

# Modeling Transformation *in LEAP*

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# Transformation

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- Conversion of primary forms of energy to secondary and further transformation (e.g. coking coal to coke, crude oil to petroleum products, heavy fuel oil to electricity)\*
  - Electricity generation
  - Oil refining
  - Coal transformation
  - Heat generation
  - Liquefaction

\* IEA definition



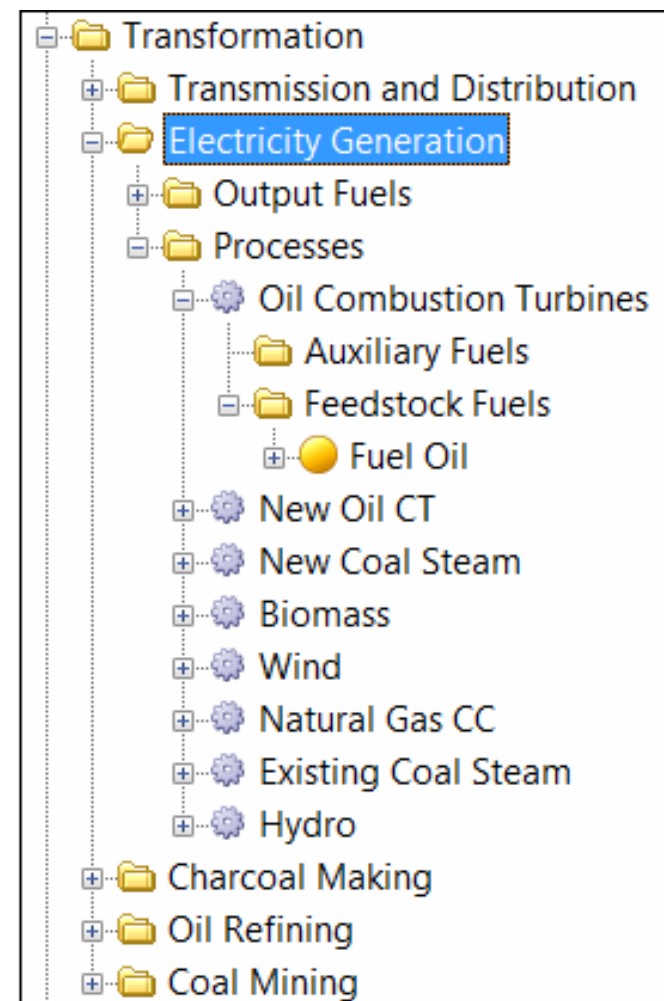
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# Transformation in LEAP

- Transmission & distribution
- Energy conversion
- Resource extraction



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# Basic parameters

Basic Parameters

Scope & Scale | Years | Default Units | Calculations | **Loads** | Optimization | Stocks | Internet | Charts | Folders | Security

Area

Name: Name of Area

Description:

Scope

☒ Transformation & Resources

☐ Statistical Differences & Stock Changes

☐ Costs

☐ Energy Sector Environment Loadings

☐ Non-Energy Sector Environment Loadings

☐ Indicators

[Edit List of Result Variables to Save](#)

Scale

☐ Global

☐ Multi-national

☒ National

☐ Sub-national

Country

User Information: from COMMEND

Property	Value
Organization	KEPA
Organization Type	Academic Organization
City	Athens
Country	Greece
Email	promitheas@kepa.uo...
Web	http://www.kepa.uoa....
License Expires:	10/21/2016

[Visit COMMEND to edit your user profile](#)

Close Help

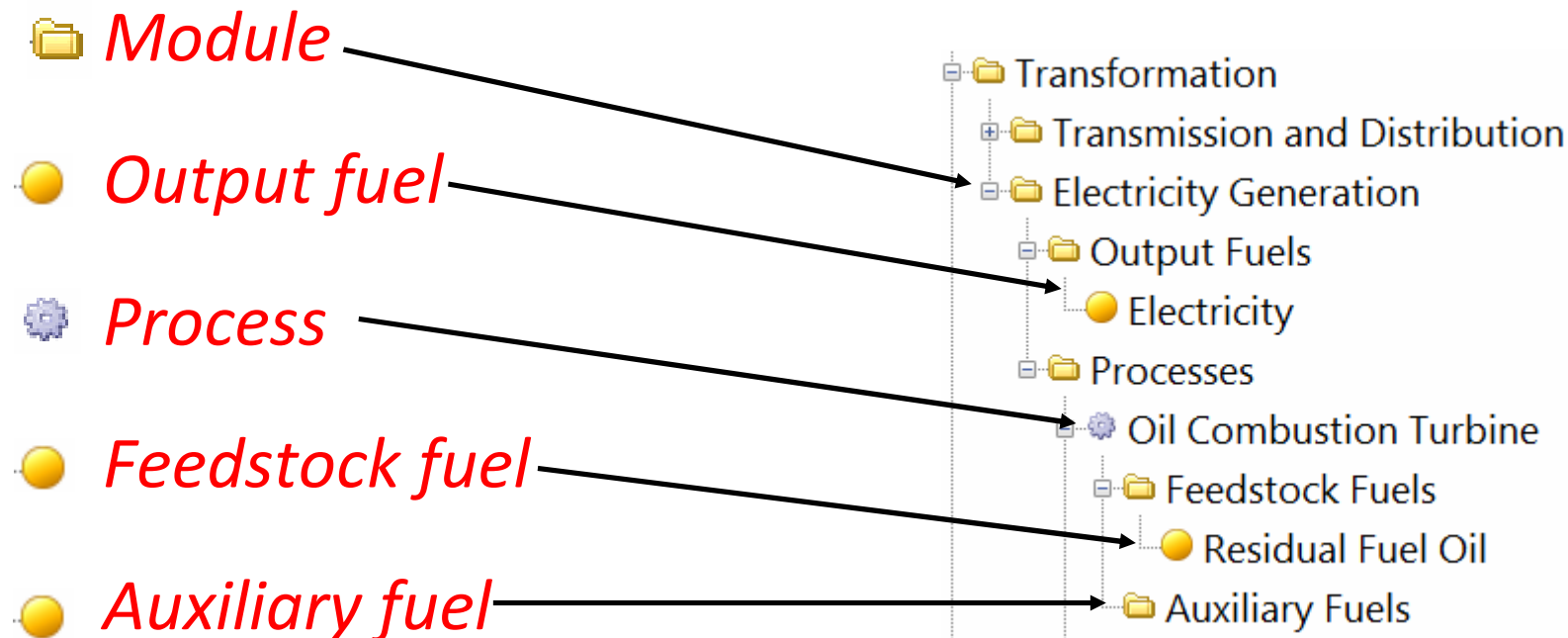


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# Branch types



**Basic hierarchy:** “Modules” (sectors), each containing one or more “processes”. Each process can have one or more feedstock fuels and one or more auxiliary fuels.

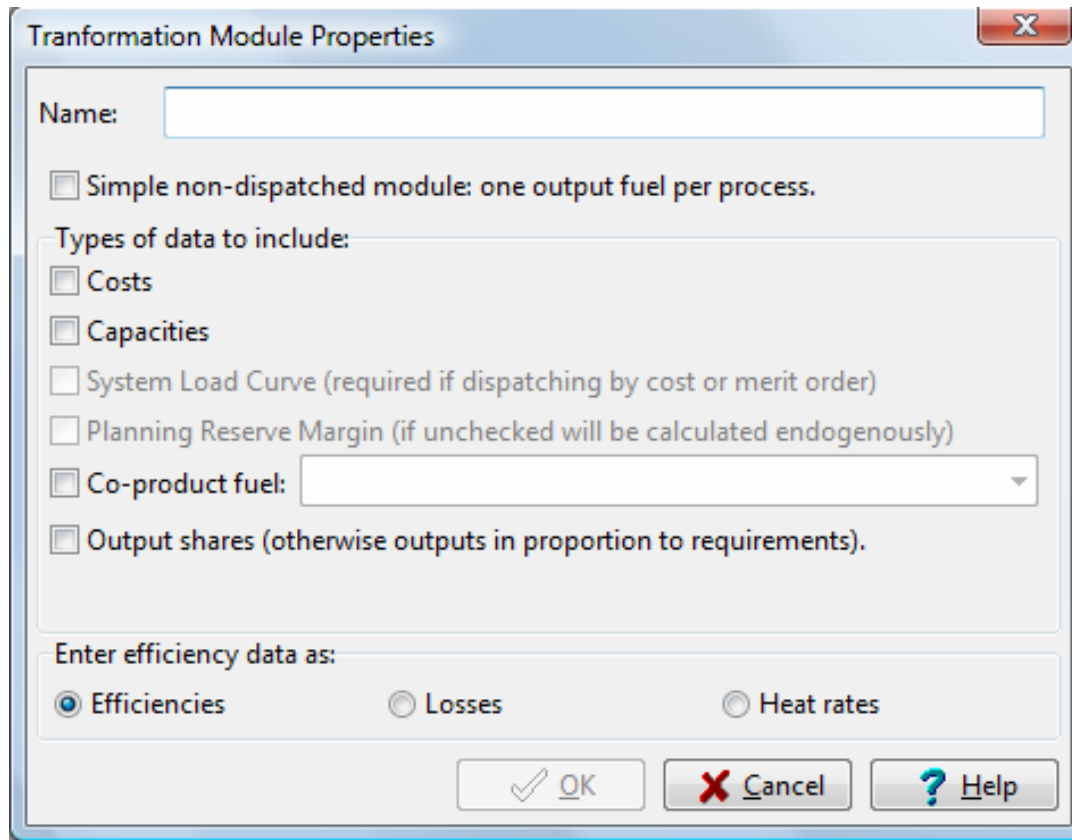


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# Module properties



Transformation Module Properties

Name:

☐ Simple non-dispatched module: one output fuel per process.

Types of data to include:

☐ Costs

☐ Capacities

☐ System Load Curve (required if dispatching by cost or merit order)

☐ Planning Reserve Margin (if unchecked will be calculated endogenously)

☐ Co-product fuel:

☐ Output shares (otherwise outputs in proportion to requirements).

Enter efficiency data as:

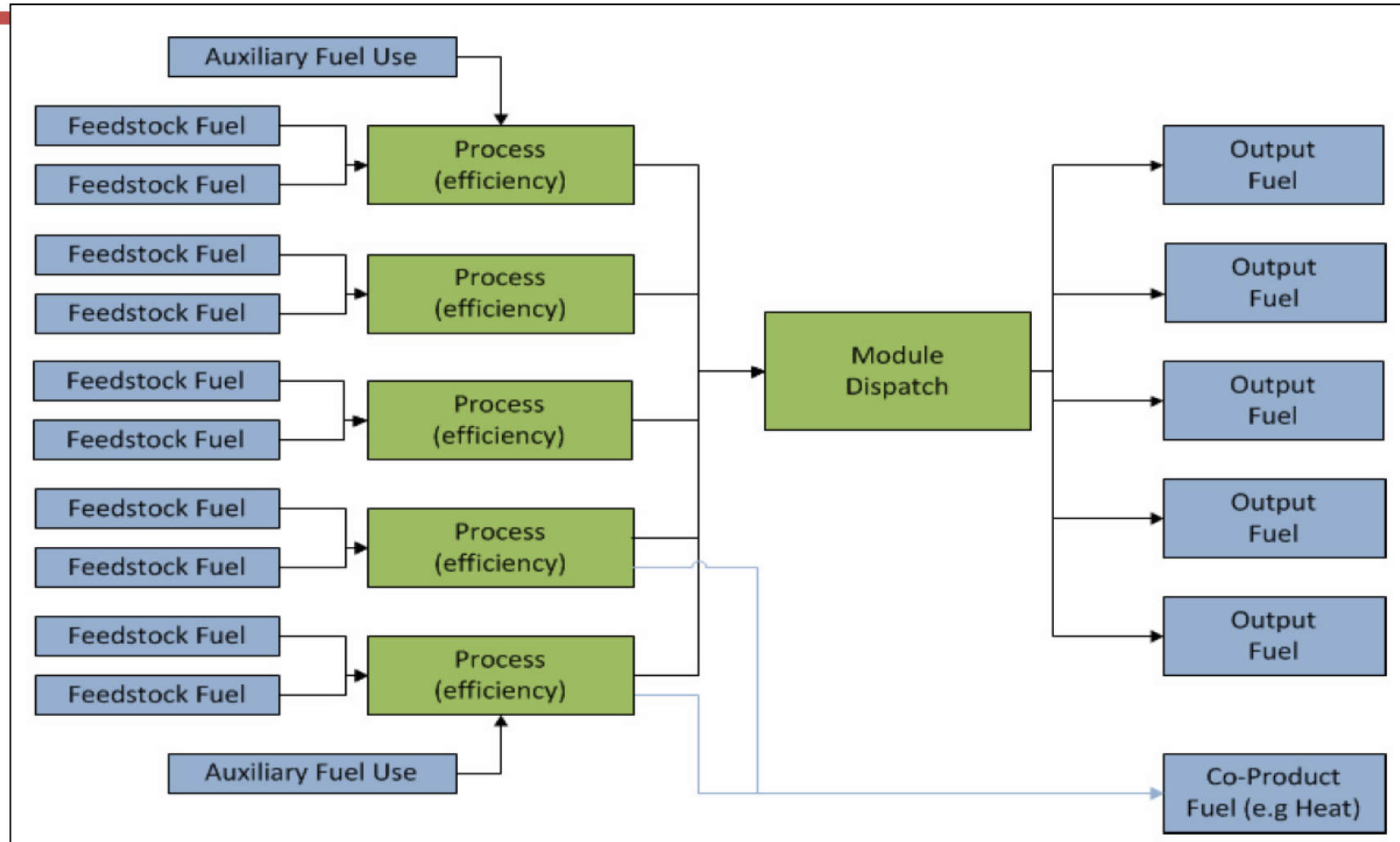
☒ Efficiencies ☐ Losses ☐ Heat rates



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# General module structure



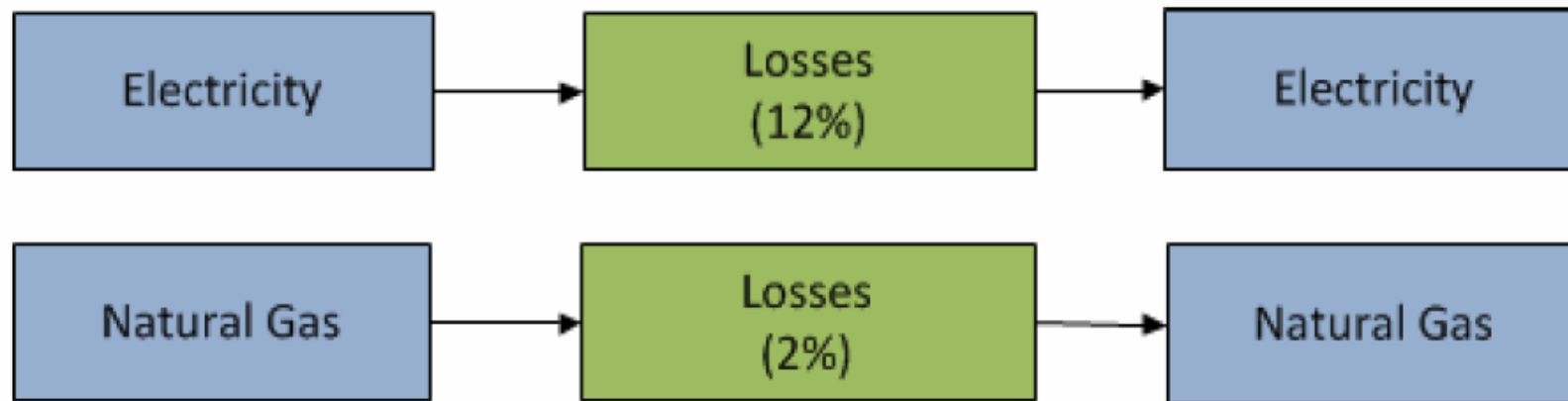
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## Example module 1: Simple non-dispatched

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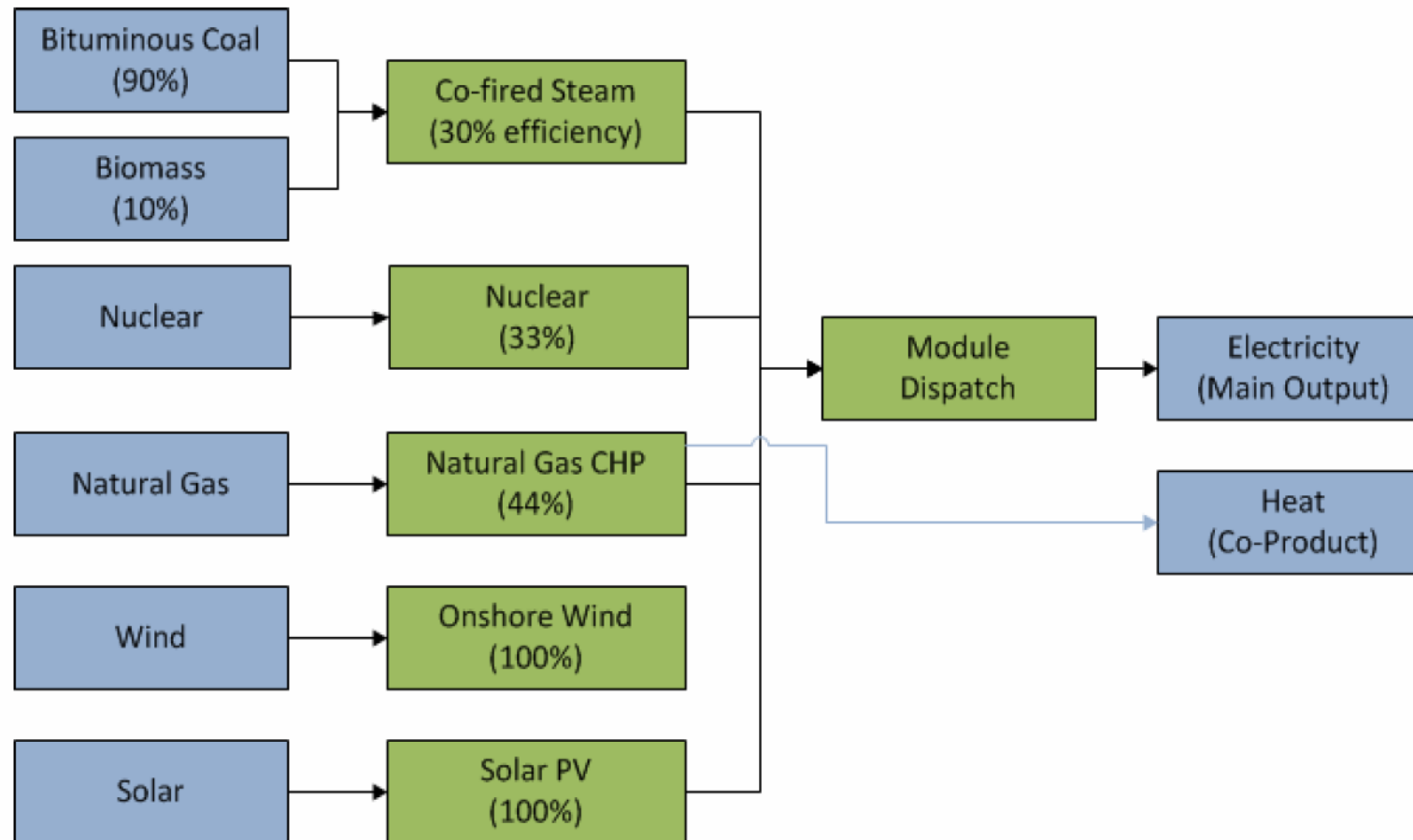


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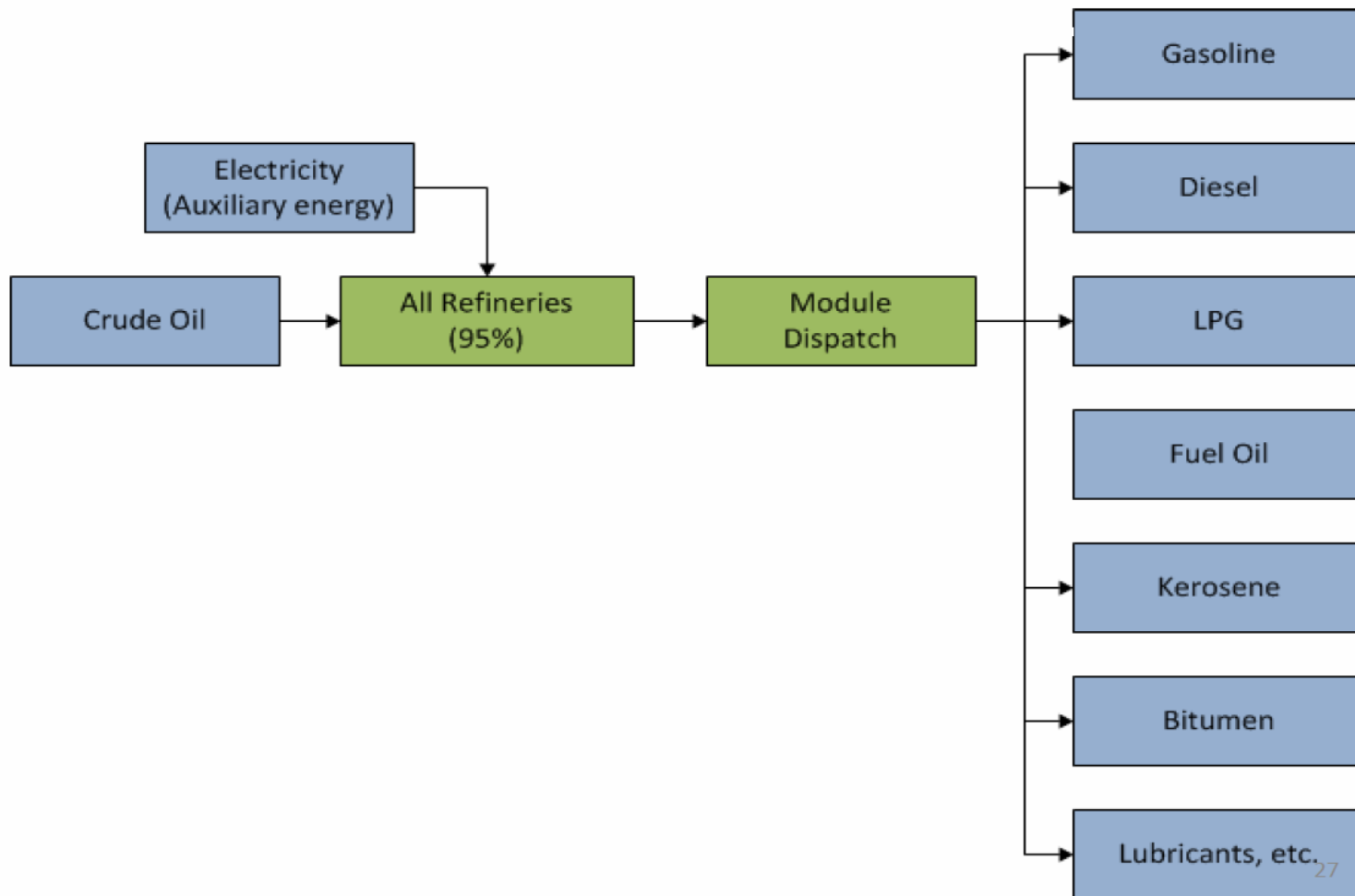
## Example module 2: Electricity generation



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## Example module 3: Oil refining



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# Set-up Transformation model

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1. Identify modules to include
2. Arrange modules in correct order
3. Set module properties
4. Determine level of detail
5. Enter data



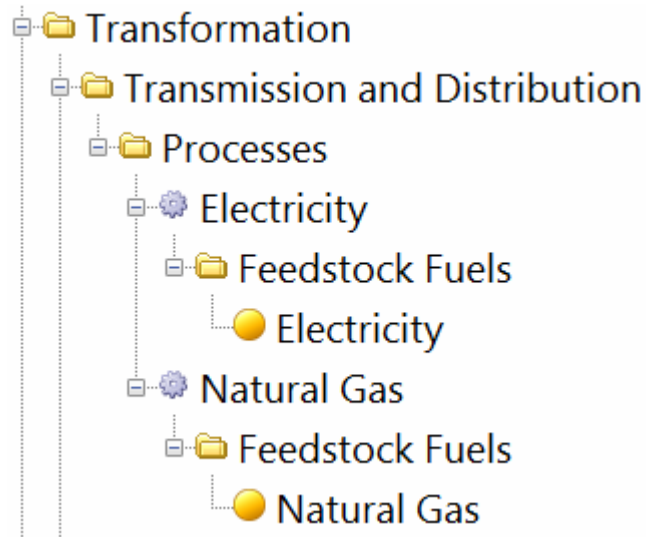
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# Modeling Transmission & Distribution

1. Add Module
2. Set Module properties
3. Add Processes
4. Set Process properties
5. Enter data



Transformation Module Properties

Name:

☒ Simple non-dispatched module: one output fuel per process.

Types of data to include:

☒ Costs

☐ Capacities

☐ System Load Curve (required if dispatching by cost or merit order)

☐ Planning Reserve Margin (if unchecked will be calculated endogenously)

☐ Co-product fuel:

☐ Output shares (otherwise outputs in proportion to requirements).

Enter efficiency data as:

☐ Efficiencies ☒ Losses

Add Process to Module: Transmission and Distribution

First Feedstock Fuel:

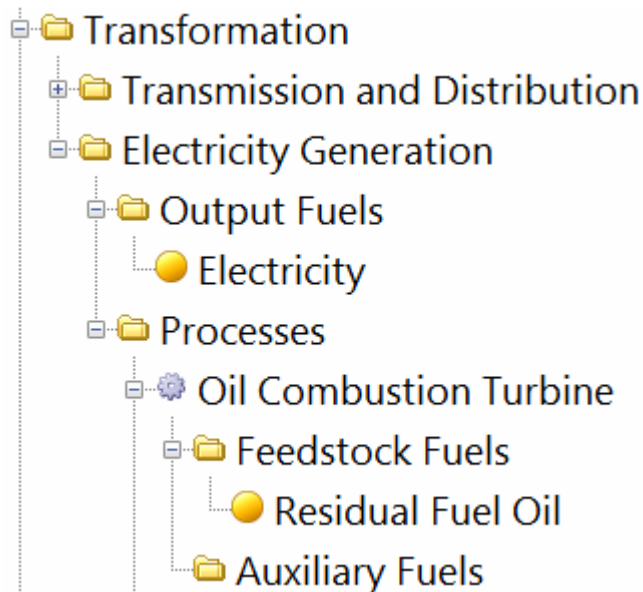
Process Name:



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# Modeling electricity generation

1. Add Module
2. Set Module properties
3. Add Processes
4. Set Process properties
5. Enter data




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# Data requirements

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- Key assumptions
- Plants characteristics
  - Exogenous capacity
  - Endogenous capacity
  - Historical production
  - Maximum availability
  - Efficiency
  - Lifetime
  - Capacity credit
  - Dispatch rules
  - System load curve



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# Making a load shape

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1. Divide year into time slices
2. Make load shape with data for each time slice
3. Assign the load shape to electricity system



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# Time slices

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- Seasonal and time-of-day divisions into which annual electricity loads can be divided
- Set up wizard to create seasonal, quarterly, monthly, weekly, or daily time slices



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LEAP: Freedonia

Area Edit View Analysis **General** Tree Chart Advanced Help

New Open Save Basic Parameters Alt+B Results Variables to Save Scenarios

Fuels Alt+L Fuel Groupings Regions Region Groupings Effects Units Alt+U References Lifecycle Profiles Yearly Shapes Ctrl+Alt+Y **Time Slices** Constants Calculation Checksums Reset Prompts

Branch: Transformation\Electricity Generation\Production

Branch: All Branches Variable: Dispatch Rule Scenario: Current Accounts

Dispatch Rule First Simulation Year Process Efficiency Historical Production Exogenous

Dispatch Rule: Used to simulate dispatch of processes from first simulation year onwards.

Branch	Expression
New Oil Combustion Turbine	MeritOrder
Existing Oil Combustion Turbine	MeritOrder
New Coal Steam	MeritOrder
Existing Hydro	MeritOrder
Existing Coal Steam	MeritOrder

Expression OK Check as You Type

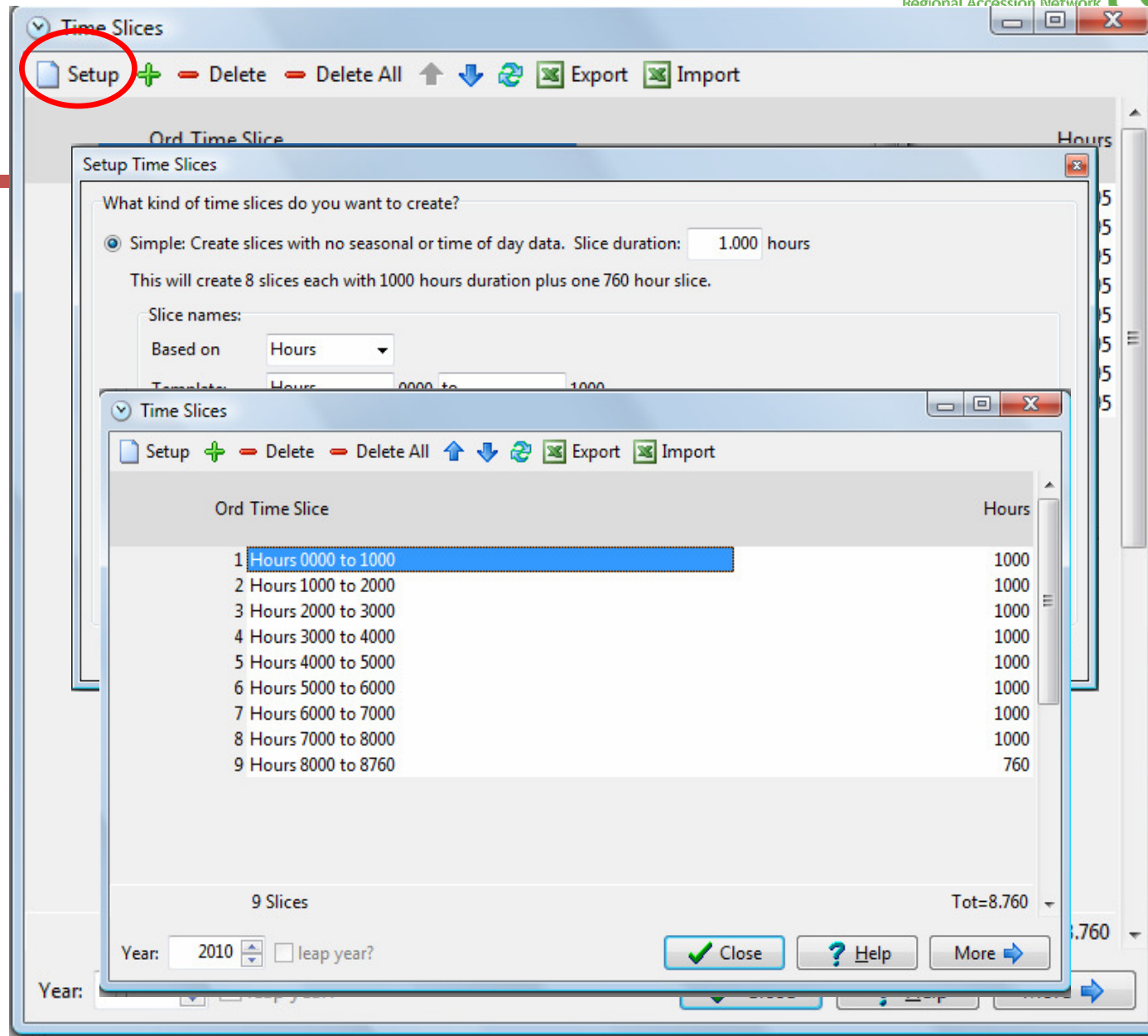
Chart Table Builder Notes Elaboration Help

3,00



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# Loads

The screenshot shows a software window titled 'Basic Parameters' with a close button (X) in the top right corner. Below the title bar is a tabbed interface with the following tabs: 'Scope & Scale', 'Years', 'Default Units', 'Calculations', 'Loads' (which is the active tab), 'Optimization', 'Stocks', 'Internet', 'Charts', 'Folders', and 'Security'. The 'Loads' tab contains the following content:

How do you want to enter electricity load curves?

- ☒ Load shape for entire system (% of Peak Generation)
- ☐ Load shape for entire system (% of Annual Generation)
- ☐ Load shapes for each device (System load shape will be calculated)

☒ Only show load shapes for electric technologies

At the bottom right of the dialog box are two buttons: a green checkmark button labeled 'Close' and a blue question mark button labeled 'Help'.

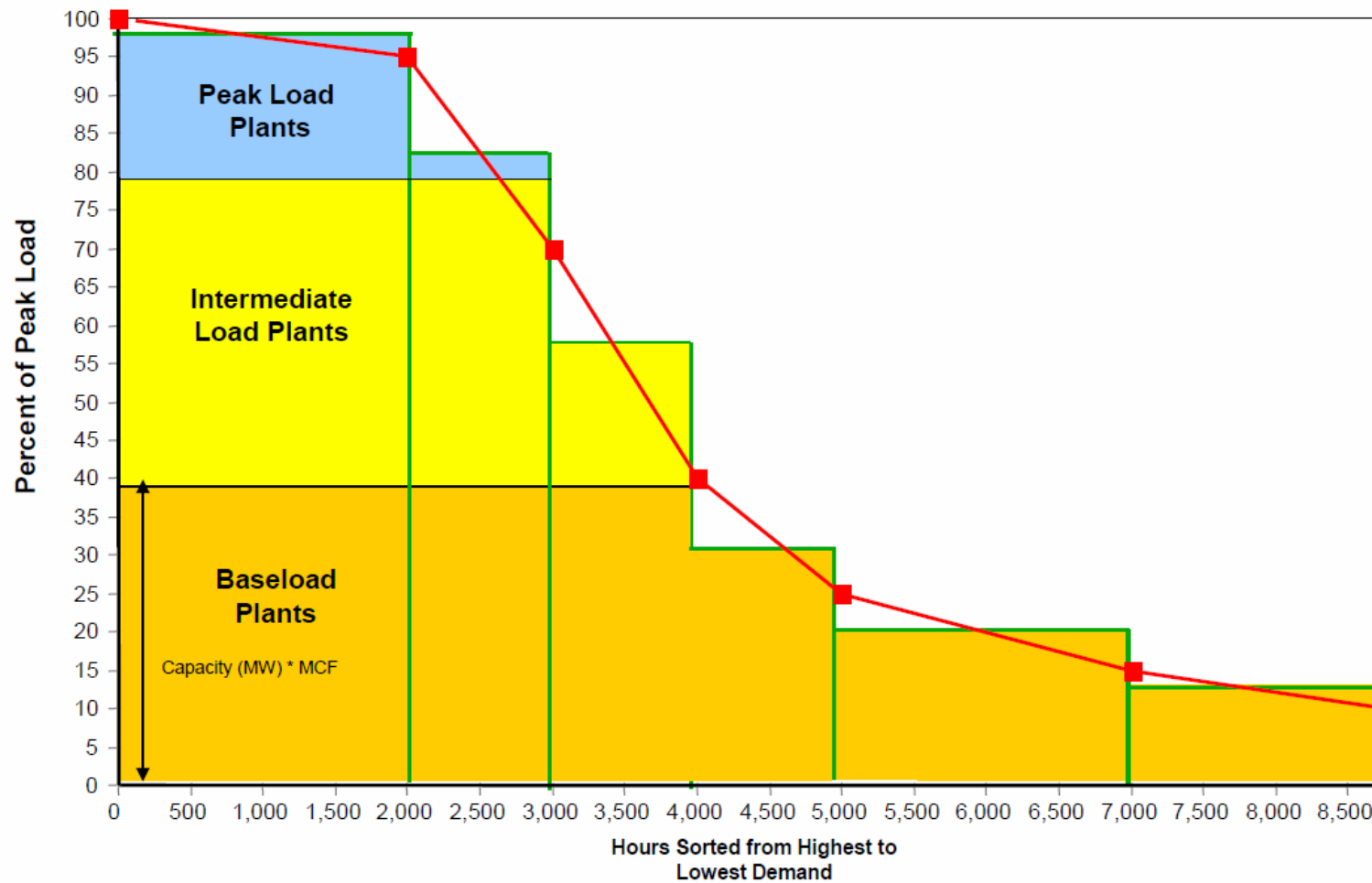


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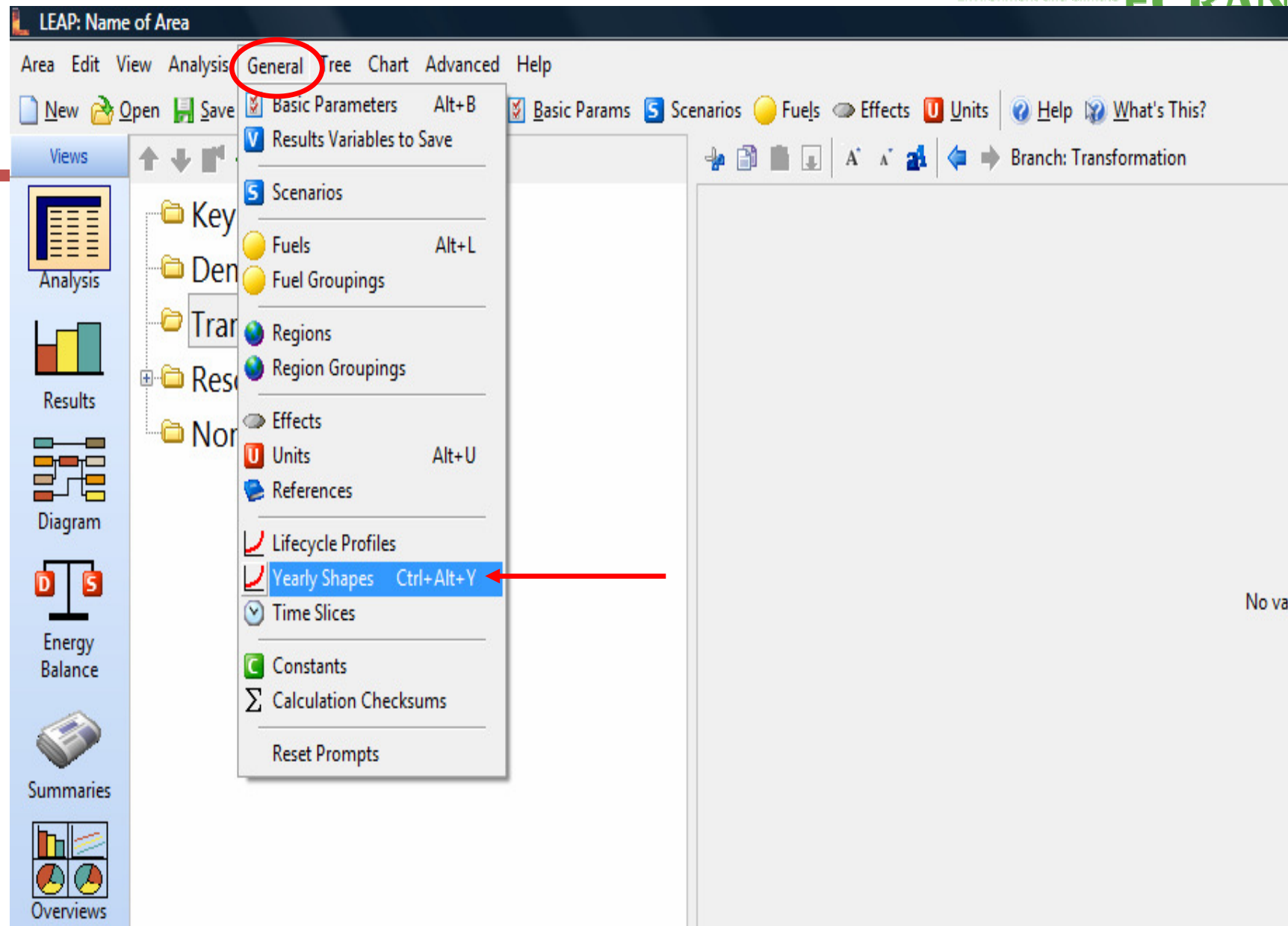
# Load duration curve



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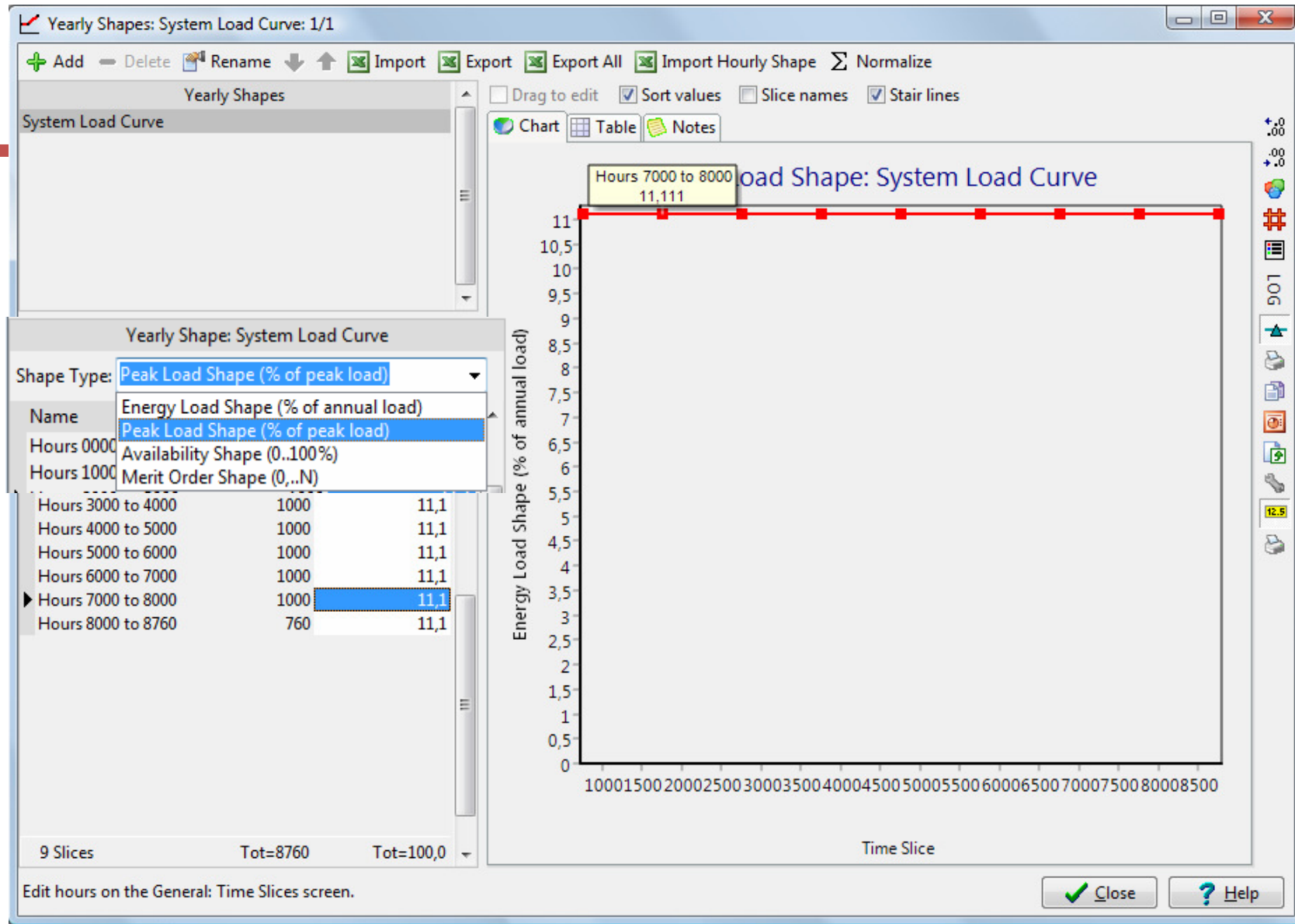


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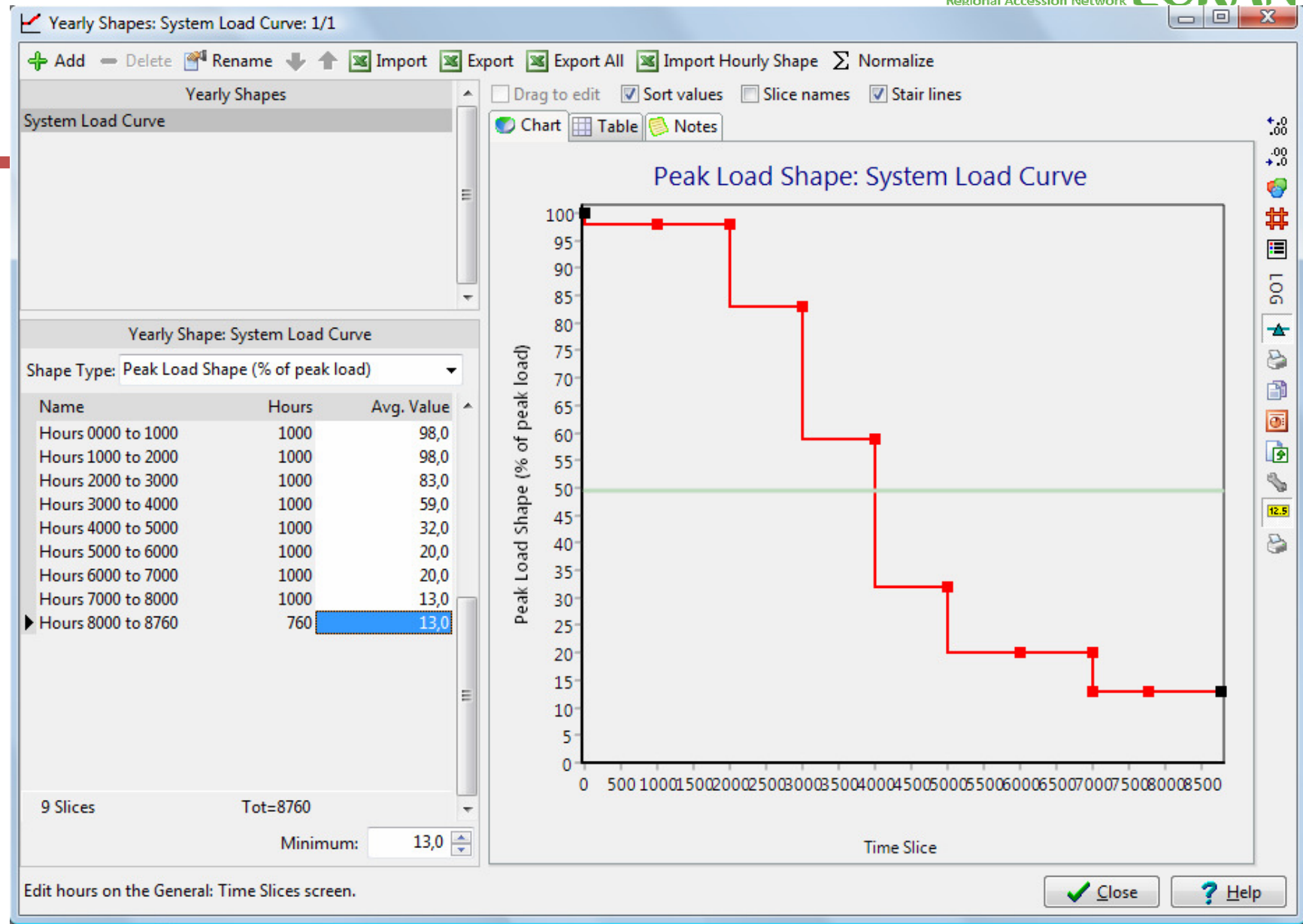




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The screenshot displays the ECRAN software interface. On the left, a tree view shows the project structure: Freedonia, Key Assumptions, Demand, Transformation, Transmission and Distribution, Electricity Generation, Output Fuels, Processes, and Resources. The main window shows the 'Branch: Transformation\Electricity Generation\...' and 'Variable: System Peak Load Shape' selected. The 'System Peak Load Shape' variable is circled in red. Below this, the 'Expression' field contains 'YearlyShape(System Load Curve)'. A context menu is open over the 'System Load Curve' variable, showing options like Cut, Copy, Ditto, Reset to Inherited, Branch/Variable, Function, Time Series, and Use Aliases. The 'System Load Curve' variable is also circled in red.



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# Dispatch modes

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- **Mode 1: Historical**
  - dispatch of plants based on historical generation
- **Mode 2: Simulation**
  - dispatch of plants based on various dispatch rules ranging from very simple (% of total generation) to more sophisticated (dispatch by merit order or in order of running costs)
- Set the **First Simulation Year** variable for each process to determine when to use historical mode and when to use simulation mode.
- Mix modes and dispatch rules in neighboring processes (e.g. dispatch wind by percentage to meet a renewable portfolio standard, but dispatch other processes by merit order).



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# Dispatch rules

Branch: Transformation\Electricity Generation\Processes\...

Branch: All Branches Variable: Dispatch Rule Scenario: Current Accounts

Dispatch Rule First Simulation Year Process Efficiency Historical Production Exogenous Capacity Endogenous Capacity Maximum Availability Capacity Credit Interest Rate Lifetime Merit Order

Dispatch Rule: Used to simulate dispatch of processes from first simulation year onwards. [Default= "PercentShare"]

Branch	Expression
New Oil Combustion Turbine	MeritOrder
Existing Oil Combustion Turbine	MeritOrder
New Coal Steam	MeritOrder
Existing Hydro	MeritOrder
Existing Coal Steam	MeritOrder

Legend:

- PercentShare: Runs in proportion to Process Share variable.
- ProportionalToCapacity: Runs in proportion to available capacity.
- FullCapacity: Dispatches up to full available capacity regardless of requirements.
- MeritOrder: Dispatches in order using Merit Order variable.

Keyboard shortcuts:

- Cut Ctrl+X
- Copy Ctrl+C
- Paste Ctrl+V
- Paste Special
- Ditto Ctrl+D
- Reset to Inherited
- Branch/Variable Ctrl+B
- Function Ctrl+F
- Time Series Ctrl+T
- Use Aliases



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# Let's practice!

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