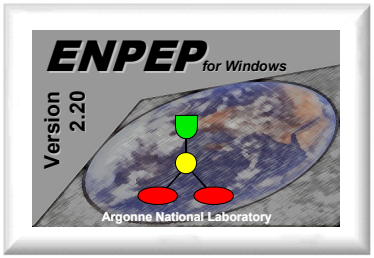
ENPEP-BALANCE: Simple Case

ENPEP-BALANCE Training Course
Singapore
December 5-9, 2011



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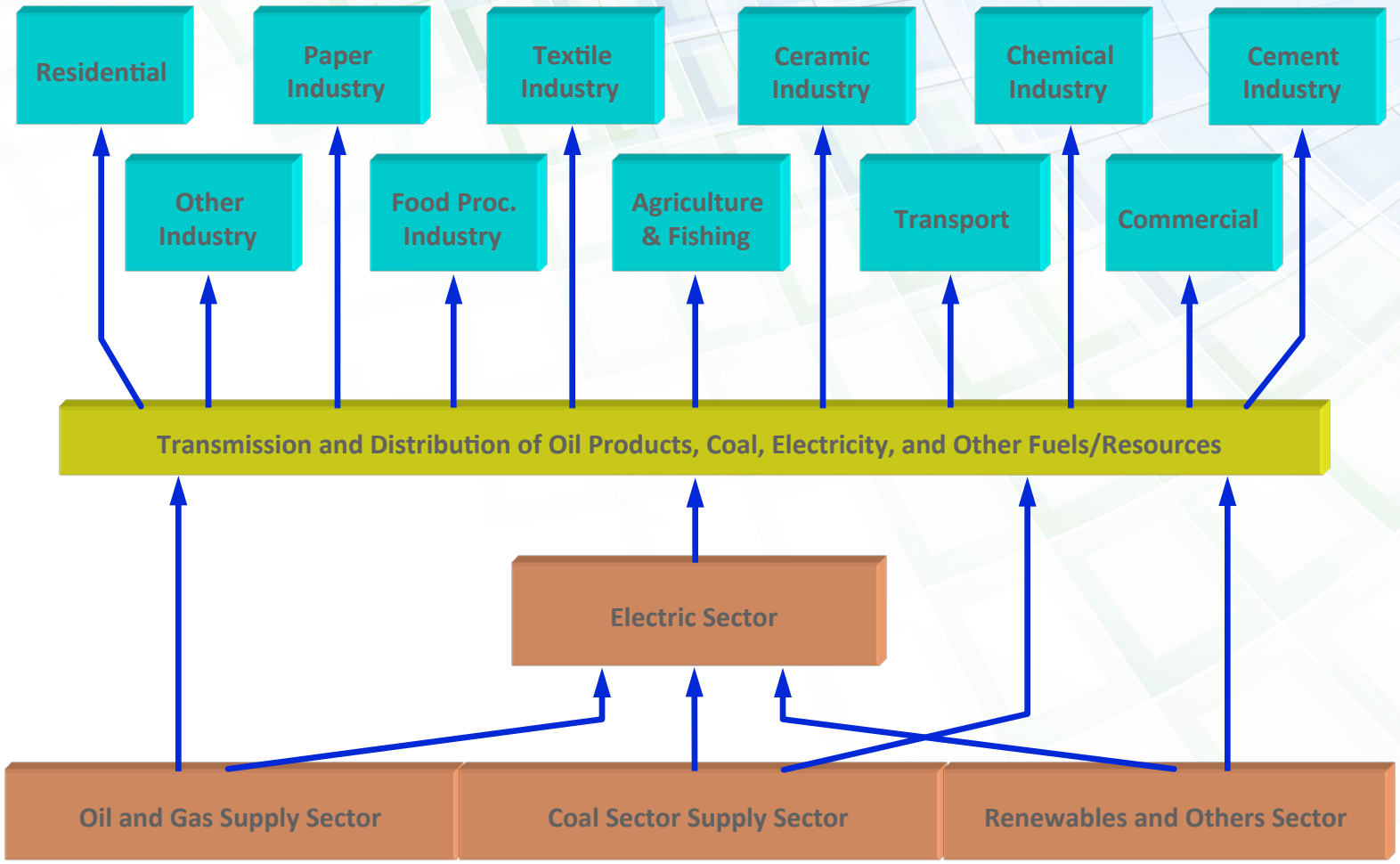
Purpose of Simple Case is to Illustrate some of the Basic Calculations in BALANCE

Lecture will cover the following:

- Simple Case definition & node input description
- Example of network development
- Testing the sensitivity of model results to various model parameters

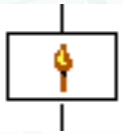
The Basic Starting Point in BALANCE is the Energy Network that Simulates Energy Markets



The Following Node Types are Available to Construct Cases

- Demand

- Conversion Processes



Single In-/Output

Multi Output

Multi Input

Transport

- Resource Processes

Depletable

Renewable

- Economic Processes

Decision/Allocation

Pricing

Stockpile

- Electricity Dispatch and Thermal and Hydro Units

Central Dispatch

Thermal Unit

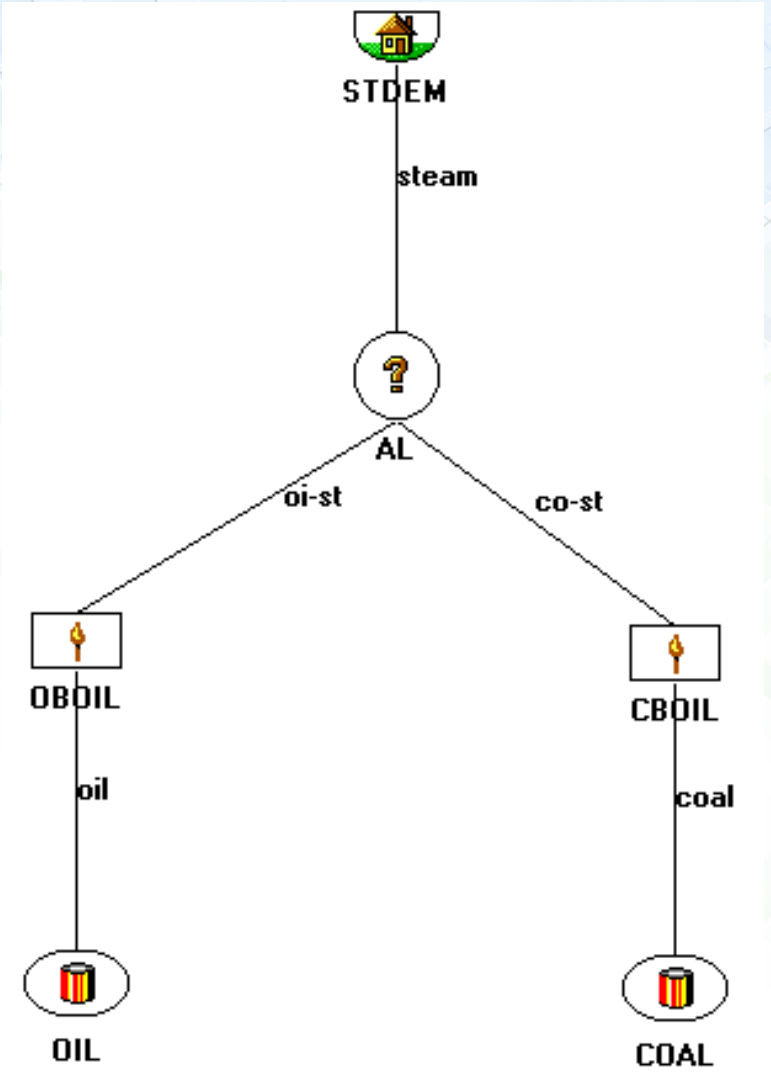
Hydro Unit

Steps in Network Development

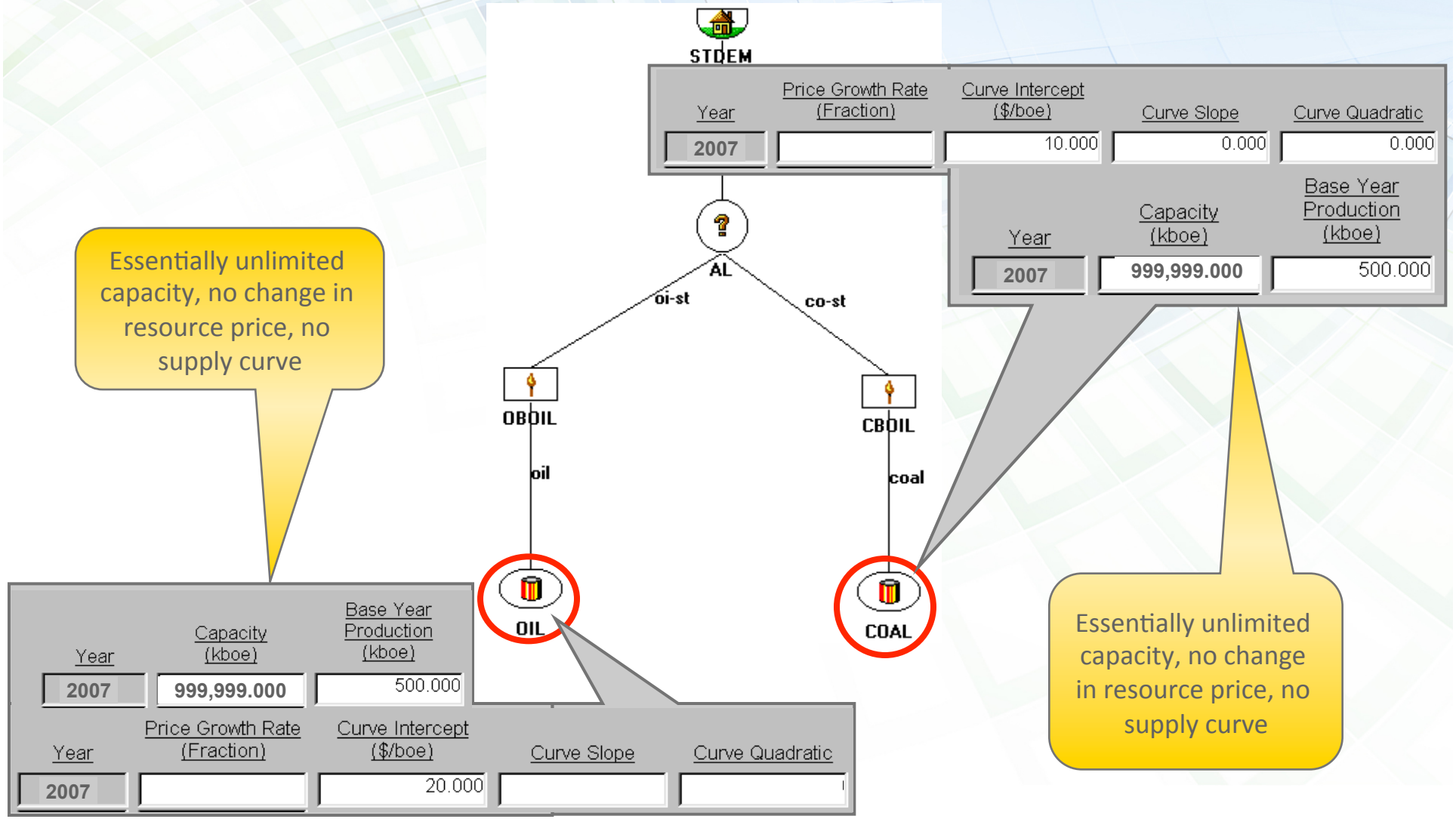
- Prepare the network structure
  - Draw the network
  - Label the network (each link and node has a name and abbreviation
- Prepare the input data
- Prepare (run/check) the node visitation sequence (Up/Down-Pass)
- Run BALANCE
- Check/printout the results (tables, graphs, text files)

Structure of Simple Network

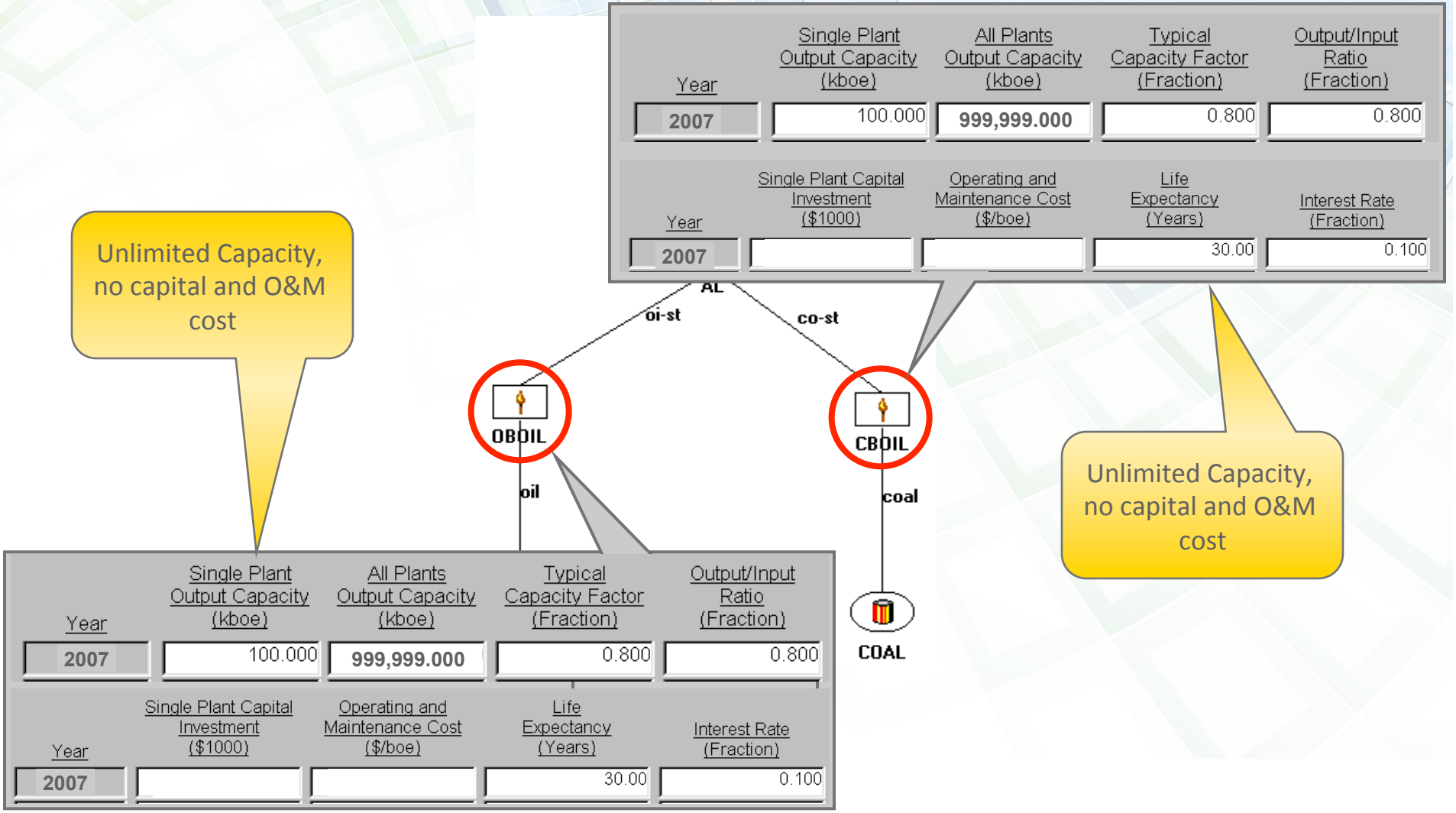
- Two resource nodes: OIL and COAL
- Two conversion processes or boilers: OBOIL
- One decision node: AL
- One demand node: STDEM (steam demand)
- Study period: **2007-2026**



Resource Node Input Data (Case 1)



Conversion Process Node Input Data (Case 1)



Allocation Node Input Data (Case 1)

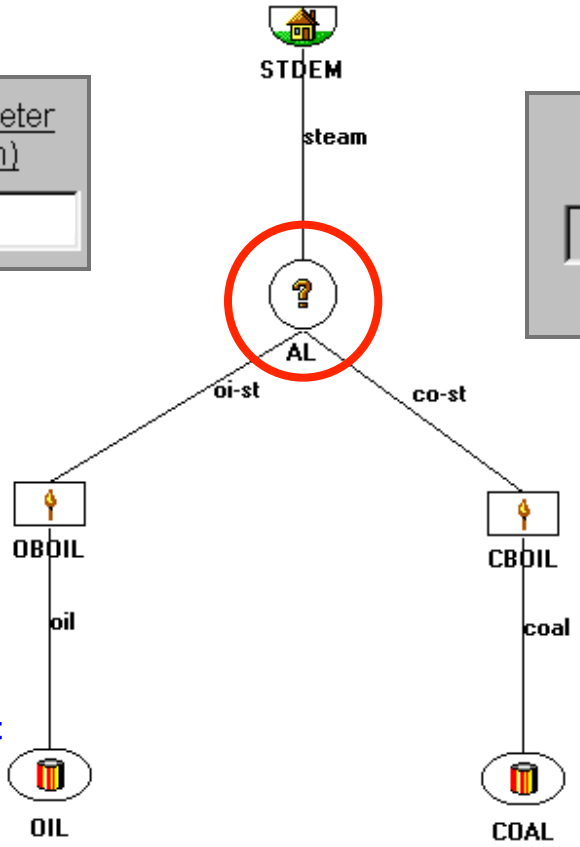
No priority, no premium multipliers

Year	Input Link Abbreviation	Priority	Premium Multiplier
2007	co-st		
2007	oi-st		

Year	Price Sensitivity	Lag Parameter (Fraction)
2007		

Blank means 0:
Decision is not sensitive to prices (sensitivity of 0);
Market cannot respond to price signals (lag of 0)

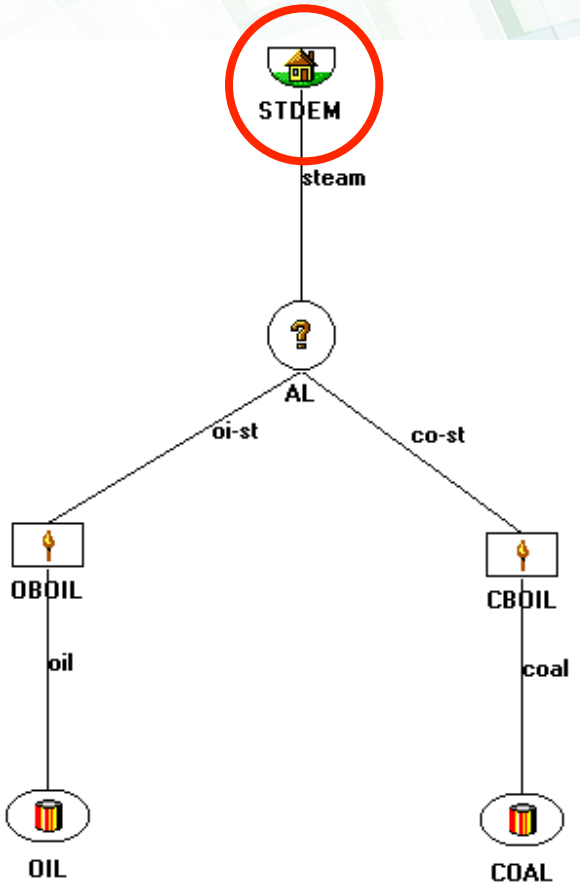
Lag of 1.0: Entire market can potentially shift
Lag of 0.5: Half the market can potentially shift
Lag of 0: No change in market shares



Output Link Abbreviation	Base Year Split (Fraction)
steam	1.0000
Sum:	1

Sum of the base year splits has to equal 1.0; Note that this is **OUTPUT SPLIT**; this input is used only in the base year calculations

Demand Node Input Data (Case 1)

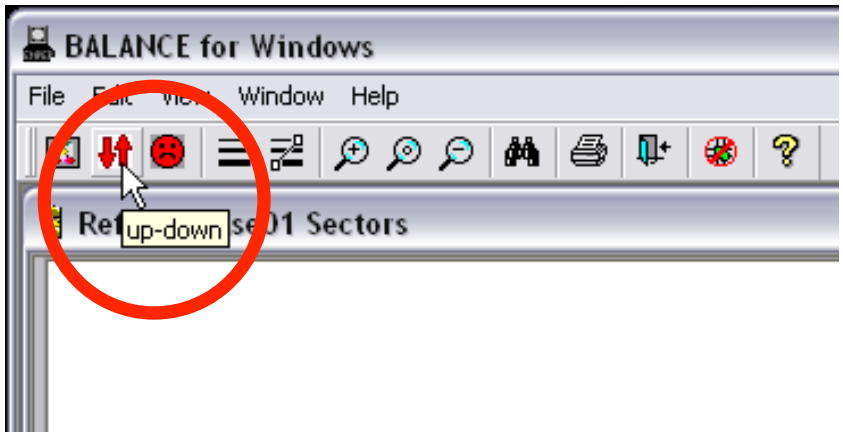


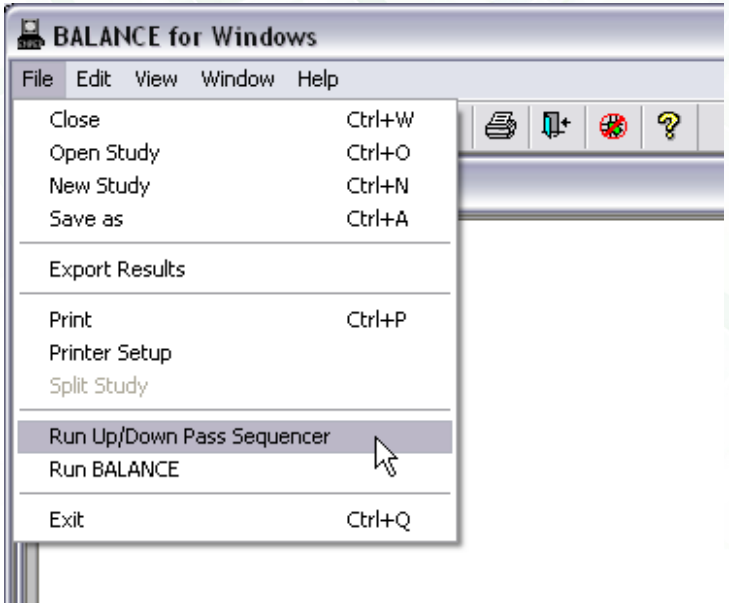
Year	Growth Rate (Fraction)	Elasticity	Type
2007			
2008			
2009			
2010			
2011			
2012			
2013			
2014			
2015			
2016			
2017			
2018			
2019			
2020			
2021			
2022			
2023			
2024			
2025			
2026			

Demand stays constant:
A **Blank** growth rate means growth rate of 0 in that year

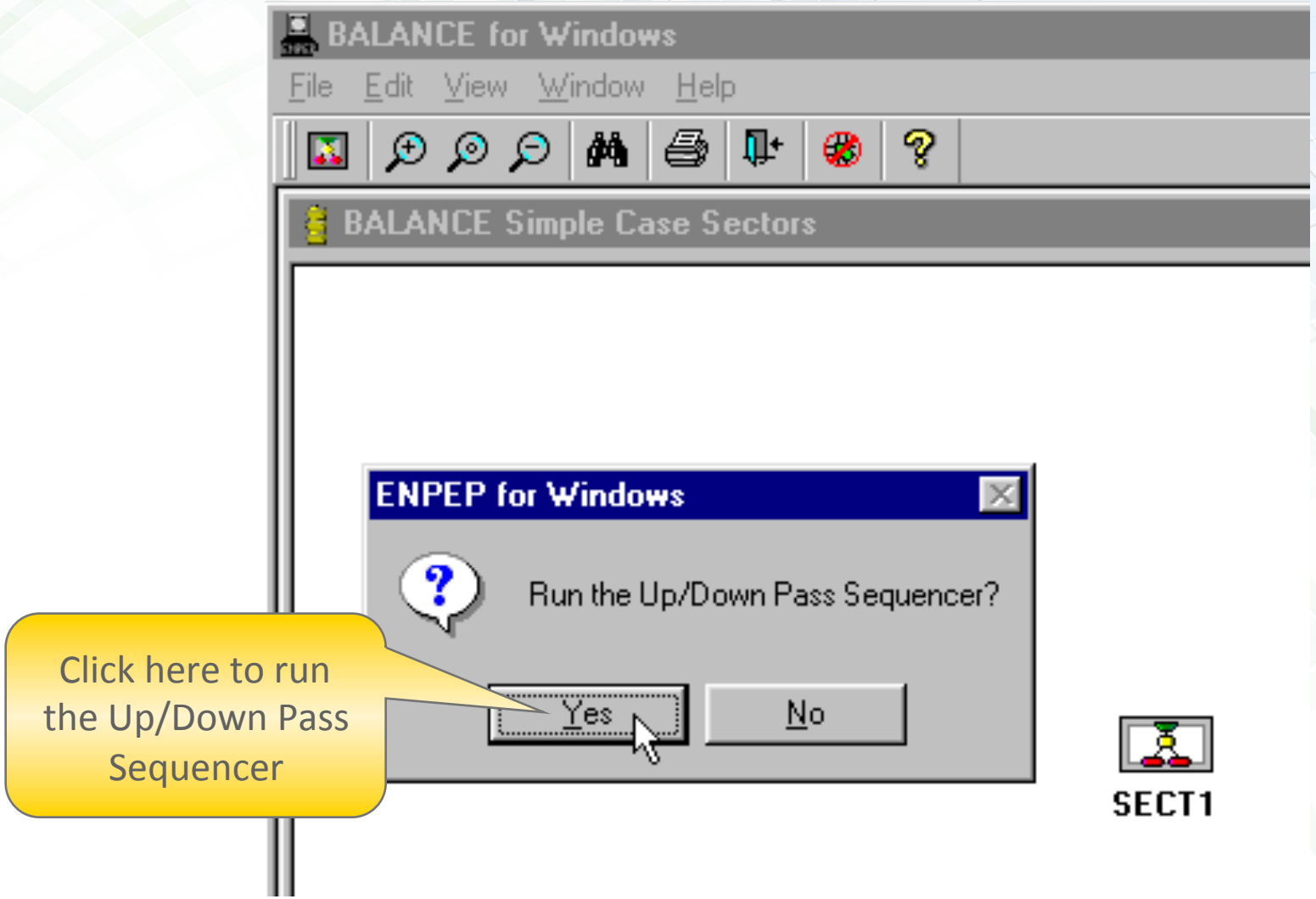
Before Running BALANCE, the Node Visitation Sequence Has to be Determined

- Before running BALANCE for the first time it is necessary to execute the Up/Down Pass program to determine the node visitation sequence
  - Up-down tells the model in which sequence to do the node calculations during the simulations
- Later, the Up/Down Pass has to be executed only if there has been a change in the structure of the energy network
  - add/delete node
  - add/delete link
- If the up-down icon is red, you should click it to run the sequencer

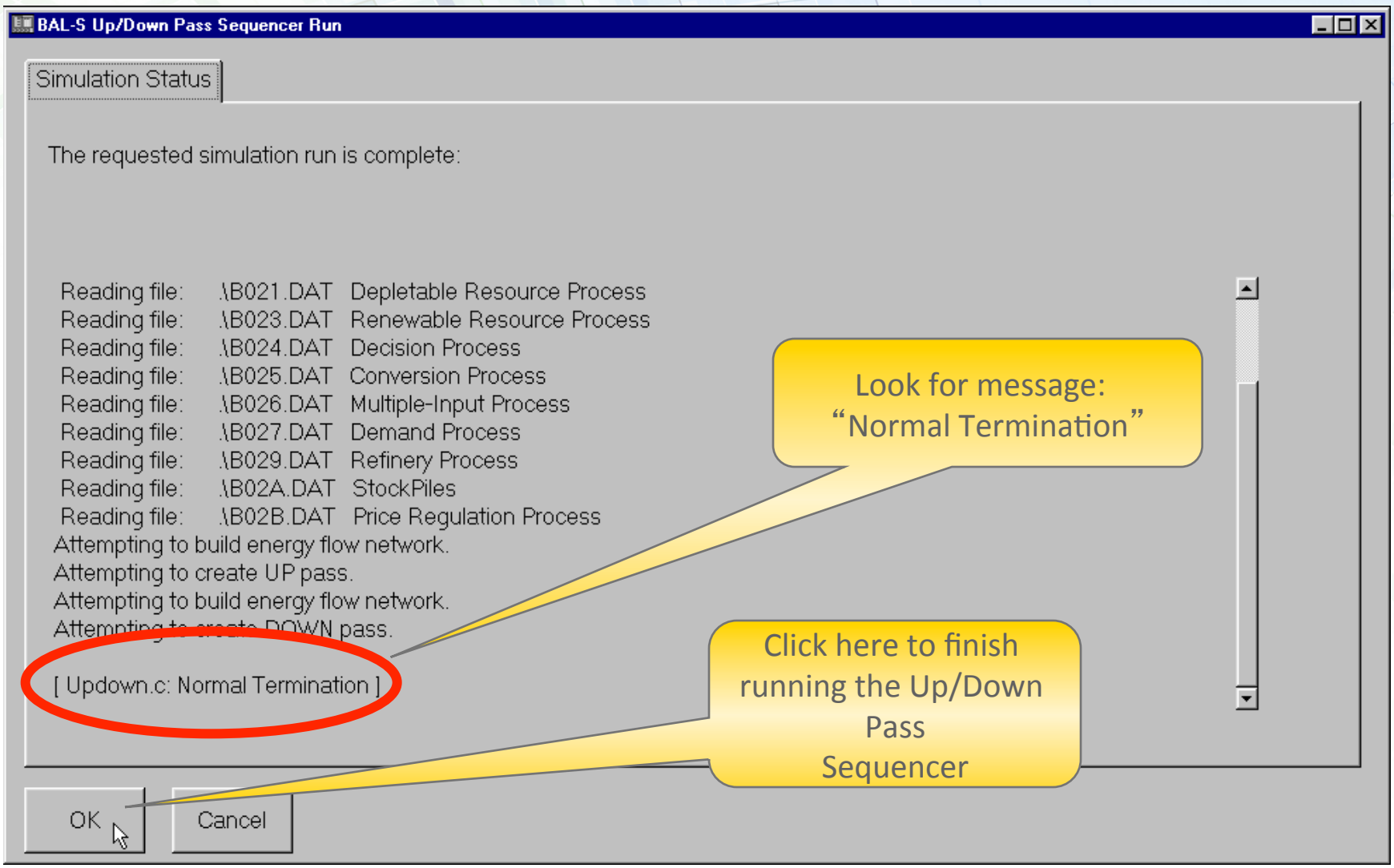




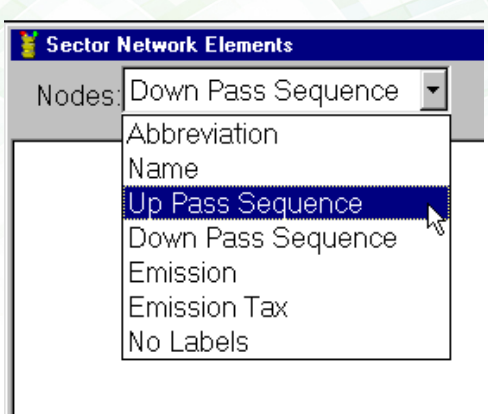
BALANCE Asks for User Confirmation to Run the Routine

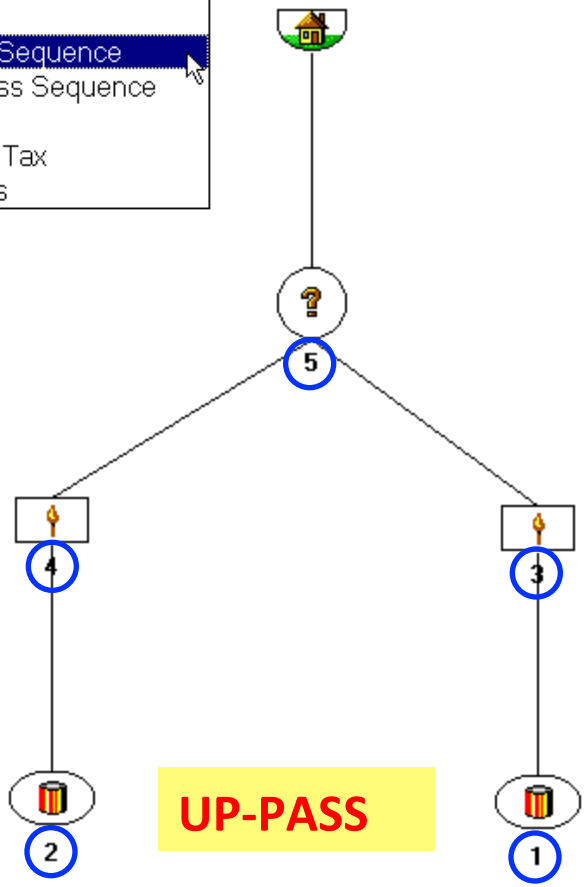


BALANCE Produces a Simulation Status Report for the Up/Down Pass Sequencer

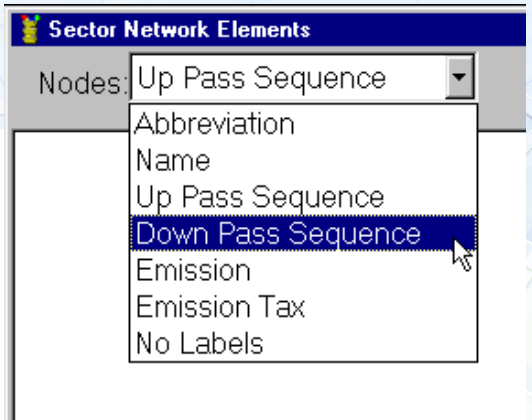


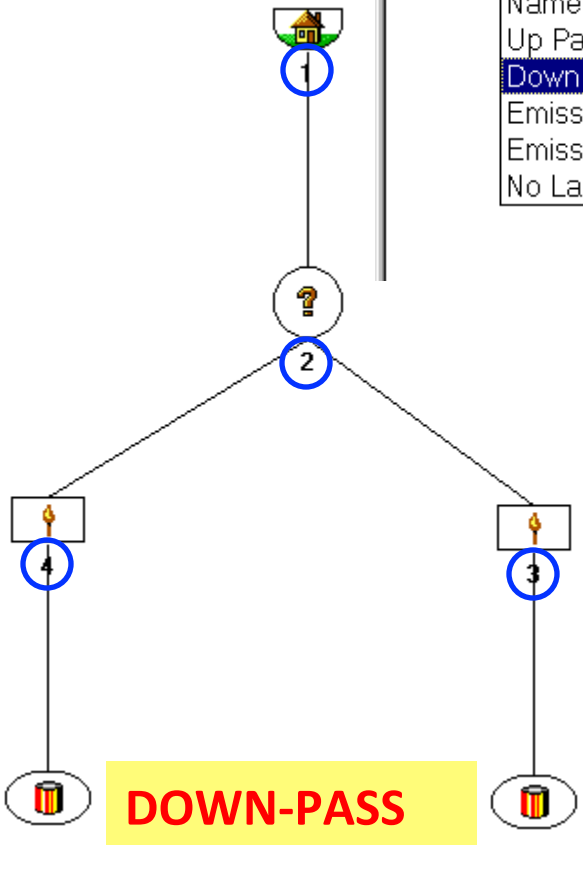
Case 1: Definition of Node Visitation Sequences





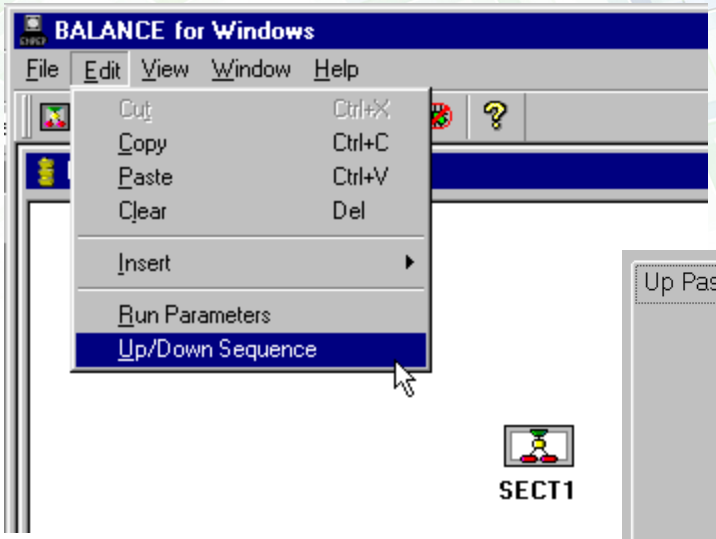
UP-PASS





DOWN-PASS

You Can View and Edit the Up and Down Pass Sequence



Up Pass Sequence | Down Pass Sequence

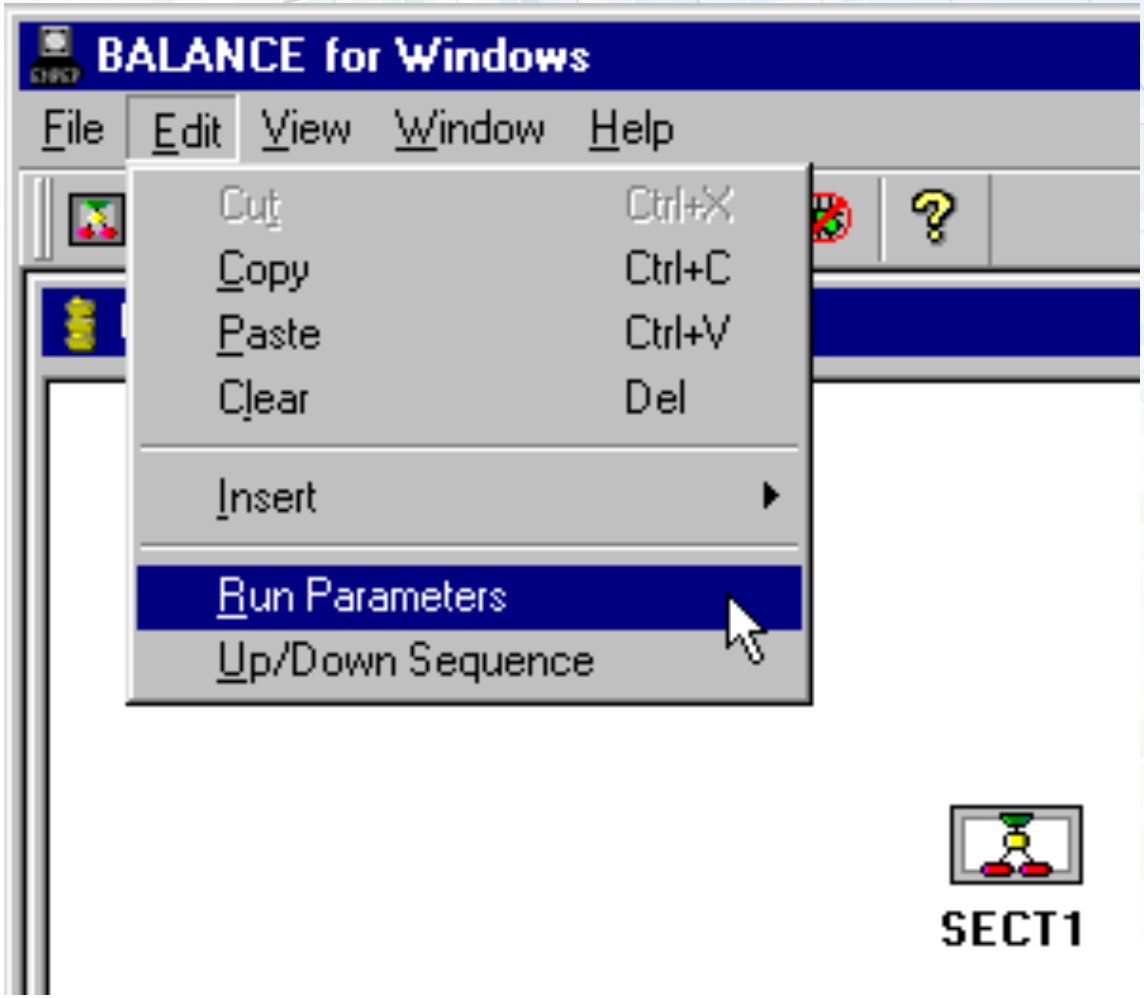
Node Type	Node Abbreviation	Node Name	Sector Abbreviation	Sector Name	Up Sequence
RS	COAL	Coal resource	SECT1	Sector	1
RS	OIL	Oil resource	SECT1	Sector	2
PR	CBOIL	Coal Boiler	SECT1	Sector	3
PR	OBOIL	Oil Boiler	SECT1	Sector	4
AL	AL	Allocation Node	SECT1	Sector	5

You usually need to edit the sequence only if you have COGENERATION in the network. Also it may be necessary in some situations with the oil refinery.

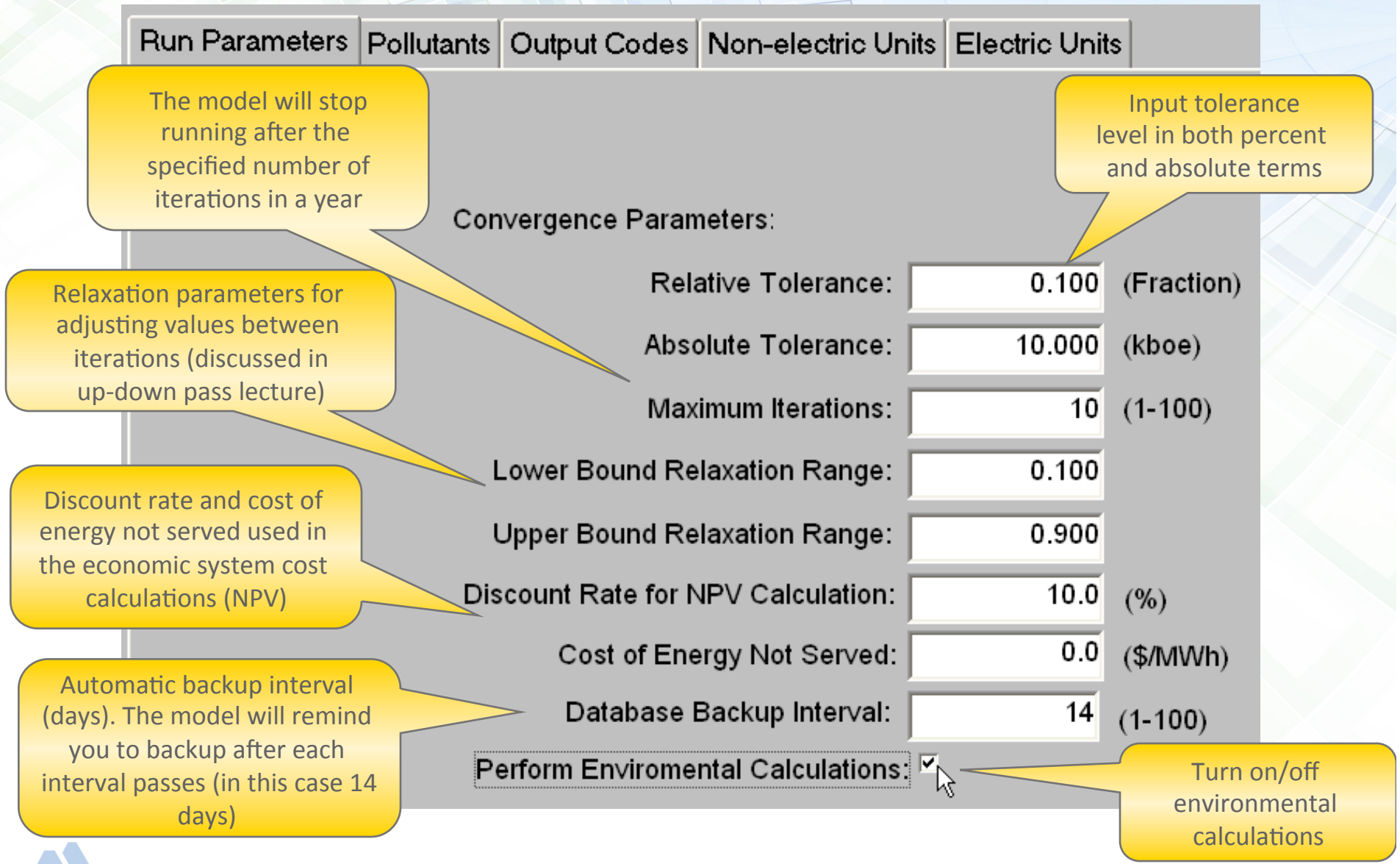
Up Pass Sequence | Down Pass Sequence

Node Type	Node Abbreviation	Node Name	Sector Abbreviation	Sector Name	Down Sequence
DE	STDEM	Steam demand	SECT1	Sector	1
AL	AL	Allocation Node	SECT1	Sector	2
PR	CBOIL	Coal Boiler	SECT1	Sector	3
PR	OBOIL	Oil Boiler	SECT1	Sector	4

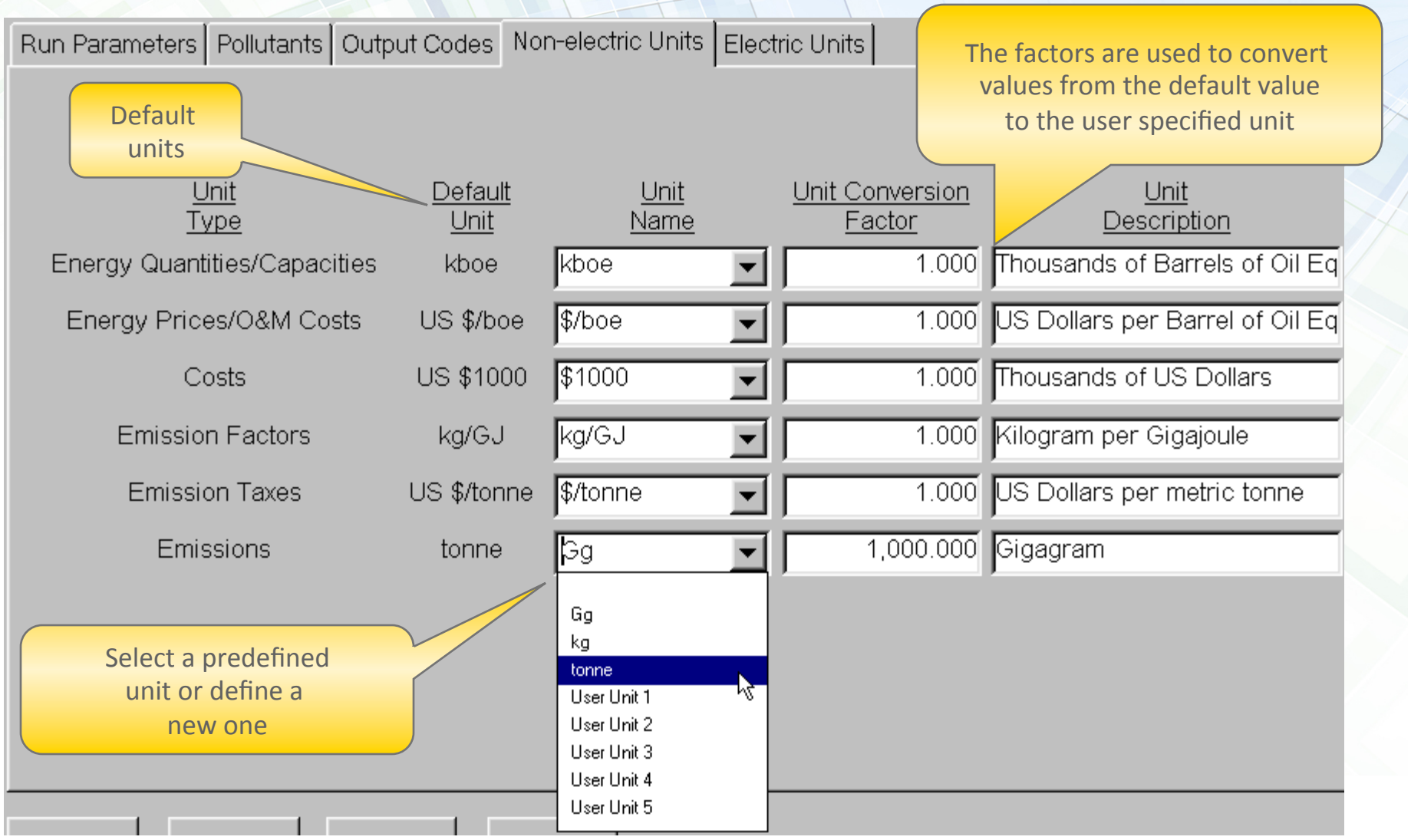
You May also Want to View/Modify some of the Run Parameters



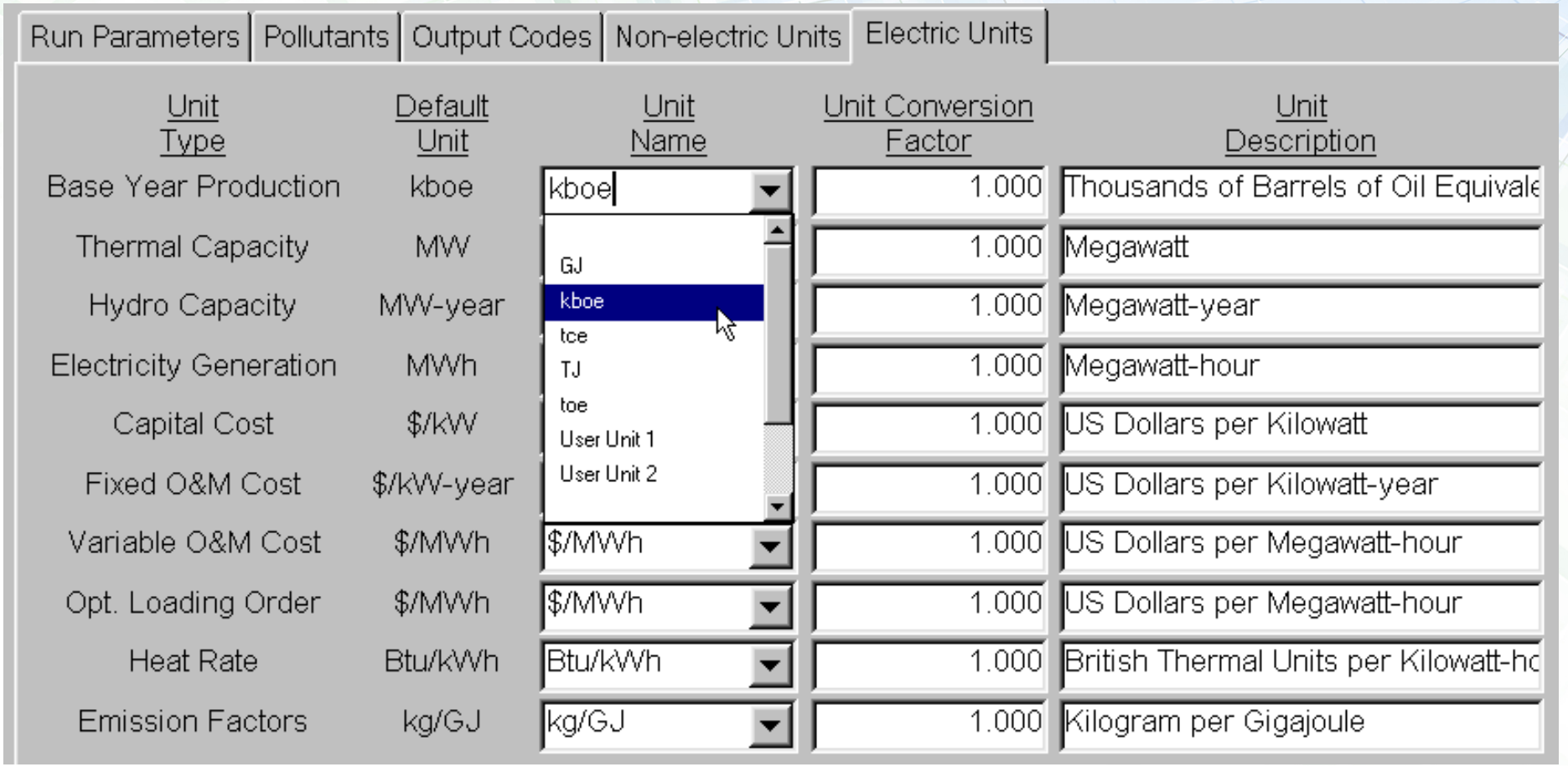
Run Parameters Allow the User to Specify Convergence Parameters and Discount Rate



The User Can Change the Units for Energy, Costs, Prices, and Environment



Units Can be Changed for both Electric and Non-Electric Processes



Under "Output Codes" Options for Standard Reports Can be Modified; These Reports are mostly useful for Debugging

Run Parameters | Pollutants | Output Codes | Non-electric Units | Electric Units

	Start Year	End Year	Step	Start Iteration	End Iteration
Converged Price/Quantity Results:	2007	2026	1		
Converged Electric Sector Results:	2007	2026	1		
Diagnostic Price/Quantity calculations:	2007	2026	1	1	10
Diagnostic Electric Sector Calculations:	2007	2026	1	1	10

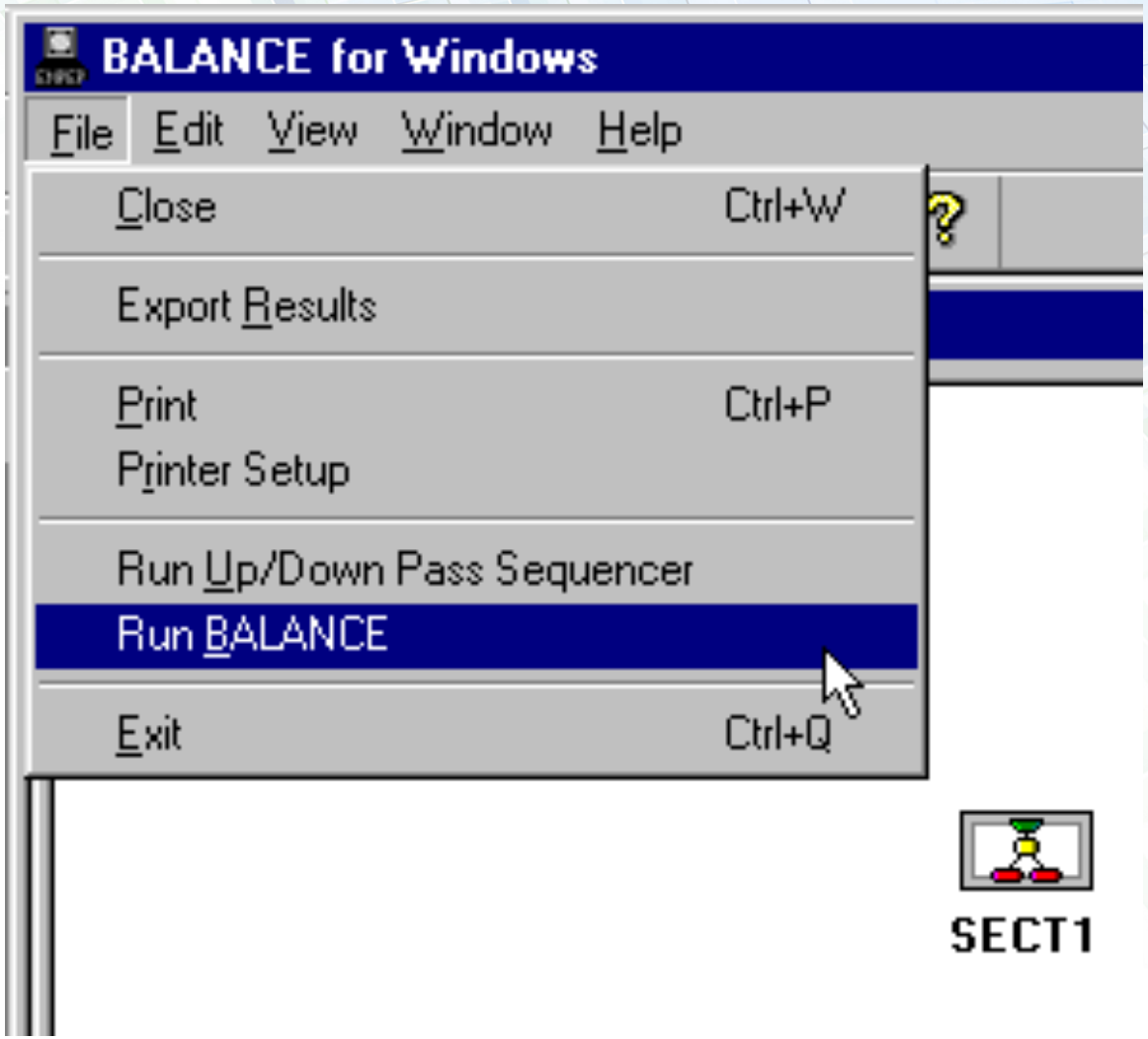
Diagnostic Output to be Generated:

Non-electric: Node Sequence ☑ Node Calculations ☑ Market Share ☑

Electric: Detailed Electric Sector Iteration Calculations ☑

Input Data: ☑

To Run the Model Select "Run BALANCE" Under the File Menu When You Are in the Sector Window



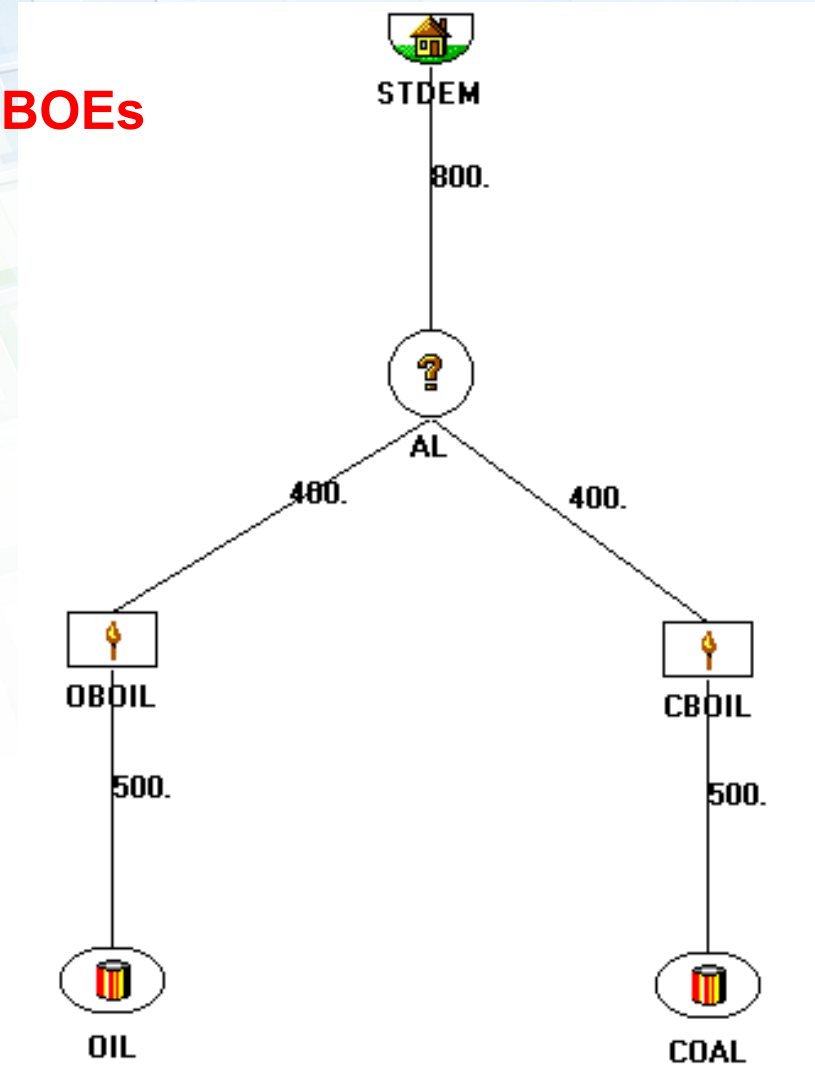
Case 1: Check of Base Year Energy Flows

Base Year (2007) Energy Flows in kBOEs

AL: $Qout_t = \Sigma Qin_{(t,l)} = 400+400 = 800$

PR: $Qout_t = Qin_t \times f = 500 \times 0.8 = 400$

RS: $Qout_0$ = user-specified = 500



Case 1: Check of Base Year Prices

Base Year (2007) Energy Prices in $/BOE

AL: $Pout_t = \Sigma [P_l \times S_l]$

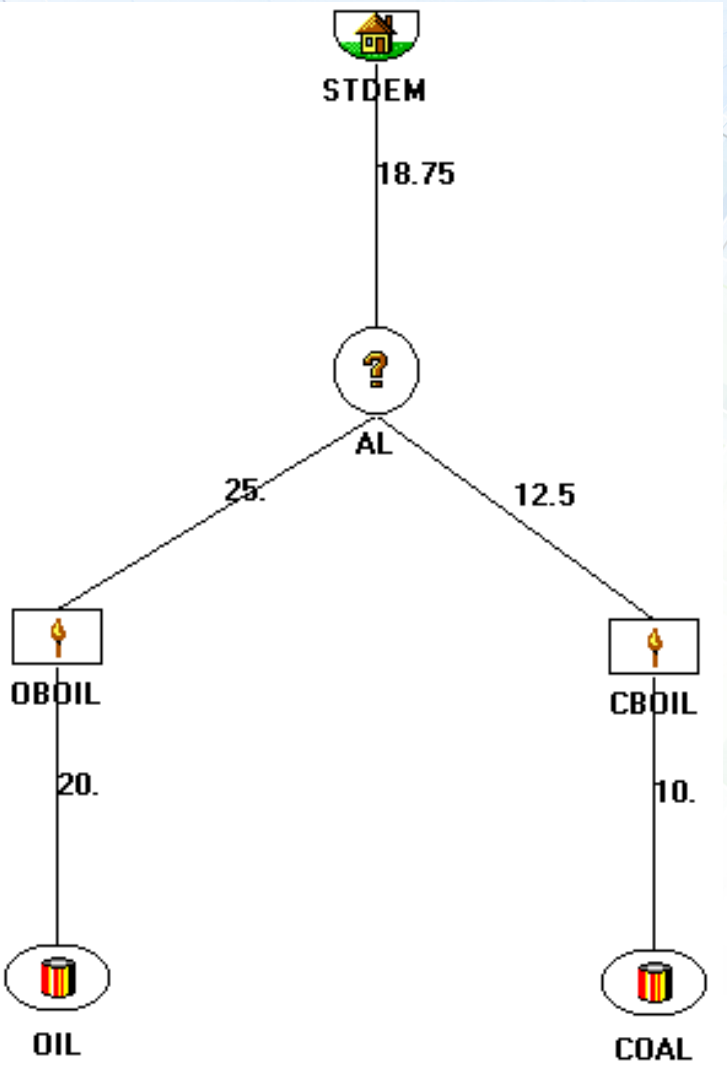
$= 25 \times 0.5 + 12.5 \times 0.5 = 18.75$

PR-OBOIL: $Pout_t = Pin_t/eff + OM+ + [TCI/(CAPxCF)] \times CRF(i,n)$

$= 20/0.8 + 0 + 0 = 25$

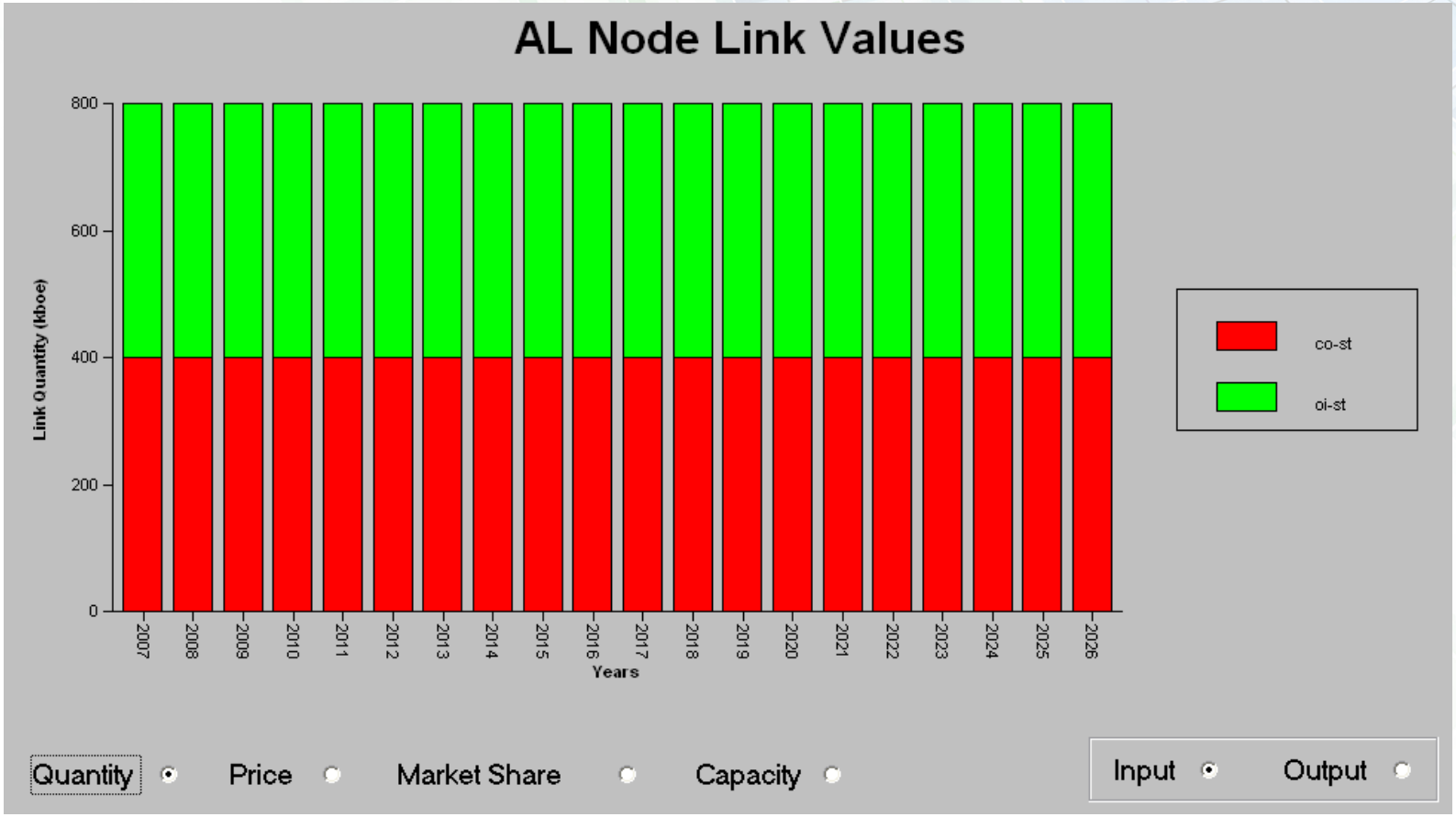
RS-OIL: $Pout_t = A(Qout_{t-1}) \times (1+R_t) + B \times Qout_t + C \times Qout_t^2$

$= 20 \times (1+0) + (0 \times 500) + (0 \times 500^2) = 20$



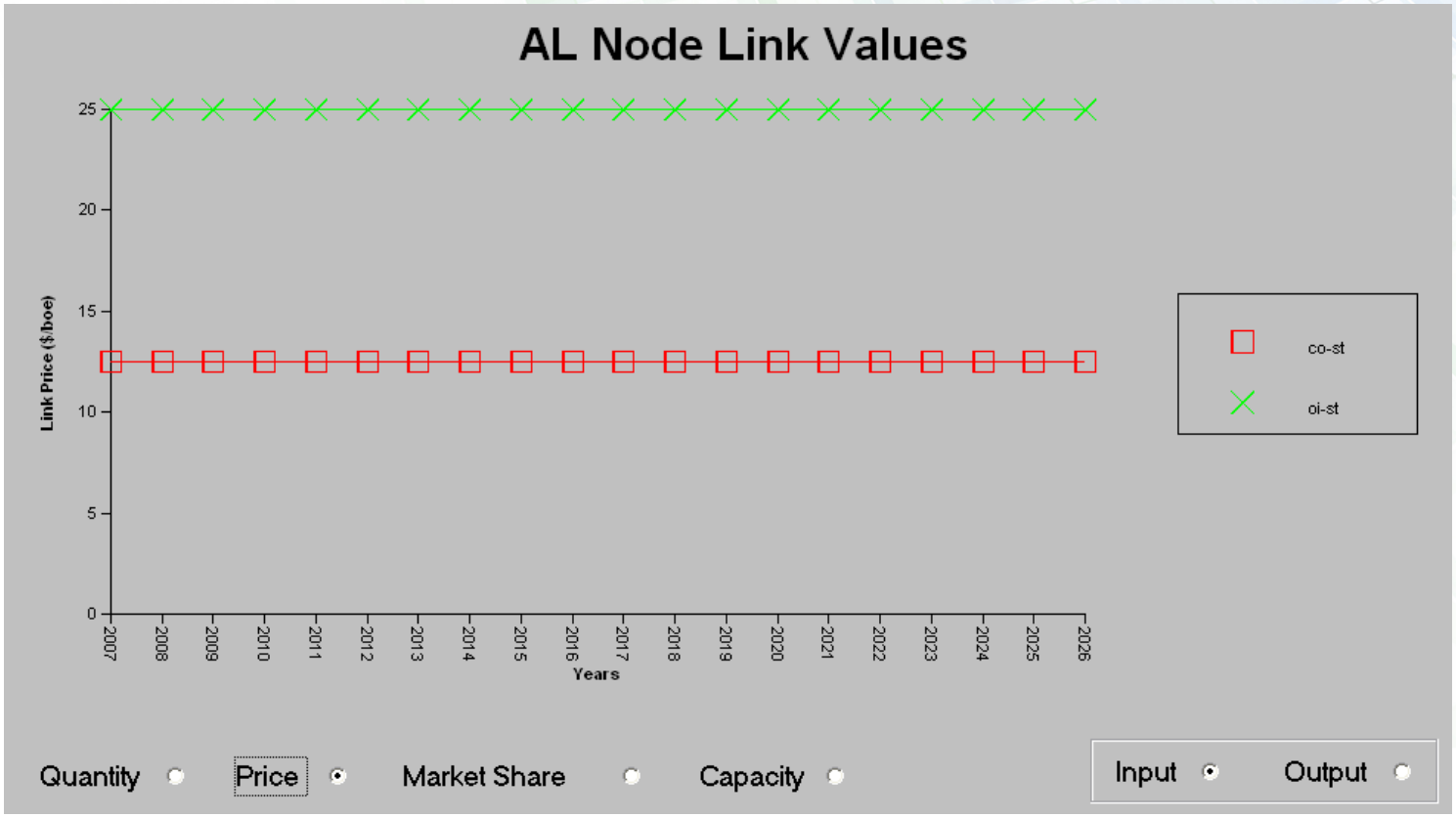
Case 1 Results:
Check of the QUANTITIES at the Allocation Node

- No demand growth specified over the study period
- The quantities are equally distributed on input links (equal market shares) because of inputs for price sensitivity (0) and lag parameter (0)



Case 1 Results:
Check of the PRICES at the Allocation Node

- The prices of steam generated using coal (12.5 $/BOE) and oil (25 $/BOE) are different
- But because of price sensitivity and lag of 0, the model does not respond to this price signal and leaves the quantities/market shares the same (see previous slide)



Changes in Input Variables: Cases 1 to 8

Case	1	2	3	4	5	6	7	8
Demand Growth (each year)	blank	**0.05**	blank	blank	blank	blank	blank	blank
Resource Price (Coal) Growth (each year)	blank	blank	**0.03**	blank	blank	blank	blank	blank
Price Sensitivity	blank	blank	blank	**5**	**2**	**2**	**5**	**2**
Lag Parameter	blank	blank	blank	**0.5**	**0.1**	**0.9**	**0.5**	**0.9**
Priority Link	blank	blank	blank	blank	blank	blank	blank	**O: 2 C: 1**
Premium Multiplier	blank	blank	blank	blank	blank	blank	**O: 0.6 C: 1.0**	blank

Cases 9-17: For Exercise

- Prepare the network structure
  - Draw the network
  - Label the network (each link and node has a name and abbreviation
- Prepare the input data
- Prepare (run/check) the node visitation sequence
- Run BALANCE
- Check/printout the results (tables, graphs, text files)

Changes in Input Variables: Case 9 to 17

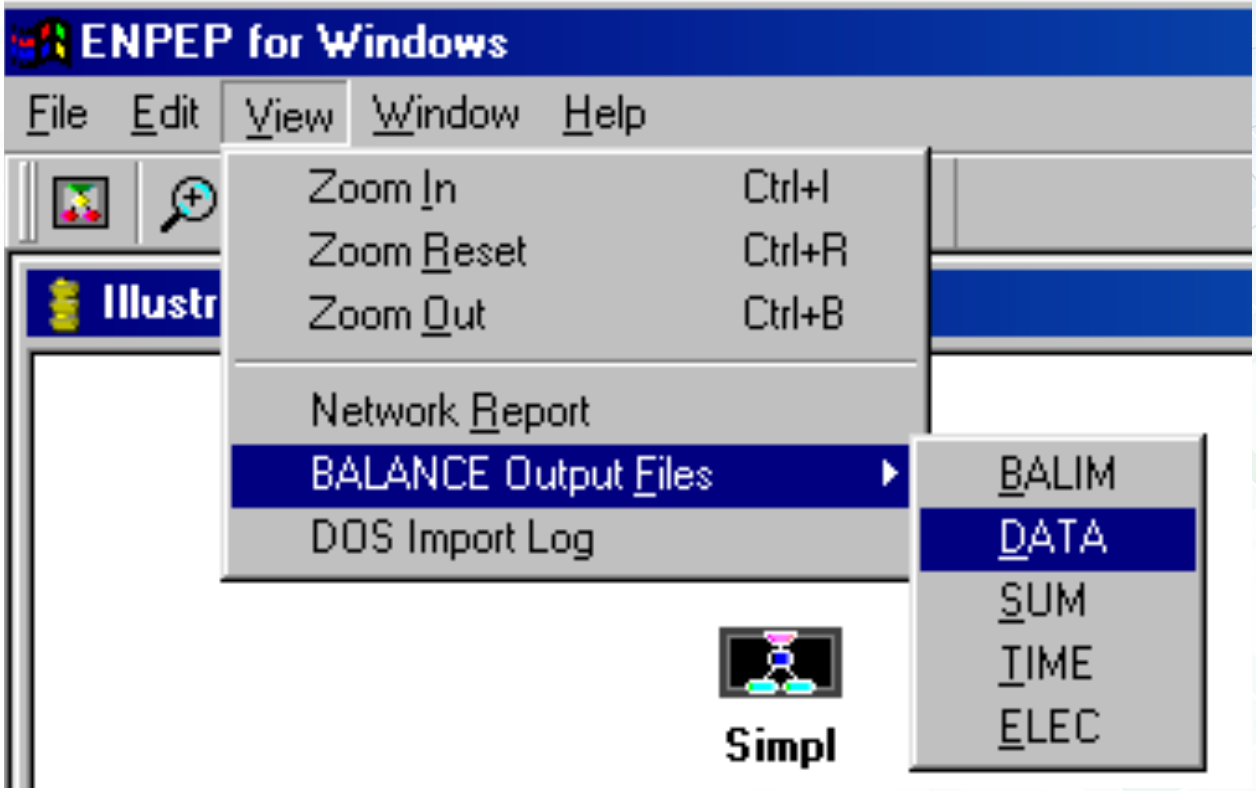
Case	9	10	11	12	13	14	15	16	17
Priority Link	blank	blank	blank	blank	blank	blank	blank	blank	Blank
Premium Multiplier	blank	blank	blank	blank	blank	blank	blank	blank	Blank
Price Sensitivity	5	5	5	5	5	5	5	5	5
Lag factor	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Resource Price Growth (every year)	blank	blank	blank	blank	blank	blank	blank	blank	**O: 0.02 C: 0.04**
Conversion Process Capacity Factor	O: 0.8 C: 0.8	O: 0.8 C: 0.8	**O: 0.8 C: 0.4**	**O: 0.8 C: 0.4**	**O: 0.8 C: 0.4**	**O: 0.8 C: 0.4**	**O: 0.8 C: 0.4**	O: 0.8 C: 0.8	O: 0.8 C: 0.8
Conversion Process O-I Ratio (efficiency)	O: 0.8 C: 0.8	O: 0.8 C: 0.8	O: 0.8 C: 0.8	**O: 0.8 C: 0.6**	**O: 0.8 C: 0.6**	**O: 0.8 C: 0.6**	**O: 0.8 C: 0.6**	O: 0.8 C: 0.8	O: 0.8 C: 0.8
Conversion Process O&M Cost	**O: 0 C: 2**	**O: 0 C: 2**	**O: 0 C: 2**	**O: 0 C: 2**	**O: 0 C: 2**	**O: 0 C: 2**	**O: 0 C: 2**	O: 0 C: 0	O: 0 C: 0
Conversion Process Investment Cost ($1000)	O: 0 C: 0	**O: 0 C: 5000**	**O: 0 C: 5000**	**O: 0 C: 5000**	**O: 0 C: 5000**	**O: 0 C: 5000**	**O: 0 C: 5000 (2007) 10000 (2012)**	O: 0 C: 0	O: 0 C: 0
Conversion Process Lifetime	O: 30 C: 30	O: 30 C: 30	O: 30 C: 30	O: 30 C: 30	O: 30 C: 30	**O: 30 C: 40**	**O: 30 C: 40**	O: 30 C: 30	O: 30 C: 30
Conversion Process Interest Rate	O: 0.1 C: 0.1	O: 0.1 C: 0.1	O: 0.1 C: 0.1	O: 0.1 C: 0.1	**O: 0.1 C: 0.05**	**O: 0.1 C: 0.05**	**O: 0.1 C: 0.05**	O: 0.1 C: 0.1	O: 0.1 C: 0.1
Capacitated Link (Steam Links)	O: blank C: blank	O: blank C: blank	O: blank C: blank	O: blank C: blank	O: blank C: blank	O: blank C: blank	O: blank C: blank	**O: blank C: blank C 200 (2012) C 300 (2017)**	O: blank C: blank

This entry means investment of $5 million

There Are Several Ways to Look at Simulation Results

- Output variables include
  - Prices
  - Quantities
  - Price X Quantity
- Results are displayed in BALANCE in the form of
  - Tables
  - Graphs
- Values are displayed
  - On the network for a specific sector & year
  - For all years for a single node or link
  - For all years for all links in a sector
- Results can be exported and viewed in another software package (e.g., Excel)

Invalid Input Data May Crash the Model: If this Happens, you can Use the Detailed Output Reports for Debugging



- The ***DATA* file** will indicate invalid network data
- The ***ELEC* file** will indicate invalid dispatch data
- The ***SUM* file** will show detailed calculation results