

# Using VEDA-BE with ANSWER-TIMES

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## 1. Context

VEDA-BE, the VEDA (**VE**rsatile **D**ata **A**nalyst) **B**ack-**E**nd (BE) system allows the TIMES modeler to construct custom Sets and Tables to facilitate the analysis and interpretation of results. This includes the case where a TIMES modeler uses either VEDA Front-End (FE) or ANSWER-TIMES to manage their TIMES model data and to initiate their TIMES GAMS model runs. This document pays particular attention to how to use VEDA-BE for those working with ANSWER-TIMES, where the user has properly installed on their PC:

- The ANSWER-TIMES software (property of Noble-Soft Systems, Australia);
- The VEDA-BE software (property of KanORS-EMR, India); and
- The GAMS modeling language software (property of GAMS Development Corporation, United States).

In the remainder of this document the user is also assumed to have created subfolder AT\_VBE-Example4 of the C:\VEDA\Veda\_BE\Databases folder by proceeding as follows:

- Copied the file **AT\_VBE-Example4.zip** supplied by Noble-Soft Systems into the C:\VEDA\Veda\_BE\Databases folder; and
- Invoked Winzip to “Extract to here” to create the subfolder AT\_VBE-Example4 (so creating subfolder C:\VEDA\Veda\_BE\Databases\AT\_VBE-Example4).


In addition, the user is assumed to have a copy of the ANSWER-TIMES demonstration database **Example4.mdb**. For ANSWER-TIMES version 6.8.1 onwards, this is supplied by Noble-Soft Systems in the C:\AnswerTIMESv6\Answer\_Databases folder.

VEDA-BE employs a simple Table Definition form (below), a dynamic table data cube for viewing and manipulating results, a set management subsystem, and a powerful direct connection with Excel that enables tables and graphs to be dynamically updated. Each of these key capabilities is discussed in this document.


This overview for ANSWER-TIMES users is complemented by the VEDA-BE online documentation at <http://www.kanors-emr.org/vedasupport/>.

## 2. Starting VEDA-BE



To start VEDA-BE click on the  icon on your desktop. This brings up the Table Definition form:

Attribute	Commodity	UserConstraint	Scenario	Region
Code	Original Description			
Cost_Act	Cost_Act			
Cost_Flo	Cost_Flo			
Cost_Flox	Cost_Flox			
Cost_Inv	Cost_Inv			
Cost_ire	Cost_ire			
Cost_Salv	Cost_Salv			
EQ_Combal	Commodity Slack/Levels (+ Marginals)			
EQ_CombalM	EQ_CombalM			
EQ_Peak	Peaking Constraint Slack (+ Marginals)			
EQ_PeakM	EQ_PeakM			
Objz	Objz			
PAR_Pasti	PAR_Pasti			
Reg_irec	Reg_irec			
Reg_obj	Reg_obj			
Reg_wobj	Reg_wobj			
User_confXM	User_confXM			
VAR_Act	Process Activity (+ Marginals)			
VAR_ActM	VAR_ActM			
VAR_Cap	Technology Capacity (+ Marginals)			
VAR_CapM	VAR_CapM			
VAR_Comet	VAR_Comet			
VAR_Comprd	VAR_Comprd			
VAR_Fin	Commodity Consumption			
VAR_FOut	Commodity Production			
VAR_Ncap	VAR_Ncap			
VAR_NcapM	VAR_NcapM			

The form caption  **VEDABE: [TIDEMO-D] -4.8.77: TIMES** indicates that by default the TIDEMO-D model results database has been opened, that the version of VEDA-BE is 4.8.77, and that this is a TIMES model (as opposed to MARKAL). Of course your version of VEDA-BE may differ which may mean you observe slight differences in what you see from the screenshots in this document.

### 3. Bringing ANSWER-TIMES Model Run Results into VEDA-BE

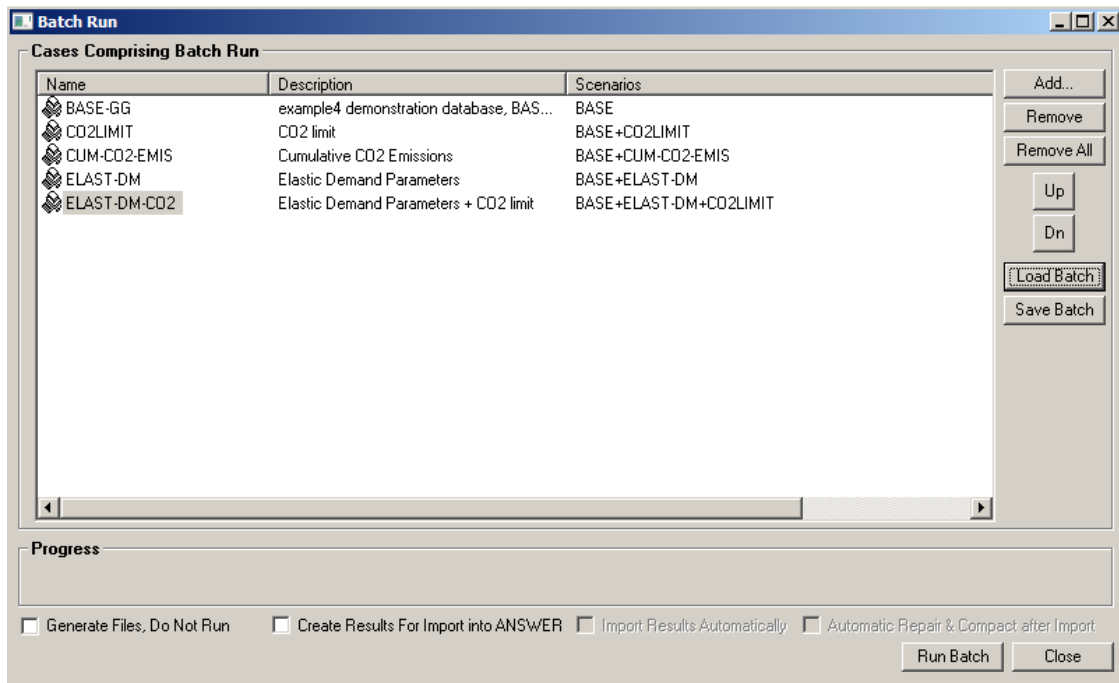
This section comprises a number of subsections as follows:

1. Creating ANSWER-TIMES model run results for subsequent import into VEDA-BE;
2. Selecting the (predefined) VEDA-BE model results database; and
3. Importing the ANSWER-TIMES model run results into the VEDA-BE model results database.


#### 3.1 Creating ANSWER-TIMES model run results for subsequent import into VEDA-BE

To create ANSWER-TIMES model run results for subsequent import into VEDA-BE proceed as follows:

- Open the ANSWER-TIMES demonstration database **Example4.mdb** (see section 1 “Context”) and click on the **Batch Run...** button below the Selected Scenarios frame to bring up the Batch Run form. Since our focus is the creation of results for Import into VEDA-BE, there is no need to also create results for Import into ANSWER, so uncheck the  **Create Results For Import into ANSWER** button.
- Click on the **Load Batch** button on the Batch Run form to bring up the Batch Management form, select the stored batch of cases **AT\_VBE-EXAMPLE4CASES** and click on the **Load** button. You will be returned to the Batch Run form which will appear as follows:



- Click on the **Run Batch** button to initiate a Batch Run of the above 5 Cases.

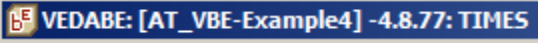
- Check the BatchRunSummary.log file to ensure that **Solve status: Optimal** has been obtained for each of the 5 runs. Note that provided **Solve status: Optimal** is obtained for a run, creation of results for Import into VEDA-BE occurs automatically.
- Click on the  button to close the Batch Run form.

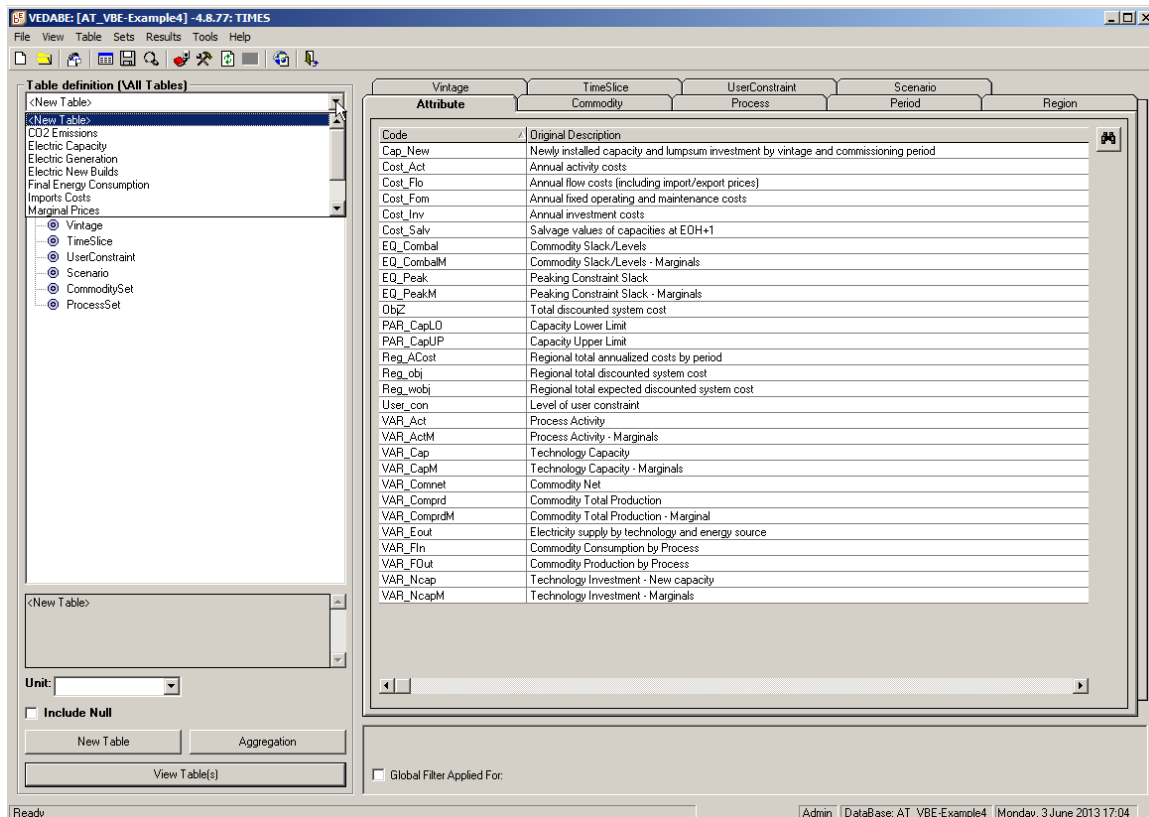
For each of the above GAMS model runs initiated by ANSWER-TIMES, both the model input and control information for the run, as well as the GAMS output and model results files (<run>.VD\* for VEDA-BE and <run>.ANT for ANSWER-TIMES if creation of ANSWER results is requested), are created in the GAMS Work folder (default is C:\AnswerTIMESv6\Gams\_WrkTI).

- In order to bring run results from an ANSWER-TIMES run into a VEDA-BE results database the latter must be aware of the GAMS Work folder, as discussed next.

### 3.2 Selecting the (predefined) VEDA-BE model results database

Select the predefined VEDA-BE model results database **AT\_VBE-Example4** as follows:

- Start VEDA-BE as described in section 2 “Starting VEDA-BE”.
- Invoke the “File, Open Database” menu option on the VEDA-BE Main Table Definition form and use the “Browse for Folder” form to select the **AT\_VBE-Example4** subfolder of C:\VEDA\Veda\_BE\Databases (see section 1 “Context”). The Table Definition form caption  indicates that the AT\_VBE-Example4 subfolder of C:\VEDA\Veda\_BE\Databases is now the active model results database:



The screenshot shows the VEDA-BE Table Definition form for the database 'VEDABE: [AT\_VBE-Example4] -4.8.77: TIMES'. The form is divided into several sections:


- Table definition (All Tables):** A list of tables including CO2 Emissions, Electric Capacity, Electric Generation, Electric New Builds, Final Energy Consumption, Imports Costs, Marginal Prices, Vintage, TimeSlice, UserConstraint, Scenario, CommoditySet, and ProcessSet.
- Attribute Table:** A table with columns for Attribute, Vintage, TimeSlice, UserConstraint, Scenario, and Region. The table lists various attributes and their descriptions, such as Cap\_New (Newly installed capacity and lumpsum investment by vintage and commissioning period), Cost\_Act (Annual activity costs), and VAR\_Act (Process Activity).
- Unit:** A dropdown menu for selecting the unit.
- Include Null:** A checkbox to include null values.
- New Table / Aggregation:** Buttons for creating a new table or aggregating data.
- View Table(s):** A button to view the selected table.
- Global Filter Applied For:** A checkbox to apply a global filter.

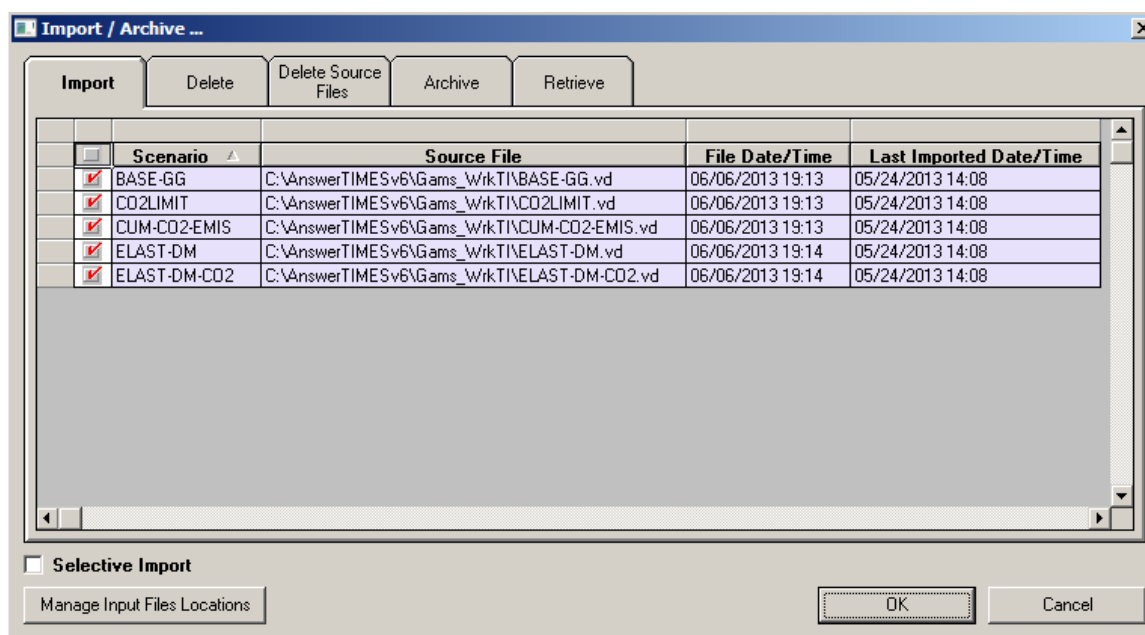
The status bar at the bottom indicates 'Ready' and 'Admin | DataBase: AT\_VBE-Example4 | Monday, 3 June 2013 17:04'.

In the screenshot above, the combobox below **Table definition (All Tables)** has been dropped down to show that for the predefined AT\_VBE-Example4 model results database, a number of Tables have already been defined (CO2 Emissions, Electric Capacity, Electric Generation, etc).

### 3.3 Importing ANSWER-TIMES model run results into the VEDA-BE database

First confirm that the VEDA-BE model results database (**AT\_VBE-Example4**) is aware of the ANSWER-TIMES GAMS Work folder:

- On the VEDA-BE Main Table Definition form click on the red book icon  or invoke the "Results, Import/Archive" menu option to bring up the Import/Archive form. The form may appear as follows:

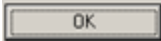


- If the form does appear as above, we have immediate confirmation that the AT\_VBE-Example4 model results database is aware of the GAMS Work folder C:\AnswerTIMESv6\Gams\_WrkTI, and that the VEDA-BE <run>.VD\* results files for the model runs BASE-GG, CO2LIMIT, CUM-CO2-EMIS, ELAST-DM and ELAST-DM-CO2 in the GAMS Work folder are available for import into the AT\_VBE-Example4 model results database. The red check marks indicate that these cases have already been imported into the VEDA-BE model results database.

**Note:** The form above will have a line for each model run in the GAMS Work folder(s) for which VEDA-BE <run>.VD\* results files exist. So if ANSWER-TIMES model runs apart from the Batch Run described in subsection 3.1 have been performed, the Import/Archive form will contain additional lines to those displayed above.

It is suggested that the user should keep this form sorted by File Date/Time with the most recent runs at the top.

To Import the ANSWER-TIMES model run results into the VEDA-BE model results database:

- Check the box to the left of the case for each case you wish to import, and click on the  button.

## 4. Using VEDA-BE to create Custom Sets

An important precursor for VEDA-BE Table Definition is to create the Custom Sets that most often comprise the Table definitions. A Set is a group of like Items (either Commodity Items or Process Items) that are handled together for certain purposes (e.g., power plant by fuel type, final energy by end-use).

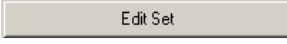
For the ANSWER-TIMES demonstration database *Example4.mdb* the Process Sets below have been created, using the form that follows, by specifying the "rules" (Set Membership, Name (Code), Description, Input Commodity, Output Commodity, and exclusions of same), to qualify individual Processes for membership in the particular Process Set. These Process Sets are then employed to aggregate information to an appropriate level in the various tables, as will be shown later.

Name	Description	Specification
DM_R	Residential	Sets-DMD;Name-R*;
DM_T	Transportation	Sets-DMD;Name-T*;
DM_XXX	Demand devices Missing!!!	Sets-DMD;Name-*;SetsNot-DM_T,DM_R;
IMP_COA	Coal	Sets-IRE;Name-IMPHCO*;
IMP_GAS	Natural Gas	Sets-IRE;Name-IMPGAS*;
IMP_NUC	Nuclear	Sets-IRE;Name-IMPU*;
IMP_OIL	Oil and Products	Sets-IRE;Name-IMPOIL*,IMPDSL*,IMPGSL*;
IMP_XXX	Imports Missing!!!	Sets-IRE;Name-*;SetsNot-IMP_COA,IMP_GAS,IMP_NUC,IMP_OIL;
PP_COAL	Coal-fired	Sets-CHP,ELE;Input-HCO;
PP_GAS	Gas-fired	Sets-CHP,ELE;Input-GAS*;
PP_HYDRO	Hydro	Sets-CHP,ELE;Desc-PUMP*,HYDRO*;
PP_NUKE	Nuclear	Sets-CHP,ELE;Input-URN;
PP_OIL	Oil-fired	Sets-CHP,ELE;Input-DSL;
PP_XXX	Power Plants Missing!!!	Sets-CHP,ELE;Name-*;SetsNot-PP_COAL,PP_NUKE,PP_HYDRO,PP_GAS,PP_OIL;

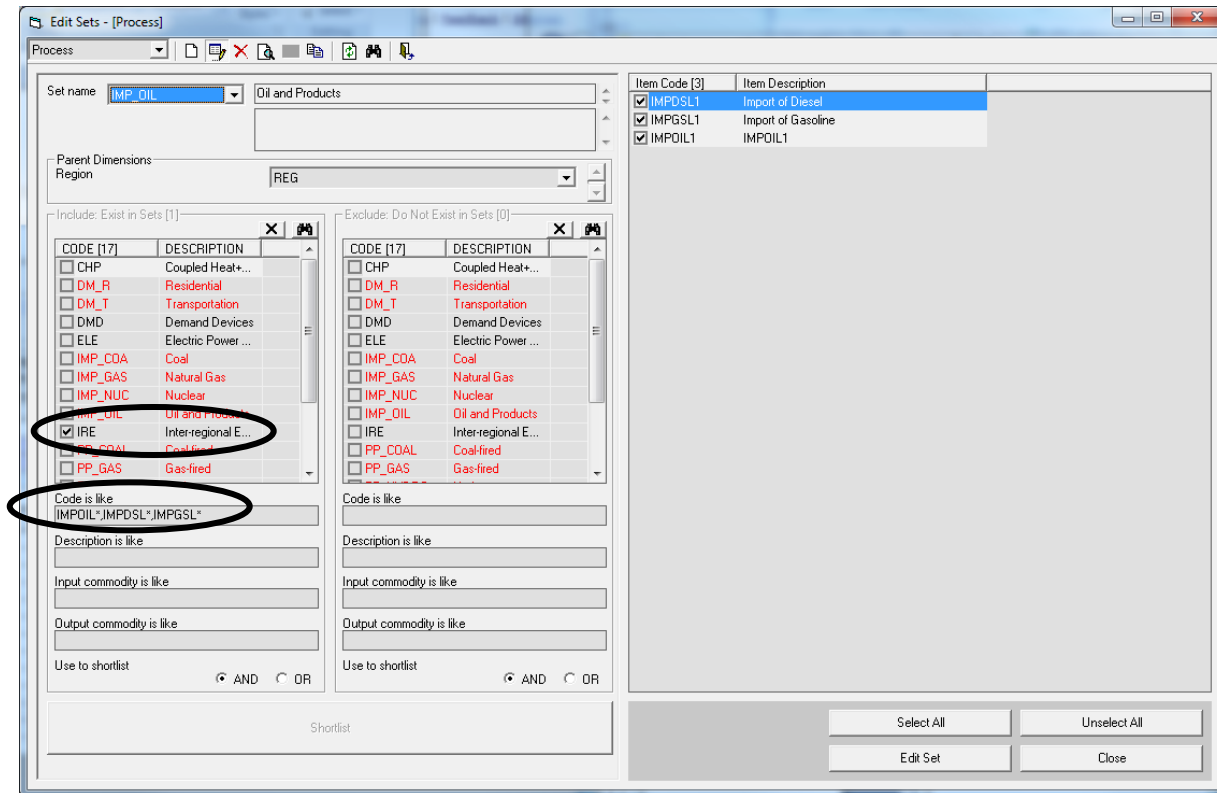
Note that so far as each of the Name, Description, Input Commodity and Output Commodity "rules" (filters) are concerned, these are specified using the **like** construct. So for example in Set DM\_R the **Name-R\*** filter means that the Process Name is **like R\***, meaning that the Name begins with R, with no restriction on the remaining characters; in Set PP\_COAL the **Input-HCO** filter means that the Input Commodity is **like HCO**, meaning that the Input Commodity must be HCO; in Set PP\_HYDRO the **Desc-PUMP\*,HYDRO\*** filter means that the Process Description is **like PUMP\*** or **like HYDRO\***, thus the Process Description begins with PUMP or HYDRO.

- Note that the **like** construct is not case-sensitive.

To create a Set invoke the "Sets, New Set(s)" menu option to bring up the Create New Sets form, and to edit an existing Set invoke the "Sets, Edit Set" menu option to bring up the Edit Sets form. In either case the form that is displayed has a combobox at the top upper left that allows either Commodity or Process to be selected.

The screenshot below shows the Edit Sets form, with Process selected in the top upper left combobox, and with Set IMP\_OIL selected in the Set name combobox immediately below. Note that when looking to Edit a Set you first need to click on the  button on the lower right to initiate the editing process.





**Note:** You may be wondering why the Description of Process IMPOIL1 appears as “IMPOIL1” (rather than as “Import of Crude”) in the above screenshot. In the current version of VEDA-BE, this indicates that the Process IMPOIL1 is defined but does not enter any model solution. [A VEDA-BE fix is underway that will remove such entries until such time as they appear in a model solution.]

When you click on the [Edit Set] button its caption changes to [Update Set] and a [Cancel Update] button appears to the left of the [Update Set] button. Also the large [Shortlist] button at the bottom LHS of the form becomes enabled:



Above we see on the LHS of the form that Set IMP\_OIL has been defined to comprise Processes in Set IRE (Inter-Regional Exchange):



and where the Process Name (Code) is restricted to be like IMPOIL\*, IMPDSL\*, IMPGSL\*:



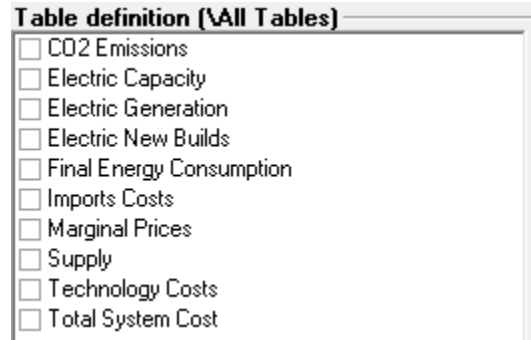
to identify all imported oil products.

The RHS of the form displays the Processes that satisfy these Set membership and Name restrictions.

Note that after changing any of the restrictions on the LHS of the form, you need to click on the [Shortlist] button to cause the RHS of the form to display the Processes that satisfy the new set of conditions.

## 5. VEDA-BE Table Definition

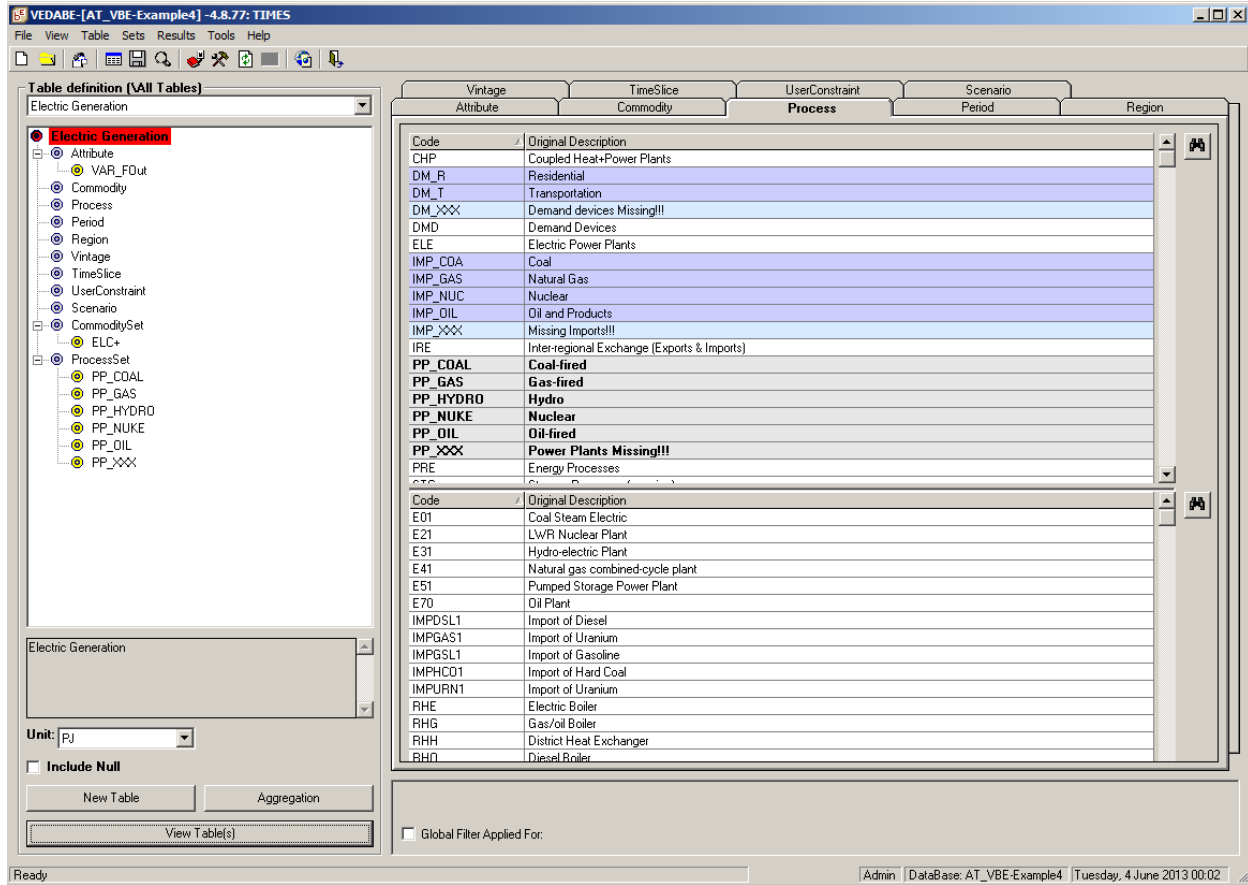
Once the Custom Sets (possibly Custom Commodity Sets as well as Custom Process Sets) have been defined Tables are assembled by identifying which Components (Attributes, Scenarios, Regions, individual and/or groups of Commodities/Processes, Periods, etc.) corresponding to the various tabs on the right side of the Table Definition form, are to constitute the table. As Components are selected (by double-clicking on them) they are highlighted and moved to the definition part (LHS) of the form. For the ANSWER-TIMES demo model the following Tables have been created:



Using the Table Definition combobox drop-down list, select each of these Tables in turn to see what Attributes (solution value from the model) and Component selections have been used to define the Table.

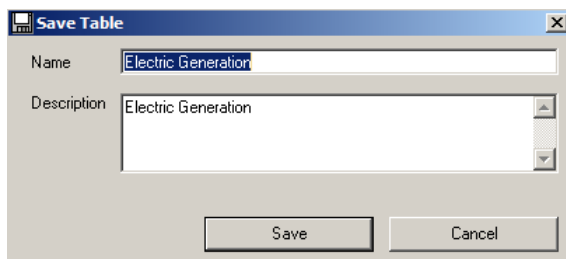
Below we see that to create an Electricity Generation Table that shows generation by fuel type, we need to specify that the Attribute is VAR\_Fout (Commodity Production by Process), the Commodity Set is ELC+ (Electricity - because we don't want the emissions), and that the Process Sets are PP\_COAL, PP\_GAS, PP\_HYDRO, PP\_NUKE, PP\_OIL, PP\_XXX.

- Note that the Set PP\_XXX is defined to be the set of Electricity producing Processes (so in Set CHP or ELE) that are not in any of the Sets PP\_COAL, PP\_GAS, PP\_HYDRO, PP\_NUKE, PP\_OIL. The Set PP\_XXX is currently empty. If over time we enhance the model by adding new Electricity producing Processes, say for solar, then these solar Processes will appear as members of Set PP\_XXX until such time as they are assigned to one of the existing Sets, or in this case a new Set PP\_RNW is created and the definition of Set PP\_XXX is adjusted to ignore the Processes in Set PP\_RNW as well.
- Note also that the Unit of electricity generation is PJ, as that is the way it is handled in the model, though as we'll see later VEDA-BE will allow it to be changed when displaying a table, as long as the original units are defined for the table.



If you click on the  button at the bottom LHS of the form, then:

- If you are specifying a New Table or you have changed the definition of the existing Table a Save Table dialog box will be displayed:



Click on the [Save] button and the Table definition will be saved, and then the Table will be displayed (see next section).

- Or, if the definition of the existing Table is unchanged then the Table will be directly displayed (see next section).

## 6. VEDA-BE Dynamic Data Cubes

### 6.1 Table Layout

VEDA-BE tables are presented as highly dynamic data cubes, where each of the components are usually laid out as rows by column headers to the left and periods running across the table. The next screenshot shows the Electricity Generation Table information (as initially defined in the AT\_VBE-Example4 model results database) with the column headers to the left being Scenario, Process Set and Process in that order, with a total by Scenario:

Electric Generation									
Original Units: PJ		Active Unit	Data values filter:						
Attribute	Commodity	Region	*Vintage*	*TimeSlice*	CommoditySet				
			Period						
Scenario	ProcessSet	Process	2000	2010	2020	2035	2050	2065	2080
BASE-GG	Coal-fired	Coal Steam Electric	5.54	3.78	0.16	0.15	0.13		
	Gas-fired	Natural gas combined-cycle plant	0.88	5.99	6.82	6.69	6.70	6.78	6.78
	Hydro	Hydro-electric Plant	2.26	3.12	6.01	6.15	6.15	6.21	6.21
		Pumped Storage Power Plant	0.72	0.75	1.00	0.99	0.99	1.00	1.00
Total			9.41	13.64	13.99	13.97	13.97	13.98	13.98
CO2LIMIT	Gas-fired	Natural gas combined-cycle plant	6.74	11.94	11.76	6.85			
	Hydro	Hydro-electric Plant	2.95	3.64	7.12	24.70	58.24	77.91	95.19
		Pumped Storage Power Plant	0.44	1.11	1.03	2.00	3.12	4.08	5.12
	Nuclear	LWR Nuclear Plant		15.36	12.91	7.96	1.53		
Total			10.13	32.05	32.81	41.51	62.88	81.99	100.31
CUM-CO2-EMIS	Coal-fired	Coal Steam Electric	5.54	3.78	0.16	0.15	0.13		
	Gas-fired	Natural gas combined-cycle plant	0.88	5.99	6.82	6.69	6.70	6.78	6.78
	Hydro	Hydro-electric Plant	2.26	3.12	6.01	6.15	6.15	6.21	6.21
		Pumped Storage Power Plant	0.72	0.75	1.00	0.99	0.99	1.00	1.00
Total			9.41	13.64	13.99	13.97	13.97	13.98	13.98
ELAST-DM	Coal-fired	Coal Steam Electric	5.54	3.78	0.16	0.15	0.13		
	Gas-fired	Natural gas combined-cycle plant	0.88	5.99	6.82	6.69	6.70	6.78	6.78
	Hydro	Hydro-electric Plant	2.26	3.12	6.01	6.15	6.15	6.21	6.21
		Pumped Storage Power Plant	0.72	0.75	1.00	0.99	0.99	1.00	1.00
Total			9.41	13.64	13.99	13.97	13.97	13.98	13.98
ELAST-DM-CO2	Gas-fired	Natural gas combined-cycle plant	6.74	11.94	11.76	6.85			
	Hydro	Hydro-electric Plant	2.95	3.64	7.12	24.70	58.24	77.91	95.19
		Pumped Storage Power Plant	0.44	1.11	1.03	2.00	3.12	4.08	5.12
	Nuclear	LWR Nuclear Plant		15.36	12.91	7.96	1.53		
Total			10.13	32.05	32.81	41.51	62.88	81.99	100.31

The ProcessSet Descriptions (in place of ProcessSet Names) were selected via a right-mouse option:

ProcessSet	Process	2000	2010
Coal	Coal Steam Electric	1,540.04	1,051.33
Gas	Natural gas combined-cycle plant	245.06	1,662.85
Hydro	Hydro-electric Plant	626.42	866.63
Total		201.07	207.80

invoked in the ProcessSet column. Likewise the Process Descriptions (in place of Process Names) were added via the same right-mouse option, invoked in the Process column.

When the above Electricity Generation Table was created the Totals were also added via a right-mouse option. As stated in the VEDA Support website under **Displaying Sub-totals**, “right-click while the cursor lies on the dimension (in row or col area) that you want to sub-total on, and activate/deactivate Totals”.

You might like to deactivate the Totals in the above Table, by right-clicking while the cursor lies in any cell in the ProcessSet column and selecting **Totals**, for example below right-clicking has occurred in the ProcessSet column (in the first Hydro cell):

Scenario	ProcessSet	Process
BASE-GG	Coal-fired	Coal Steam Electric
	Gas-fired	Natural gas combined-cycle plant
	Hydro	Hydro-electric Plant
	Total	
CO2LIMIT	Gas-fired	
	Hydro	

Having deactivated the Totals, you might like to activate them by right-clicking in the same cell and again selecting **Totals**.

## 6.2 Manipulating the Dynamic Data Cubes

VEDA-BE tables are highly dynamic data cubes that may be readily rearranged. If you move the cursor over any (black) header a cross-hair will appear; if you then hold down the cursor (left-mouse) you will be able to drag this header to any other position in the table (when the green line appears).

For example the screenshot below shows the result of:

- Reconfiguring the Electricity Generation Table above by moving Scenario to the right (and removing the Totals) thereby bringing each result next to each other to facilitate comparison.

The screenshot below also demonstrates another feature of the VEDA-BE dynamic data cubes – if Units and Unit Conversion Factors have been specified, Units can be converted right in the cube (and saved). To change Units from PJ to Gwh in the Electricity Generation Table requires:

- Changing the setting of the **Active Unit** combobox at the top of the form from **PJ** to **Gwh**.

(See section 9 “VEDA-BE Units Handling” for details of how to specify Units and Unit Conversion Factors.)

Having taken the trouble to modify the initial Electricity Generation Table so that it appears as below, you may wish to save it with a different name from Electricity Generation.

Electric Generation										
Original Units: PJ		Active Unit: GWh		Data values filter:						
Attribute	Commodity	Region	Vintage	TimeSlice	CommoditySet	Period				
ProcessSet	Process	Scenario	2000	2010	2020	2035	2050	2065	2080	
Coal-fired	Coal Steam Electric	BASE-GG	1,540.04	1,051.33	45.39	41.94	36.35	~	~	
		CUM-CO2-EMIS	1,540.04	1,051.33	45.39	41.94	36.35	~	~	
		ELAST-DM	1,540.04	1,051.33	45.39	41.94	36.35	~	~	
Gas-fired	Natural gas combined-cycle plant	BASE-GG	245.06	1,662.85	1,893.27	1,857.29	1,860.59	1,882.08	1,882.08	
		CO2LIMIT	1,872.16	3,315.68	3,266.97	1,902.02	~	~	~	
		CUM-CO2-EMIS	245.06	1,662.85	1,893.27	1,857.29	1,860.59	1,882.08	1,882.08	
		ELAST-DM	245.06	1,662.85	1,893.27	1,857.29	1,860.59	1,882.08	1,882.08	
		ELAST-DM-CO2	1,872.16	3,315.68	3,266.97	1,902.02	~	~	~	
Hydro	Hydro-electric Plant	BASE-GG	626.42	866.63	1,669.13	1,707.24	1,709.69	1,725.64	1,725.64	
		CO2LIMIT	819.16	1,011.91	1,978.22	6,862.33	16,177.32	21,641.92	26,442.56	
		CUM-CO2-EMIS	626.42	866.63	1,669.13	1,707.24	1,709.69	1,725.64	1,725.64	
		ELAST-DM	626.42	866.63	1,669.13	1,707.24	1,709.69	1,725.64	1,725.64	
		ELAST-DM-CO2	819.16	1,011.91	1,978.22	6,862.33	16,177.32	21,641.92	26,442.56	
	Pumped Storage Power Plant	BASE-GG	201.07	207.80	277.16	273.77	274.20	276.99	276.99	
		CO2LIMIT	121.72	307.53	284.73	556.44	865.52	1,132.74	1,422.28	
		CUM-CO2-EMIS	201.07	207.80	277.16	273.77	274.20	276.99	276.99	
		ELAST-DM	201.07	207.80	277.16	273.77	274.20	276.99	276.99	
		ELAST-DM-CO2	121.72	307.53	284.73	556.44	865.52	1,132.74	1,422.28	
Nuclear	LWR Nuclear Plant	CO2LIMIT	~	4,267.25	3,585.23	2,209.76	424.62	~	~	
		ELAST-DM-CO2	~	4,267.25	3,585.23	2,209.76	424.62	~	~	

Furthermore, simple graphs can be drawn, though using the Linkage with Excel (discussed in section 10) higher publication quality graphs can be created and maintained.

## 7. Managing Tables in VEDA-BE

Most often the user accesses their tables via the Main Table Definition form discussed earlier, dubbed Interactive (single table at a time) mode. However there is also a batch mode where multiple tables can be requested. To invoke this batch mode:


- Select the “View, Execution Mode, Batch” menu option.
- Under **Table Definition** check the checkboxes corresponding to the Tables of interest.
- Click on the large [View Table(s)] button at the bottom LHS of the form.

The resulting multi-table stacked view of all the associated cubes is shown below:

The screenshot shows the VEDA Tables interface with a multi-table stacked view. The 'Final Energy Consumption' table is the active window, displaying data for various scenarios, processes, and commodities over time. The table has columns for Scenario, ProcessSet, Commodity, and Period (2000, 2010, 2020, 2035, 2050, 2065, 2080). The data is organized into groups for BASE-GG, CO2LIMIT, and CUM-CO2-EMIS, each with sub-groups for Residential and Transportation processes. The 'Original Units' are PJ and the 'Active Unit' is also PJ. The 'Data values filter' is set to PJ.

Scenario	ProcessSet	Commodity	2000	2010	2020	2035	2050	2065	2080
BASE-GG	Residential	Diesel	5.28	7.26	7.26	7.28	7.28	7.28	7.28
		Electricity	8.40	12.60	12.60	12.60	12.60	12.60	12.60
		GAS	47.49	65.37	65.37	65.51	65.51	65.50	65.50
		Low-Temp Heat	0.86	5.85	5.85	5.74	5.75	5.76	5.76
BASE-GG	Transportation	Diesel	27.27	50.61	50.61	50.61	50.61	50.61	50.61
		Gasoline	6.49						
CO2LIMIT	Residential	Diesel	4.71	5.63	5.80	5.64	5.89	4.67	3.45
		Electricity	8.40	18.42	17.26	23.16	28.07	36.60	45.12
		GAS	42.38	50.70	52.20	50.72	53.01	42.05	31.09
		Low-Temp Heat	4.84	11.45	11.45	6.70			
CO2LIMIT	Transportation	Diesel	23.27	7.32					
		Electricity	1.12	12.09	14.14	14.14	14.14	14.14	14.14
CUM-CO2-EMIS	Residential	Diesel	5.28	7.26	7.26	7.28	7.28	7.28	7.28
		Electricity	8.40	12.60	12.60	12.60	12.60	12.60	12.60
		GAS	47.49	65.37	65.37	65.51	65.51	65.50	65.50
		Low-Temp Heat	0.86	5.85	5.85	5.74	5.75	5.76	5.76

In addition, users may create reports as groups of tables using the “Table, Table Master” menu option.

Here all the power sector tables have been grouped and with a single request (hitting ) all can be brought into the viewer, along the lines that were just shown.


The screenshot shows the Table Master interface with a list of tables grouped under 'PowerPlant Tables'. The table has columns for Table Name, Table Description, and Date & Time. The tables listed are Electric C..., Electric G..., and Electric N... with their respective descriptions and dates.

Table Name [3]	Table Description	Date & Time
<input type="checkbox"/> Electric C...	Electric & CHP ...	4/10/2013 5:3...
<input type="checkbox"/> Electric G...	Electric Genera...	4/19/2013 8:5...
<input type="checkbox"/> Electric N...	Electric & CHP ...	4/10/2013 5:3...


## 8. ExRES Cascade through RES

A dynamic way to view results is to use the right-mouse over any item (or set) on either the Process or Commodity Component tab or an entry in the cube and request ExRES via the right-mouse, to expand the RES and bring up details for said item(s), as shown below for the **Natural gas combined-cycle plant** Process showing only the input and output flows (including emissions) for each scenario.

Natural gas combined-cycle plant											
Original Units:		Active Unit		Data values filter:							
*Vintage*		*TimeSlice*		Period							
Scenario	Process	Region	Attribute	Commodity	2000	2010	2020	2035	2050	2065	2080
BASE-GG	E41	REG	VAR_FIn	GAS	1.96	13.30	14.78	14.51	14.53	14.67	14.67
			VAR_FOut	CO2	109.74	744.93	827.90	812.34	813.60	821.58	821.58
				ELC	0.88	5.99	6.82	6.69	6.70	6.78	6.78
				HEAT	0.86	5.85	5.85	5.74	5.75	5.76	5.76
CO2LIMIT	E41	REG	VAR_FIn	GAS	14.31	26.42	26.10	15.22			
			VAR_FOut	CO2	801.19	1,479.38	1,461.84	852.08			
				ELC	6.74	11.94	11.76	6.85			
				HEAT	4.84	11.45	11.45	6.70			
CUM-CO2-EMIS	E41	REG	VAR_FIn	GAS	1.96	13.30	14.78	14.51	14.53	14.67	14.67
			VAR_FOut	CO2	109.74	744.93	827.90	812.34	813.60	821.58	821.58
				ELC	0.88	5.99	6.82	6.69	6.70	6.78	6.78
				HEAT	0.86	5.85	5.85	5.74	5.75	5.76	5.76
ELAST-DM	E41	REG	VAR_FIn	GAS	1.96	13.30	14.78	14.51	14.53	14.67	14.67
			VAR_FOut	CO2	109.74	744.93	827.90	812.34	813.60	821.58	821.58
				ELC	0.88	5.99	6.82	6.69	6.70	6.78	6.78
				HEAT	0.86	5.85	5.85	5.74	5.75	5.76	5.76
ELAST-DM-CO2	E41	REG	VAR_FIn	GAS	14.31	26.42	26.10	15.22			
			VAR_FOut	CO2	801.19	1,479.38	1,461.84	852.08			
				ELC	6.74	11.94	11.76	6.85			
				HEAT	4.84	11.45	11.45	6.70			

To get all the details associated with an ExRES view click on the  icon (which is the third icon from left in the menu bar for Veda Tables):



This results in the view below, and causes the  icon to change to an  icon.

Clicking on the  icon toggles back to just the flows again (as above).



Natural gas combined-cycle plant													
Original Units: PJ		Active Unit		Data values filter:									
Vintage TimeSlice UserConstraint													
Period													
Scenario	Process	Region	Attribute	Commodity	2000	2010	2020	2035	2050	2065	2080		
BASE-GG	E41	REG	Cap_New	-		105.43	617.43		151.10	545.49	101.90	414.03	
			Cost_Act	-		0.42	2.94	3.27	3.24	3.25	3.29	3.29	
			Cost_Fom	-		5.34	36.37	36.37	38.58	34.78	34.84	34.84	
			Cost_Inv	-		6.12	41.98	41.98	44.63	40.46	40.52	40.52	
			Cost_Salv	-		4.59							
			VAR_Act	-			1.06	7.35	8.18	8.10	8.13	8.21	8.21
			VAR_Cap	-			0.15	1.07	1.07	1.05	1.05	1.06	1.06
			VAR_Fln	GAS			1.96	13.30	14.78	14.51	14.53	14.67	14.67
			VAR_FOut	CO2			109.74	744.93	827.90	812.34	813.60	821.58	821.58
			VAR_FOut	ELC			0.88	5.99	6.82	6.69	6.70	6.78	6.78
			VAR_FOut	HEAT			0.86	5.85	5.85	5.74	5.75	5.76	5.76
			VAR_Ncap	-			0.15	0.92		0.23	0.83	0.15	0.63
CO2LIMIT	E41	REG	Cap_New	-		590.97	817.68						
			Cost_Act	-		3.09	5.76	5.69	3.36				
			Cost_Fom	-		29.93	71.03	71.03	41.10				
			Cost_Inv	-		34.32	81.81	81.81	47.49				
			VAR_Act	-		7.73	14.40	14.22	8.41				
			VAR_ActM	-			69.57	24.11	318.07	488.93	534.89	748.62	
			VAR_Cap	-			0.86	2.07	2.07	1.22			
			VAR_Fln	GAS			14.31	26.42	26.10	15.22			
			VAR_FOut	CO2			801.19	1479.38	1461.84	852.08			
			VAR_FOut	ELC			6.74	11.94	11.76	6.85			
			VAR_FOut	HEAT			4.84	11.45	11.45	6.70			
			VAR_Ncap	-			0.86	1.21					
CUM-CO2-EMIS	E41	REG	Cap_New	-		105.43	617.43		151.10	545.49	101.90	414.03	
			Cost_Act	-		0.42	2.94	3.27	3.24	3.25	3.29	3.29	
			Cost_Fom	-		5.34	36.37	36.37	38.58	34.78	34.84	34.84	
			Cost_Inv	-		6.12	41.98	41.98	44.63	40.46	40.52	40.52	
			Cost_Salv	-		4.59							
			VAR_Act	-			1.06	7.35	8.18	8.10	8.13	8.21	8.21
			VAR_Cap	-			0.15	1.07	1.07	1.05	1.05	1.06	1.06
			VAR_Fln	GAS			1.96	13.30	14.78	14.51	14.53	14.67	14.67
			VAR_FOut	CO2			109.74	744.93	827.90	812.34	813.60	821.58	821.58
			VAR_FOut	ELC			0.88	5.99	6.82	6.69	6.70	6.78	6.78
			VAR_FOut	HEAT			0.86	5.85	5.85	5.74	5.75	5.76	5.76

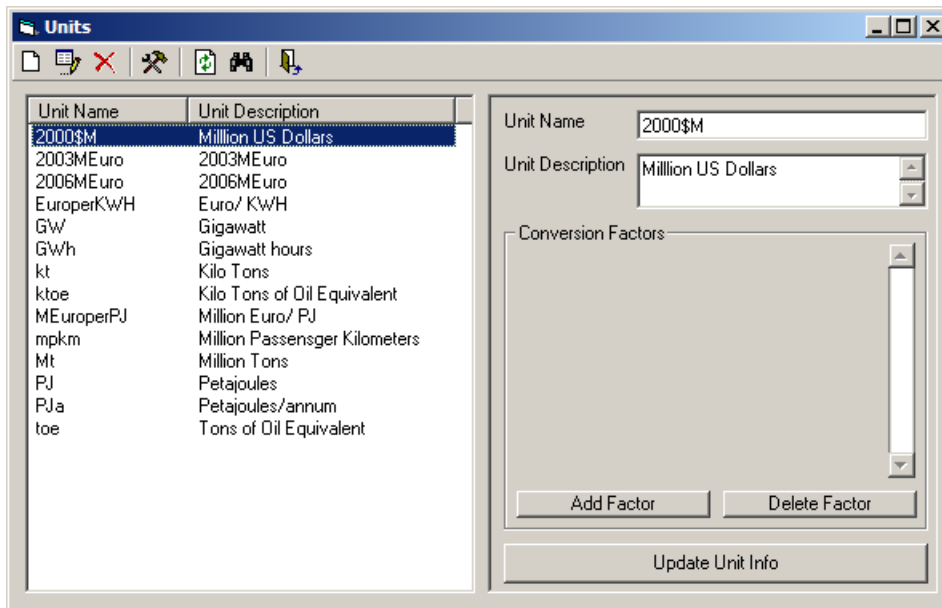
In an ExRES datacube to examine the dependencies, both up and down stream, left-mouse click on a Process or Commodity name. For example left-mouse clicking on commodity GAS brings up all the associated information for **GAS**, as shown below:

ExRES_Commodity_GAS										
GAS										
Original Units: PJ		Active Unit		Data values filter:						
Commodity Vintage TimeSlice										
Period										
Scenario	Region	Attribute	Process	2000	2010	2020	2035	2050	2065	2080
BASE-GG	REG	VAR_Fln	E41	1.96	13.30	14.78	14.51	14.53	14.67	14.67
		VAR_Fln	RHG	47.49	65.37	65.37	65.51	65.51	65.50	65.50
		VAR_FOut	IMPGAS1	49.45	78.68	80.16	80.02	80.04	80.17	80.17
CO2LIMIT	REG	VAR_Fln	E41	14.31	26.42	26.10	15.22			
		VAR_Fln	RHG	42.38	50.70	52.20	50.72	53.01	42.05	31.09
		VAR_FOut	IMPGAS1	56.69	77.12	78.30	65.93	53.01	42.05	31.09
CUM-CO2-EMIS	REG	VAR_Fln	E41	1.96	13.30	14.78	14.51	14.53	14.67	14.67
		VAR_Fln	RHG	47.49	65.37	65.37	65.51	65.51	65.50	65.50
		VAR_FOut	IMPGAS1	49.45	78.68	80.16	80.02	80.04	80.17	80.17
ELAST-DM	REG	VAR_Fln	E41	1.96	13.30	14.78	14.51	14.53	14.67	14.67
		VAR_Fln	RHG	47.49	65.37	65.37	65.51	65.51	65.50	65.50
		VAR_FOut	IMPGAS1	49.45	78.68	80.16	80.02	80.04	80.17	80.17
ELAST-DM-CO2	REG	VAR_Fln	E41	14.31	26.42	26.10	15.22			
		VAR_Fln	RHG	42.38	50.70	52.20	50.72	53.01	42.05	31.09
		VAR_FOut	IMPGAS1	56.69	77.12	78.30	65.93	53.01	42.05	31.09

## 9. VEDA-BE Units Handling



VEDA-BE has a simple yet powerful means for handling Units. The user must identify the Units, and each alternate Unit Conversion Factor, but once this is done Units can be swapped freely.

To create, edit and delete Units and to specify Unit Conversion Factors use the menu option “Tools, Units, Create/Edit/Delete” to bring up the Units form:



Note the role of the menu bar  in the operation of the Units form.


To specify a **New Unit**, e.g. to specify Unit with Name bn-t-km and Description billion-tonne-kilometres:

- Click on the  icon to clear the Unit Name and Unit Description textboxes.
- Enter bn-t-km in the Unit Name textbox, and enter billion-tonne-kilometres in the Unit Description textbox.
- Click on the  button.


The Units form will now appear as follows, with the new Unit **bn-t-km (billion-tonne-kilometres)** that has just been added appearing at the bottom of the list of Units on the LHS of the form:

Unit Name	Unit Description
2000\$M	Million US Dollars
2003MEuro	2003MEuro
2006MEuro	2006MEuro
EuroperKWH	Euro/ KWH
GW	Gigawatt
GWh	Gigawatt hours
kt	Kilo Tons
ktoe	Kilo Tons of Oil Equivalent
MEuroperPJ	Million Euro/ PJ
mpkm	Million Passensger Kilometers
Mt	Million Tons
PJ	Petajoules
PJa	Petajoules/annum
toe	Tons of Oil Equivalent
bn-t-km	billion-tonne-kilometres


#### To Edit a Unit:


- Select the Unit from the list of Units on the LHS of the form. The Unit Name and Unit Description textboxes will automatically be populated with the Name and Description of the selected Unit.
- Make the desired changes to the Unit Name and/or Unit Description.
- Click on the  button.


#### To Delete a Unit:

- Select the Unit from the list of Units on the LHS of the form.
- Click on the  icon.
- Click on the [Yes] button when a message appears asking you to confirm the deletion of the Unit.

To specify **Unit Conversion Factors**, e.g. to specify Unit Conversion Factors for **PJ** from **PJ** to **GWh**, and from **PJ** to **ktoe**:

- Select the Unit **PJ** from the list of Units on the LHS of the form.
- Click on the  button on the RHS of the form, which causes a new row to be created in the Conversions Factors part of the form:

- Enter the numeric value **277.777777777778** in the textbox and use the combobox to select the Unit **GWh**.
- Again click on the  button on the RHS of the form, which causes a new row to be created in the Conversions Factors part of the form, below the row just specified for **PJ** to **GWh**:

- Enter the numeric value **23.8840192027514** in the textbox and use the combobox to select the Unit **ktoe**.
- Click on the  button.

The Units form will now appear as follows, displaying the Unit Conversion Factors for **PJ** from **PJ** to **GWh**, and from **PJ** to **ktoe** that have just been specified by the above procedure:

Unit Name	Unit Description
2000\$M	Million US Dollars
2003MEuro	2003MEuro
2006MEuro	2006MEuro
bn-t-km	billion-tonne-kilometres
EuropeKWH	Euro/ KWH
GW	Gigawatt
GWh	Gigawatt hours
kt	Kilo Tons
ktoe	Kilo Tons of Oil Equivalent
MEuropePJ	Million Euro/ PJ
mpkm	Million Passensger Kilometers
Mt	Million Tons
<b>PJ</b>	<b>Petajoules</b>
PJa	Petajoules/annum
toe	Tons of Oil Equivalent

Units are automatically defined for the reciprocal relationship for each Conversion Factor created.

Note also that there are “Tools, Units, Export Unit(s)” and “Tools, Units, Import Unit(s)” menu options that allow Units to be Exported/Imported between VEDA-BE databases, and then augmented as desired (using the facilities provided by the “Tools, Units, Create/Edit/Delete” menu option).

## Units in VEDA-BE as compared with Units in ANSWER-TIMES?

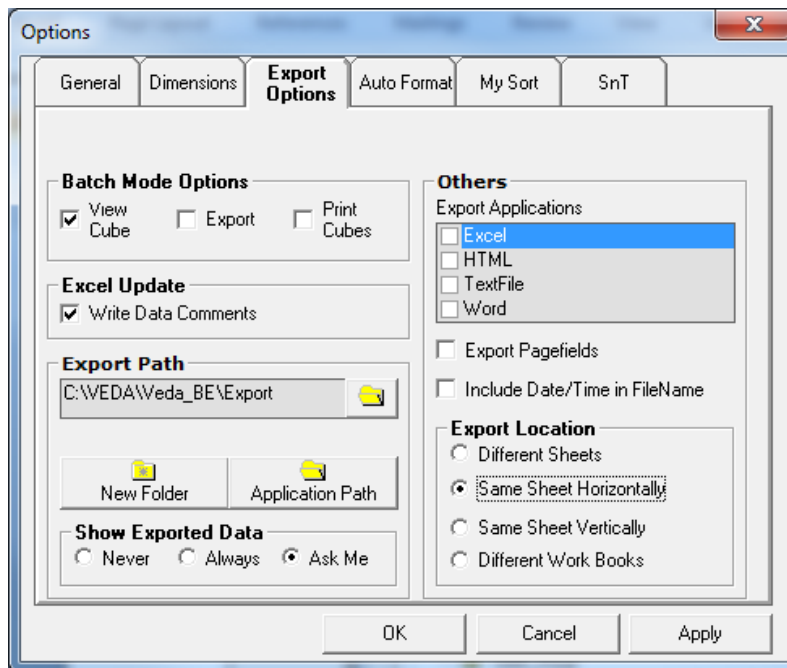
In section 1 “Context” we stated that “a model run initiated by ANSWER-TIMES together with the TIMES GAMS run itself create all of the files that are needed for VEDA-BE results analysis”. While this statement is substantially correct, the user needs to be aware that none of the Units information in the ANSWER-TIMES database is transferred across to VEDA-BE when run results are imported into VEDA-BE.


- It is the user's responsibility to ensure consistent and appropriate use of Units in their TIMES model (as specified in their ANSWER-TIMES database), and likewise to ensure that the Units specified in their VEDA-BE model results database correspond to the Units in their TIMES model.

## 10. VEDA-BE Linkage with Excel

One of VEDA-BE's more powerful facilities is the tight link with Excel.

The "Tools, Options" menu item can be used to indicate where exported files are to go as well as how the tables are to be distributed across/over sheets.



The Export to Excel button (  ) can be used to dump the table currently in the viewer in a user specified Excel workbook in a "what you see is what you get" layout, along the lines below.

	A	B	C	D	E	F	G	H	I	J	K	L
4												
5			Table Name: ElectricGeneration									
6			Active Unit: GWh									
7			Scenario	ProcessSetDesc	ProcessDesc\Period	2000	2010	2020	2035	2050	2065	2080
8			BASE-GG	Coal-fired	Coal Steam Electric	1540.044	1051.333	45.38896	41.9394	36.34748		
9			BASE-GG	Gas-fired	Natural gas combined-cycle plant	245.0648	1662.847	1893.268	1857.286	1860.591	1882.078	1882.078
10			BASE-GG	Hydro	Hydro-electric Plant	626.4194	866.6319	1669.126	1707.24	1709.693	1725.642	1725.642
11			BASE-GG	Hydro	Pumped Storage Power Plant	201.0656	207.8023	277.1561	273.7671	274.1972	276.9923	276.9923
12			BASE-GG	Total		2612.593	3788.614	3884.939	3880.232	3880.829	3884.711	3884.711
13			CO2LIMIT	Gas-fired	Natural gas combined-cycle plant	1872.16	3315.678	3266.969	1902.016			
14			CO2LIMIT	Hydro	Hydro-electric Plant	819.1639	1011.908	1978.217	6862.333	16177.32	21641.92	26442.56
15			CO2LIMIT	Hydro	Pumped Storage Power Plant	121.7228	307.5312	284.7278	556.4435	865.5212	1132.743	1422.278
16			CO2LIMIT	Nuclear	LWR Nuclear Plant		4267.248	3585.229	2209.759	424.6248		
17			CO2LIMIT	Total		2813.047	8902.366	9115.142	11530.55	17467.46	22774.66	27864.84
18			CUM-CO2-EMIS	Coal-fired	Coal Steam Electric	1540.044	1051.333	45.38896	41.9394	36.34748		
19			CUM-CO2-EMIS	Gas-fired	Natural gas combined-cycle plant	245.0648	1662.847	1893.268	1857.286	1860.591	1882.078	1882.078
20			CUM-CO2-EMIS	Hydro	Hydro-electric Plant	626.4194	866.6319	1669.126	1707.24	1709.693	1725.642	1725.642
21			CUM-CO2-EMIS	Hydro	Pumped Storage Power Plant	201.0656	207.8023	277.1561	273.7671	274.1972	276.9923	276.9923
22			CUM-CO2-EMIS	Total		2612.593	3788.614	3884.939	3880.232	3880.829	3884.711	3884.711
23			ELAST-DM	Coal-fired	Coal Steam Electric	1540.044	1051.333	45.38896	41.9394	36.34748		
24			ELAST-DM	Gas-fired	Natural gas combined-cycle plant	245.0648	1662.847	1893.268	1857.286	1860.591	1882.078	1882.078
25			ELAST-DM	Hydro	Hydro-electric Plant	626.4194	866.6319	1669.126	1707.24	1709.693	1725.642	1725.642
26			ELAST-DM	Hydro	Pumped Storage Power Plant	201.0656	207.8023	277.1561	273.7671	274.1972	276.9923	276.9923
27			ELAST-DM	Total		2612.593	3788.614	3884.939	3880.232	3880.829	3884.711	3884.711
28			ELAST-DM-CO2	Gas-fired	Natural gas combined-cycle plant	1872.16	3315.678	3266.969	1902.016			
29			ELAST-DM-CO2	Hydro	Hydro-electric Plant	819.1639	1011.908	1978.217	6862.333	16177.32	21641.92	26442.56
30			ELAST-DM-CO2	Hydro	Pumped Storage Power Plant	121.7228	307.5312	284.7278	556.4435	865.5212	1132.743	1422.278
31			ELAST-DM-CO2	Nuclear	LWR Nuclear Plant		4267.248	3585.229	2209.759	424.6248		
32			ELAST-DM-CO2	Total		2813.047	8902.366	9115.142	11530.55	17467.46	22774.66	27864.84

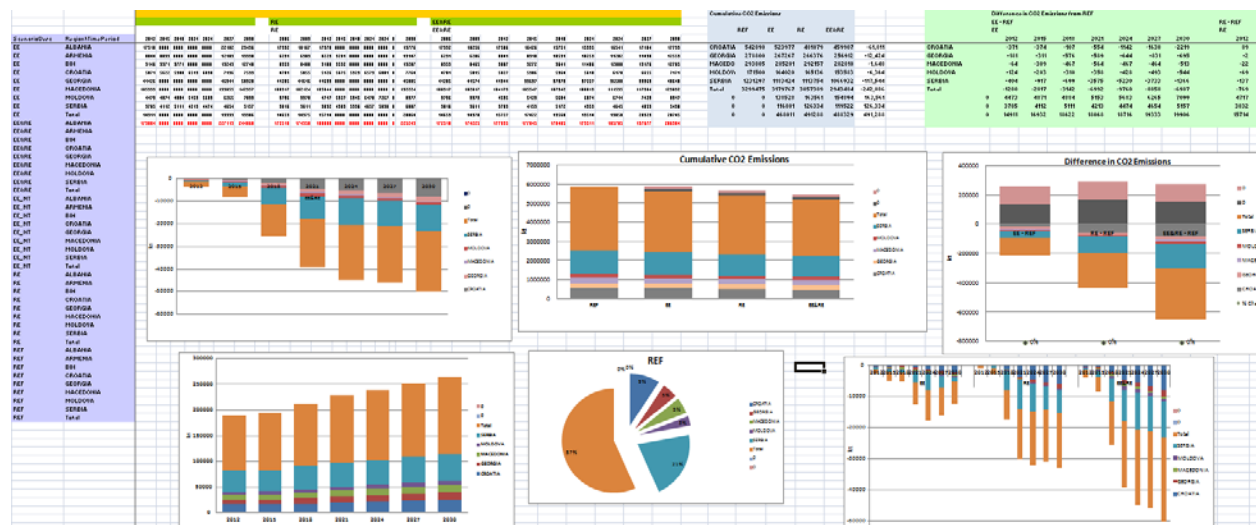
Once a table has been dumped, with the cube view closed, the “Options, Update Excel File” menu option may be employed to update previously exported tables. This involves VEDA-BE searching for the Table Name, then examining each row updating the associated data entries (in yellow) or highlighting any problems encountered (in red). When there are problems of bad or missing entries a log is created that can be viewed at the end of the update request.

Table Name: Electric Generation			2000	2010	2020	2035	2050	2065	2080
Active Unit: GWh	ProcessSetDesc	ProcessDesc\Period							
BASE-GG	Coal-fired	Coal Steam Electric	1540.044	1051.333	45.38896	41.9394	36.34748		
BASE-GG	Gas-fired	Natural gas combined-cycle plant	245.0648	1662.847	1893.268	1857.286	1860.591	1882.078	1882.078
BASE-GG	Hydro	Hydro-electric Plant	626.4194	866.6319	1669.126	1707.24	1709.693	1725.642	1725.642
BASE-GG	Hydro	Pumped Storage Power Plant	201.0656	207.8023	277.1561	273.7671	274.1972	276.9923	276.9923
BASE-GG	Total		2612.593	3788.614	3884.939	3880.232	3880.829	3884.711	3884.711
CO2LIMIT	Gas-fired	Natural gas combined-cycle plant	1872.16	3315.678	3266.969	1902.016			
CO2LIMIT	Hydro	Hydro-electric Plant	819.1639	1011.908	1978.217	6862.333	16177.32	21641.92	26442.56
CO2LIMIT	Hydro	Pumped Storage Power Plant	121.7228	307.5312	284.7278	556.4435	865.5212	1132.743	1422.278
CO2LIMIT	Nuclear	xxxLWR Nuclear Plant							
CO2LIMIT	Total		2813.047	8902.366	9115.142	11530.55	17467.46	22774.66	27864.84
CUM-CO2-EMIS	Coal-fired	Coal Steam Electric	1540.044	1051.333	45.38896	41.9394	36.34748		
CUM-CO2-EMIS	Gas-fired	Natural gas combined-cycle plant	245.0648	1662.847	1893.268	1857.286	1860.591	1882.078	1882.078
CUM-CO2-EMIS	Hydro	Hydro-electric Plant	626.4194	866.6319	1669.126	1707.24	1709.693	1725.642	1725.642
CUM-CO2-EMIS	Hydro	Pumped Storage Power Plant	201.0656	207.8023	277.1561	273.7671	274.1972	276.9923	276.9923
CUM-CO2-EMIS	Total		2612.593	3788.614	3884.939	3880.232	3880.829	3884.711	3884.711
ELAST-DM	Coal-fired	Coal Steam Electric	1540.044	1051.333	45.38896	41.9394	36.34748		
ELAST-DM	Gas-fired	Natural gas combined-cycle plant	245.0648	1662.847	1893.268	1857.286	1860.591	1882.078	1882.078
ELAST-DM	Hydro	Hydro-electric Plant	626.4194	866.6319	1669.126	1707.24	1709.693	1725.642	1725.642
ELAST-DM	Hydro	Pumped Storage Power Plant	201.0656	207.8023	277.1561	273.7671	274.1972	276.9923	276.9923
ELAST-DM	Total		2612.593	3788.614	3884.939	3880.232	3880.829	3884.711	3884.711
ELAST-DM-CO2	Gas-fired	Natural gas combined-cycle plant	1872.16	3315.678	3266.969	1902.016			
ELAST-DM-CO2	Hydro	Hydro-electric Plant	819.1639	1011.908	1978.217	6862.333	16177.32	21641.92	26442.56
ELAST-DM-CO2	Hydro	Pumped Storage Power Plant	121.7228	307.5312	284.7278	556.4435	865.5212	1132.743	1422.278
ELAST-DM-CO2	Nuclear	LWR Nuclear Plant			4267.248	3585.229	2209.759	424.6248	
ELAST-DM-CO2	Total		2813.047	8902.366	9115.142	11530.55	17467.46	22774.66	27864.84

Besides ensuring that the table layout is identical in VEDA-BE and the workbook (in VEDA-BE the table name will be red if a table has been used in an "Update Excel File" operation) syncing is the user's responsibility. This can be a problem if for different runs tables lose/gain entries, or when new runs are done. But once synced properly dynamic updating of graphs can be automatically performed.

### DecisionWare Group AnalyticsXLS

The DecisionWare Group AnalyticsXLS employs some VBA code to facilitate taking full advantage of the VEDA-BE Update Excel facility. It supports squaring tables, managing scenarios and comparison graphs. Contact Gary Goldstein at [DecisionWare.NY@gmail.com](mailto:DecisionWare.NY@gmail.com) for more information on the DecisionWare Group AnalyticsXLS. Below is a display of a potpourri of graphs that can be produced using Excel graphing facilities:



## 11. VEDA-BE Errors and Bugs

If you encounter any problems working with VEDA-BE the first place to turn for assistance is the VEDA Forum, <http://support.kanors-emr.org/forum/> where Q&A on a wide range of VEDA as well as TIMES modeling issues are discussed. Should you encounter an error, you can post it on the Forum or email the Logs\amit@kanors.com.

## 12. Acknowledgements

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- The roles of Gary Goldstein of DecisionWare Group and GAMS Corporation in the development of the GDX2VEDA facility that allows (results) information in a GDX file created by a GAMS run to be passed to VEDA-BE, and hence means that VEDA-BE can readily perform results analysis for a TIMES GAMS run initiated from ANSWER-TIMES or VEDA-FE.
- The pivotal role of Gary Goldstein of DecisionWare Group ([DecisionWare.NY@gmail.com](mailto:DecisionWare.NY@gmail.com)) in suggesting that there should be a **Using VEDA-BE with ANSWER-TIMES** manual, building the AT\_VBE-Example4 VEDA-BE database, preparing the initial draft of this manual, and reviewing this version.