tree:** the main organizational data structure in LEAP – a visual tree similar to the one used in Windows Explorer.
- **Branch:** an item on the tree: branches can be organizing categories, technologies, modules, processes, fuels and independent key assumption variables, etc.
- **Variable:** Each branch may have multiple variables. Types of variables depend on the type of branch and its properties. In LEAP, Variables are displayed as “tabs” in the Analysis view. Variables can contain data values which may be static or which may vary from year to year, or they may contain Expressions—mathematical formulae that specify the value of a variable over time at a given branch and for a given scenario.




6. HOW TO USE A LEAP DATA SET

Each country data set is provided as a single “.leap” data file. Before opening the data set, you need to download and install the LEAP software system. LEAP is available at no charge to the organizations involved in the UNDP LECB project. You can download it here: <http://www.energycommunity.org/default.asp?action=40>

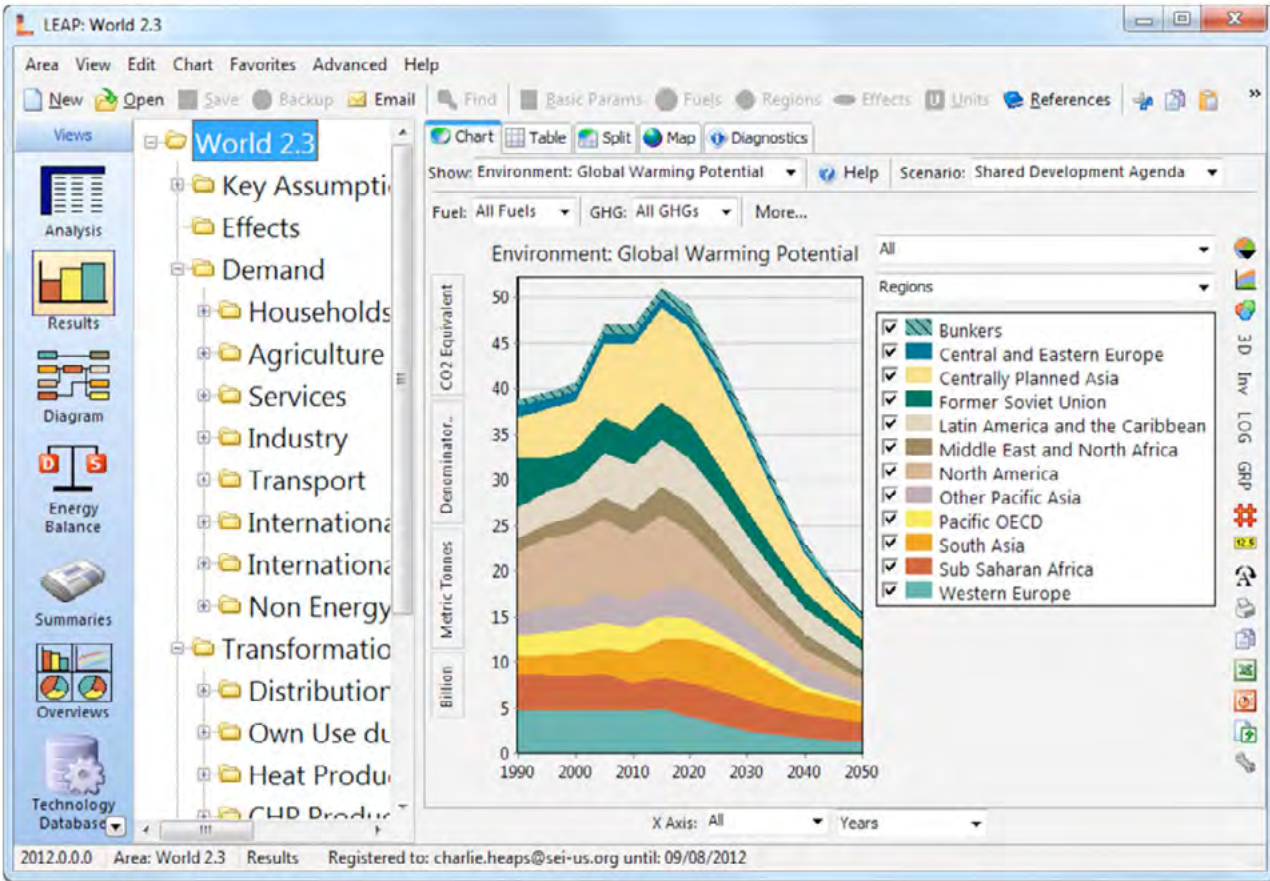
To fully enable LEAP, you will need to request a free li-
cense. You can do that here: <http://www.energycommunity.org/default.asp?action=65>

If you do not obtain a license code, you can still install and review your country data set, but you will not be able to save any changes you make. Once you have applied for a license, SEI will send you a user name and password used to fully enable the software.

Once LEAP has been downloaded and installed, you can simply double-click on a data set to use it (look for a file with this icon: ).

Notes:

1. LEAP is primarily designed for Windows-based computers. Experimental instructions for installing and using LEAP on Apple or Linux computers are available here: <http://www.energycommunity.org/default.asp?action=183>
2. As with all Windows software, you must have administrative rights to install LEAP. You may need to contact your system administrator for assistance in installing LEAP. Once it is installed, you can run LEAP without administrative rights.



7. DATA STRUCTURES, METHODS AND ASSUMPTIONS

Each country data set is structured using LEAP’s tree branch structure. The top level branches in the tree are Key Assumptions, Demand, Statistical Differences, Transformation, Stock Changes, Resources, Non-Energy-Sector Effects and Indicators. Each of these is described in turn.

Key Assumptions

The key assumptions branches in the data sets store a variety of demographic, economic, and development indicators extracted from a variety of data sources. Some of these data are referenced in LEAP’s energy calculations (see descriptions below) while other data are included for information purposes or for potential use in new versions of the data set.

The **Key Assumptions** branch contains the following sub branches:

- Constraints**

Under the **Constraints** folder, you will find a series of parameters (assumptions), which are later used to constrain the projections of individual variables in LEAP to reasonable values. These values can all be edited if you wish to tighten or relax any of these constraints. They include the following variables:

- MaxGrow:** The maximum rate of growth of energy intensities in the baseline scenario (default =3%).
- MaxShareGrow:** The maximum rate of growth or decline of fuel shares or value-added shares in the baseline scenario.
- MaxElecGenShareGrow:** The maximum rate of growth or decline of electricity generation process shares in the baseline scenario.
- MaxSv/MinSv:** The maximum and minimum value for service value added as a percentage of GDP (default = 92% max and 2% min based on cross-country scan).
- MaxAg/MinAgv:** The maximum and minimum value for agricultural value added as a percentage of GDP (default = 65% max and 0% min based on cross-country scan).

- OtherParams**

Under the **OtherParams** folder, you will find a series of parameters (assumptions), which are later used in the baseline projections. They include:

- FirstIntenYear:** The first year used for calculating historical growth rates for energy intensities (default = 1995).
- FirstShareYear:** The first year used for calculating historical growth rates for fuel shares or value-added shares (default = 1995).

- FirstVAYear:** The first year used for calculating historical growth rates for value-added shares (default = 1995).

- GDP**

Current Accounts: Under the GDP branch, you will find historical data on GDP in both market exchange rate (MER) and purchasing power parity (PPP) terms in units of billions of constant dollars. This data comes from the World Bank World Development Indicators (WDI 2010) database and typically covers the years up to 2012.

Baseline Scenario: In the baseline scenario, GDP is projected forward using regional growth forecasts taken from the US EIA's International Energy Outlook (IEO, 2011), which provides regional GDP estimates out to 2035. The regional growth rates seen in the IEO are assumed to continue thereafter, yielding GDP estimates to 2040.

- ValueAdded, AbsValueAdded and Manufacturing**

Current Accounts: Under the AbsValueAdded branch, you will find historical data from WDI 2012 for the added value coming from services, agriculture and industry. These values are in turn used to calculate the percentage share of GDP coming from each of these three "macro" sectors.

Under the Manufacturing folder, we further calculate the share of industrial value added that comes from manufacturing.

Baseline Scenario: In the baseline scenario, the value-added shares for industry, services and agriculture are projected forward based on how those shares have been evolving in the period 1995-2009. The value-added shares are first projected forward individually using the calculated historical growth rates for 1995-2009. These projected values (in LEAP variable **Unscaled-VAShare**) are then normalized so that the three values sum to 100% of GDP in all future years. The normalized results are recorded in the Key Assumption variable.

- Population**

Current Accounts: Under the Population branch, you will find historical data on the population of the country in units of millions of people. This data comes from the UN Population Prospects, medium variant, 2008 Revision, and typically covers the years 1950-2050.

Baseline Scenario: The baseline includes the UN's medium variant population projections to the year 2050.

- Income**

The variable labelled **income** calculates GDP per capita in the country. This is calculated internally by dividing GDP by the population of the country. It is calculated both in MER and PPP terms in units of current international dollars per person. The same equation is used both for historical data (Current Accounts) and for the baseline projection.

Energy Demand

The Demand branches in the data sets are the place where LEAP calculates all final energy consumption as well as direct demand-side emissions of pollutants. Total energy demand is broken down into six sectors following the approach used in the IEA's energy balances: households, industry, services, transport, agriculture and fishing, non-energy/non-specified. Aggregations of these sectors also broadly match the categories used for reporting GHG inventories under the UNFCCC.

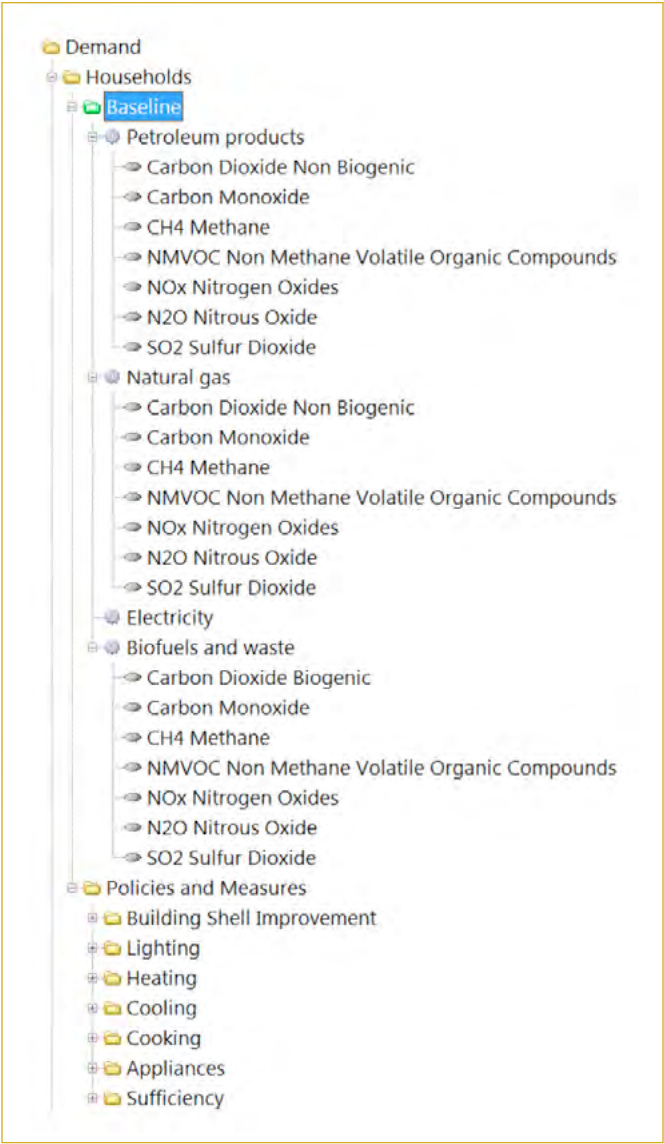
Current Accounts

Since the IEA energy statistics record energy consumption, not energy intensity data, the LEAP data needs to calculate historical energy intensities in each sector for its Current Accounts (historical) data.

In the household, services, agriculture, and non-energy/non-specified sectors, these intensities are calculated for the sector as a whole.

In the transport sector, intensities are calculated by mode for road, rail, domestic marine transport, domestic aviation, pipelines and other non-specified types of transportation. Note that data on energy use and emissions from international aviation and international shipping (aviation and marine bunkers) are not included in these data sets since these energy uses are not assigned at the country level in national communications to the UNFCCC.

For industry, intensities are calculated for the major industrial subsectors: iron & steel; chemicals & petrochemicals; non-metallic minerals; transport equipment; machinery;



Sample Data Structure Used For Energy Demand Calculations

food & tobacco; paper, pulp & printing; wood & wood products; textiles & leather; construction; mining & quarrying and other industries. Note, however, that for some developing countries, some of these major industrial sectors are not present and thus no energy consumption data exists for some of these sectors. In other countries, data availability by industrial subsector is poor, and thus reporting on industrial energy use sometimes occurs only under the “other industry” sector.

Both Current Accounts (historical) data and baseline projections are stored under branches labelled **Baseline** under each sector. The different fuels consumed in each sector are listed immediately below these branches, while the emission factors for each different pollutant are listed in branches immediately below each fuel. The figure to the right shows an example of this data structure for the household sector. Note that the list of fuels in each sector will vary from country to country, depending on local national circumstances.

Historical energy intensities are calculated once for each sector using the following formula in each year.

$$EI = E / AL$$

Where:

EI = Energy Intensity

E = Total energy consumption at each sector

AL = Activity level for each sector.

Different activity levels are used in each sector to calculate these energy intensities, as shown in the table below. In the services sector, the activity level is specified as the product of GDP MER and the percentage value added from the services sector, both of which are stored as data in the Key Assumptions branches. The equation in LEAP is written as:

$$\text{Key}\backslash\text{GDP}\backslash\text{GDP MER}[\text{Billion US\$}] * (\text{Key}\backslash\text{ValueAdded}\backslash\text{Services}[\%]/100)$$

A similar equation is used to calculate the Agricultural and Industrial value-added shares.

Total historical energy consumption for each sector is recorded in a user-defined variable (initially defined in the General: User Variables screen) labelled **HistTotalEnergy** with units of Thousand TOE. These data are extracted directly from the IEA’s World Energy Balances. Energy in-

Sector	Activity Level
Households	Total population
Services	Services value added
Transport	GDP MER
Industry	Industrial value added
Agriculture & Fishing	Agricultural value added
Non-energy/non-specified	GDP MER

Activity Level Drivers Used in the LEAP Country Data Sets

tensities are calculated in LEAP’s **Final Energy Intensity** variable as the total energy consumption divided by total activity level for each sector/subsector using the following type of equation in LEAP:

$$\text{HistTotalEnergy[TOE] / Total Activity}$$

The share of energy consumption provided by each major fuel type is recorded in the **Fuel Share** variable and is taken directly from the IEA’s World Energy Balances. Emission factors for each pollutant are specified in the branches below each fuel.

Baseline Scenario

In the baseline scenario, the **HistTotalEnergy** variable is no longer used. Instead, total energy is projected as the product of the separate projections of the activity level and energy intensity variables. This is the reverse of the approach used for the Current Accounts calculations and can be written as follows:

$$E = AL \times EI$$

For the **Activity Level** variable projections, we take the UN’s own population projections to project population data to 2040. Overall GDP is projected (in MER terms) based on the regional growth assumptions of the US EIA’s International Outlook (EIA, 2009), while GDP is broken down into the three major sectors using trend projections of value added by sector (see section 4.1).

Projections of total energy consumption for each sector are broken down using the **Fuel share** variable in order to calculate baseline projections of energy consumption for each fuel in each sector. Finally, these energy values are multiplied by the various emission factors to calculate demand-side emissions of each greenhouse gas.

Fuel shares are projected forward as follows. Fuel shares are first projected forward individually using the calculated historical growth rates for 19995-2009. These projected values (recorded in LEAP variable **UnscaledFuelShare**) are then normalized so that the values sum to 100% across all fuels. The results are recorded in the **FuelShare** variable.

Transformation

The data sets also include simple representation of the following major Transformation sectors: distribution losses, own use, heat production, combined heat and power (CHP), electricity generation and oil refining. Note that some of these sectors (e.g., CHP and heat production) exist in only a few countries. Therefore, some country data sets will not include some sectors depending on national circumstances.

Efficiency and historical production data for each sector are derived from the IEA’s World Energy Balances. Other supplementary variables required to allow LEAP’s Transformation calculations to proceed are all set to SEI assumed values. These include lifetime, interest rate, and maximum availability. Since the IEA databases do not include information on the installed capacity of electricity generation plants, this information is calculated internally based on the recorded information about the production of elec-

tricity from each major fuel type, combined with assumptions about the average availability of each plant type. The equation used to calculate capacity is as follows:

$$\text{Capacity [MW]} = \frac{\text{Historical Production[MW-hr]} / (8760 * \text{Maximum Availability[\%]})}{1}$$

Countries will likely wish to make use of their own national data on the electricity sector to improve this part of the data set. In particular, they may wish to use better data for power plant capacities, efficiencies and availability, or they may wish to use a more detailed set of power plants (for example, distinguishing between combined cycle and combustion turbine type power plants, since they have significantly different operating efficiencies and hence significantly different emissions profiles).

The baseline scenario does not attempt to make detailed projections of how the mix of energy supply technologies will change in any country. It simply assumes that each type of generation grows at the trend rate.

Statistical Differences

The starter data sets include historical data on statistical differences (the difference between final consumption values and energy supplies). For Current Accounts, this data is taken directly from the IEA’s World Energy Balances database. The baseline scenario has no explicit projections of these values, so that all future statistical differences are set to zero.

Stock Changes

The starter data sets include historical data on stock changes (the supply of primary energy from in-country stocks). The convention used in LEAP is that negative stock changes indicate an increase in stocks. For Current Accounts, this data is taken directly from the IEA’s World Energy Balances. The baseline scenario has no explicit projections of these values, so all future stock changes are set to zero.

Energy-Sector Emissions

As noted in Section 4, the country data sets use the IPCC’s standard Tier 1 emissions factors to calculate all energy-sector GHG emissions. Most factors are specified in units of Tonnes per TJ of fuel combusted. All emission factors are assumed to be constant in the starter data set.

Non-Energy-Sector Effects

As noted in Section 4, historical non-energy-sector emissions for the Current Accounts are all taken directly from version 4.1 of the EDGAR database developed by PBL. Our baseline scenario makes no explicit projections of these historical values. Thus, net emissions from the non-energy sector are assumed to remain constant. Clearly this is unlikely to be the case in reality. Better nationally appropriate assumptions on non-energy-sector emissions will be needed in any finalized baseline data set,

particularly in countries where sectors such as agriculture, forestry and waste are important net producers of GHG emissions.

Training Outputs

The workshop resulted in the following outputs:

- 23 participants trained in the use of LEAP and in GHG mitigation assessment in the context of reporting to the UNFCCC
- LEAP software provided to all trainees on USB drives.
- Provision of supplemental training materials including PowerPoint slides, training exercises, software manuals, etc.
- Provision of national “starter” data sets developed by SEI for LEAP to each participant for all countries except the Palestinian authority for which, unfortunately, no readily available international data exists.
- This short report covering the proceedings of the workshop and next step recommendations.



8. CONCLUSIONS

As a result of this training, a core group of participants from 16 countries received a basic introduction to the topic of GHG mitigation assessment in the context of developing national communications to the UNFCCC, and introductory training in one specific software tool, LEAP, which can be used for such assessments.

The two main difficulties in using LEAP or any similar tools for such assessments are the serious lack of data available in many of the target countries and the lack of sufficient capacity in local organizations to make use of such tools.

Addressing the first point, during the training sessions, workshop participants discussed data shortages, and while there was no immediate fix for these shortages, we believe that participants now have a better idea of where the most important data gaps lie and what sort of data needs to be collected to fill such gaps. In some cases, targeted energy surveys can help to overcome some of these issues, while in the longer term there is a need for more detailed energy statistics to be collected and maintained on a regular basis.

The second issue, the lack of sufficient expertise in the target organizations, is harder to address. Unless sufficient staff can be assigned to work on these issues on a regular basis, it is very hard for agencies to build, and much less maintain, the capacity required to rigorously analyse and

plan for low-emission development. Doing this properly will require a major change in investment priorities in most countries, which we believe is far beyond the scope of what can be achieved by individual programmes such as ClimaSouth and ClimaEast. Nevertheless, such programmes can still make a useful contribution by sowing the seeds for what can hopefully become larger and more coordinated efforts to develop significant low-emission development strategies in future years.

The ClimaSouth project will facilitate mentoring services to partner countries who continue working on GHG modelling using LEAP or other appropriate tools at the country level.

Key Next Steps

Key next steps would include conducting follow-up training sessions focusing on the development of country-specific data sets for GHG mitigation assessment. Since these training sessions need to address the data and capacity challenges specific to particular countries, it would be a challenge to organize them in the same regional format used for the first workshop. Ideally, these follow-up training sessions could be organized in each beneficiary country, although we are aware that the ability to do this is likely to be limited by the costs involved in such an effort.

While the first workshop was only able to build basic skills, including the skills required to use the LEAP software sys-

tem, follow-up training sessions could have two main outcomes: first, they could lead to helping countries start to build more tangible outputs, including country-specific LEAP data sets able to answer important questions about the potential for GHG mitigation in each country and its likely economic costs and benefits; and secondly, they could provide insights into important related issues, including the likely impact of GHG mitigation strategies on issues such as energy security, poverty alleviation and air pollution abatement.

Additional key next steps that might be considered by ClimaSouth and ClimaEast include:

- targeted data collection (e.g., energy surveys) to help overcome data shortages, and
- additional investment in human resource development to build capabilities in beneficiary countries for conducting GHG mitigation analysis and planning.



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