Climate Change Mitigation Scenarios: Planning the Future

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The Challenge

We Face Existential Challenges:

- **Climate:** Keeping warming within safe limits (2°C or less).
- **Biodiversity:** ending the dramatic loss of species caused by human development.
- **Development:** achieving peace and prosperity for people and the planet: ending poverty, improving health and education, reducing inequality.

But we are not ready:

- **Climate:** We are on course for 4°C warming.
- **Biodiversity:** 1 million species face extinction with the rate loss 10-100 times higher than the average of the last 10 million years.
- **Development:** Extreme poverty reduced, but remains persistent, absolute income inequality has increased dramatically since the mid-1970s.

What journey are we on?

A carefully planned voyage with a clear and desirable destination?

Or a runaway train?

How Should We Respond?

- Need a paradigm shift: away from reactive, end-of-tailpipe responses to environmental and developmental crises.
- Adopt holistic, science-based methods for **planning** a transition to a more equitable and sustainable low emissions future.
- Set up systems for monitoring, reporting and verifying the implementation of plans.
- Need better data: you can't plan a journey if you don't know where you are today.
- There are no right answers. All pathways involve tradeoffs: vital to get meaningful input from diverse set of stakeholders.
- Methods should not purport to provide objective answers: only to support processes by informing stakeholders of implications of alternatives (costs; climate, air pollution and biodiversity impacts; social and development implications, etc.)
- Scenario analysis can be used to identify **robust** futures, rather than single "optimal" solutions.
- Countries have started to conduct more holistic analyses (e.g. NDCs, National Communications, National action planning on air pollution) but these are typically divorced from actual development pathways countries are following.
- Cooperation across sectors and ministries is rare in most countries.

A Special Challenge for Developing Countries

- Data are of low quality and in short supply. Few data on energy services.
- Limited human capacity in government agencies; reliance on consultants.
- Modeling tools too complex, data intensive and expensive.
- Planning processes rarely transparent: hard for stakeholders to engage and encourage change.
- Use of energy systems to promote social goals under threat from emerging distributed RE technologies (e.g. electric subsidies to farmers) .

This is a huge challenge

- It expects more complex analyses to be done by institutions with chronic shortages of data and human capacity.
- Requires large long-term investments in institution building and a new generation of more accessible and usable tools.

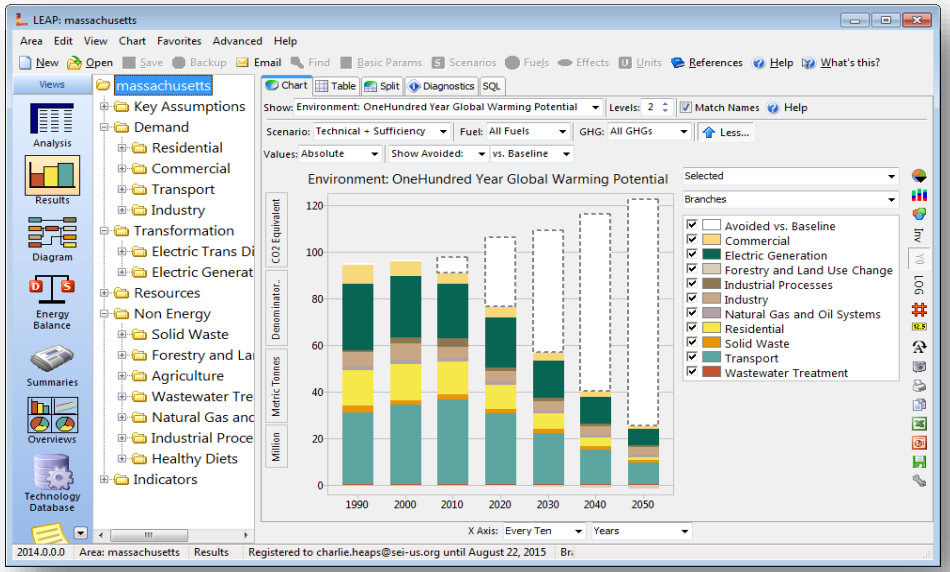
What is SEI Doing?

- Developing modeling tools that meet the needs of developing country planners:
  - Based on principles of robust and holistic planning
  - Support bottom-up, energy service-based modeling
  - Our LEAP software is now used in 190 countries. Used by ~40 countries to help develop their Paris commitments.
- Disseminating LEAP for free to target organizations in low-income and lower-middle-income country.
- Teaching skills needed by developing country climate and sustainability planners.
- Fostering communities of practice to build planning capacity.
- Advancing the science:
  - New methods for assessing human health and ecosystem impacts of climate and air pollution.
  - New methods for better a.

A participant from Nepal at a recent LEAP Training Workshop explaining her analysis.

LEAP

- Designed for planners and analysts: Not just modelers.
- Focused on energy-related emissions but can also cover non-energy sectors.
- Tracks all GHGs and air pollutants.
- Tools for managing, comparing and evaluating scenarios.
- Not just a model: supports data management, reporting and stakeholder-driven scenario design and evaluation.
- Transparent calculations, low initial data requirements, flexible data structures and choice of methods.
- Widely-used for energy planning, national communications, low emission development strategies, and national action planning on SLCPs.



- Free for government agencies, universities and NGOs in low and middle income countries.
- Runs on standard Windows PCs.
- Actively supported by SEI with large web-based community (40,000 members): www.energycommunity.org

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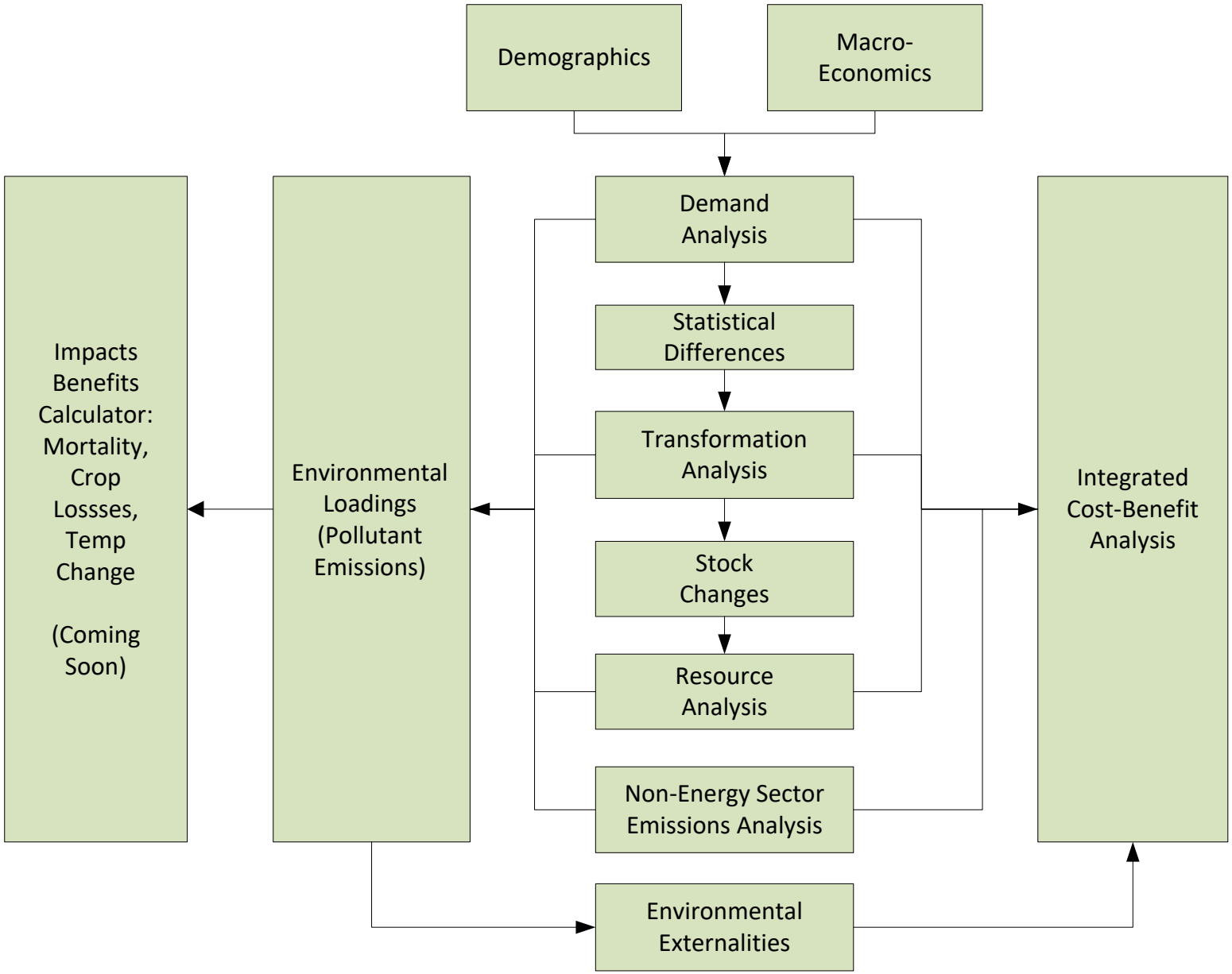
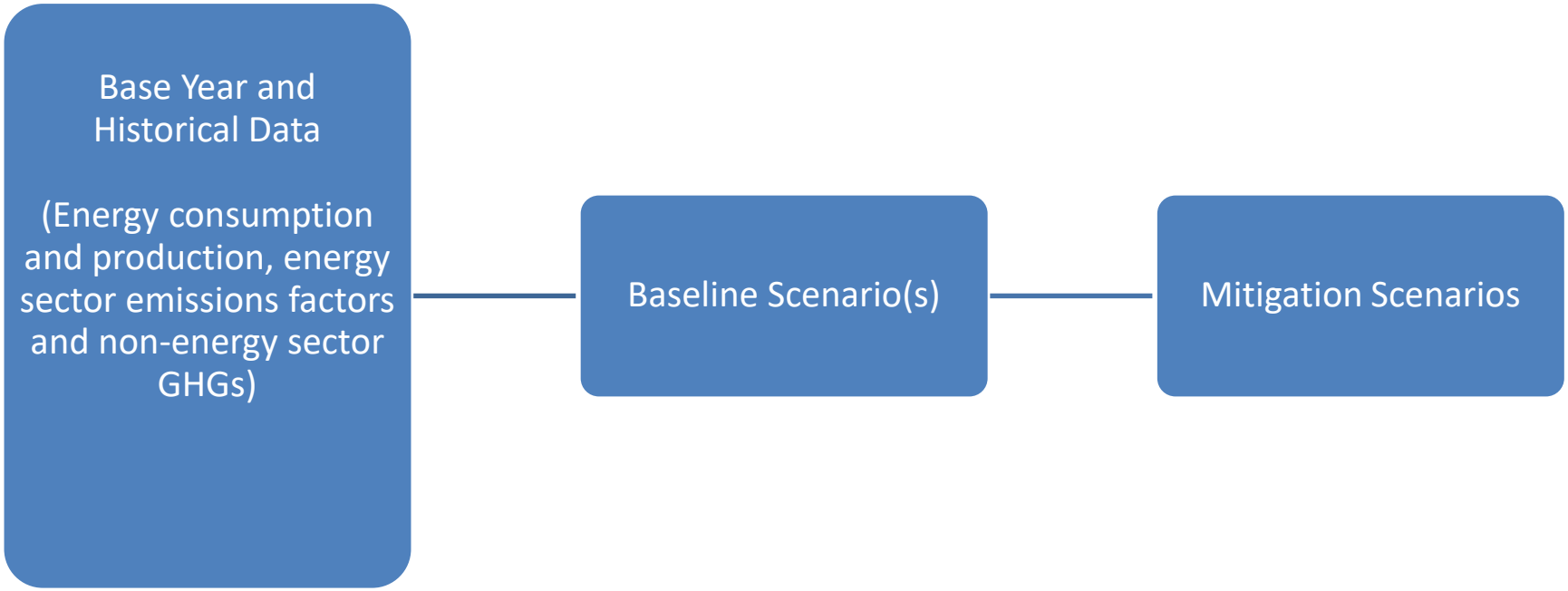
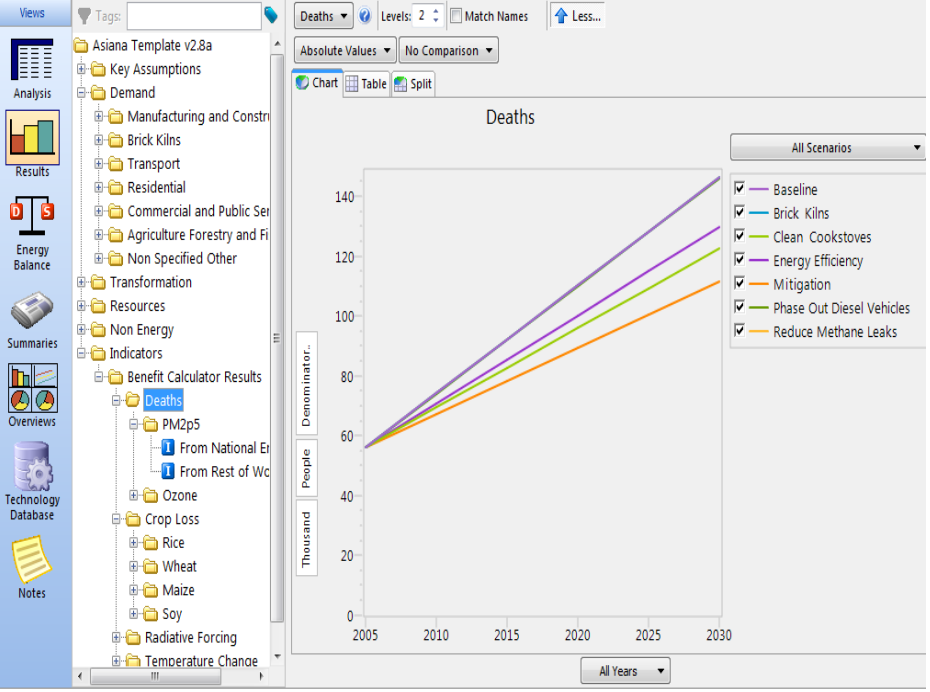
LEAP

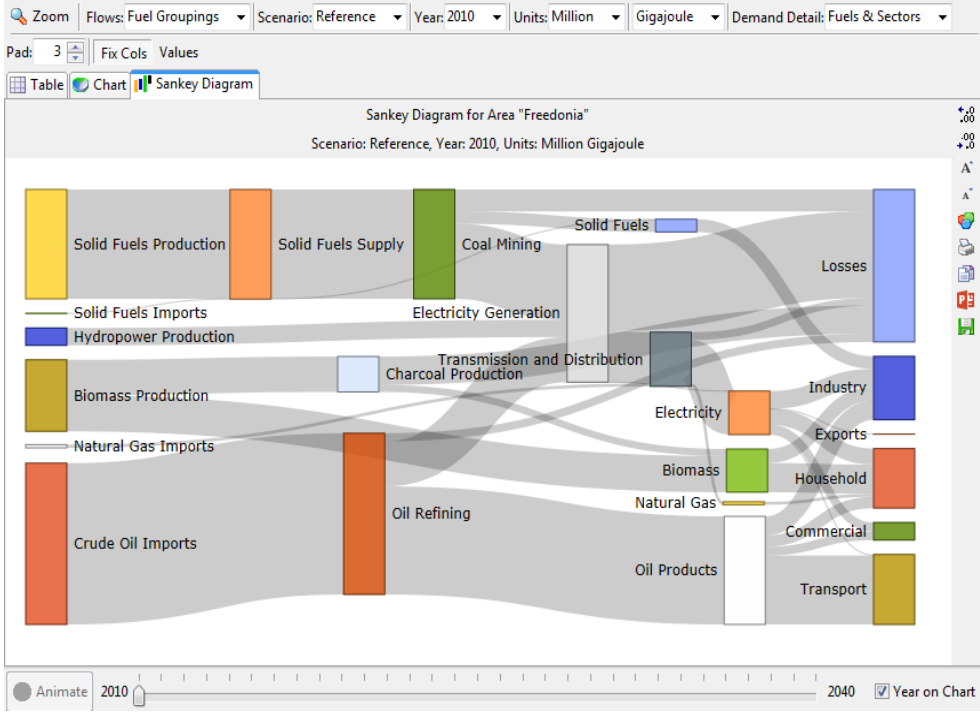
LEAP Structure

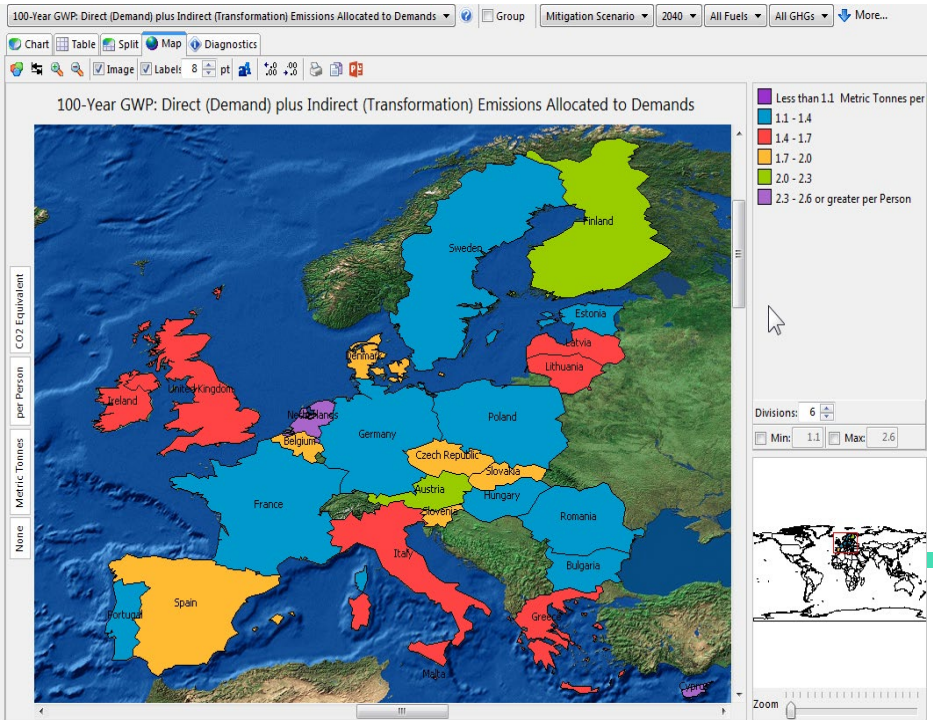


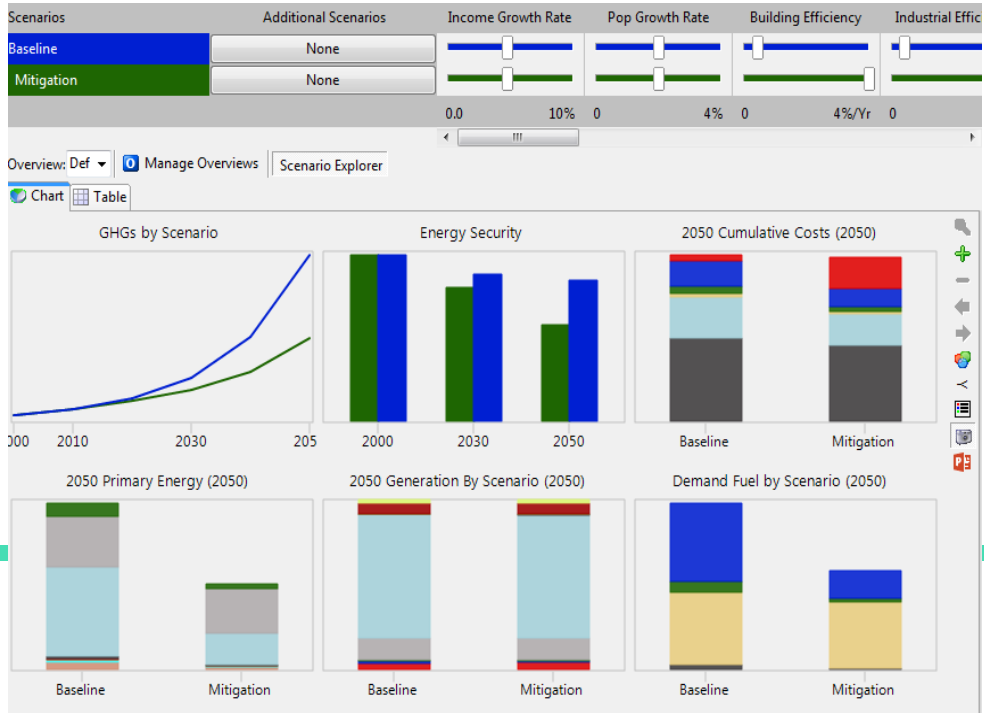
Key steps in Using LEAP




Views
Analysis
Results
Energy Balance
Summaries
Overviews
Technology Database
Notes
Tags:
Asiana Template v2.8a
Key Assumptions
Demand
Manufacturing and Constr
Brick Kilns
Transport
Residential
Commercial and Public Ser
Agriculture Forestry and Fi
Non Specified Other
Transformation
Resources
Non Energy
Indicators
Benefit Calculator Results
Deaths
PM2p5
From National Er
From Rest of Wc
Ozone
Crop Loss
Rice
Wheat
Maize
Soy
Radiative Forcing
Temperature Change
Deaths
Levels: 2
Match Names
Less...
Absolute Values
No Comparison
Chart
Table
Split
Deaths
All Scenarios
Baseline
Brick Kilns
Clean Cookstoves
Energy Efficiency
Mitigation
Phase Out Diesel Vehicles
Reduce Methane Leaks
Denominator...
People
Thousand
140
120
100
80
60
40
20
0
2005
2010
2015
2020
2025
2030
All Years


Zoom
Flows: Fuel Groupings
Scenario: Reference
Year: 2010
Units: Million
Gigajoule
Demand Detail: Fuels & Sectors
Pad: 3
Fix Cols
Values
Table
Chart
Sankey Diagram
Sankey Diagram for Area "Freedonia"
Scenario: Reference, Year: 2010, Units: Million Gigajoule
Solid Fuels Production
Solid Fuels Supply
Coal Mining
Solid Fuels
Losses
Solid Fuels Imports
Electricity Generation
Hydropower Production
Transmission and Distribution
Charcoal Production
Biomass Production
Industry
Electricity
Exports
Natural Gas Imports
Biomass
Household
Natural Gas
Oil Refining
Crude Oil Imports
Commercial
Oil Products
Transport
Animate
2010
2040
Year on Chart


100-Year GWP: Direct (Demand) plus Indirect (Transformation) Emissions Allocated to Demands
Group
Mitigation Scenario
2040
All Fuels
All GHGs
More...
Chart
Table
Split
Map
Diagnostics
Image
Labels
8
pt
100-Year GWP: Direct (Demand) plus Indirect (Transformation) Emissions Allocated to Demands
Less than 1.1 Metric Tonnes per
1.1 - 1.4
1.4 - 1.7
1.7 - 2.0
2.0 - 2.3
2.3 - 2.6 or greater per Person
Divisions: 6
Min: 1.1
Max: 2.6
Zoom
CO2 Equivalent
per Person
Metric Tonnes
None
Finland
Sweden
Estonia
Latvia
Lithuania
Ireland
United Kingdom
Netherlands
Belgium
Germany
Poland
Czech Republic
Slovakia
Austria
Hungary
Slovenia
France
Romania
Italy
Bulgaria
Spain
Portugal
Malta


Scenarios
Additional Scenarios
Income Growth Rate
Pop Growth Rate
Building Efficiency
Industrial Effic
Baseline
None
Mitigation
None
0.0
10%
0
4%
0
4%/Yr
0
Overview: Def
Manage Overviews
Scenario Explorer
Chart
Table
GHGs by Scenario
Energy Security
2050 Cumulative Costs (2050)
000
2010
2030
205
2000
2030
2050
Baseline
Mitigation
2050 Primary Energy (2050)
2050 Generation By Scenario (2050)
Demand Fuel by Scenario (2050)
Baseline
Mitigation
Baseline
Mitigation
Baseline
Mitigation

Case Study: Integrated Planning of Climate and Air Pollution Across Multiple Gases (CO2, CH4, BC, HFCs, etc.)

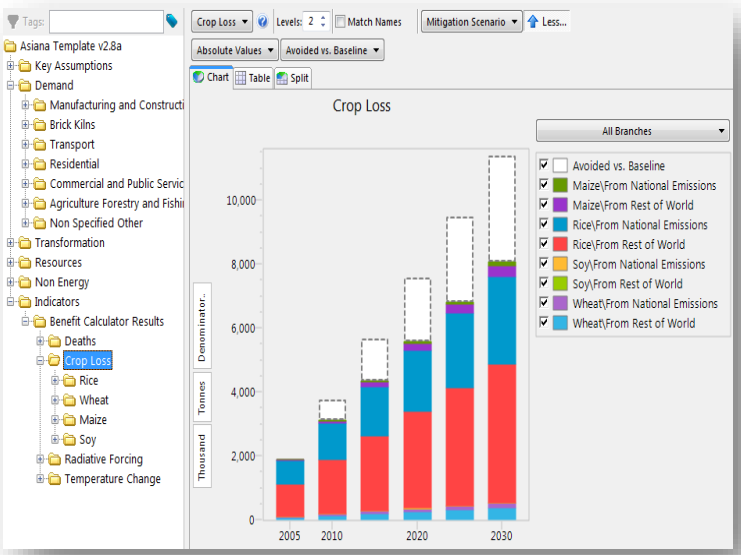
- Highlights co-benefits of action: e.g. reducing health and ecosystem impacts, helping to achieve SDGs, providing affordable clean energy, *as well as* avoiding climate warming.
- Motivates more ambitious climate mitigation, esp. in countries that have poor air quality.
- Encourages engagement & coordination among diverse stakeholders: e.g. ministries of energy, environment, health, agriculture, transport.
- Going beyond GWPs, promotes consideration of alternative pathways that can avoid near-term warming as well as long-term low carbon targets.

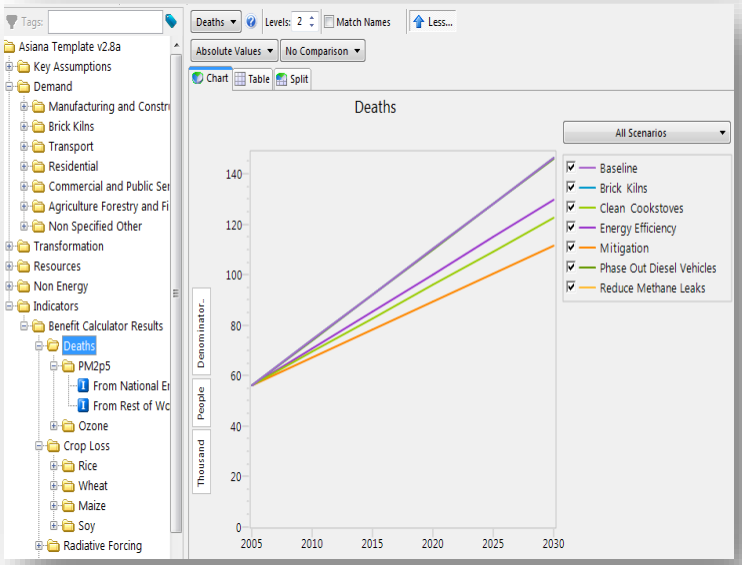
Challenges for Integrated Planning

- Integrated planning of climate and air pollution is more complex than for GHGs alone: Places additional strain on scarcest resources: data and expertise.
- So any tools need to be easy-to-use, minimize data requirements, be usable by planners (not just expert modelers), and build on any analyses already developed (e.g. national communications & NDCs).
- But it results in a significant pay off:
  - more relevant to the development aspirations of developing countries,
  - more credible with more details of implementation, and
  - encourages greater mitigation ambition

LEAP-IBC

- The Integrated Benefits Calculator (IBC).
- Emissions changes for primary pollutants (CO_2, $PM_{2.5}$, CH_4, CO, NO_x, NMVOCs, BC, OC, SO_x) developed in LEAP.
- Supplemented by natural background & rest-of-world emissions from IIASA's ECLIPSE scenarios.
- IBC translates emissions into population-weighted concentrations based on results from Geoschem-Adjoint (G-A).
- Concentration-exposure-response functions from the Global Burden of Disease study (GBD) used to calculate health (prem. mortality and YLL). Other functions calculate crop losses (primarily from tropospheric ozone).
- Results generated quickly: displayed in LEAP.
- Currently works at national scale: urban version coming in late 2019.
- Being used in about a dozen countries. Calibrated for use in about 100 countries.





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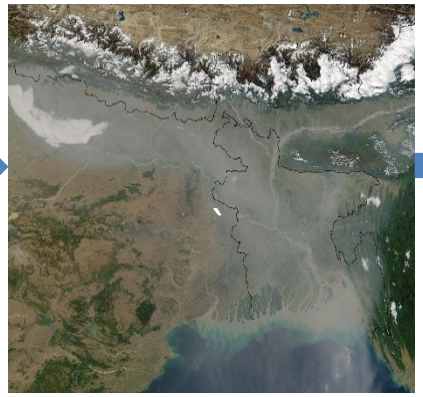
LEAP-IBC Model Pathway

Emissions



Transport

Exposure

Impacts: Climate

Impacts: Health and Vegetation

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Africa Integrated Assessment of Air Pollution And Climate Change

- Air pollution and climate change interlinkages can exacerbate the impact of poorly designed policies, or amplify co-benefits and catalyse greater climate ambition.
- Africa has the second fastest growing regional economy in the world and is particularly vulnerable to climate change.
- The assessment responds to requests from member countries to tackle air quality and climate change together in a rigorous scientific assessment.
- Chaired by Youba Sokona, currently Vice-Chair of the IPCC and coordinated by Alica Kaudia, Environment Secretary at the Ministry of Environment in Kenya
- The study will bring together practitioners across Africa and promote capacity building and action.
- LEAP-IBC will be used as main analytical framework to build an Africa-wide model of emissions, health and ecosystem impacts with national scale resolution.
- Taking Place 2019-2021

Coming Soon in LEAP 2019

Summer 2019

- Gender-disaggregated air pollution health impacts.
- Health impacts of indoor air pollution (in addition to existing outdoor calculations).
- New super-fast optimization modeling engine: supports analysis of energy storage & large-scale deployment of variable renewables.
- Emissions and other results dynamically allocated to map grids for detailed analysis of impacts.
- Faster calculations and a much more responsive user interface.

Later

- Air pollution modeling at the city-scale, including mapping of concentrations and impacts.
- Modeling of GHG emissions & sinks of land-use, land-use change and forestry.
- Cloud-based environmental technology database (EDB): with costs, emission factors and characteristics of technologies. Use with LEAP & other models via an open API.
- webLEAP: LEAP results in an interactive web site to better engage stakeholders.

Area Edit View Chart Favorites Advanced Help

New Open Save Backup Auto Refresh Regions What's This?

Views

Analysis Results Energy Balance Summaries Overviews Technology Database Notes

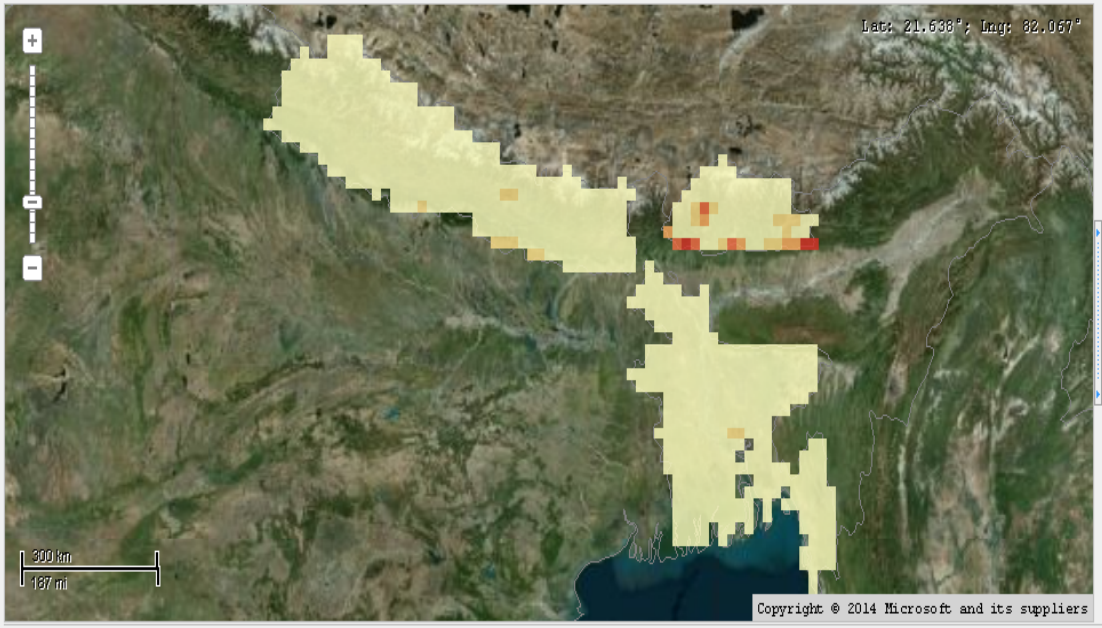
- Freedonia
  - Key Assumptions
  - Demand
    - Household
      - Urban
        - Electrified
      - Rural
        - Electrified
        - Non Electrified
    - Industry
    - Transport
    - Commercial

Scenario: Reference | 2010 | All Branches | All Fuels | Effect: Sulfur Dioxide | All Regions | All Tags | Less...

Absolute Values | No Comparison | Region Groups

Chart | Table | Split | SQL

Sulfur Dioxide (SO2)

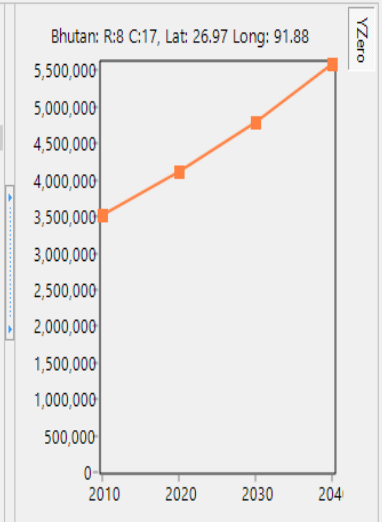


734 Cells:
- 269 - 523,134 (702 Cells)
- 523,134 - 1,140,825 (20 Cells)
- 1,140,825 - 1,870,541 (5 Cells)
- 1,870,541 - 2,732,598 (4 Cells)
- 2,732,598 - 3,750,999 (3 Cells)

Pan | Exponential | Bing Satellite | Divisions: 5

Labels | Tran (%): 20 | Asia

28	21.60													
29	21.40													
30	21.20													
31	21.00													
Bhutan	Long >	5	6	7	8	9	10	11	12	13	14	15	16	17
	Lat v	89.40	89.60	89.80	90.00	90.20	90.40	90.60	90.80	91.00	91.20	91.40	91.60	91.80
1	28.60				15,746									
2	28.40		26,542	10,530	4,198	3,473								
3	28.20	18,198	18,197	11,245	12,124	20,407	59,281	94,865	28,535	21,305	38,593	37,443		
4	28.00	38,494	113,836	131,885	55,221	58,988	101,201	101,721	81,629	122,773	78,798	71,341		
5	27.80	728,288	2,080,831	1,004,552	242,206	134,021	202,275	136,411	114,526	222,388	232,614	426,102		
6	27.60	747,107	1,265,882	156,013	64,643	75,785	122,422	132,189	125,736	220,579	583,713	838,363	539,513	86,503
7	27.40	491,766	251,759	124,494	490,006	175,992	141,741	220,431	140,108	173,028	478,196	733,806	256,164	148,449
8	27.20	2,311,329	298,657	355,941	545,552	1,887,946	1,387,541	108,172	148,937	582,047	631,485	1,380,319	1,659,335	3,530,358



Dissemination and Installation

- Available at no charge to non-profit, academic and governmental institutions based in low-income and lower-middle income countries.
- Download from: www.energycommunity.org
- Support from web site or leap@sei.org
- User name and password required to fully enable software. Available on completion of license agreement.
- Most users will need training: available through SEI or regional partners.
- Runs on standard Windows PCs.