Using LEAP for Electric Sector Modeling

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LEAP

What Do We Do?

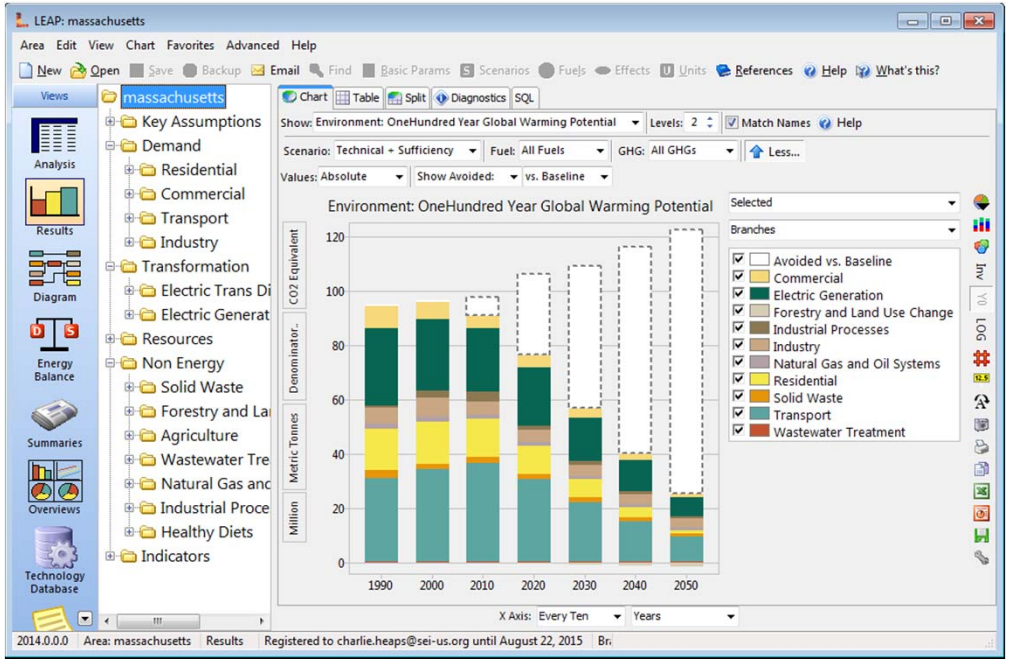
- Develop, distribute and support **LEAP**: the Long-range Energy Alternatives Planning system.
- Training & capacity building.
- Manage an online community for LEAP users and other sustainability practitioners. Now with > 24,000 members in > 190 countries.
  www.energycommunity.org
- Develop our own analyses to support policy.

- Our core audience is developing country energy planners and climate mitigation practitioners, rather than “hard core” modelers.

A participant from NEPAL at a recent LEAP Training Workshop explaining her mitigation analysis

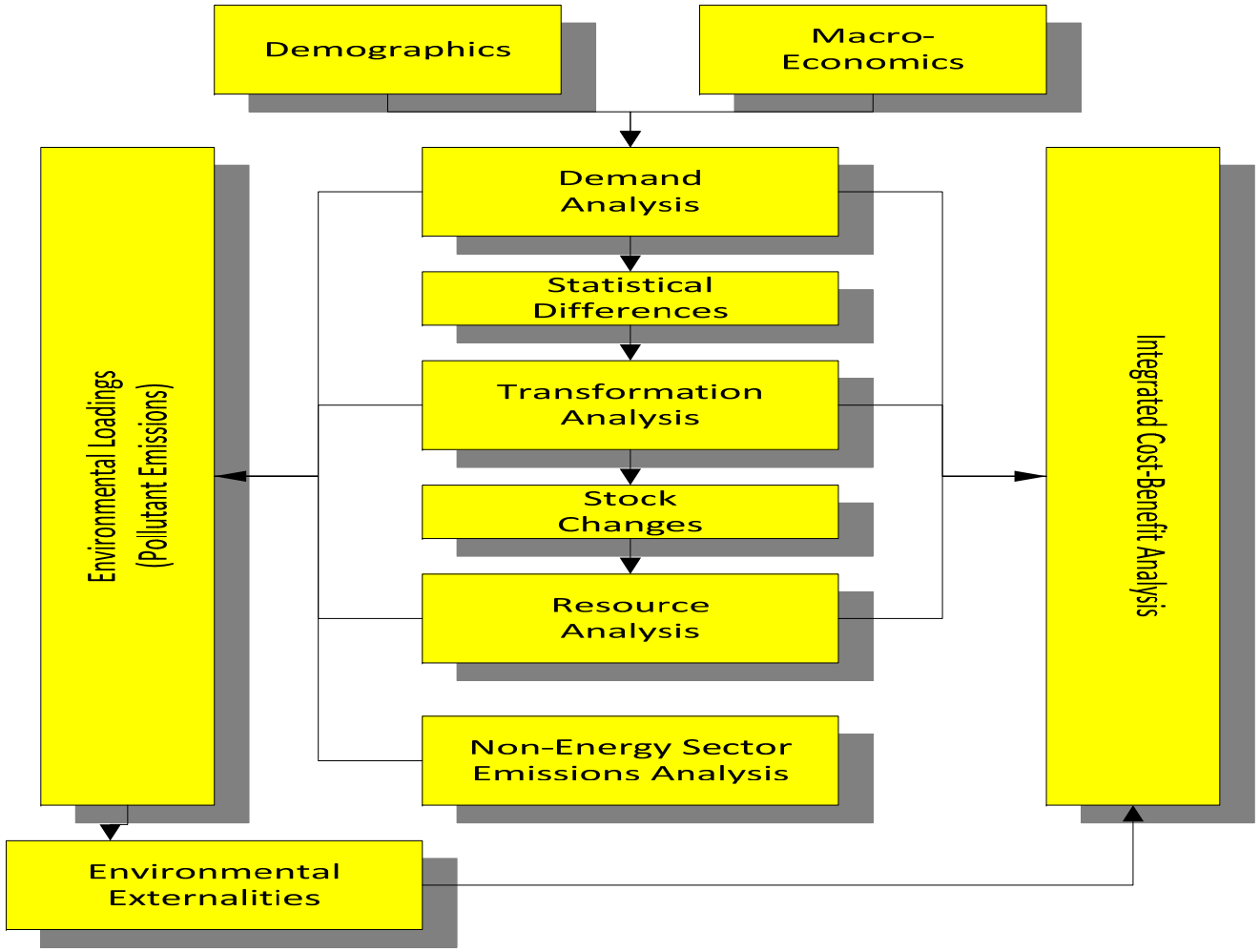
Long-range Energy Alternatives Planning System

- Easy-to-use, scenario-based modeling software for energy planning and GHG mitigation assessment.
- Broad scope, low initial data requirements, flexible data structures.
- Supports multiple methodologies: optimization, simulation, econometric models, etc.
- Widely used for energy planning, national communications, low emission development strategies (LEDS) and for developing Intended Nationally Determined Contributions (INDCs).
- Free to Governments, academia, and NGOs in developing countries.



LEAP web site:
www.energycommunity.org

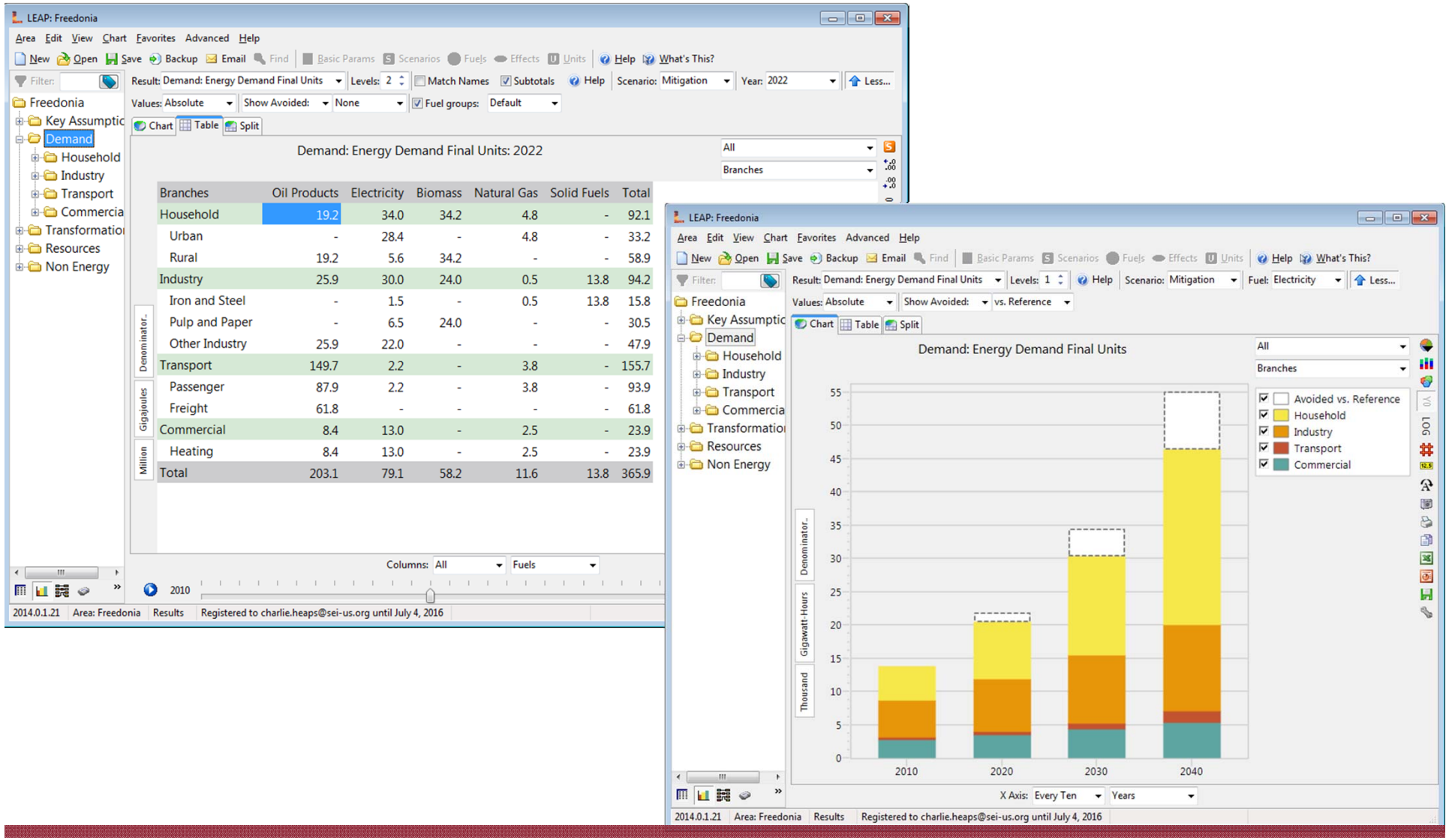
LEAP Structure



Demand Modeling Capabilities

- Top-down or bottom-up modeling of electricity demands: flexible disaggregation by sector/subsector, end-use and technology and choice of methods (econometric or engineering-based simulations).
- Choice of methods for modeling load shape:
  - Exogenous system-wide load duration curve
  - Exogenous load shape divided into user-defined seasonal/time-of-day time slices
  - Endogenous load shape built-up from individual load shapes specified for each electric demand.

Sample of Results



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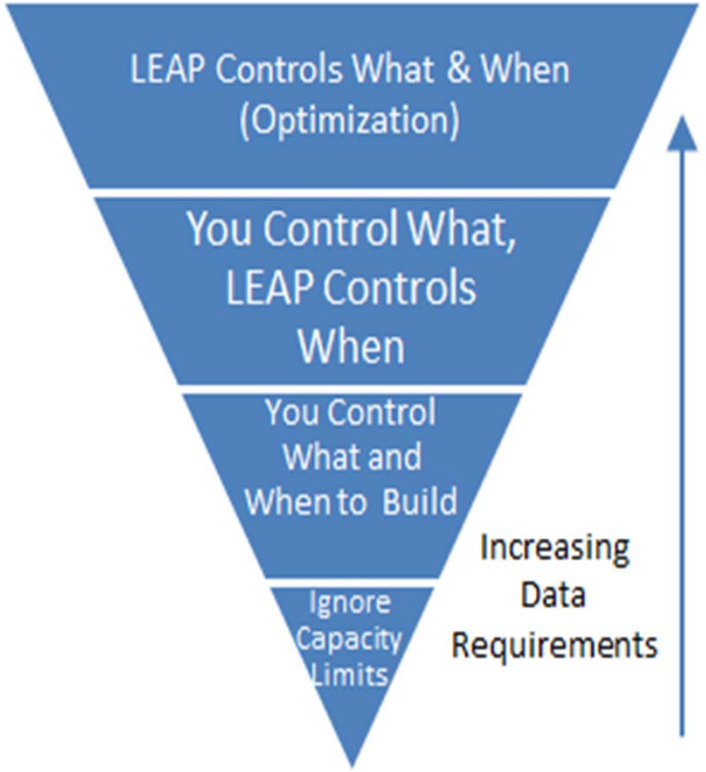
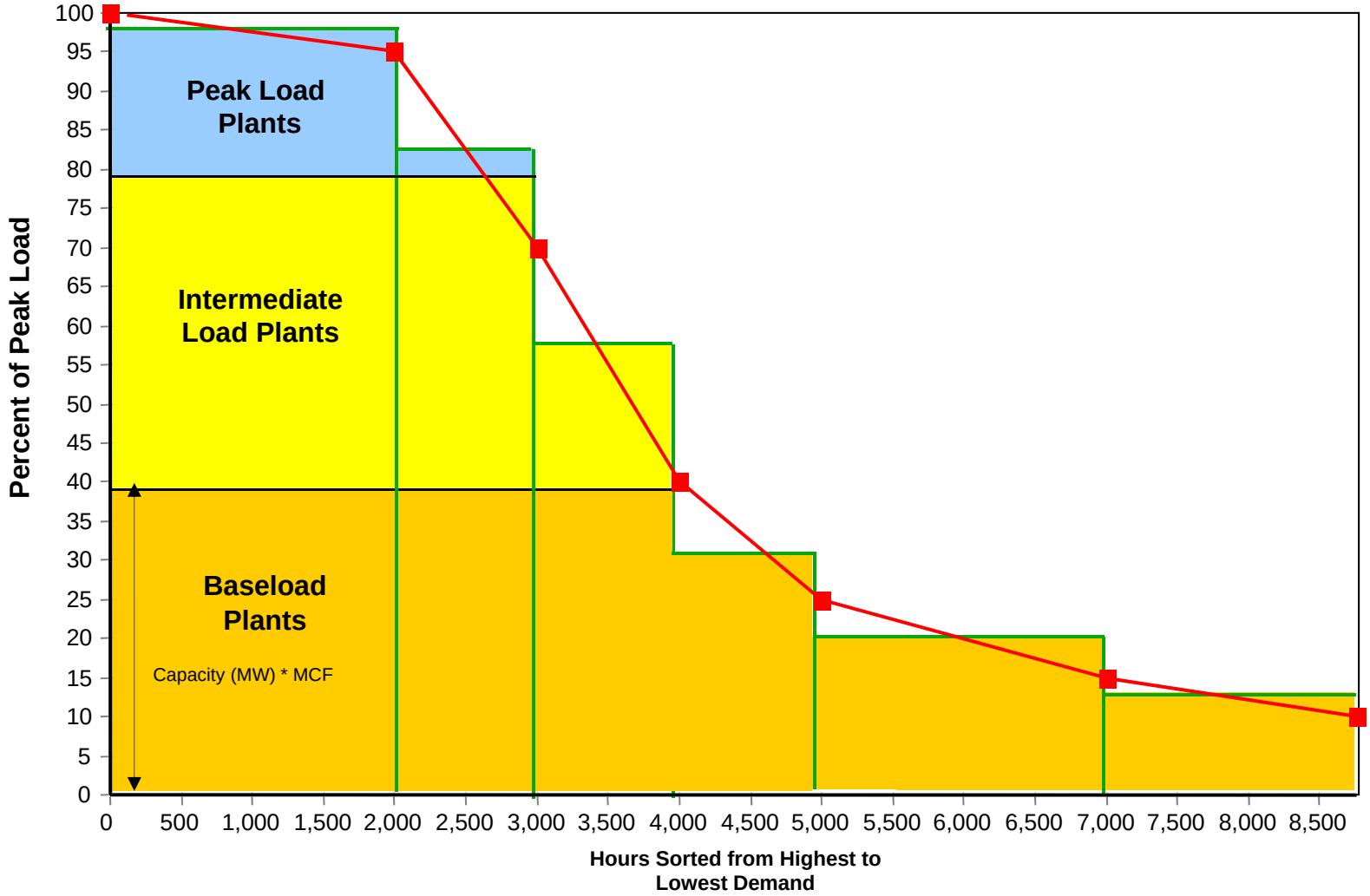
Transformation Modeling Capabilities

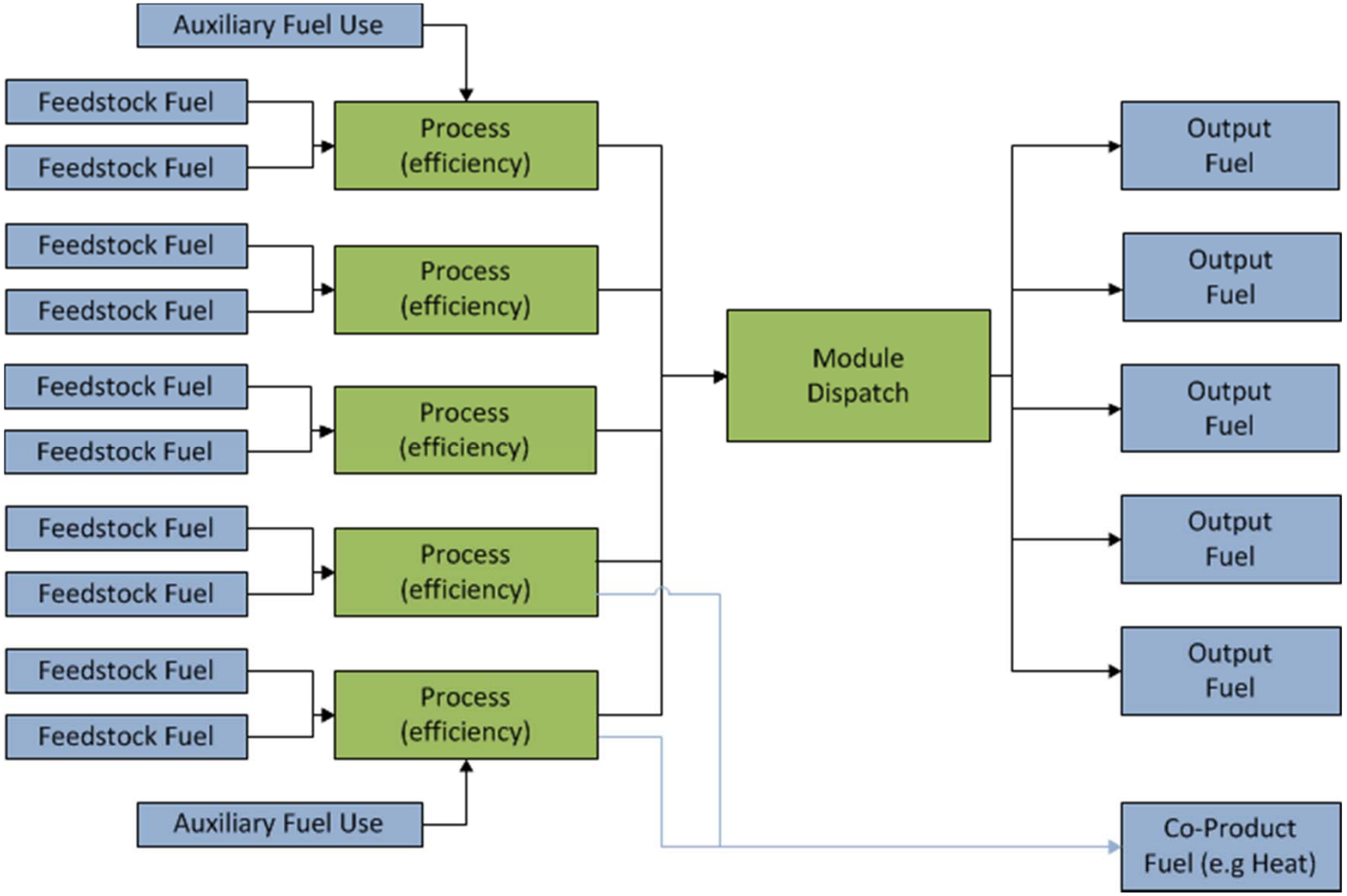
- **Level 1** (Simplest): Ignores capacity limits: dispatch specifies shares of each process.
- **Level 2:** User controls **what** to build and **when** and fully controls the dispatch of processes (e.g. by percent share or in proportion to avail. capacity).
- **Level 3:** User controls **what** to build but LEAP decides **when** (to meet a planning reserve margin). Dispatch e.g. by merit order to meet peak demands along a load-duration or a seasonal/time-of-day load curve.
- **Level 4** (Most detailed)**:** LEAP decides **what** to build and **when**, using least-cost optimization.
  - Can reflect CO_2 prices and other externalities, mitigation targets and RPS generation constraints for renewables
  - Uses OSeMOSYS with GLPK or CPLEX for optimization (linear or mixed integer programming)



Dispatch Simulation in LEAP (at its simplest)

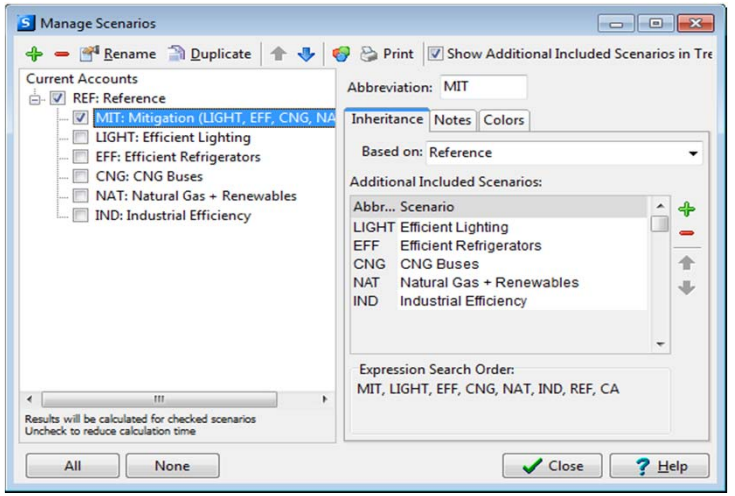


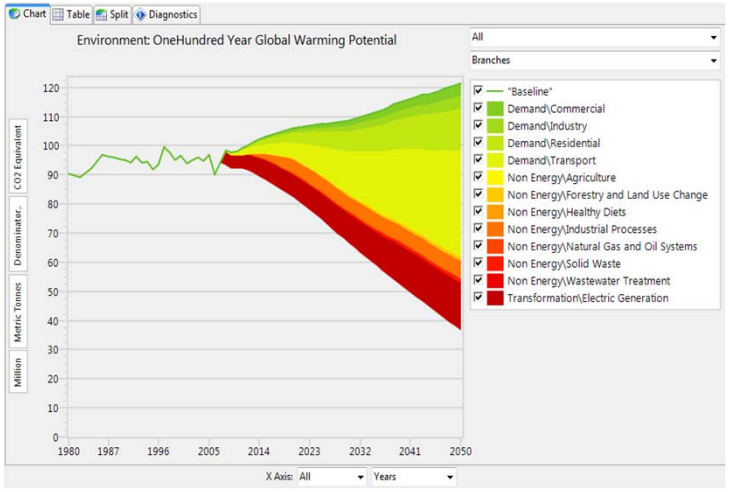
General Transformation Module Layout



Scenario Analysis

- Designed around the creation and analysis of scenarios.
- Scenarios organized in hierarchies that inherit default expressions from parent scenario(s): minimizing data entry and easing data management.
- All analyses include **Current Accounts** data describing at least one year of historical data.
- Multiple inheritance lets scenarios inherit data from more than one parent: combining of policies to create integrated scenarios.
- The **Scenario Manager** is used to organize scenarios and specify inheritance.
- Includes powerful graphics reporting for comparing scenario results.





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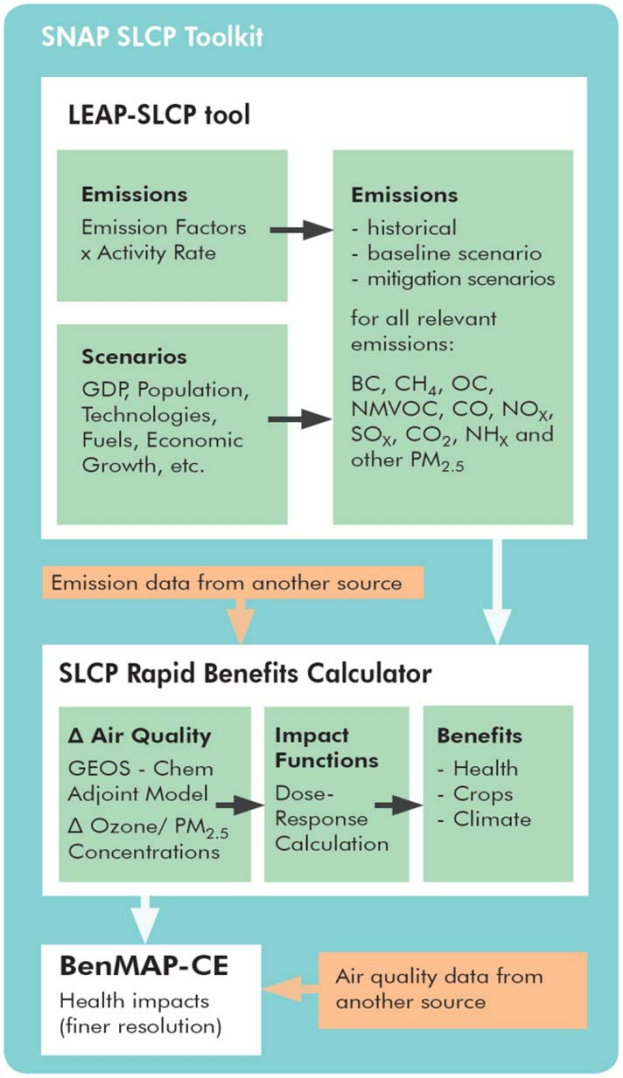
Emissions and Impacts

- LEAP itself only calculates emissions (not impacts)
- Emission factors for any GHG or local air pollutant used to calculate emissions loadings.
- EFs can optionally be specified in terms of the chemical composition of fuels (e.g. sulfur content) to reflect fuel characteristics of particular countries.
- Includes built-in database with IPCC "Tier 1" emission factors and other data. Currently being replaced by a new cloud-based database with an open API making it accessible to any energy model.
- Currently linking LEAP to a new Climate Benefits Calculator to show short and long-term climate mitigation benefits including avoided mortality, crop loss, regional temperature change (mid 2015).



As a Tool for Stakeholder Interaction

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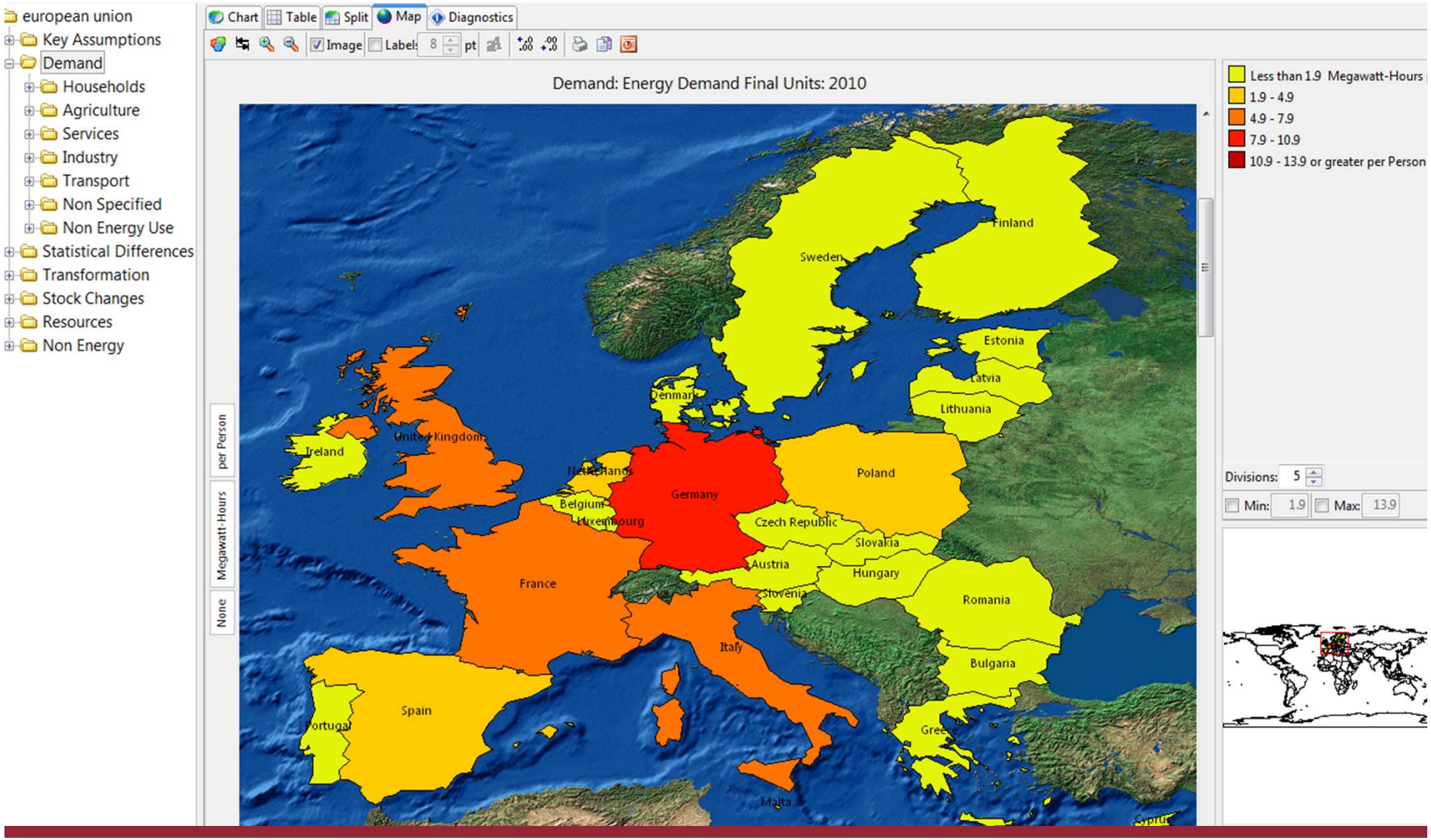
Multi-Regional Modeling



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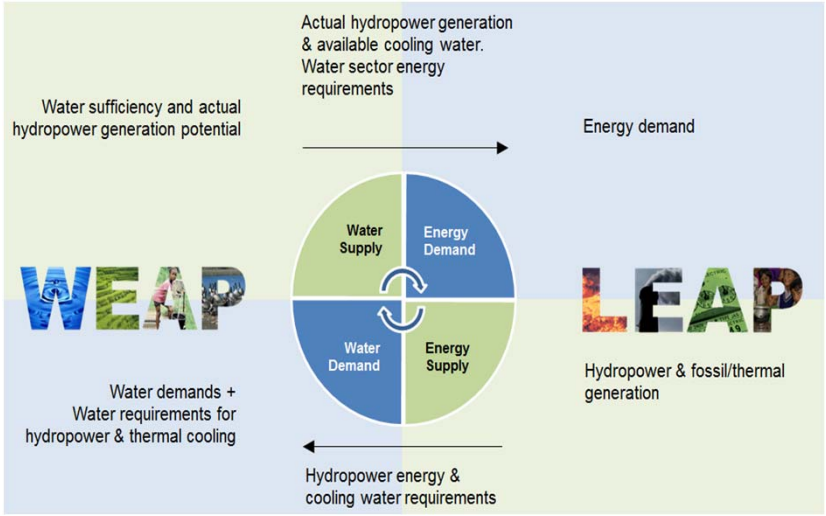
Other Capabilities

- Application Programming Interface (API):
  - Integrates with other models and standard Windows software like Excel & programing languages.
  - Used to create national-scale "starter" data sets for 105 countries based on IEA energy statistics, World Bank indicators, UN Population projections, EDGAR non-energy sector GHG emissions, etc.
  - Can also be used to integrate LEAP with tools like Crystal Ball for Monte Carlo sensitivity analysis.
  - API used to create links to the new Climate Benefits Calculator.

- Integrated with SEI's WEAP water resources planning software to support integrated energy-water "nexus" modeling.



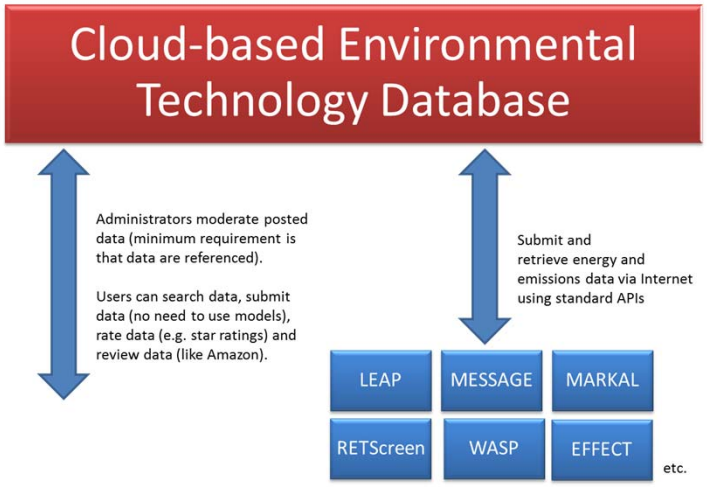
Current Key Limitations and Future Plans

Key Limitations

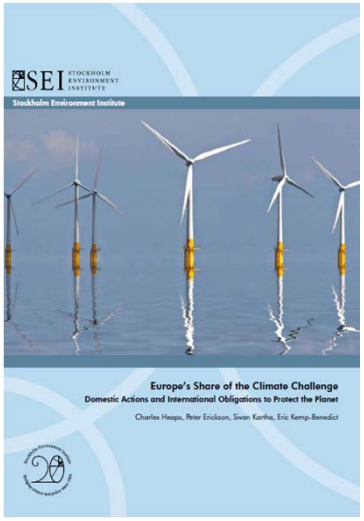
- Not an energy system optimization module: Only optimizes Electric Generation.
- Inadequate treatment of topics such as electric storage, CHP and retrofitted emissions control technologies.
- Inadequate treatment of loss of load probability.
- Multi-regional optimization not yet tested. No optimization of energy trade.

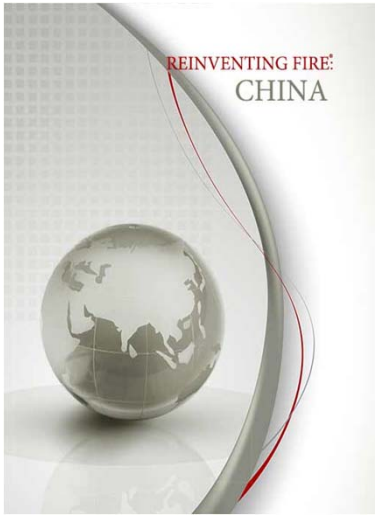
Future Plans

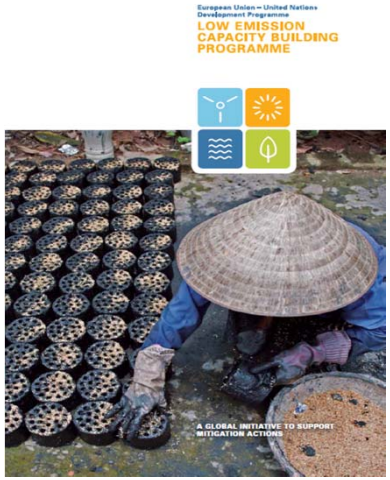
- New web-based tool for exploring LEAP scenarios online.
- Integration of Climate Benefits Calculator to show long and short-run impacts.
- New cloud-based technology and emissions factor database.

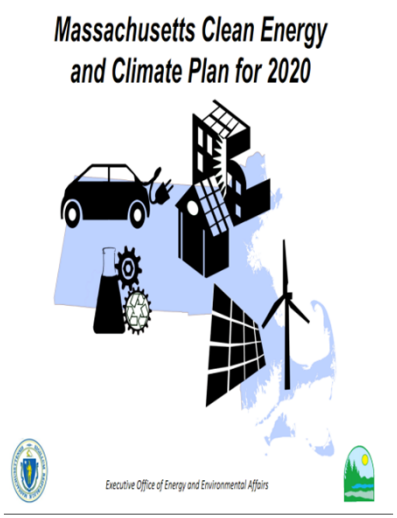


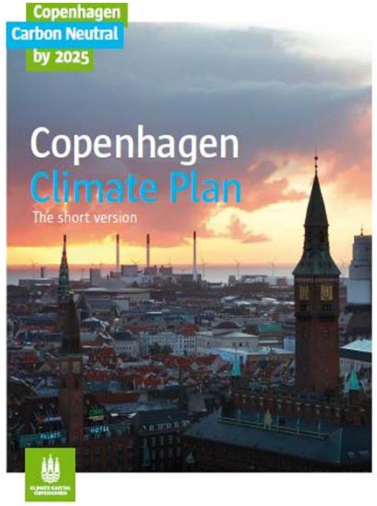
Selected Recent Scenarios Activities

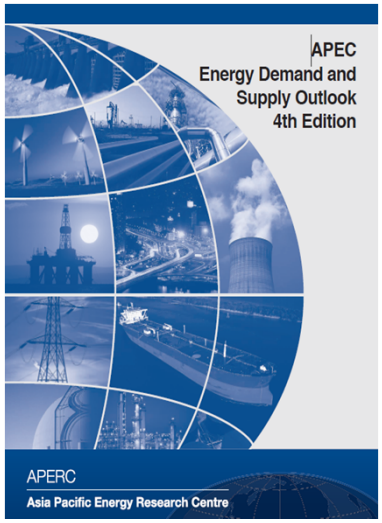












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For More Information:

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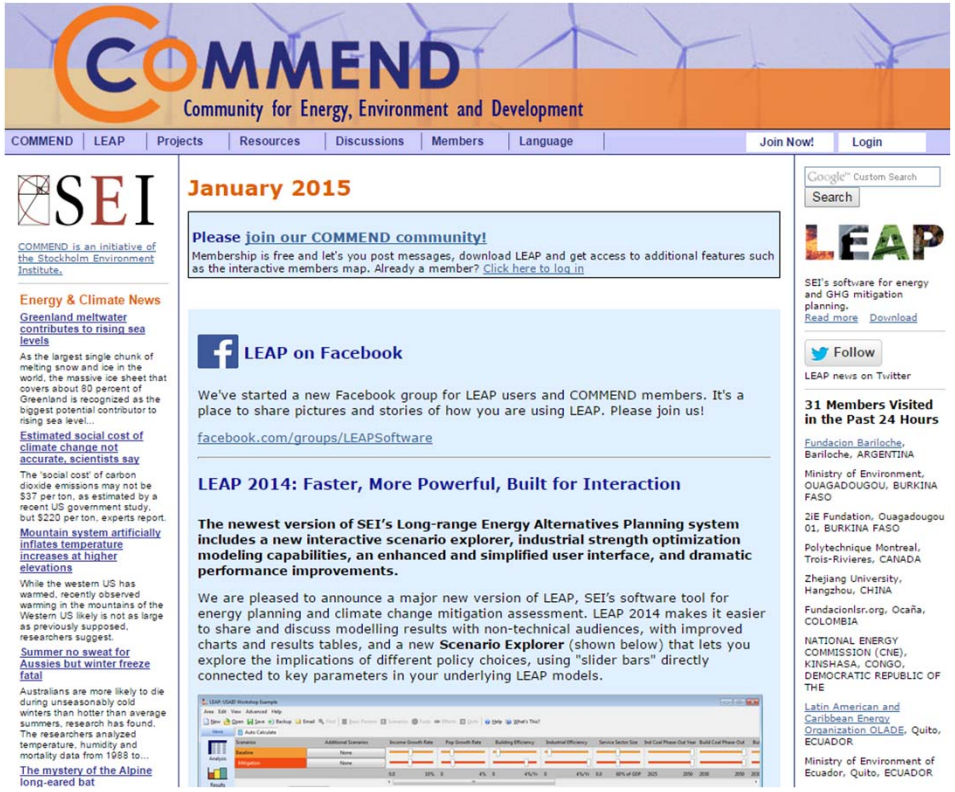

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