GIZ's Clean Affordable and Secure Energy for Southeast Asia

Phase 2 LEAP Training

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Today’s Agenda

- Take up last day’s assignment
- Other LEAP branch types
- Environmental loadings
- *Short break*
- Cost-benefit analysis using scenarios
- Today’s afternoon assignment

Coming Up…

- Introduction to LEAP-IBC
- Walkthrough of Asiana sample dataset

Logistics

Questions: Raise your hand, and if we don’t notice, please flag down one of the in-person facilitators

Chat screen: *Not monitored*

File sharing: https://tinyurl.com/Phase2GIZTraining

Software Registration

Username: CASE Phase 2 Training

Password: 897-734-988-095-426

Enter the above in LEAP by selecting **Help:Register** (not Help:Register Online). You may "skip" any request to enter your email address or username.

Yesterday's Assignment

Steps:

1. Locate and open both **afternoon_exercise_1.leap** and **LEAP2024TrainingExercise.pdf** in the Shared Materials directory.

2. Beginning on page 43, follow the instructions.
   a) *3.1 Charcoal Production*: Add the module according to the instructions. We'll do this together.
   b) *3.2 Electricity Generation*: In Current Accounts, update the Exogenous Capacity and Historical Production variables using the information in the table.
   c) *3.3 Oil Refining*: Add the module according to the instructions. We'll begin this together.
   d) *3.4 Coal Mining*: Add the module according to the instructions.

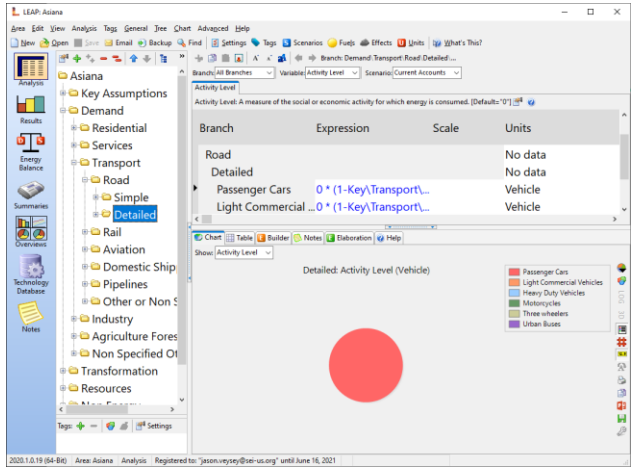
Yesterday's Assignment

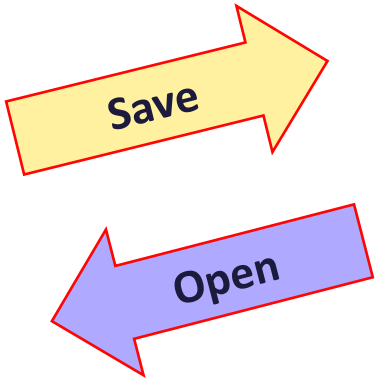
Steps:

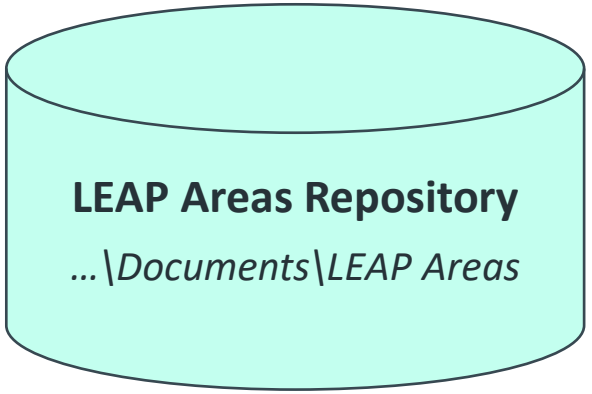
3. Section *3.5 Resources* describes how to add resource reserves or annual yields. You may skip this, as these steps have already been completed in the LEAP area.
4. Switch to the Energy Balance View, which will trigger your model to calculate.
   a) Can you generate the two tables shown on page 46?
   b) If your calculated values differ, how would you go about identifying the reason for the discrepancy?

We will briefly take up this assignment at the beginning of tomorrow's session.

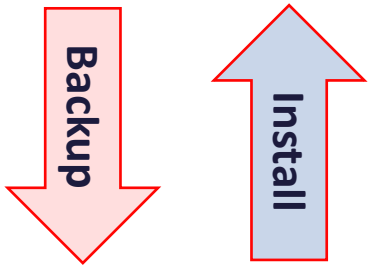
Saving and Sharing Models

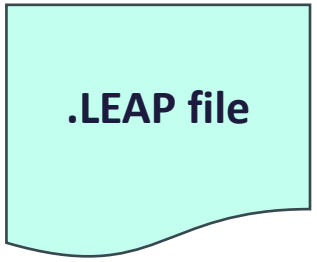






One folder with multiple files per area





One zipped file per area

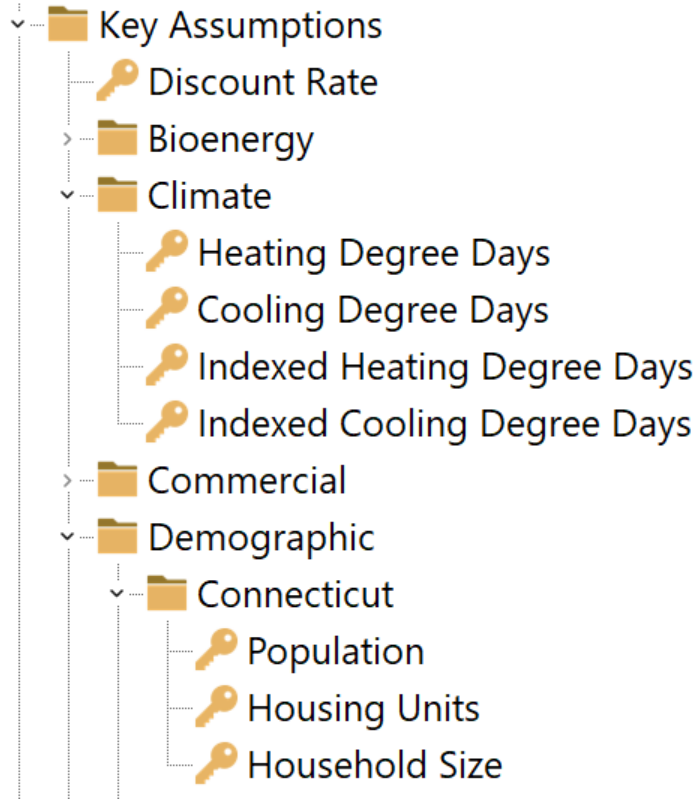
Installing an area from a .LEAP file overwrites what's in local LEAP areas repository

Be careful, you can lose work!

Other LEAP Branch Types

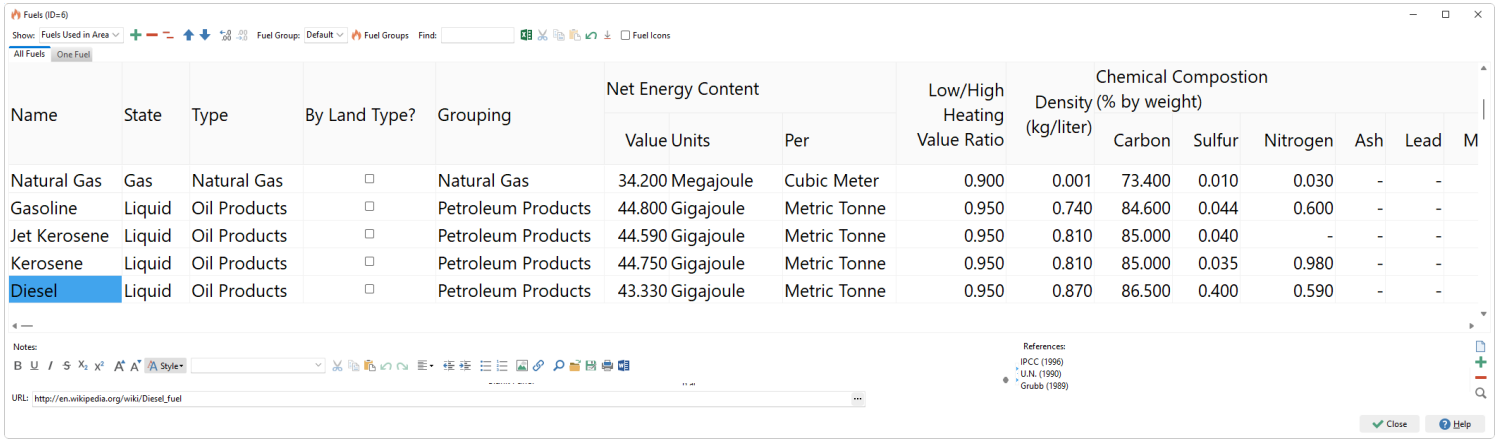
Key Assumptions

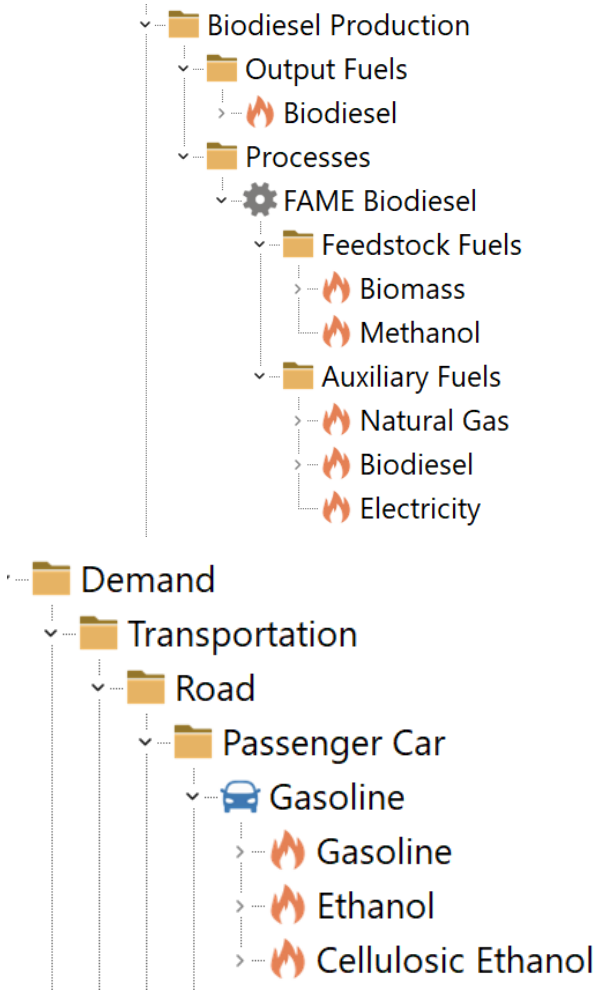
- Branches that typically contain a single variable, intended to stored information for reference by other LEAP expressions
- Useful for ensuring *consistency of assumptions* throughout a model



Fuels

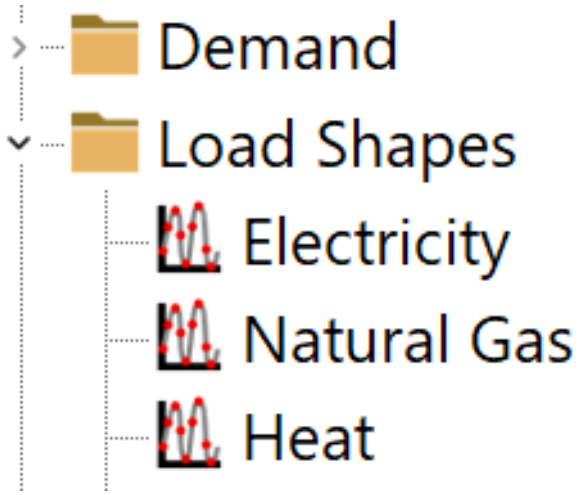
- Represent consumption, supply, or accounting adjustments for particular fuels/energy carriers
  - Demand – consumption of fuels by a technology (note: some demand technologies are associated with a single fuel assigned under one of their variables – e.g., Final Energy Intensity, Efficiency, Fuel Share, Total Energy)
  - Transformation – module outputs, process inputs
  - Resources – fuels used in modeled area
  - Statistical Differences, Stock Changes – accounting adjustments for fuels
- Fuels have properties which can be referenced in expressions – e.g., CarbonContent, Density
- Users may add to/modify fuels found in default LEAP database





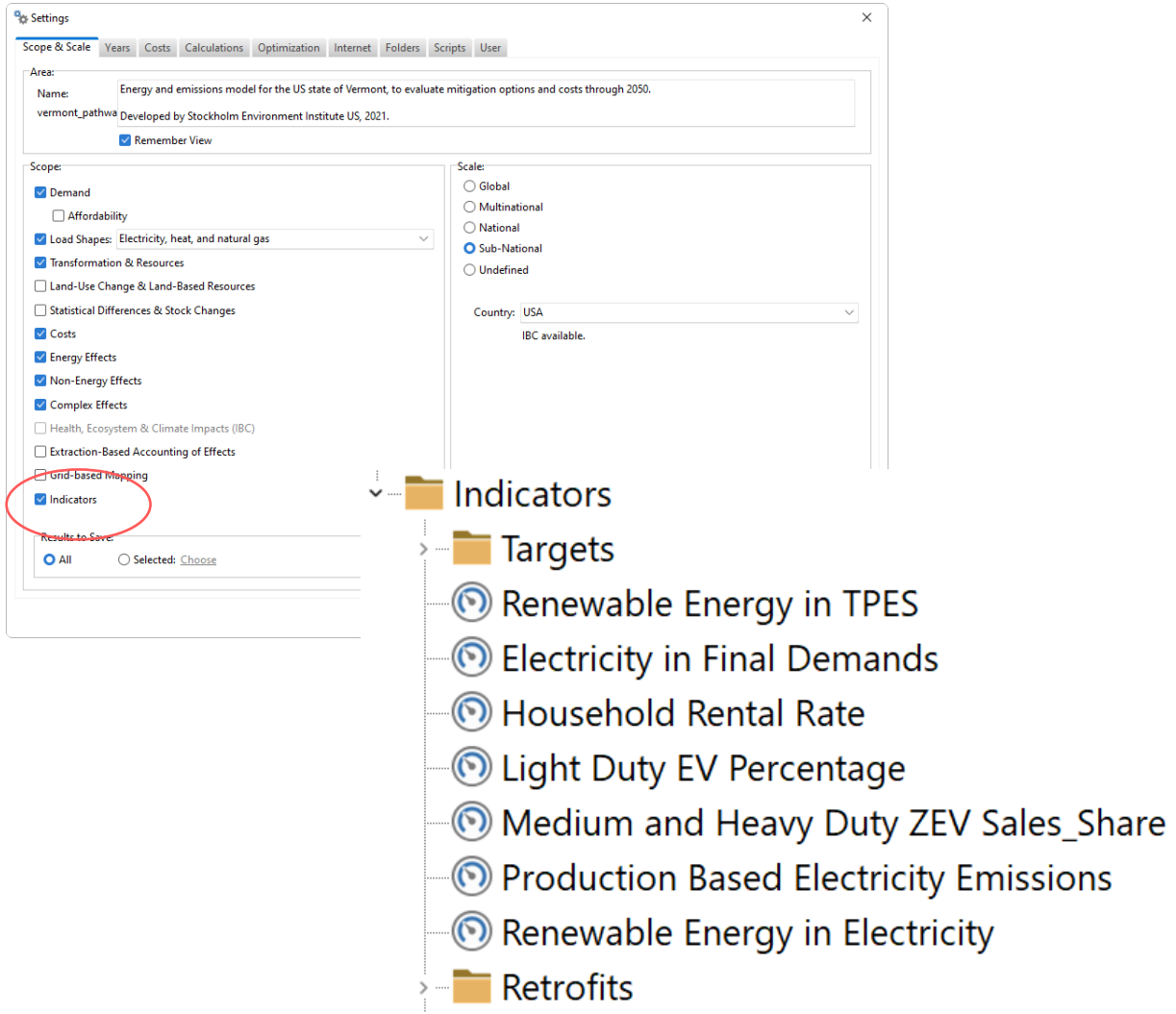
Load Shapes

- Fuel-specific branches that contain information about distribution of final energy demands among time slices
- Distribution may be specified exogenously by assigning a system-wide load curve to a Load Shapes branch; or it may be determined endogenously, by assigning load curves to final demands
- Planning Reserve Margin, Peak Load Ratio, and Renewable Target variables may also be set in Load Shapes branches



Indicators

- Optional branches, typically containing a single variable to calculate customized results, viewable in Results
- Indicators are resolved after each scenario calculation, and therefore expressions may refer to calculated results from any year



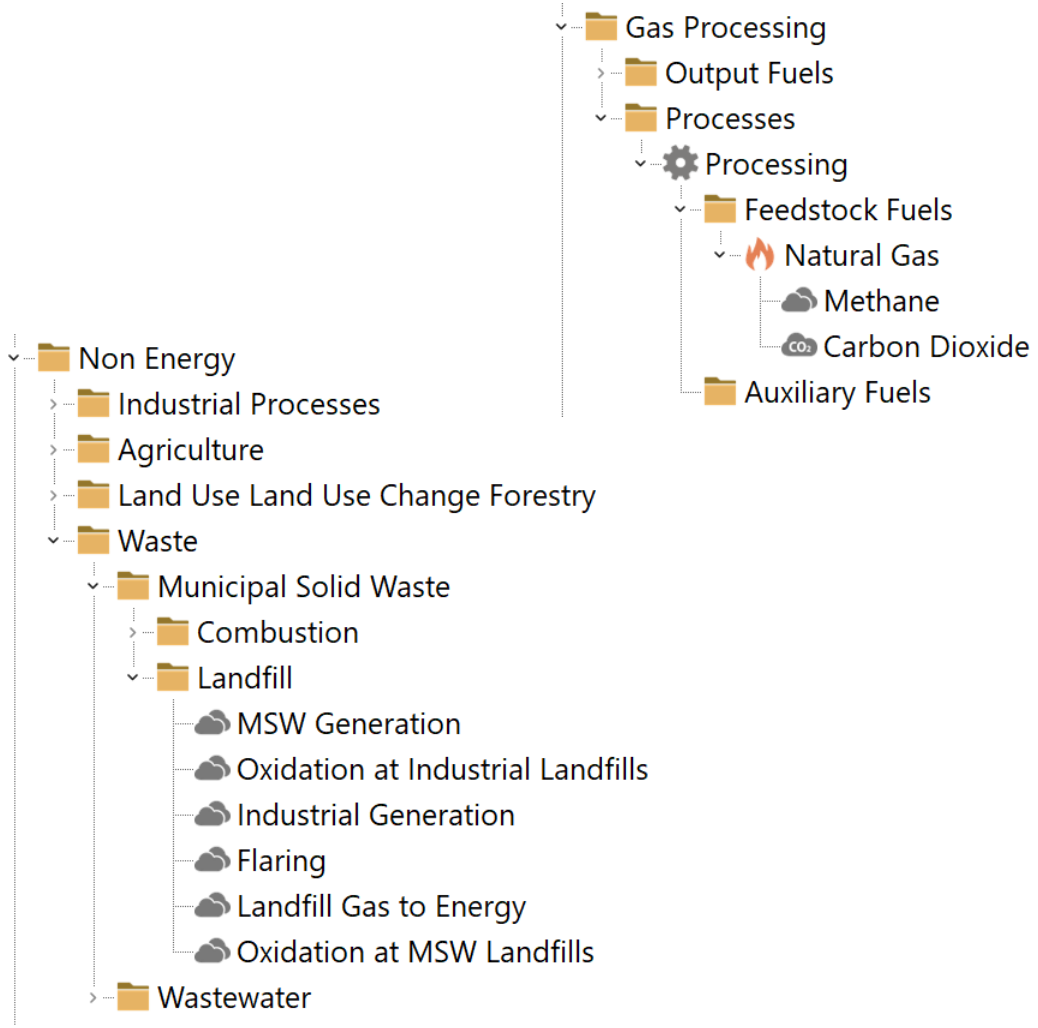
Follow Along

1. Locate and open **follow_along_2.leap** in the Shared Materials directory.
2. Enable Indicators, and add an Indicator branch called “Residential Electricity Use per Capita”, with units “kWh/person”.
3. Write an expression to calculate this, by referencing the appropriate result and key assumption. *Hint: you will need to apply a filter to select only the consumption of electricity.*
4. By what average annual growth rate does residential electricity use per capita change from 2020 through 2050?

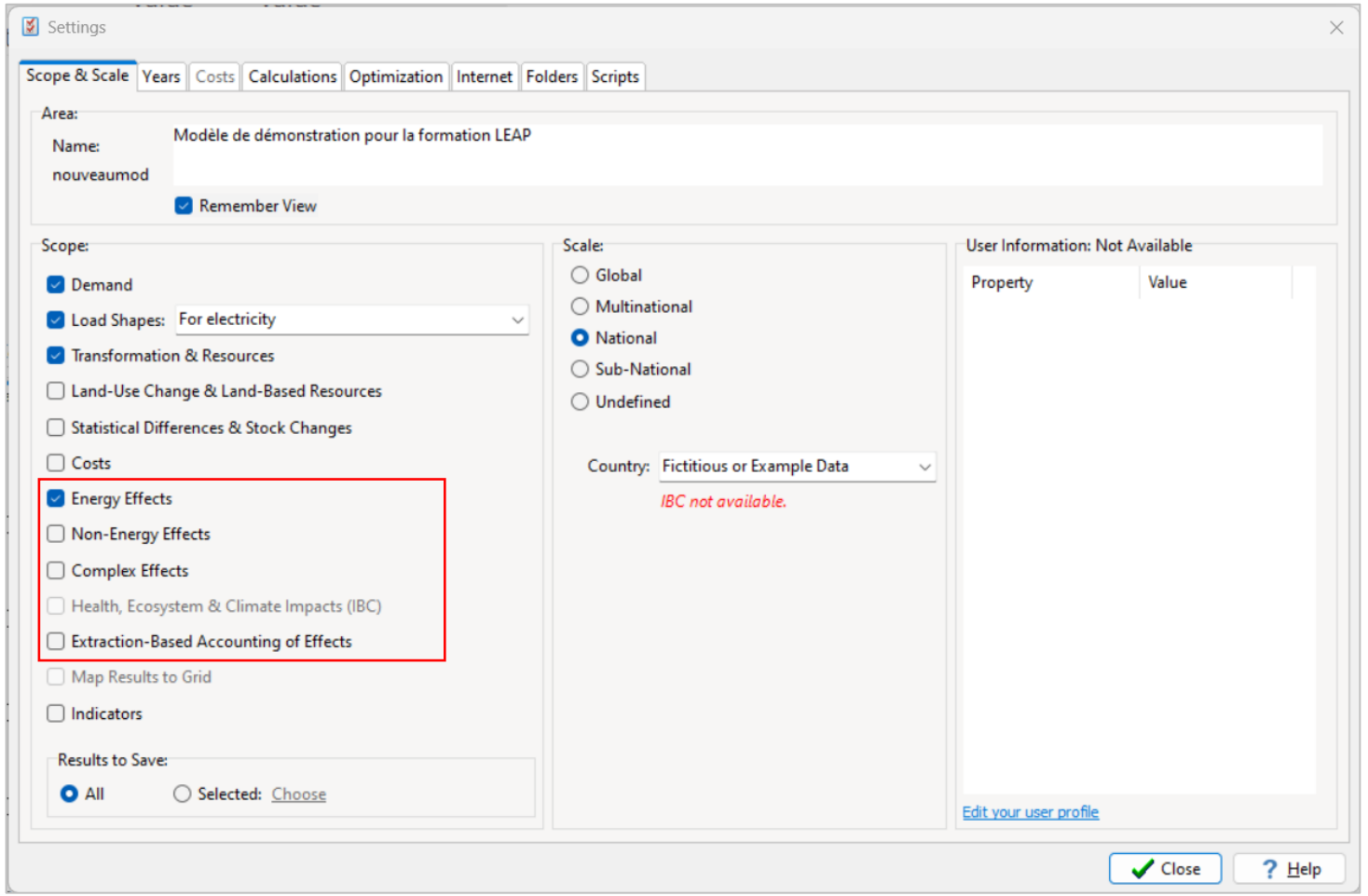
Environmental Loadings

Environmental Loadings

- Branches representing the emission of an environmental pollutant or loading of an effect, typically associated with activity at a branch
- Users may add to/modify environmental effects found in default LEAP database



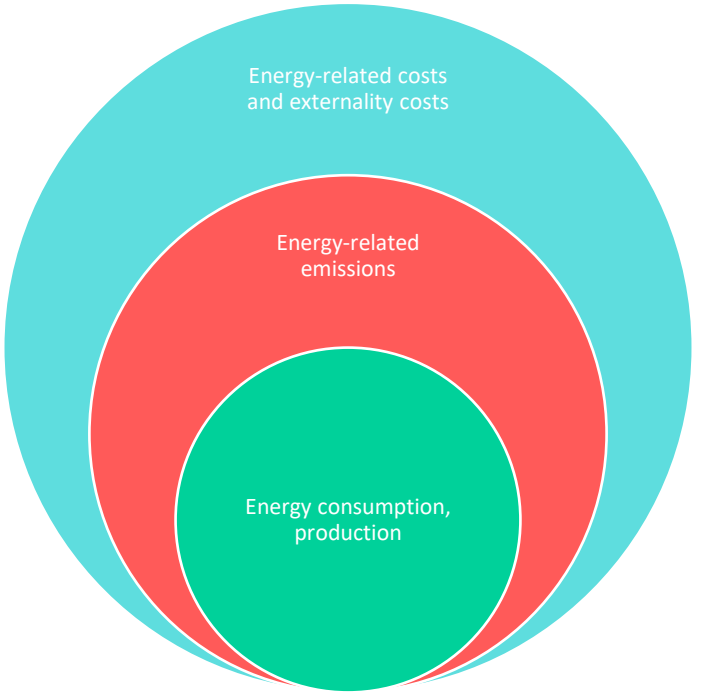
Activating Modeling of Environmental Loadings



Emissions Analysis: Energy-Related

LEAP is first and foremost an **energy accounting** tool, with expandable scope for **environmental loadings** (and **costs**). Environmental loadings are:

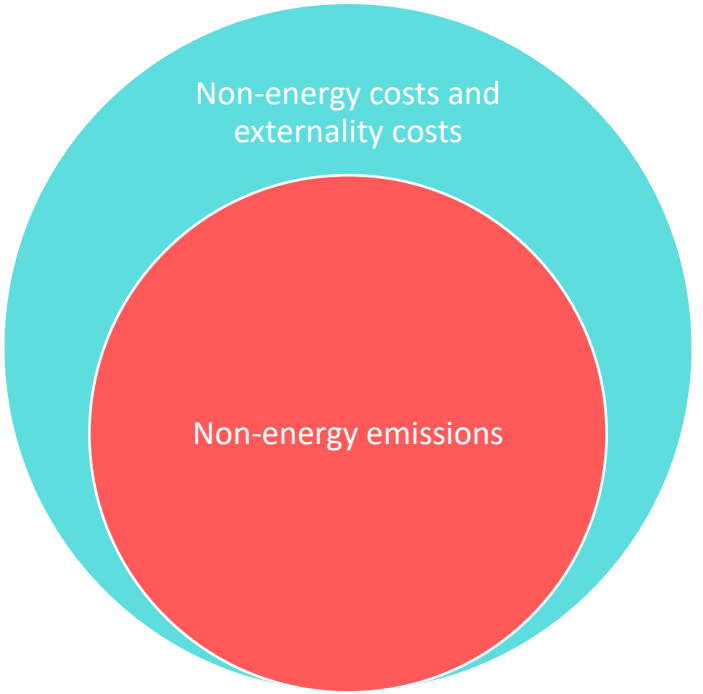
- Usually pollutant emissions,
- Usually specified as mass per energy consumed, then LEAP performs accounting,
- User-specifiable with as much detail as represented in the tree.



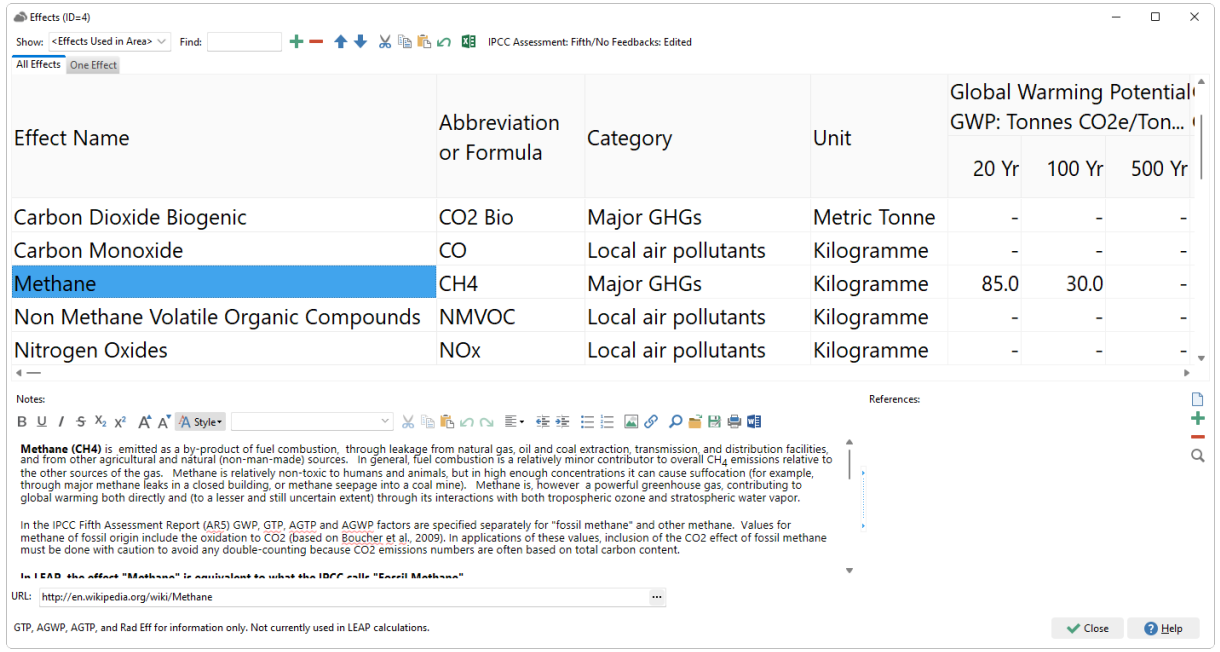
Emissions Analysis: Not Energy-Related

Non-energy emissions (such as agriculture, forestry and other land use, waste, industrial processes and product use):

- No built-in emissions accounting method,
- Non-energy branches provide a space to work, including ability to write expressions and add user-defined variables.



Global Warming Potentials



- CO_2-equivalent emissions of GHGs are calculated using global warming potentials (GWPs) for 20-, 100- and 500-year residence times
- Default GWPs are established in LEAP's Effects database – defaults can be populated with GWPs from an IPCC Assessment Report (AR)*
- Each scenario can use default GWPs or GWPs from a selected AR*

**AR 1-5 supported currently. AR 6 coming soon.*

Follow Along

1. Continue using **follow_along_2.leap** in the Shared Materials directory.
2. Navigate to Demand\Household\Urban\Electrified\Cooking\Natural Gas Stoves, and view the Avg Environmental Loading variable.
3. What is the numeric value of the CO_2 (non-biogenic) emission factor?
4. Notice that emission factor values may be denominated by both mass and energy units. Think about how LEAP allows this.
5. What are the different calculation methods available, and what do they mean?

Cost-Benefit Analysis Using Scenarios

Scenario Analysis

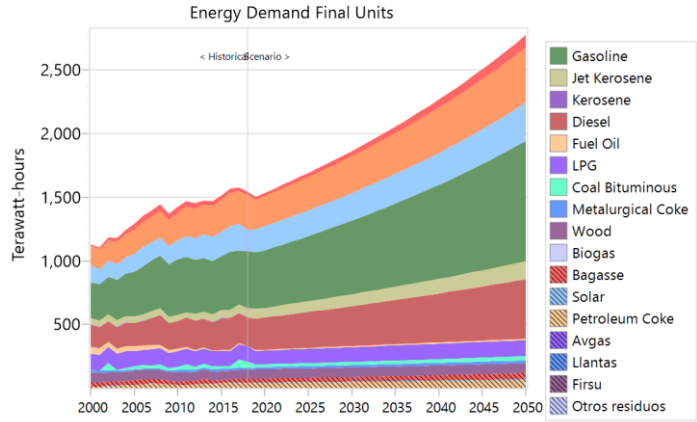
The future is unknown…

…but we can explore it using scenarios

Scenario: An internally coherent, physically plausible storyline that describes a possible state of the world. Scenarios are represented in LEAP by exogenous inputs (data and assumptions), calculation methods, and results produced from the inputs and methods.

LEAP recognizes **two main types of scenarios**

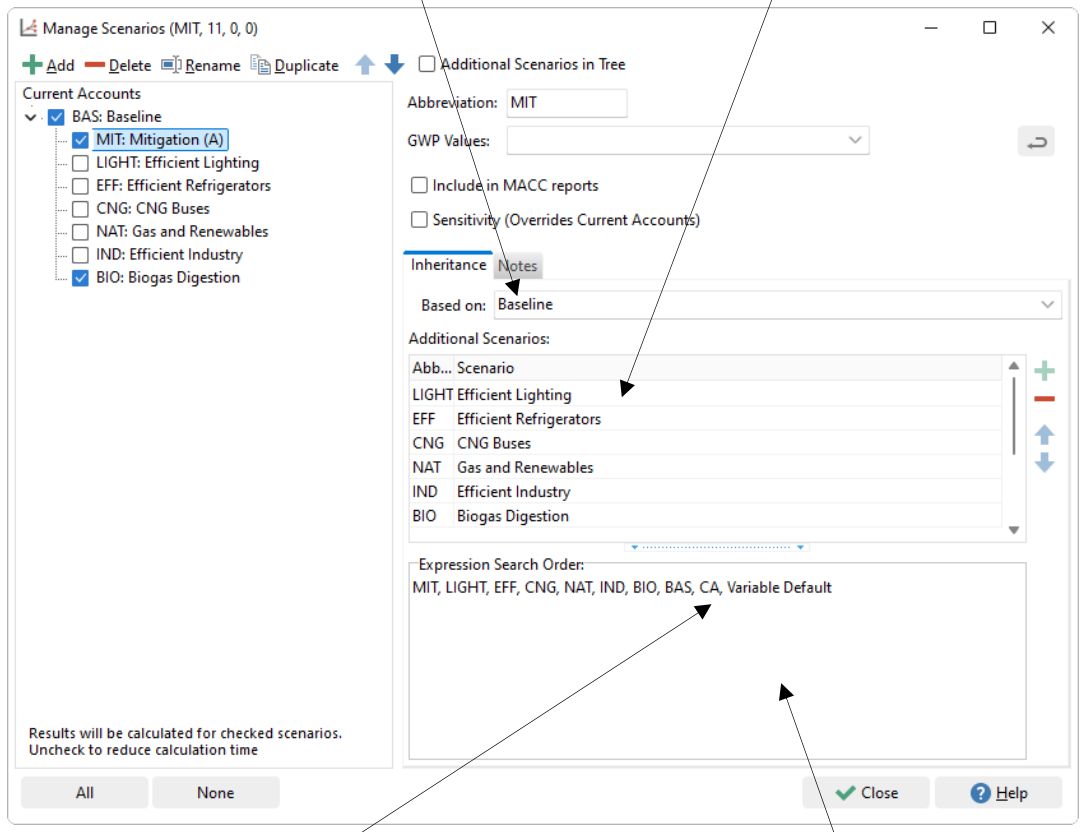
- Current Accounts: historical data
- Projection scenarios: future projections for baseline, policies, mitigation measures, etc.



Scenario Inheritance

Parent scenario: the default source of expressions and data for projection years

Other scenarios from which to inherit. The order matters!

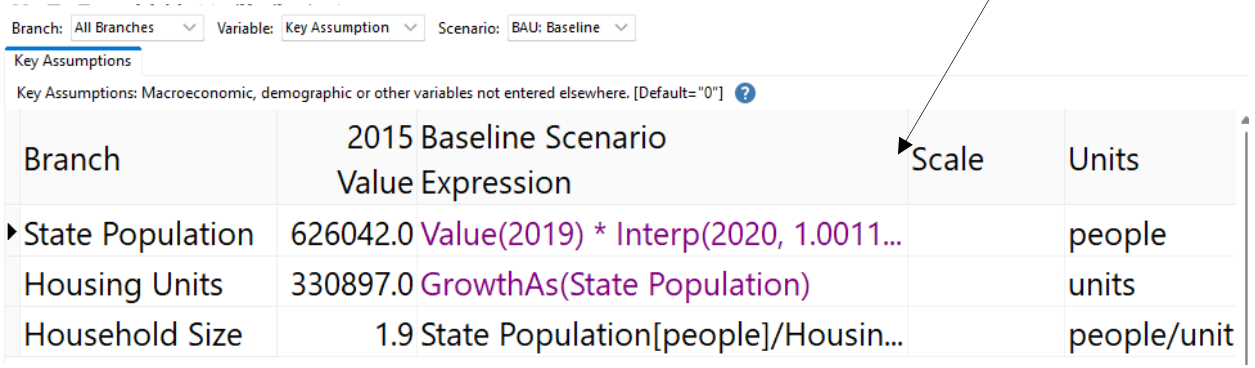


For a projection scenario, the last scenario in the inheritance chain is always Current Accounts.

LEAP follows this order when searching for expressions and data to inherit.

A scenario can **inherit** expressions and data **from multiple other scenarios**

Expressions are color-coded in the Analysis view. Purple = defined in the scenario, black = inherited from another scenario, green = inherited from another region.



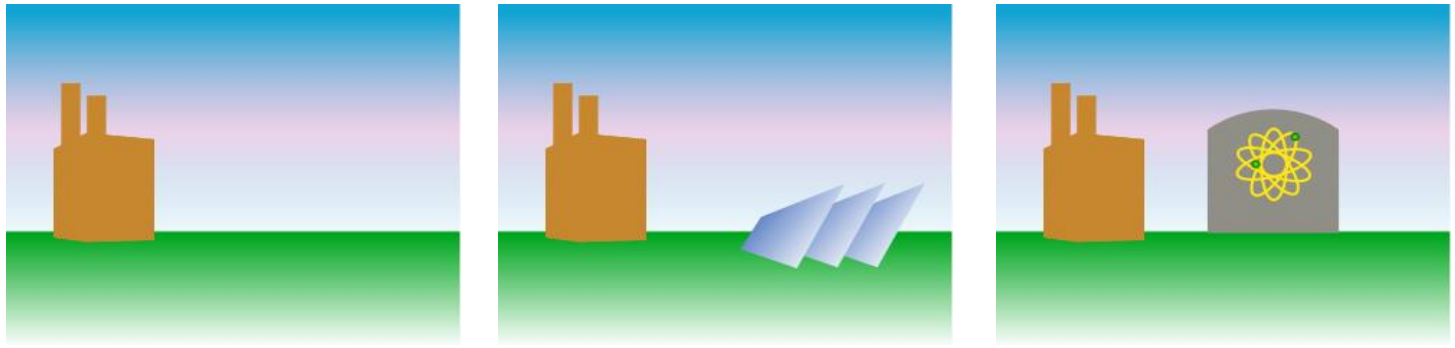
Branch	2015 Value	Baseline Scenario Expression	Scale	Units
State Population	626042.0	Value(2019) * Interp(2020, 1.0011...		people
Housing Units	330897.0	GrowthAs(State Population)		units
Household Size	1.9	State Population[people]/Housin...		people/unit

Follow Along

1. Continue using **follow_along_2.leap** in the Shared Materials directory.
2. Add five scenarios that inherit directly from the Baseline scenario: 1) Efficient Lighting, 2) Efficient Refrigerators, 3) Efficient Industry, 4) Gas and Renewables, and 5) CNG Buses.
3. Assign abbreviations. Add notes to describe the contents of each scenario.
4. How can you re-assign which scenario inherits from which other? What would you call a “parent” versus a “child” scenario?

Application: Modeling GHG Mitigation Measures

Measure: *A dedicated scenario containing assumptions characterizing a single technology or policy change, implemented on top of a reference scenario.*



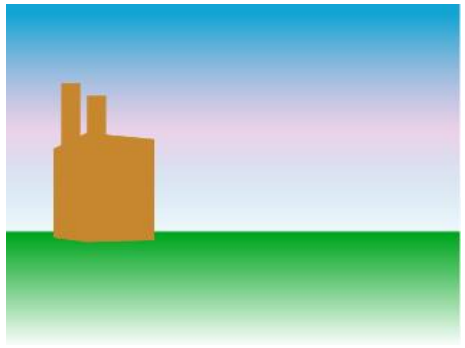
Baseline *…with solar* *…with nuclear*

Modeling requires:

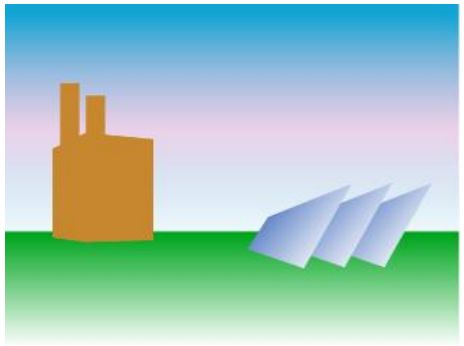
- Measure implementation (“how much of the measure?”)
- Measure impact (“what change is induced in the energy system/what emissions are avoided?”)
- Often, measure cost (“what is the relative cost?”)

Application: Modeling GHG Mitigation Scenarios

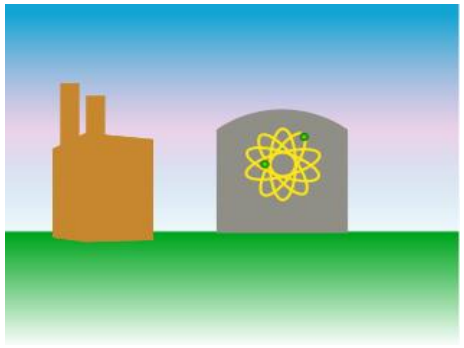
Mitigation Scenario: *A scenario containing a group of measures implemented concurrently.*



Baseline

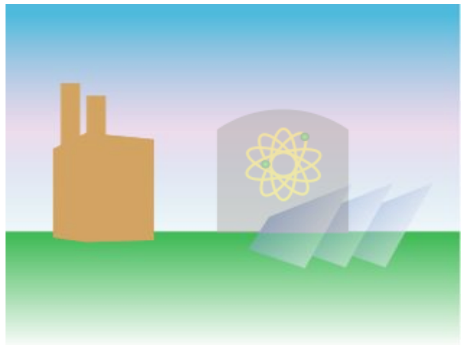


…with solar



…with nuclear

- Using inheritance, LEAP can combine individual/incremental measures into mitigation scenarios, *accounting for interactive effects*
- Assumptions and measures can be re-used and re-combined into different mitigation scenarios



…with solar and nuclear

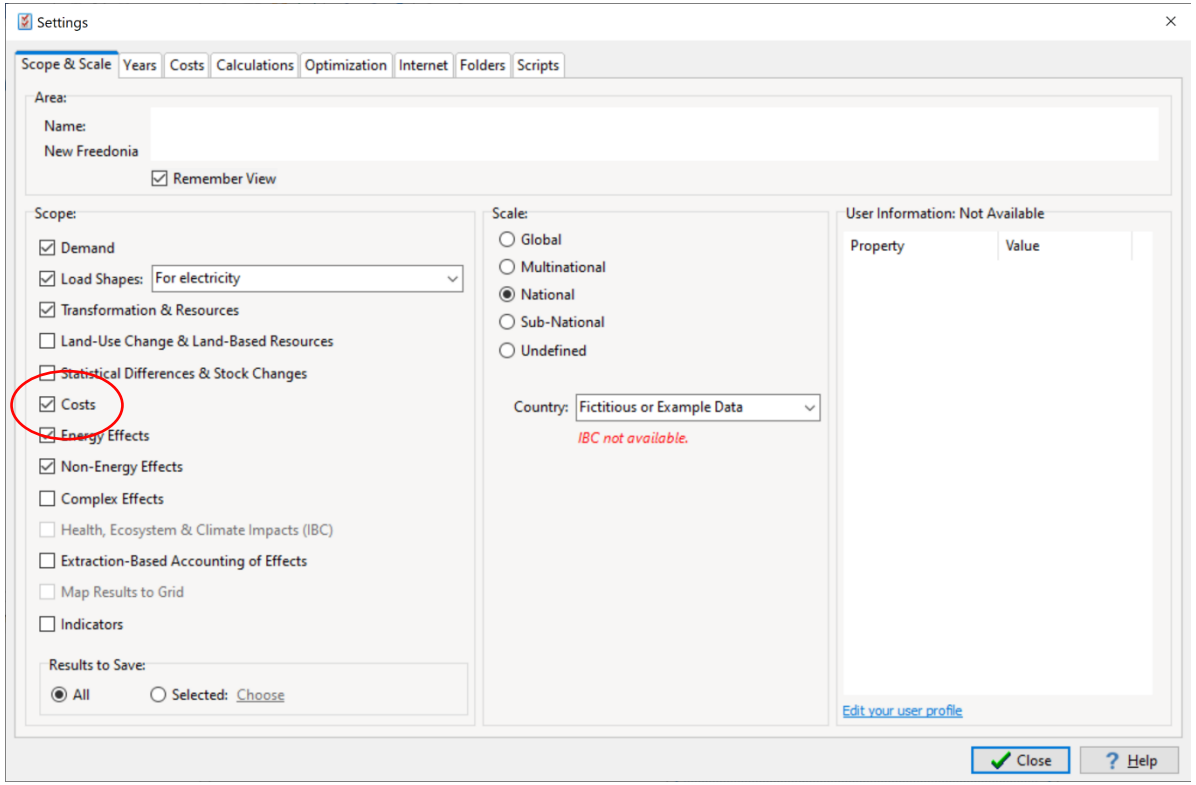
Follow Along

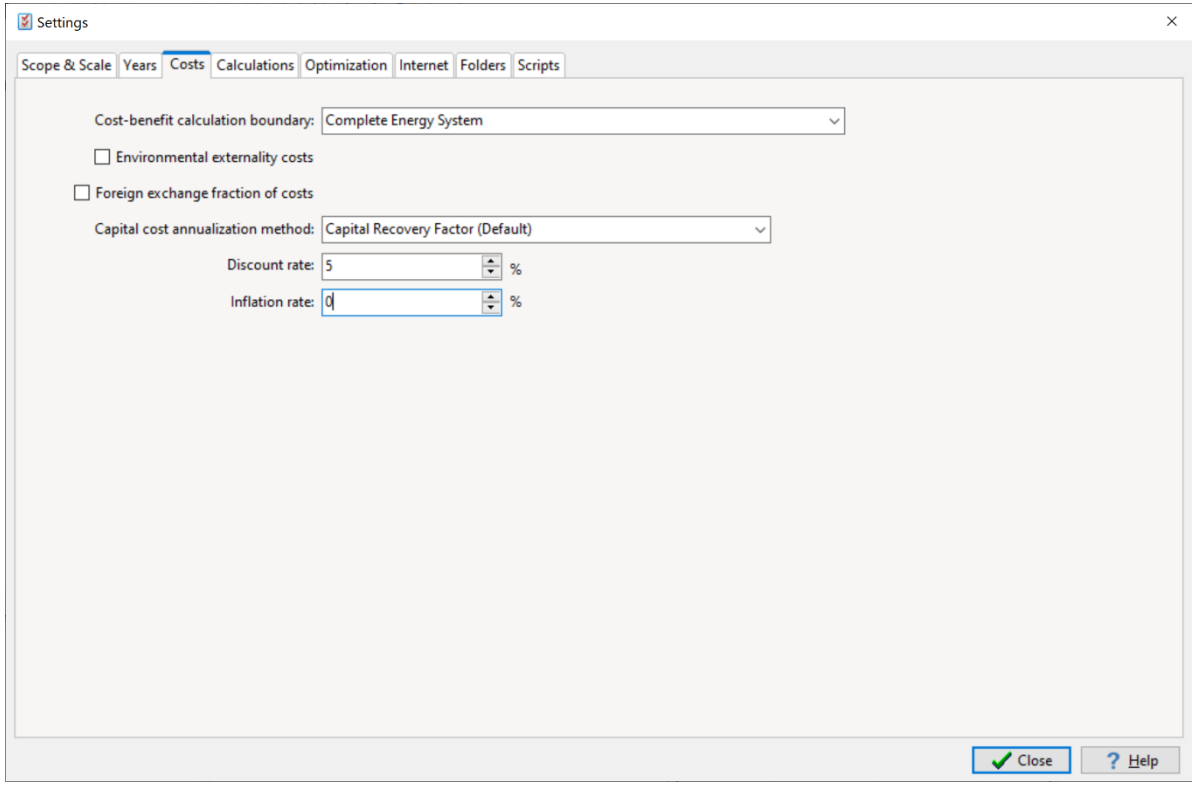
1. Add a sixth scenario, based on the Baseline scenario, that also inherits expressions from the five scenarios just created.
2. What does the expression search order mean? How do you change the ordering?

Cost-Benefit Analysis Using LEAP

- Costs can be included in energy and non-energy modeling in LEAP
- Generally, real social costs are modeled
- Undiscounted and discounted costs can be calculated and displayed
- LEAP avoids double-counting energy costs by drawing a consistent boundary around the cost analysis

Activating Cost Modeling

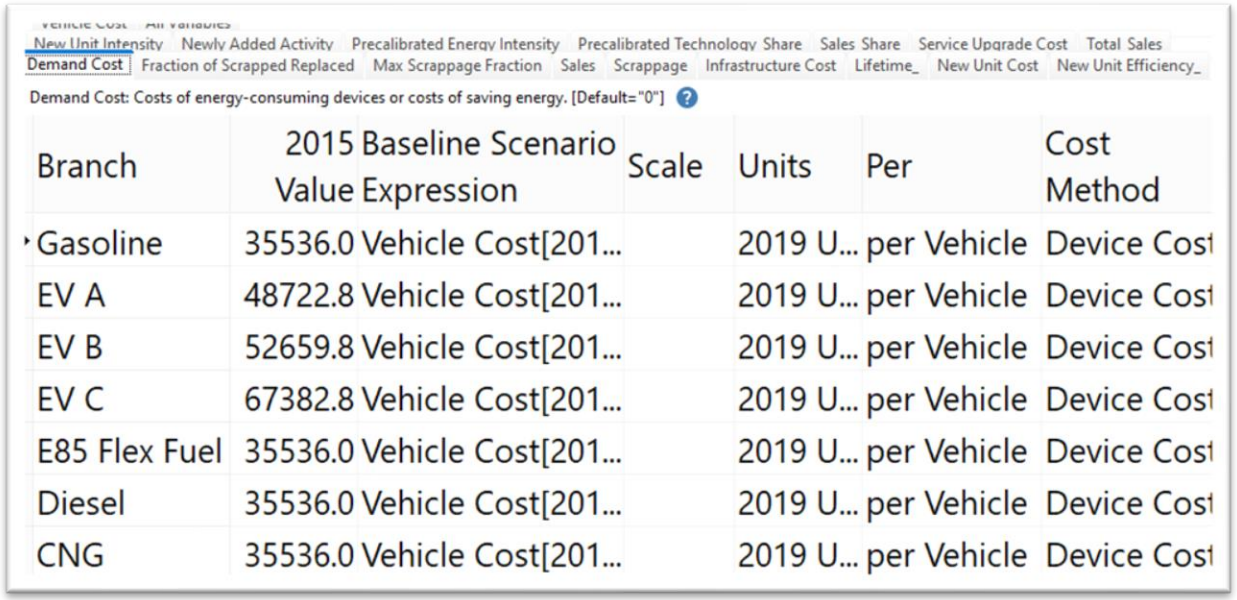




Final Energy Demand Costs

Several costing methods supported

- *Costs per activity*
  - E.g., cost per vehicle-km traveled
- *Total annual costs*
  - E.g., total annual costs of a driver education program
- *Cost of saved energy relative to a reference scenario*
  - E.g., incremental costs per unit energy saved due to efficiency retrofits of long-haul trucks
- *Cost of new vehicles/devices sold in stock turnover modeling*
  - E.g., purchase cost of new passenger cars



New Unit Intensity | Newly Added Activity | Precalibrated Energy Intensity | Precalibrated Technology Share | Sales Share | Service Upgrade Cost | Total Sales

Demand Cost | Fraction of Scrapped Replaced | Max Scrappage Fraction | Sales | Scrappage | Infrastructure Cost | Lifetime_ | New Unit Cost | New Unit Efficiency_

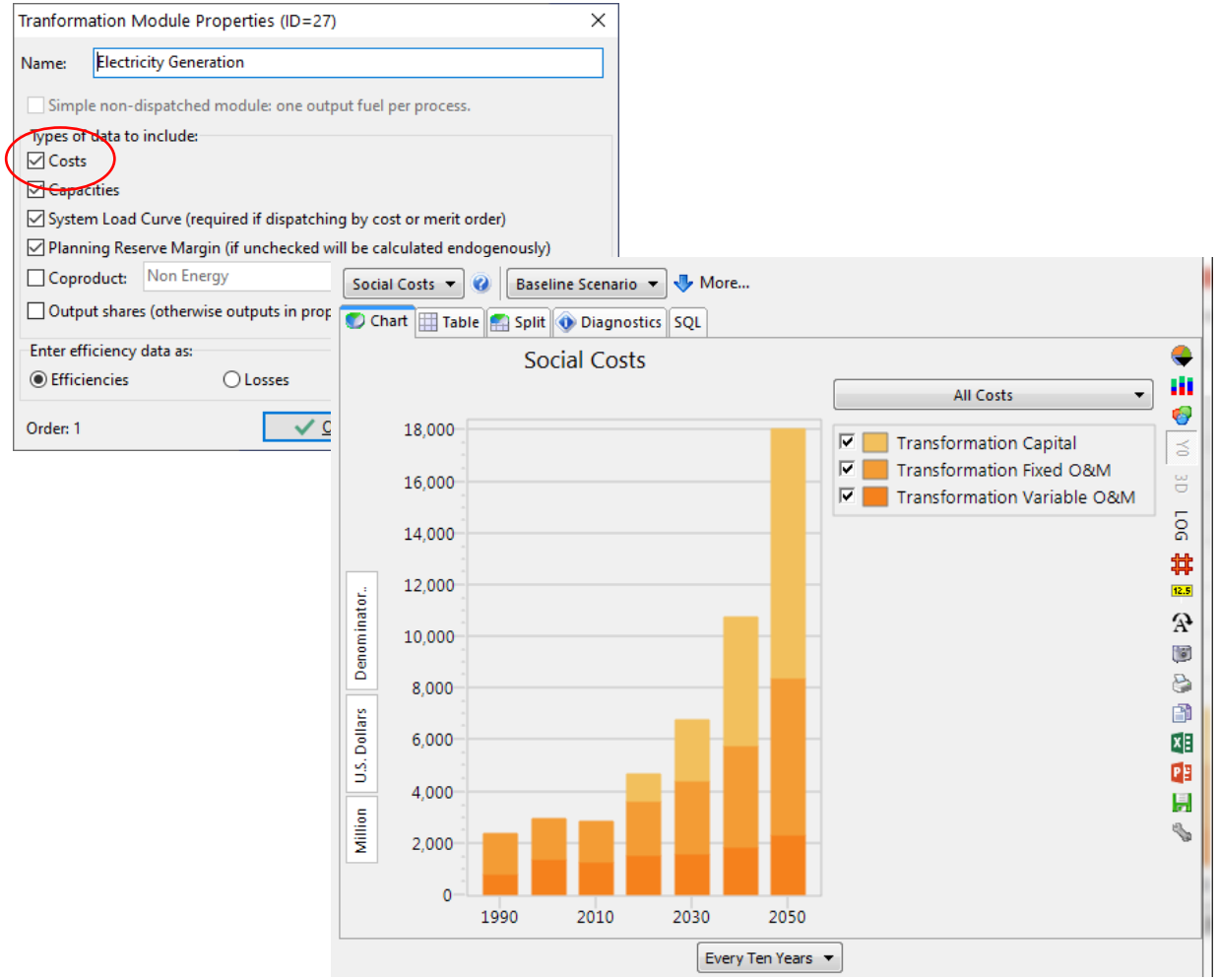
Demand Cost: Costs of energy-consuming devices or costs of saving energy. [Default="0"]

Branch	2015 Value	Baseline Scenario Expression	Scale	Units	Per	Cost Method
Gasoline	35536.0	Vehicle Cost[201...		2019 U...	per Vehicle	Device Cost
EV A	48722.8	Vehicle Cost[201...		2019 U...	per Vehicle	Device Cost
EV B	52659.8	Vehicle Cost[201...		2019 U...	per Vehicle	Device Cost
EV C	67382.8	Vehicle Cost[201...		2019 U...	per Vehicle	Device Cost
E85 Flex Fuel	35536.0	Vehicle Cost[201...		2019 U...	per Vehicle	Device Cost
Diesel	35536.0	Vehicle Cost[201...		2019 U...	per Vehicle	Device Cost
CNG	35536.0	Vehicle Cost[201...		2019 U...	per Vehicle	Device Cost

Exclude fuel costs (fuel costs are calculated separately on supply side of model)

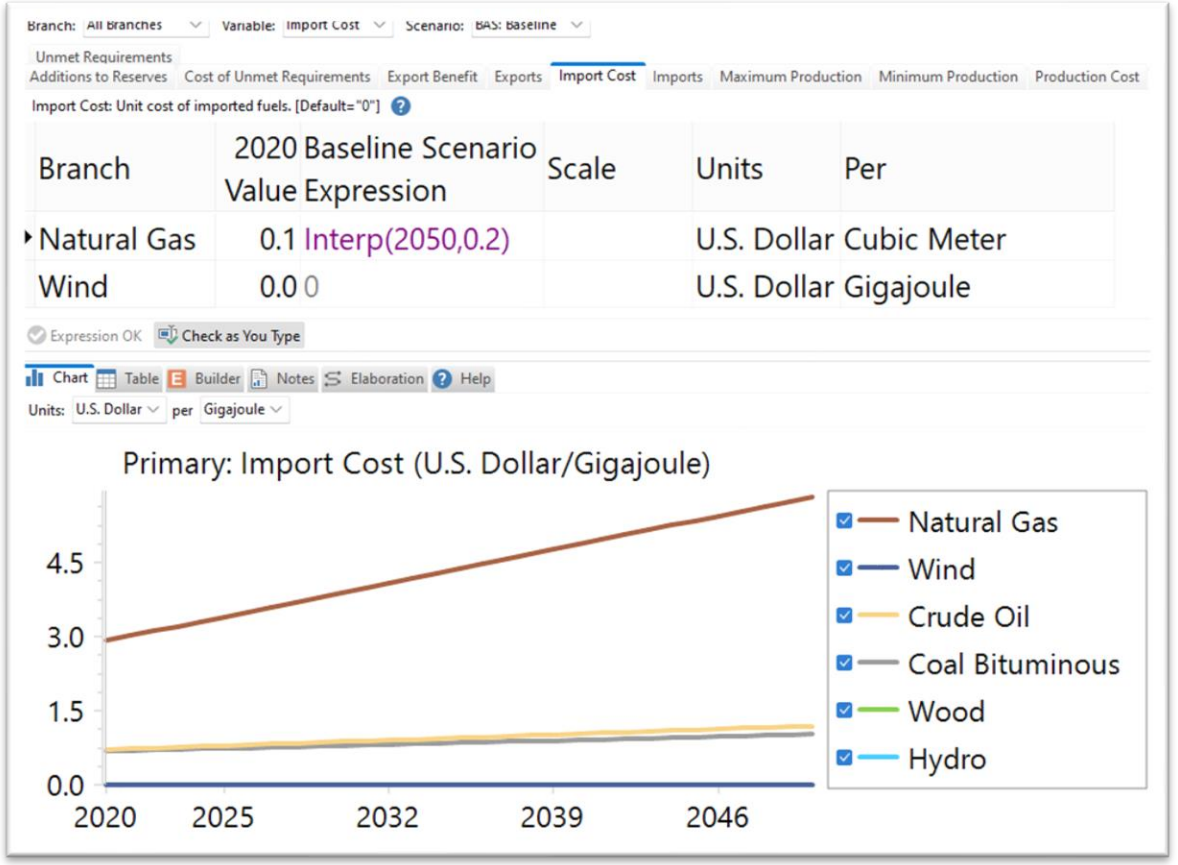
Transformation Costs

- Evaluated for transformation modules that are within the costing boundary and for which cost modeling is activated
- Can include:
  - Capital costs (amortized using process-specific interest rates)
  - Fixed and variable O&M costs
  - Decommissioning costs
  - Other module-level costs
- Fuel input costs calculated separately based on production costs of upstream industries and resource costs

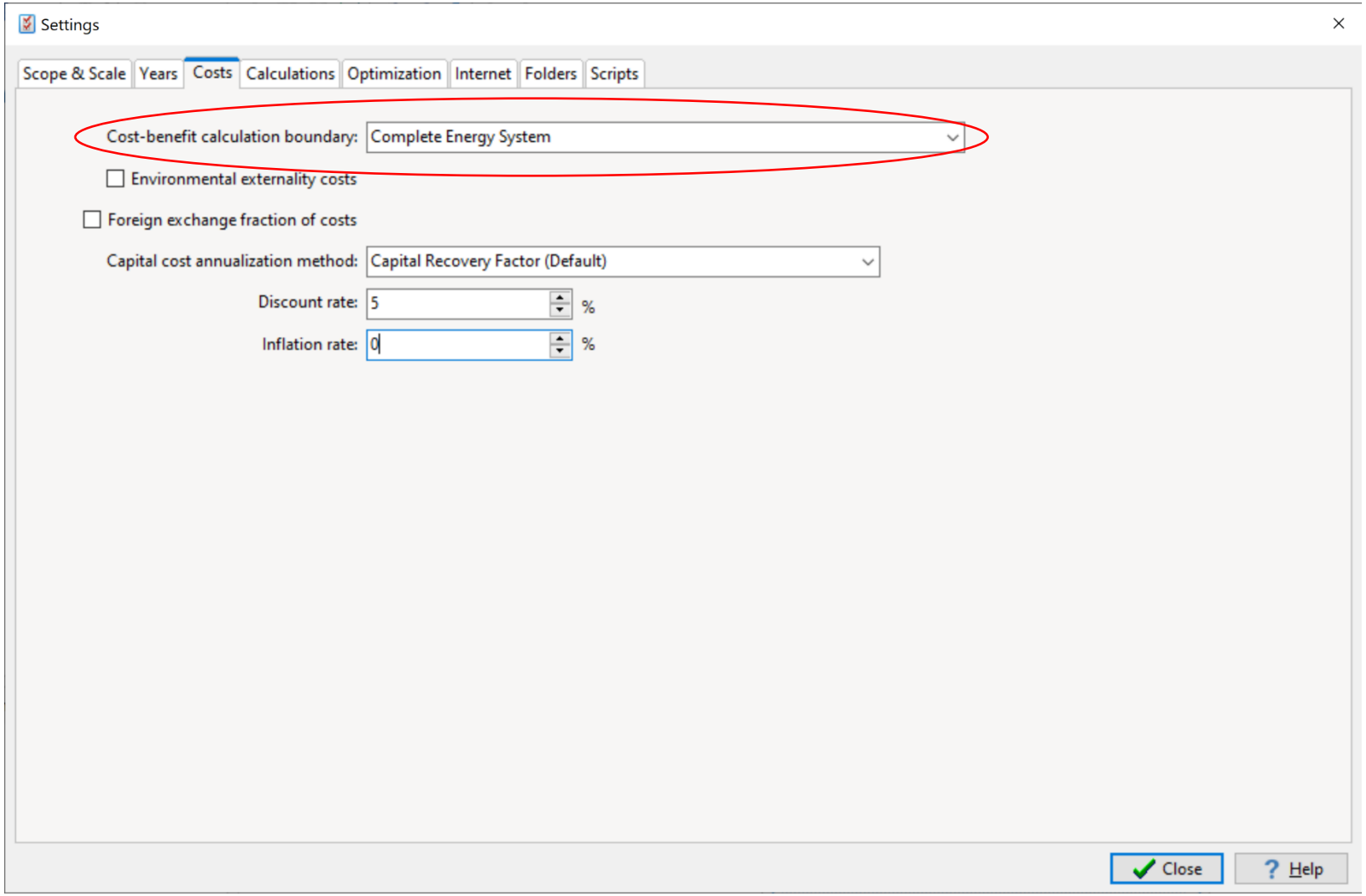


Resource Costs

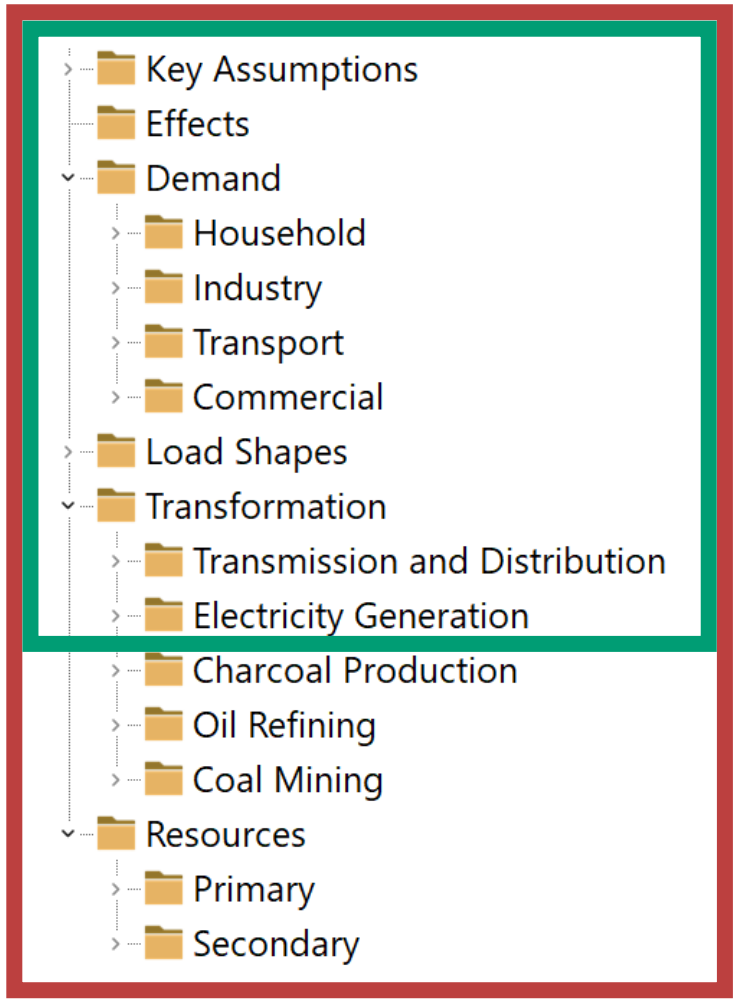
- Can include:
  - Import costs and export benefits for all fuels
  - Production costs for primary energy resources
  - Social costs of unmet requirements for fuels (e.g., costs of brown-outs due to inadequate electricity supply)



LEAP's Costing Boundary



LEAP's Costing Boundary



Red box: ***Complete Energy System***

- All final energy demand costs
- All transformation costs (in modules for which cost modeling is enabled)
- Import costs, export benefits, and primary energy production costs in Resources branch

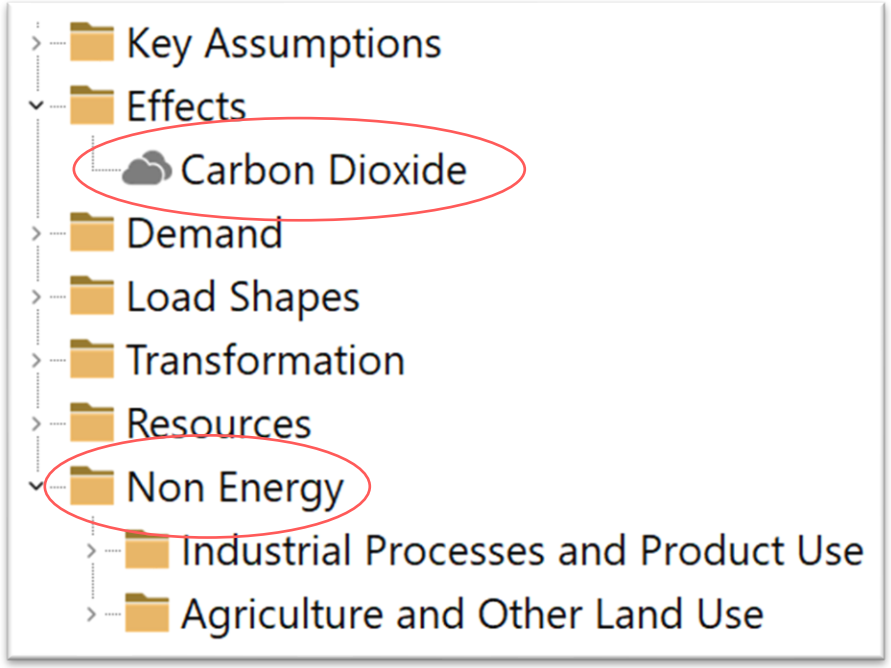
Green box: ***Subset of Energy System***

- All final energy demand costs
- All transformation costs in modules inside costing boundary (and for which cost modeling is enabled)
- No import costs, export benefits, or primary energy production costs in Resources branch => instead, a "Delivered Cost" is used for all fuels delivered to costing boundary

Costs of unmet requirements are not affected by costing boundary – they are always calculated

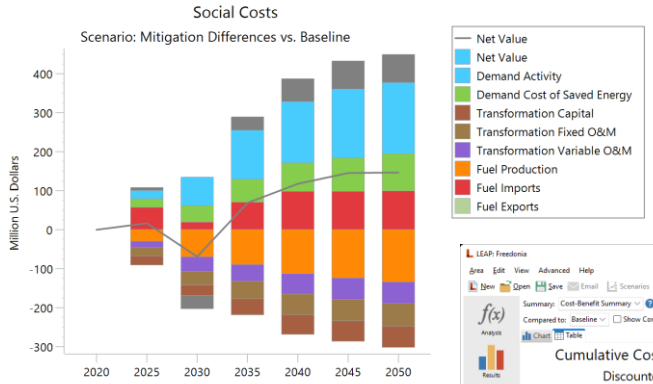
Non-Energy and Pollutant Costs

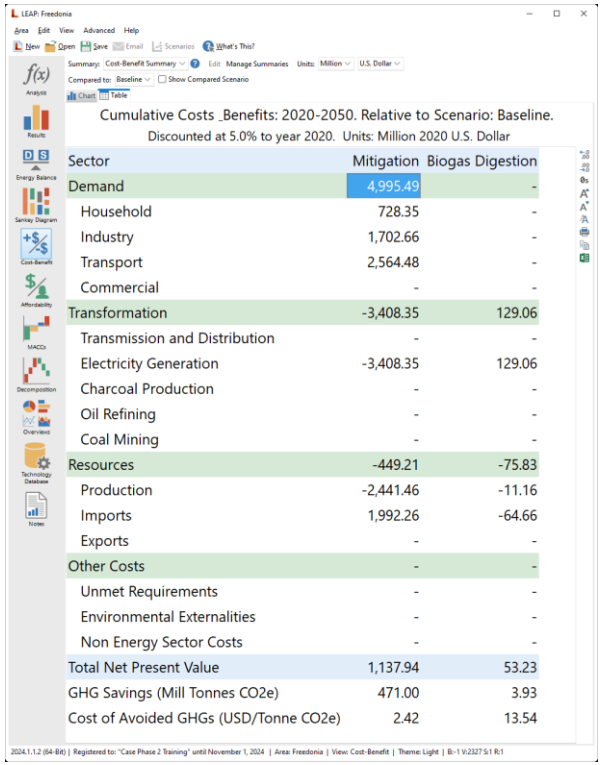
- Non-energy – defined for non-energy emissions
  - Total costs of annual emissions of a pollutant from a source
- Environmental externality – defined for pollutants
  - Costs per unit of emissions



Cost Reporting in LEAP's Results

- Real vs. discounted costs
- Annual vs. cumulative costs
- All vs. selected cost types/categories (e.g., demand, fuel)
- Currency conversions





Cumulative Costs _Benefits: 2020-2050. Relative to Scenario: Baseline.
Discounted at 5.0% to year 2020. Units: Million 2020 U.S. Dollar

Sector	Mitigation	Biogas Digestion
Demand	4,995.49	-
Household	728.35	-
Industry	1,702.66	-
Transport	2,564.48	-
Commercial	-	-
Transformation	-3,408.35	129.06
Transmission and Distribution	-	-
Electricity Generation	-3,408.35	129.06
Charcoal Production	-	-
Oil Refining	-	-
Coal Mining	-	-
Resources	-449.21	-75.83
Production	-2,441.46	-11.16
Imports	1,992.26	-64.66
Exports	-	-
Other Costs	-	-
Unmet Requirements	-	-
Environmental Externalities	-	-
Non Energy Sector Costs	-	-
Total Net Present Value	1,137.94	53.23
GHG Savings (Mill Tonnes CO2e)	471.00	3.93
Cost of Avoided GHGs (USD/Tonne CO2e)	2.42	13.54

Generally, LEAP should be used to estimate *incremental* costs of one scenario compared to another

Follow Along

1. Continue using **follow_along_2.leap** in the Shared Materials directory.
2. In Settings, enable Costs.
3. On the Costs tab, view the different options for Cost-benefit calculation boundary. What do these mean?

Afternoon Assignment

Learning goals:

- Understand different ways that cost data may be entered into LEAP
- Gain further experience adding technology branches on both demand and transformation sides of a model
- Improve understanding of how endogenous transformation capacity is added
- Explore comparative scenario results using Results View and Cost-Benefit summary

Afternoon Assignment

Steps:

1. Continue using **follow_along_2.leap,** and locate **LEAP2024TrainingExercise.pdf** in the Shared Materials directory. *[Alternatively, you may open **afternoon_exercise_2.leap**]*
2. Beginning on page 50, follow the instructions.
   a) *4.1 Cost-Benefit Analysis in LEAP*: Enable Costs. We've already done this.
   b) *4.2 Creating Policy Scenarios*: We've already done this.
   c) *4.3.1 Efficient Lighting Scenario*: Enter the assumptions into the appropriate scenario. We'll do this together.
   d) *4.3.2, 4.3.3, 4.3.4*: Enter the assumptions into the appropriate scenario.
   e) *4.3.5, 4.3.6*: Follow the instructions to complete the input assumptions for all generation technologies. We'll complete "New Wind" together.
   f) *4.3.7 Resource Costs*: Follow the instructions.

Afternoon Assignment

Steps:

3. Section *4.3.8 Environmental Loadings*. You may skip this, as these steps have already been completed in the LEAP area.

4. Switch to the Cost-Benefit View, which will trigger your model to calculate.
   a) Can you generate the values in the table shown on page 57, which show the Mitigation scenario ***compared to*** the Baseline scenario?
   b) Rows in the table corresponding to demand sectors show positive values. What does this mean?
   c) The row corresponding to Resources\Production shows a negative value. What does this mean?
   d) Comment on the sign (+/-) of the Net Present Value row. What does this mean?
   e) The final row in the table shows the Cost of Avoided GHGs. What does this represent?
   f) Now switch to the Results View. Try using the Results View (instead of the Cost-Benefit View) to generate each one of the individual costs shown in each row of the table on page 57.

Afternoon Assignment

Steps:

5. Return to Analysis View. Add the new branch Effects\Carbon Dioxide. Locate the Externality Cost variable at this new branch.
6. Working in the Baseline scenario, pick an initial value for Effects\Carbon Dioxide:Externality Cost, in USD per metric tonne. Return to the Cost-Benefit View to check the Cost of Avoided GHGs. Repeat this process to find an externality cost for carbon dioxide that results in a Cost of Avoided GHGs = 0.0 USD/tonne CO2e.
7. As a group, discuss any relationships or differences between the value you find, and the initial Cost of Avoided GHGs when the externality cost for carbon dioxide is zero.

We will briefly take up this assignment at the beginning of tomorrow's session.