

Modeling Transformation *in LEAP*

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Project implemented by Human Dynamics Consortium

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- Transformation in LEAP
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 - Branch types, properties & structure
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 - Data requirements
 - Making a system load shape
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Transformation

- 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



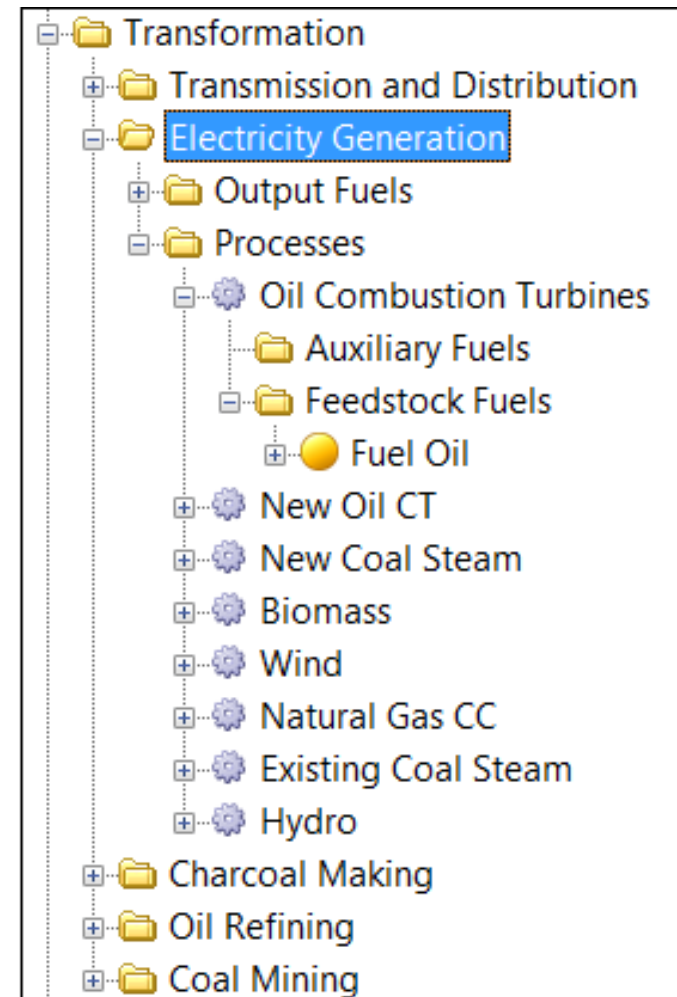
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Transformation in LEAP

- 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

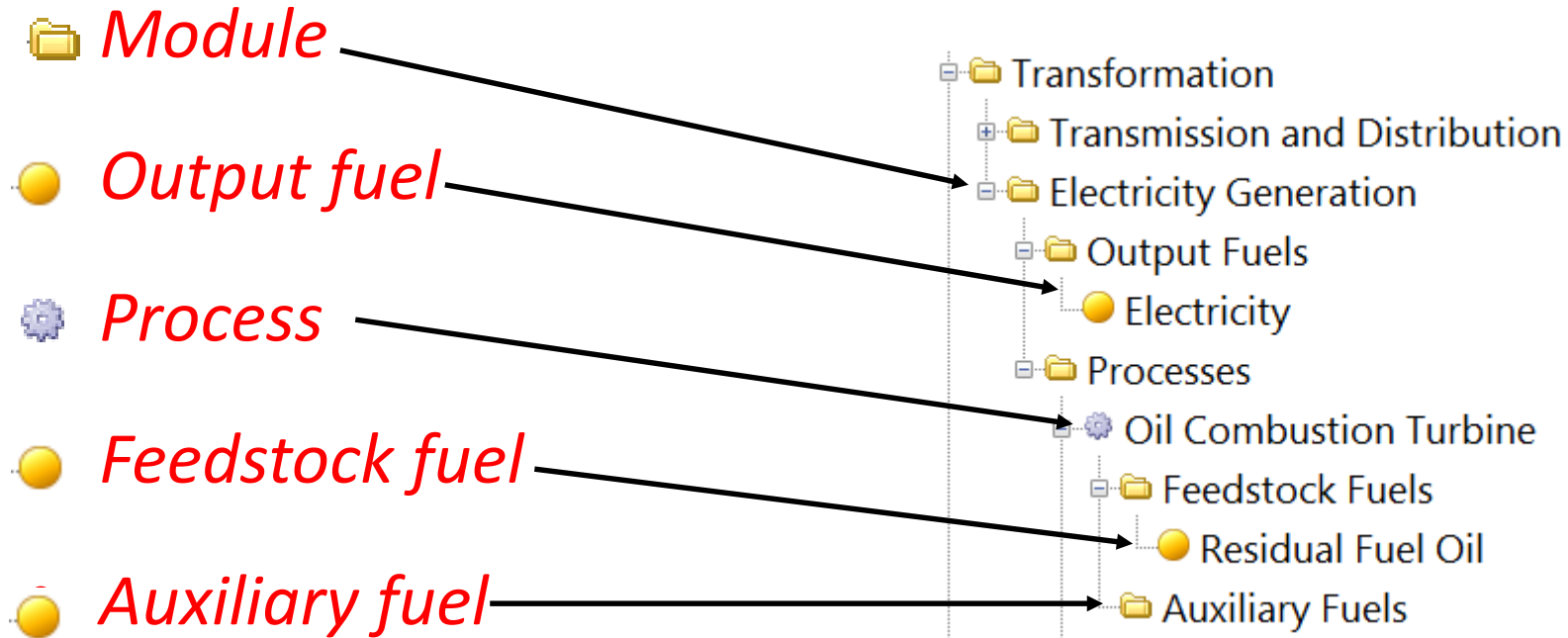
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Organization Type	Academic Organization
City	Athens
Country	Greece
Email	promitheas@kepa.uo...
Web	http://www.kepa.uoa....
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☒ Close ☐ Help



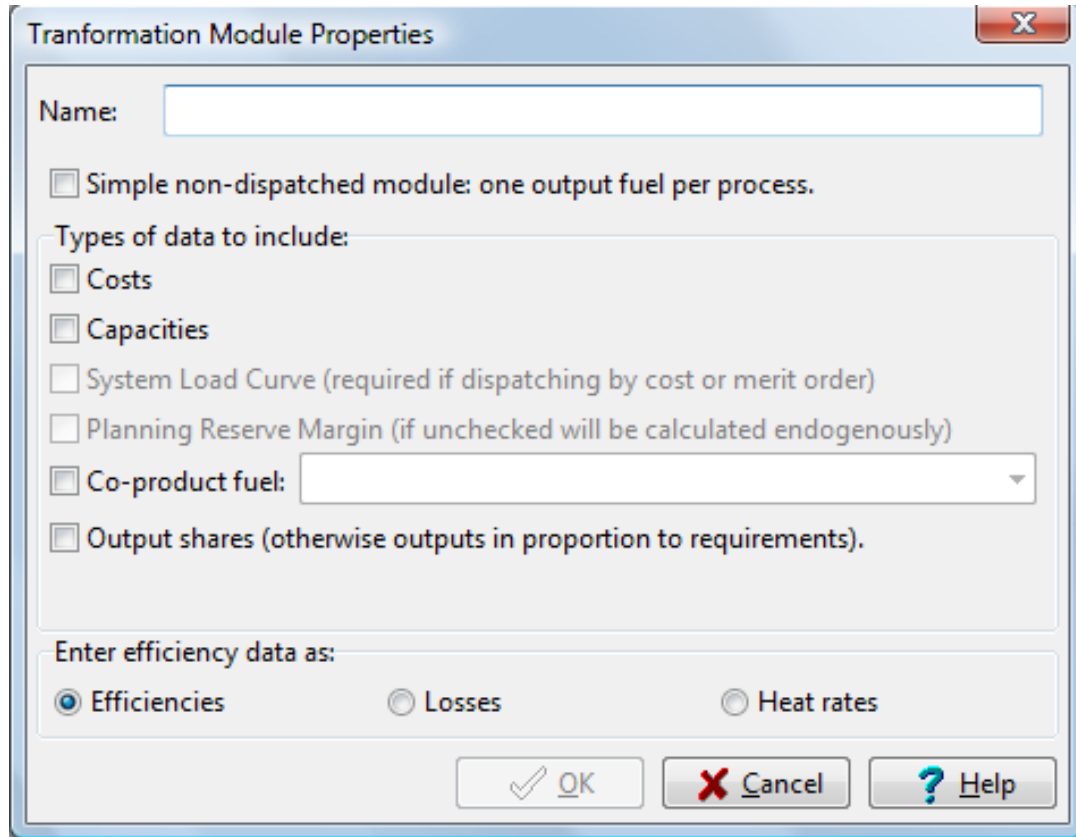
Branch types



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.



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:

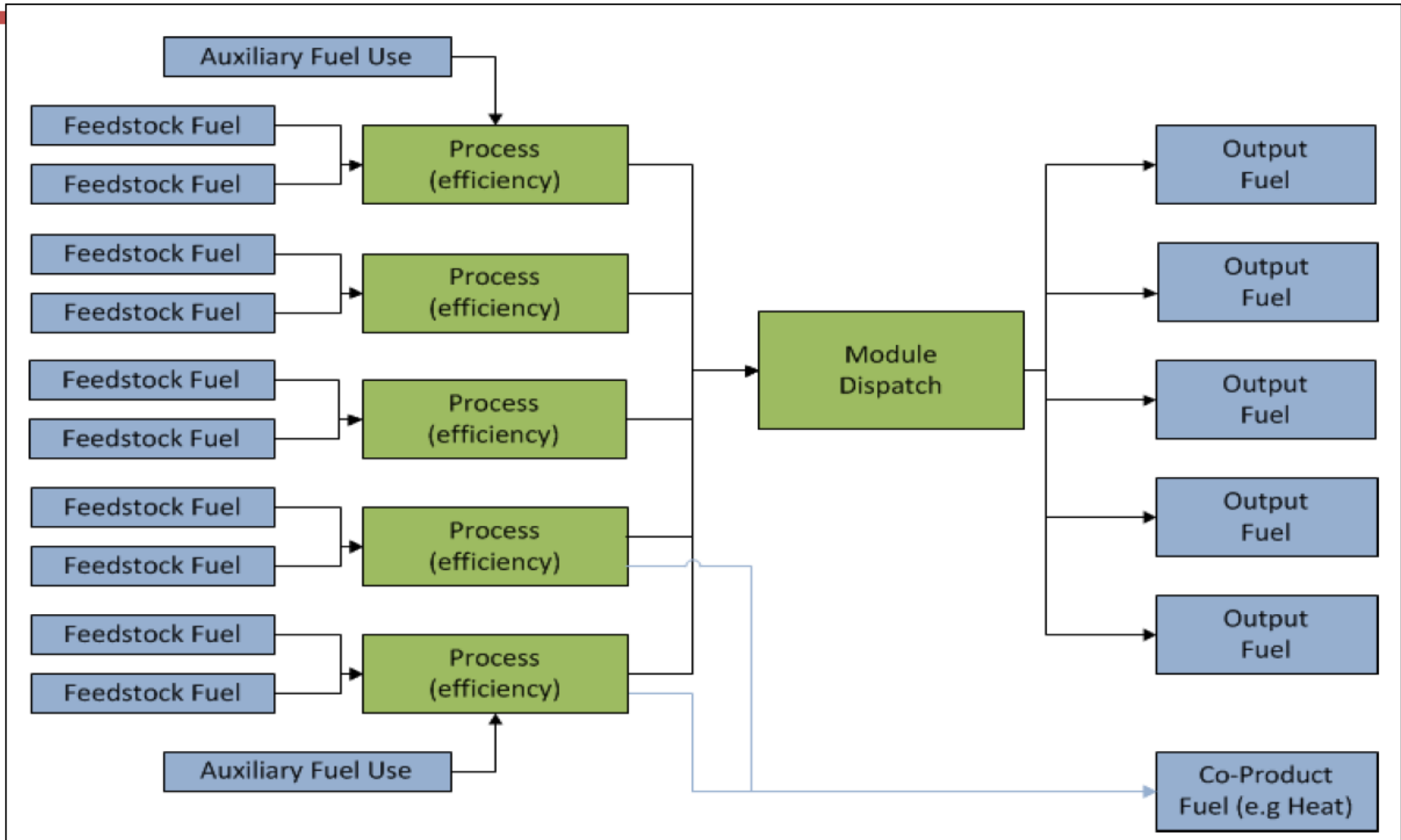
☐ Output shares (otherwise outputs in proportion to requirements).

Enter efficiency data as:

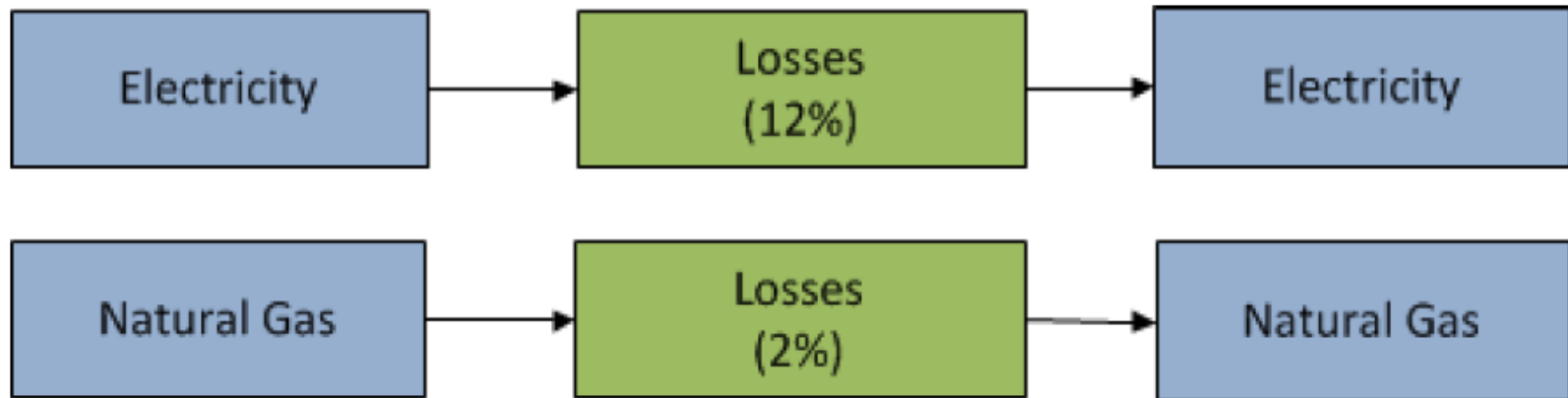
☒ Efficiencies ☐ Losses ☐ Heat rates



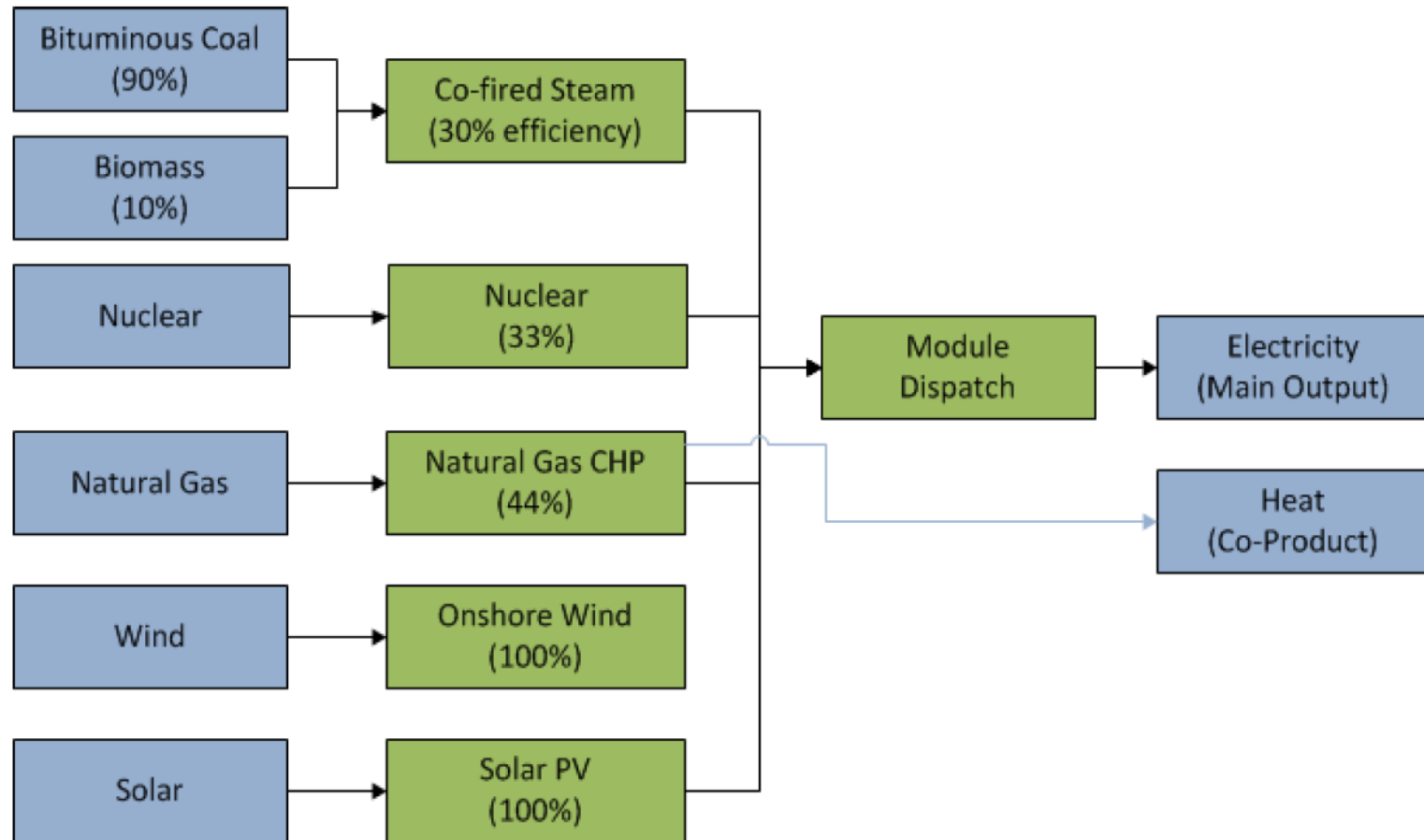
General module structure



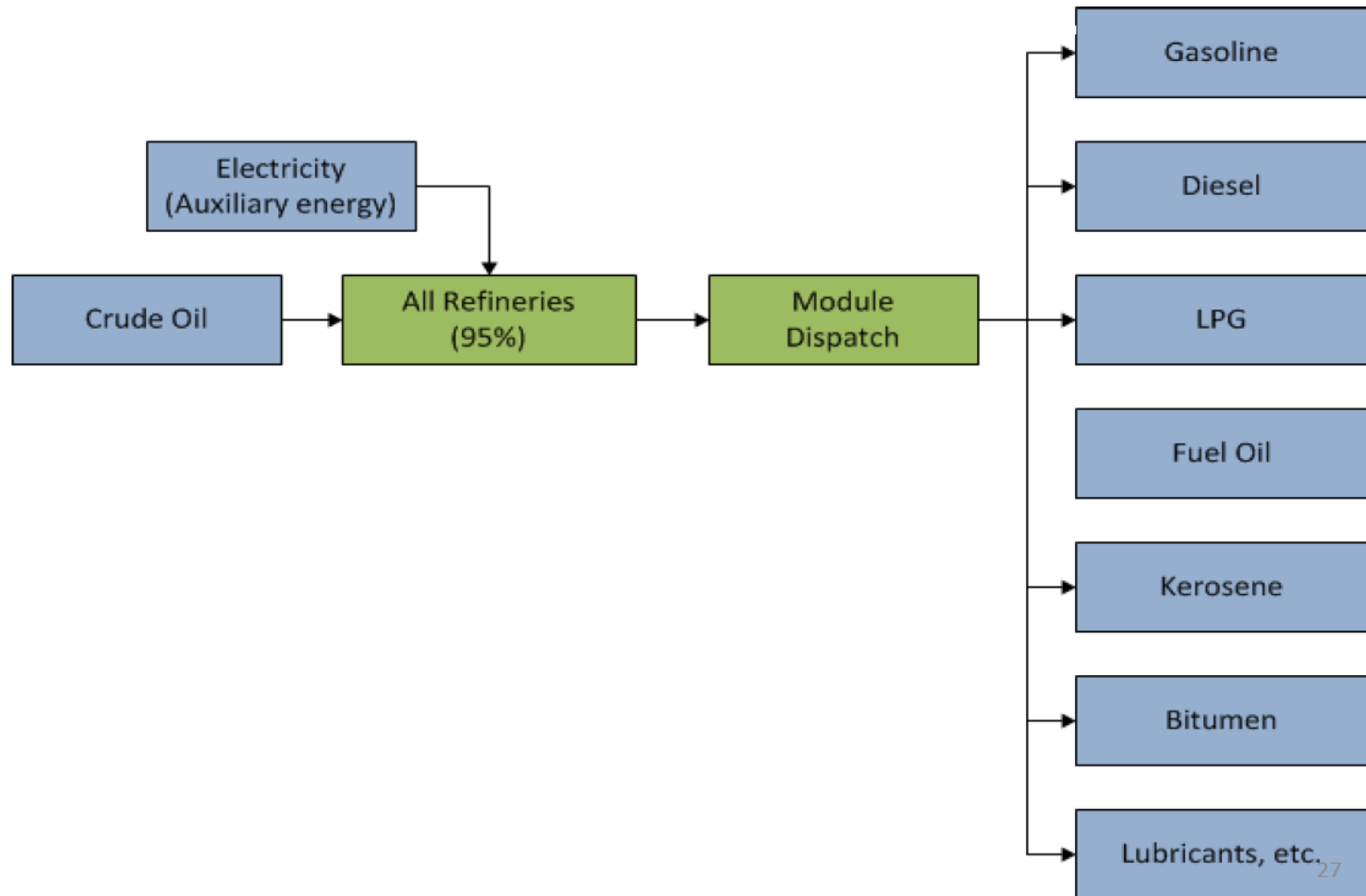
Example module 1: Simple non-dispatched



Example module 2: Electricity generation



Example module 3: Oil refining



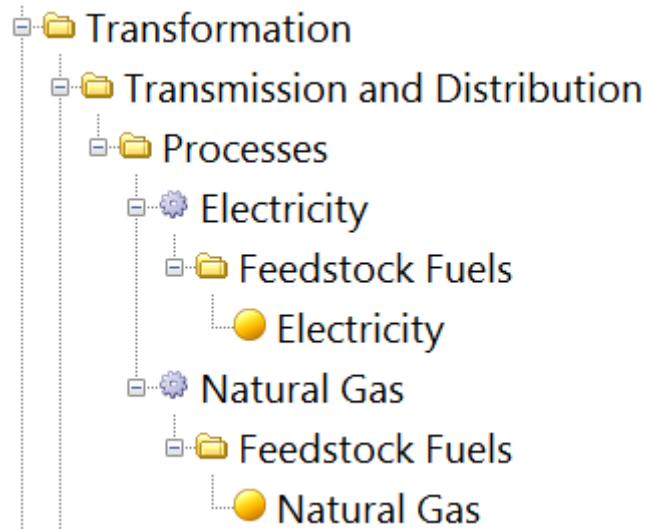
Set-up Transformation model

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



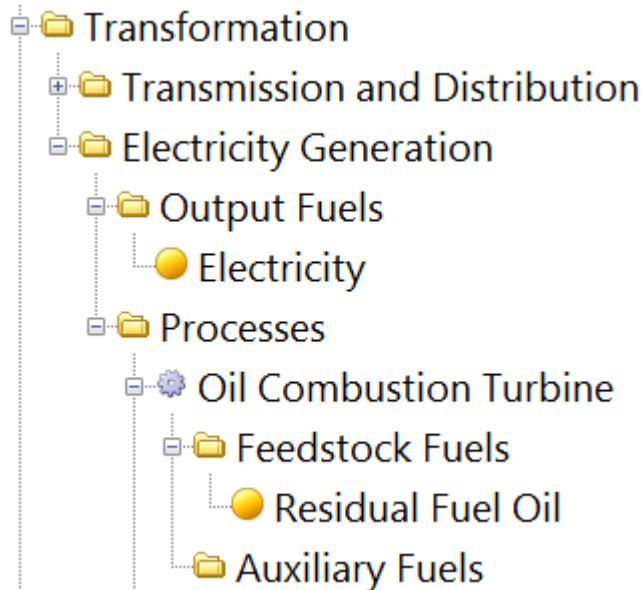
Modeling Transmission & Distribution

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




Modeling electricity generation

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




Data requirements

- 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

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



Time slices

- 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



LEAP: Freedonia

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

New Open Save Basic Parameters Alt+B Basic Params Scenarios Fuels Effects Units Help What's This?

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Basic Parameters

Results Variables to Save

Scenarios

Fuels Alt+L

Fuel Groupings

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Region Groupings

Effects

Units Alt+U

References

Lifecycle Profiles

Yearly Shapes Ctrl+Alt+Y

Time Slices

Constants

Calculation Checksums

Reset Prompts

New Coal Steam

Existing Hydro

Existing Coal Steam

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.

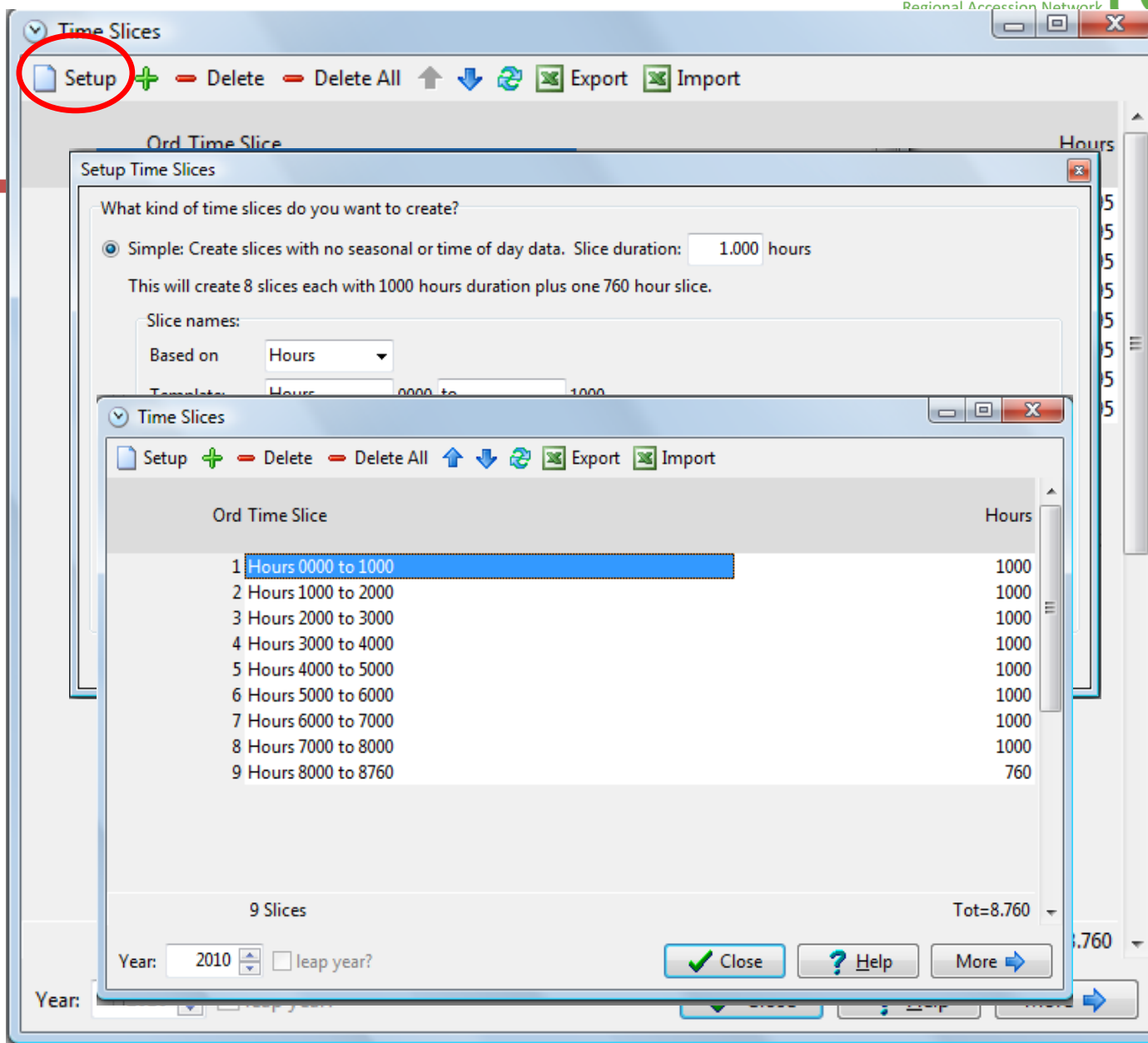
Branch	Expression
New Oil Combustion Turbine	MeritOrder
Existing Oil Combustion Turbine	MeritOrder
New Coal Steam	MeritOrder
Existing Hydro	MeritOrder
Existing Coal Steam	MeritOrder

Expression OK Check as You Type

Chart Table Builder Notes Elaboration Help

3,00





Loads

Basic Parameters

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

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

Close Help

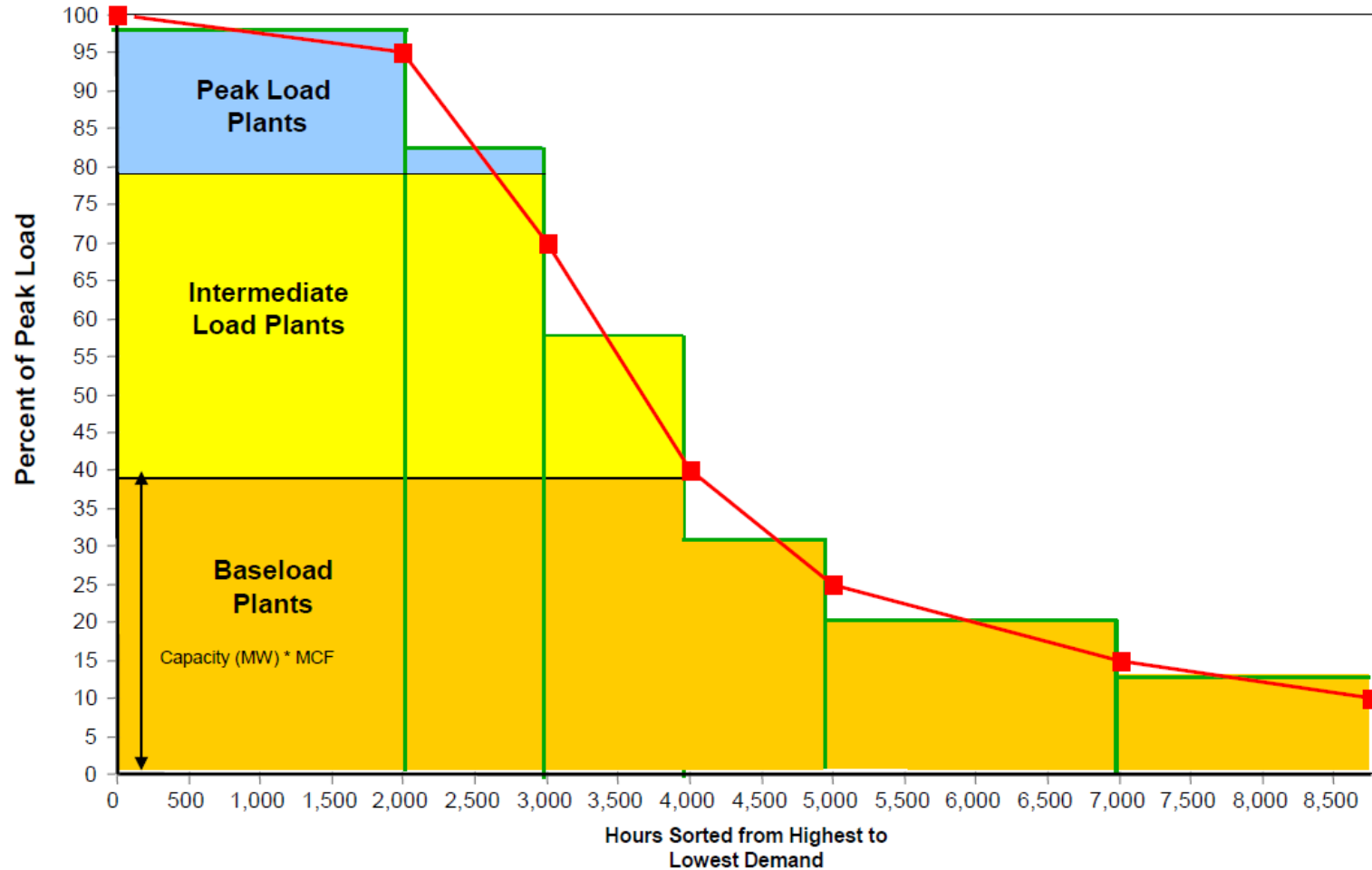


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Load duration curve



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LEAP: Name of Area

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

New Open Save Basic Parameters Alt+B Basic Params Scenarios Fuels Effects Units Help What's This?

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Units Alt+U

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Lifecycle Profiles

Yearly Shapes Ctrl+Alt+Y

Time Slices

Constants

Calculation Checksums

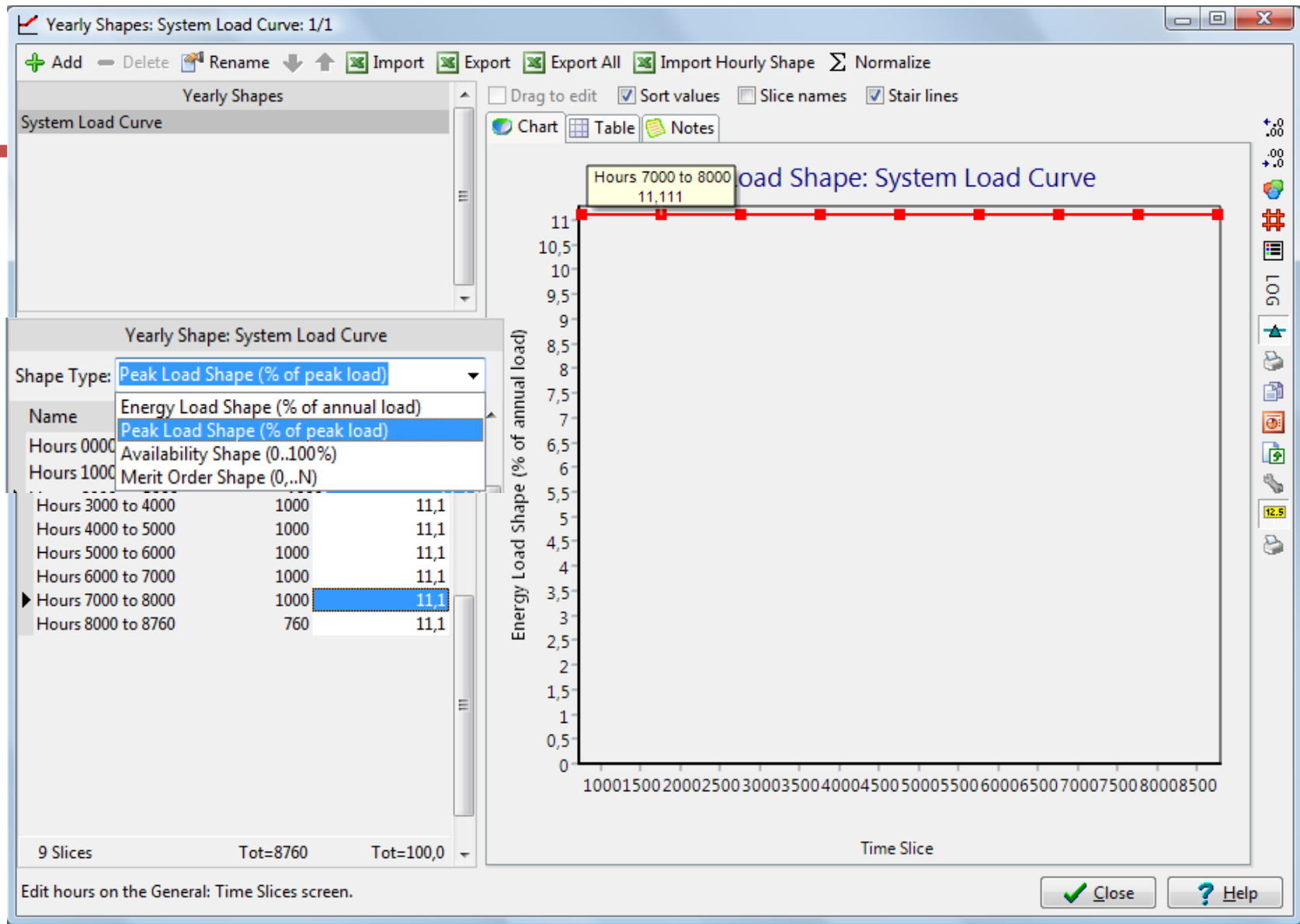
Reset Prompts

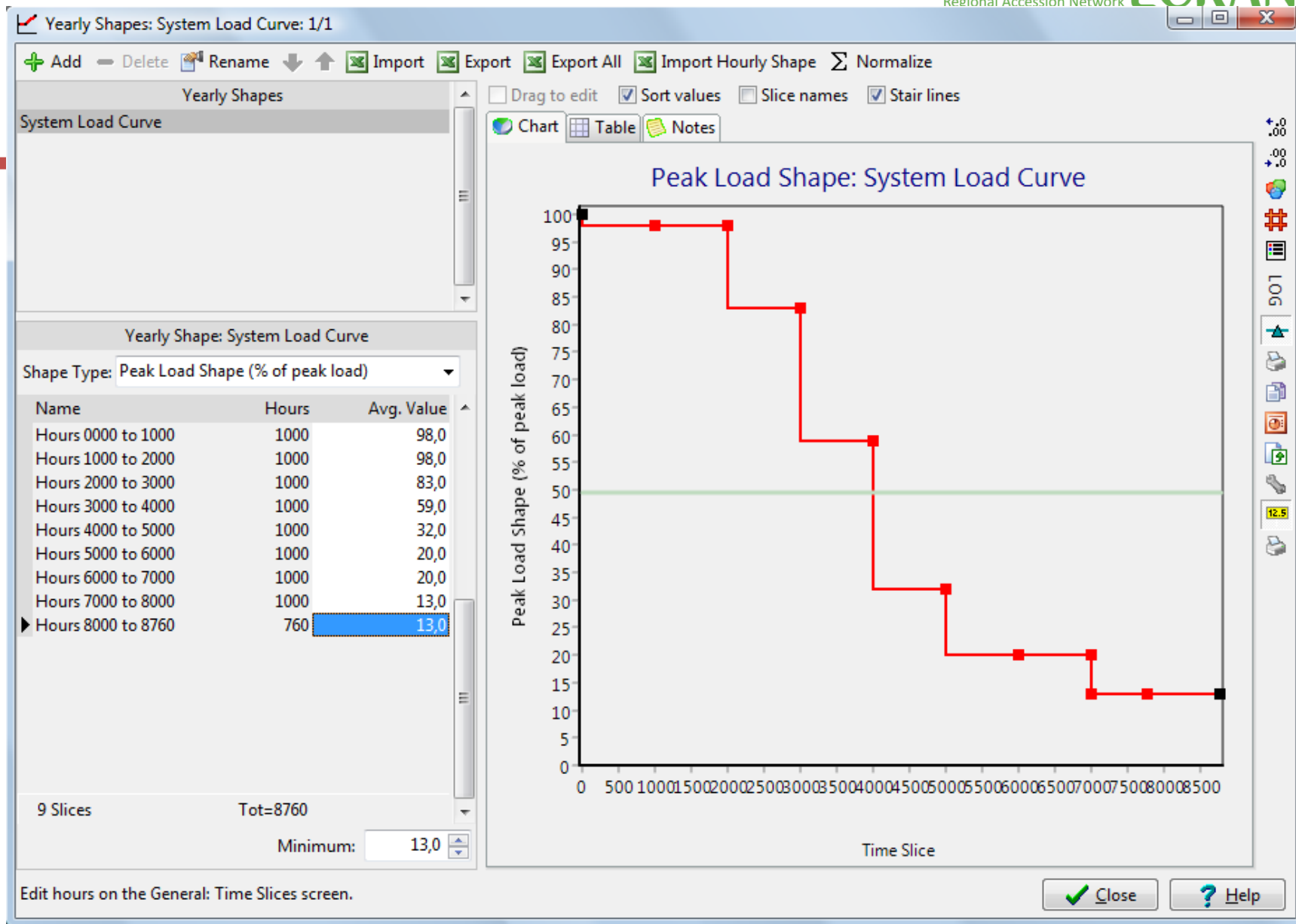
Branch: Transformation

No val



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The screenshot displays the ECRAN software interface. On the left, a tree view shows the project structure under 'Freedonia', including 'Key Assumptions', 'Demand', 'Transformation', 'Transmission and Distribution', 'Electricity Generation' (highlighted with a red underline), 'Output Fuels', 'Processes', and 'Resources'. The main window shows the 'Branch: Transformation\Electricity Generation\...' with a 'Variable: System Peak Load Shape' and 'Scenario: Current Accounts'. Below this, a table lists the 'System Peak Load Shape' variable, with its expression 'YearlyShape(System Load Curve)' highlighted in blue. A right-click context menu is open over the 'YearlyShape...' button, showing options like 'Cut', 'Copy', 'Ditto', 'Reset to Inherited', 'Branch/Variable', 'Function', 'Time Series', and 'Use Aliases'.



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Dispatch modes

- **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).



Dispatch rules

The screenshot displays the ECRAN software interface for configuring dispatch rules. On the left, a tree view shows the model structure under 'Freedonia', including 'Key Assumptions', 'Demand', 'Household', 'Transformation', 'Transmission and Distribution', 'Electricity Generation', 'Output Fuels', 'Processes', and 'Resources'. The 'Processes' folder is expanded, showing 'New Oil Combustion Turbine', 'Existing Oil Combustion Turbine', 'New Coal Steam', 'Existing Hydro', and 'Existing Coal Steam'.

The main workspace shows the 'Branch: Transformation\Electricity Generation\Processes\...' and 'Variable: Dispatch Rule'. A table lists the dispatch rules for the 'New Oil Combustion Turbine' process, all using the 'MeritOrder' expression:

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

A context menu is open over the 'MeritOrder' expression, showing the following options:

- 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.
- 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



Let's practice!

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