USAID FUNDED PROJECT FOR THE ECONOMIC COMMUNITY OF WEST AFRICAN STATES, ECOWAS,
AND THE WEST AFRICAN POWER POOL, WAPP, IN COLLABORATION WITH
THE ASSOCIATES FOR INTERNATIONAL RESOURCES AND DEVELOPMENT, AIRD

LONG-TERM ELECTRICITY
TRADE MODEL

GRAPHICAL USER INTERFACE
GUI VERSION 3.0

GUI DEVELOPERS MANUAL

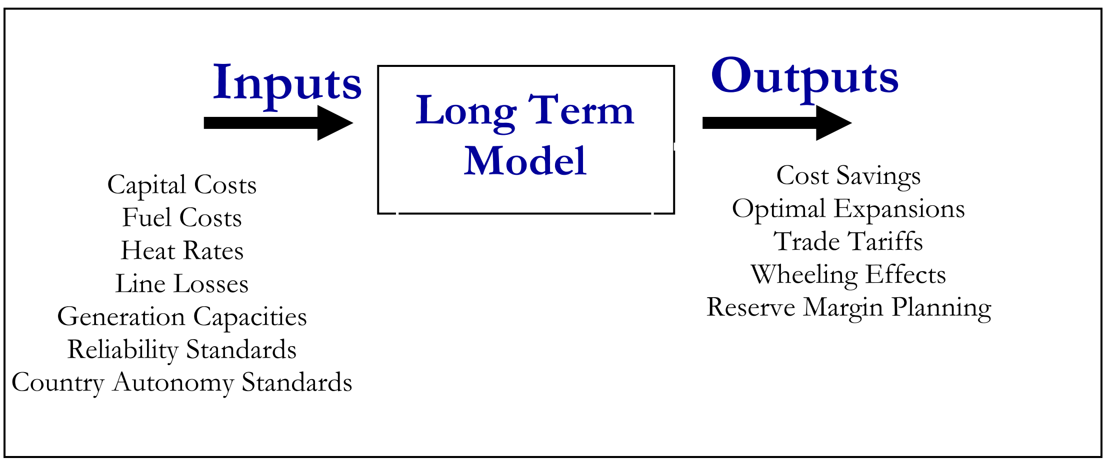
HOW TO USE THE POWERTOOLS V3 WITH AN
APPLICATION PROGRAMMING INTERFACE API

GEOFFREY M. GRANUM
SHIMON K. MODI
F. T. SPARROW
BRIAN H. BOWEN

P U R D U E U N I V E R S I T Y
S E P T E M B E R 2 0 0 4

BACKGROUND AND INTRODUCTORY DOCUMENTS

The Purdue long-term electricity trade and capacity expansion model (LTETM) was developed from 1996 to 2000 for the Southern African Power Pool, SAPP. During 2000 an initial graphical user interface was written. From 2001 to 2003 an improved interface was developed for the West African Power Pool, WAPP. Then in early 2003 the interface was totally restructured to allow for increased and more sophisticated functionalities. In April 2004 the Version 3.0 of the interface, was presented to the Economic Community of West African States, ECOWAS, at the Accra, Ghana meeting of the WAPP delegations. Funding has been provided by the United States Agency for International Development, USAID, to assist in training WAPP personnel and for giving support to the West African electricity grid infrastructure development. The Version 3.0 of the interface was part of a major training activity in collaboration with the WAPP Technical Working Group.



All of the input and output results are displayed through the graphical user interface (GUI). The model formulation and optimization constraints are described in detail in the LTETM User Manual. This User Manual is intended for technical users who are familiar and with GAMS programming. A condensed version of the User Manual, which is intended for the more general and non-technical users, is found in the General Training Manual. These documents are available at:

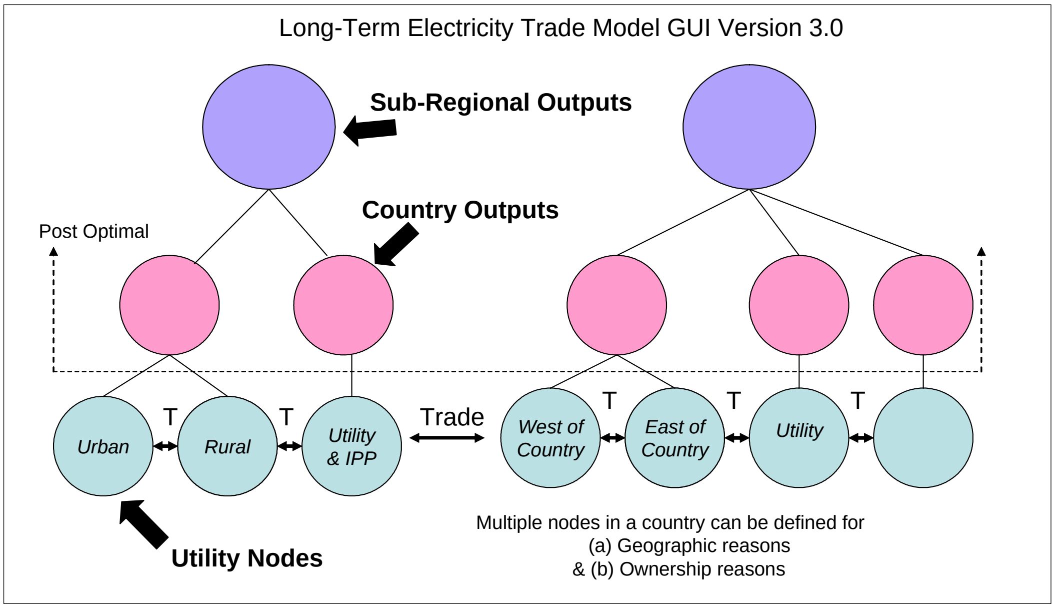
https://engineering.purdue.edu/IIES/PPDG/SAPP/user-manual.whtml

https://engineering.purdue.edu/IIES/PPDG/MODEL/GenTrainMan-Oct2003.pdf

This current document is designed to introduce the interface to future technical developers.

THE MULTI-NODE FUNCTIONALITY IN THE GUI VERSION 3 (GUI V3)

The structure of the GUI has been dramatically improved to allow extra modeling flexibility and potential for future additional improvements. The most important new functionality with this Version 3 is that it allows the general user to specify the number of nodes that are required to be in a new model. Prior to the V3 the number of nodes was limited to 14. No more nodes could be added or taken away. It was a "hard wired" parameter.



The above diagram illustrates the structure of the nodes, country nodes, and super nodes. Any country with V3 can now have its' own number of nodes specified. This means that a national transmission grid can also now be represented by the long-term electricity trade and capacity expansion model. If a country is represented by two nodes (say to distinguish between the urban community or the rural community or between an industrial load and a residential load) then this can easily be accomplished through this new version. The two nodes (blue in diagram) are defined as belonging to a specific country (pink). Then super-nodes are the sub-regional nodes and are user specified by allocating certain countries to them.

The initial request from the WAPP was to provide sub-regional output files which would be Zone A and Zone B of the West Africa region. All Zone A countries are in the eastern half of ECOWAS and Zone B countries in the western half. This functionality has been provided through this new interface while at the same time permitting a much greater level of sophistication in representing the transmission grids of each country and the whole region. International and national transmission lines can now be represented in the models. Output files are generated for each node and for each super-node.

WHAT YOU NEED TO KNOW BEFOREHAND

GENERAL INFORMATION

Within this document are tutorials for the advanced user; a pseudo-developer if you will. The tutorials do not in general assume that the reader will be modifying the Java source code. One tutorial covers the creation of new output files. Another covers the modification of allowable input ranges for individual fields, etc. The tutorials aim to allow the dedicated user to utilize the advanced capabilities inherent in PowerTools V3. In addition, tips, code hints and thoughts on where improvements could be made are included as comments by the authors.

Potential developers must obviously understand in depth how these 'advanced user' tools work before modifying their functionality. The hope is that this document will provide the required stepping blocks, allowing a potential developer to begin to understand the underlying structure enough to grasp the comments which are included in the code itself. However, a warning: it is unlikely that Purdue will be able to supply a developer with significant skill to make any serious modifications to this program. Expect a year of 'training' at minimum – that year should not be wasted, much useful work could be done while learning the code itself.

The current interface for the Purdue power modeling, PowerTools v3, has been developed using a number of different tools. As much as possible those tools were kept segregated: before jumping in you must be certain that you have at least a basic understanding of all of them, and a significant talent in one or more.

PowerTools v3 utilizes XML and Java as the primary skill sets. While an individual working on the XML side would not need to have a significant depth of knowledge of Java, the converse is not true; any Java developer who intends to alter the ***functionality*** (as opposed to the 'look and feel') of the interface *absolutely MUST have a detailed understanding of XML structure*. Even things which might seem completely unrelated to XML – such as many of the input screens – are completely defined within the Schema and created automatically at runtime. Don't play with the code until you understand the Schema and XML structure.

Efforts have been made herein to make walkthroughs that give a dedicated individual (perhaps a grad student with some computer knowledge) to make changes to the model itself; **DO NOT** take these walkthroughs as lessons in modifying the underlying code. They are not – they are simply instructions on utilizing the extremely powerful underlying Java engine, as well as a helpful glimpse into its inner workings.

THE XML DEVELOPMENT SIDE

A user who intends only to modify the XML side of the code could be quite busy in their own right. One could design an entirely new power model using XML programming alone; output files and all.

Modifying the Schema and creating new XML files which implement said Schemas requires only knowledge of the GAMS model which is being targeted, an intermediate knowledge of XML programming, and of course the syntax which we developers used when creating the interface in the first place. The ability to program in Java is not required, nor would it even help significantly.

THE JAVA DEVELOPMENT SIDE

Sadly, the converse is not true. The Java developer must have at minimum a basic understanding of how to develop in XML. In particular, any Java developer must understand how a Schema works with relation to its children XML files.

The potential Java developer should know all about Listeners in all of their glory. Line-by-Line debugging should be a mastered art. Recursion is used heavily in places – think 1000 lines with 10 possible exit/re-entry points with 20 or more levels. They should know how to use casting, inheritance, superclasses, subclasses, how static variables work, the string libraries, regular expression usage in Java, and much, much more. The most important thing to know is that the developer will simply not know every thing they need to know; they need to know how to find it. The Java Tutorial site is where the authors acquired most of their own knowledge.

The most difficult part of the code is that which utilizes the Xerces libraries. Xerces is an open-source package which is utilized by the PowerTools code to handle the XML parsing and writing. Being extremely powerful, it is also very complex. Expect a high learning curve if the code base which relies on the Xerces class needs to be modified. It shouldn't need any significant changes. In the event that it *does* need changes, help will be found in the Xerces newsgroups most readily. Code comments may provide helpful hints, but will certainly not be enough to provide an understanding of the depth of capabilities provided by the Xerces package.

A LITTLE MORE

The amount of change that can be made without actually touching the Java code could keep a single person busy for months. Everything from minor changes in input-value descriptions, to completely new output file generation, to major changes in the GAMS code can be handled without modifying the Java source.

THE HEIRARCHY

PowerTools has five major development components:

1. GAMS. The GAMS model itself.

2. GAMS Schema: The Schema which describes a GAMS model; essentially the GAMS model translated into XML.

3. PowerTools Schema: The Schema which describes the interface. This can be thought of as a 'map' of the GAMS model into some semblance of order; the GAMS code and the GAMS Schema model are "flat" whereas the PowerTools Schema is a 'tree' structure, much like a filing system. Every effort was made to create logical groups and structures

4. Java Interface: This is what you see when you "run" PowerTools v3. The Java code interprets whatever PowerTools Schema is attached to the opened model file.

5. Output Definition Files: There is an embedded scripting engine in the PowerTools package which allows for automatic creation of customized output files. Any file placed within the 'output' directory will be parsed after every successful model run. If proper commands are utilized the new file will be added to a user-defined position on the output menu within the interfaces itself, and will be opened using the default internet web browser.

PREPARING A NEW GAMS MOEL FOR USE IN POWERTOOLS V3

OVERVIEW

The goal of this section is to walk you through the process of making a brand new GAMS model editable via the PowerTools interface. We will cover:

1. Pre-parsing the GAMS model into a GAMS Schema instance
2. Using the GAMS Schema instance to build our PowerTools Schema.
3. Creating an instance XML file from the new PowerTools Schema for use as a template
4. Creating the first new GUI model file.

At the end of this section you should be able to define your own specialized Schemas for special tasks within the PowerTools interface. You will also gain a better understanding of how the GUI interface interacts with the PowerTools Schema file to create the user input screens.

***Add Documentation**

Update this section to include creating a complete new model for use in the interface.

For this exercise we are making the assumption that only mathematical functions have changed within the new GAMS model; what this means is that the input fields will not be changed. ***Changing the names of variables would require additional procedures!***

GETTING STARTED

***Todo Item**

This should be turned into a plug-in for the GUI interface

To complete this task you will need access to the Java source code. Open the java file:

gamstools.parse.modelbuilder

Within this file is a static void method titled 'testCase_1.' Code follows with descriptions:

```
public static void testCase_1() {
File gamsFile = new File("C:/Dev/wapp-IPP-dec29-2003/NewModel.GMS");
File xmlFile = new File("C:/Dev/wapp-IPP-dec29-2003/model.xml");
CreateSchemaFromGAMS test1 = new CreateSchemaFromGAMS(gamsFile, xmlFile);
gamsFile = new File("C:/Dev/wapp-IPP-dec29-2003/testModel.GMS");
 CreateGAMsFromSchema gmsSchema = new CreateGAMsFromSchema(xmlFile);
    gmsSchema.start();
    GamsModel model = null;
    try {
      while (gmsSchema.isAlive()) {
        Thread.currentThread().sleep(100);
      }
      model = gmsSchema.getModel();
    }
    catch (InterruptedException ex) {
      ex.printStackTrace();
    }
 }
```

The first line of interest is the declaration of the *File* object 'gamsFile':

```
File gamsFile = new File("C:/Dev/wapp-IPP-dec29-2003/NewModel.GMS");
```

'gamsFile' defines the location of the new GAMS model – the actual mathematical model which will be run to find an optimal solution. There are a few limitations on syntax for the GAMS file itself:

- DO NOT USE BLOCK COMMENTS! The ability to handle them has not been implemented.

- Try to avoid declaring multiple variables on the same command: use
  "SET bob;"
  "SET sally;"
  and NOT
  "SETS bob, sally;"

- Use one kind of inline comment and STICK WITH IT. Consistency is your friend. The converter will handle any inline comment declared with the $inlinecom { } function, as well as double quotes ("*comment*"). This is just a suggestion, but if you ignore it and have errors this may be part of it.

- It is worth pointing out that the parser does NOT require you to flatten the GAMS model into a single file. The $include function will suffice.

Aside from the block comments aspect, these are not desperately important; 99% of the GAMS syntax was handled when the converted was developed, however there may be situations where you have to adjust the GAMS code to accommodate the parser.

In order to run parse this new GAMS model, point the path of gamsFile to point to wherever your new model is. It is suggested to place a copy of the new model in a convenient location.

The following line determines where the new XML file will be written to:

```
File xmlFile = new File("C:/Dev/wapp-IPP-dec29-2003/model.xml");
```

It would be easiest for you if you just point this file to save itself into the same directory you copied the GAMS model file into.

Now we create the object which will do all the work:

```
CreateSchemaFromGAMS test1 = new CreateSchemaFromGAMS(gamsFile, xmlFile);
```

You can explore how this works if you desire. The net effect is that an XML representation of the GAMS model file is created. This allows us to use the Xerces tools to read all the data, edit it, and save it back to the XML file without having to write an insane amount of Java code to handle all of this.

The next line re-uses the gamsFile object to create a new file. This file is simply a comparison, a test case. It will be a GAMS model representation of the XML file we created.

```
gamsFile = new File("C:/Dev/wapp-IPP-dec29-2003/testModel.GMS");
```

We use this new file object with the now populated XML file to create our verification file:

```
CreateGAMsFromSchema gmsSchema = new CreateGAMsFromSchema(xmlFile);
 gmsSchema.start();
 GamsModel model = null;
while (gmsSchema.isAlive()) {
    Thread.currentThread().sleep(100);
 }
model = gmsSchema.getModel();
```

If you haven't guessed at this point, CreateGAMsFromSchema extends java.lang.Thread. Passing in the xmlFile object to the constructor then calling start() will cause the Thread to begin running; since we want the GamsModel object to be populated before the function dies, we must keep looping and checking until we know that the thread has 'died' (once a threads 'run' method has exhausted it is considered dead). Once the thread is dead we grab the model object.

An astute observer will at this point notice that nothing is done with the model after creating it. If you are making only minor changes to the existing GAMS model file this should be fine. For advanced or for large amounts of changes you should certainly create a file to verify that everything is working correctly. You will need to add the following lines of code to this function to do so:

```
FileWriter out = new FileWriter(gamsFile);
 out.write(model.toXML(gamsFile));
```

You will also have to change the catch block to handle the potential IOException.

Now make sure that this method is what is being called in the main function of this class, and run it. When the run is complete you will see your new XML file has been created (hopefully!) wherever it was that you told the function to write the file to. This is the point at which you will want to compare the input GMS file to the flattened version which was created by our last step above, assuming you added the code to create it.

Once you have verified the model, or if you have only made minor changes such as modifying a mathematical function, you are ready use the new XML file in the PowerTools interface. Point windows explorer to:

{powertoolsv3}\resources\gamsModels

You will see that there is already at least one XML file in this directory. Copy your new XML file into this directory. If you are supremely confident that it is correct, and you want all existing PT3 models to use this new GAMS model, by all means overwrite the existing file. If you would like to test it first, simply make sure it has a different name than the current file.

IMPORTANT: If you overwrite the existing file in this directory all existing PT3 models will run using your new mathematical model.

IMPORTANT: You are free to have multiple mathematical models stored in this directory. Each PT3 model references one of the files in this directory when you select 'Run' from the PT3 interface. The mathematical model which is used may be selected by the user from within the PT3 interface.

Open the PT3 interface and create a new model

(File → new → Empty Model)

Name the model 'TestModel'

Select the uppermost item in the tree structure:

"PowerModel: TestModel"

This will bring up the main screen (Figure 1). Look to the last item on the right-pane: There is a button titled 'Set Reference Model"

Select this button and browse to the gamsModels directory:

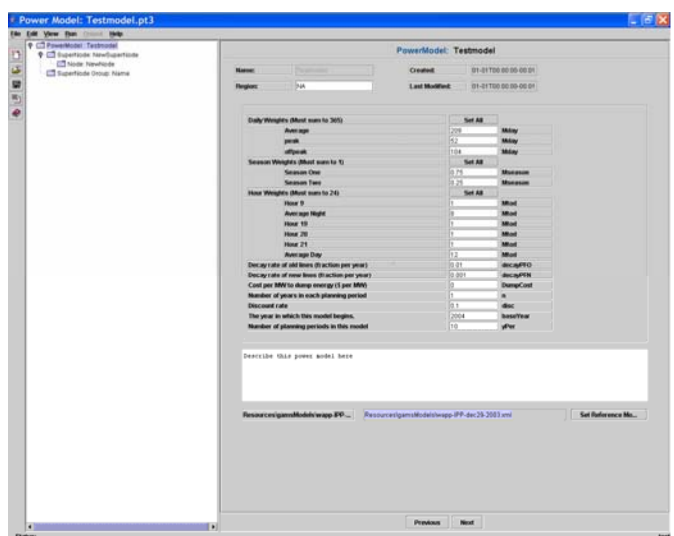


Figure 1

{powertoolsv3}\resources\gamsModels

Select your new mathematical model and click 'OK'. Add a few items to your new PT3 model and then save and run the new model from within PT3. Congratulations, you've updated the math engine for this PT3 model! To force all existing models to use this GAMS model, browse back to the gamsModels directory in windows explorer, backup the existing XML file and rename your new XML model to the same name as the old one had (probably "wapp-IPP-dec29-2003.xml"). It is recommended avoiding this however, as it will create confusion later: how do you know that a user has the most up-to-date mathematical model stored in the gamsModels directory? If you e-mail a new PT3 model after updating your mathematical model and have simply overwritten your old XML file the user will be able to run the model you sent them without trouble; except you and they will have different outputs! Instead, if it is worth updating the math, it is worth updating your files. If there was an error in the old mathematical model then DELETE the XML file which exists within the gamsModels directory and place your new XML file in there *with a different name*. This will FORCE you to update the 'reference model' field via the 'Set Reference Model" button on every model, as the program will crash out when you attempt to run it with the old reference model, which no longer exists. Then when you e-mail the file to a user that does not have the new mathematical model the will not be able to run your PT3 model until they get updated reference models from you.

***Todo**

The PT3 interface has some ugly issues with 'Set Reference Model."

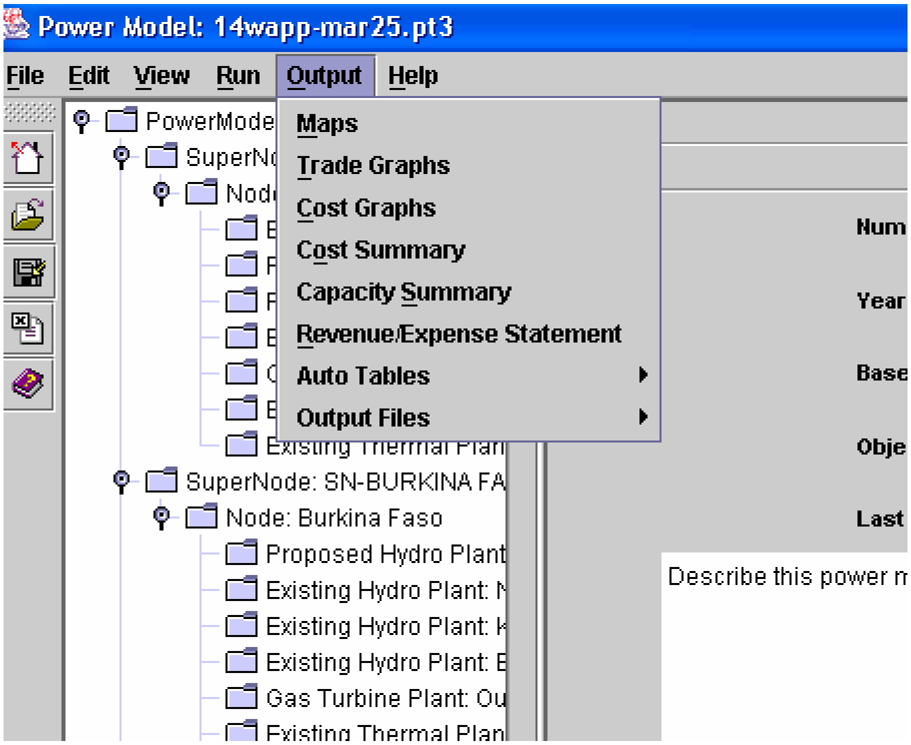
For one thing, there is no safety check: the interface assumes that the reference model field is always valid, and does not inform the user if it is not. Hence, the directions to the right are not quite right.

Also, it is literally ugly: the button text is cut off, the description field is simply a copy of the text Field, etc. Soooo…..

1. *Make the PT3 interface pretty*
2. *Check for the existence of the reference file, warn user if not valid*
3. *Make the file browser pop up in the correct directory ({powertoosv3}/resources/gamsModels)*

THE JAVA DEVELOPMENT SIDE: OUTPUT MENU

The entire PowerTools V3 interface runs on the XML schema; except for the following menu items under the Output menu (they are also shown in the figure):



- Maps
- Trade Graphs
- Cost Graphs
- Cost Summary
- Capacity Summary

A developer wanting to modify any of the above mentioned menu items will require in-depth knowledge of java swing; in particular the Graphics package. The intention was to make the entire Output menu XML schema driven, and it should be an ongoing project for anyone wanting to pick up the trail. The following part of the document will focus on giving an in-depth explanation of the java code which generates all of the above mentioned menu items, so that if someone wants to make it XML schema base, they have an understanding of the underlying structure. Each of the above mentioned menu items will be discussed in the following sub sections.

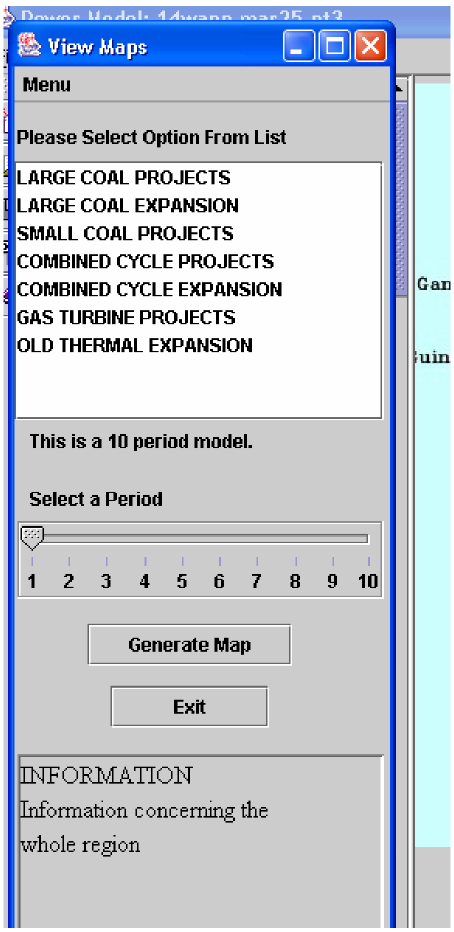
THE JAVA DEVELOPMENT SIDE: OUTPUT MENU

→ MAPS

The starting point for maps is the method

void jmnu_Output_Map_actionPerformed(ActionEvent e) found in XMLDevFrame.java in the PowerTools V3 package. The code for showing maps consists of two different parts:

1. MapPane



The MapPane, shown in the adjoining figure.

The main purpose of the MapPane is to show all the different technology types grouped by a common characteristic.

A datatype called MapData is created, which populates a vector and groups all the different technology types according to the common characteristic. If you look at MapData.java, you will see that objects of the type MapDataType are hard coded and filled with the required data. The required data is the common category type, text to be displayed, the respective GAMS parameter, unit type, the type of point to be drawn on the map.

This is the first place that an XML structure can be introduced in the Maps output menu.

2. MapLabelPanel

The MapLabelPanel is the panel onto which the map.jpg is pasted. A LayeredPanel is used to paste the MapLabelPanel onto it. A GlassPane is used to draw the graphics and layered on top of the MapLabelPanel, using the LayeredPanel.

GlassPane.java defines all the components needed for drawing the power units and the transmission lines. An indepth knowledge of the graphics package is required to modify the Maps menu, please keep in mind.

THE JAVA DEVELOPMENT SIDE: OUTPUT MENU

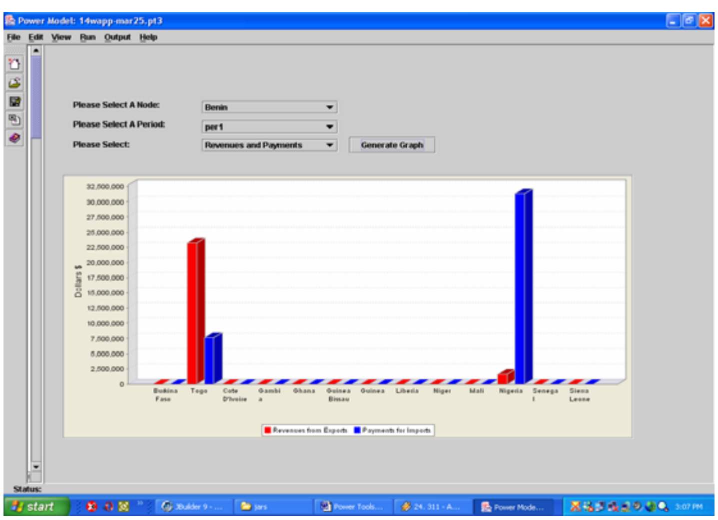
→ TRADE GRAPHS

The trade graphs display bar charts of Energy Trade and Revenues and Payments. The open source graphing package JFreeChart 9.16 is used to create the graphs. Currently, this open source project is hosted on sourceforge.net. There is ample documentation and examples available with the installation package. Anyone not familiar with JFreeChart 9.16 should refer to these examples and documents before proceeding to change any of the code. Focusing only on the BarChart demos will be sufficient.

There are two vectors in TradeGraph.java which hold the key to understanding the code in this class. They are jCmbTypeData and jCmbTypeParam. jCmbTypeData contains the data to be displayed on the screen and jCmbTypeParam contains the GAMS parameter name which has to be used to extract the relevant data. The two categories for Energy Trade are: energy exported and energy imported. The GAMS parameters for these two categories are expgenzp and impgenzp respectively. The two categories for Revenues and Payments are: Revenues from exports and Payments for imports. The GAMS parameter for these two categories is Profj. It might seem strange that the same parameter can give two different values. This particular parameter gives different values based on the ordering of the arguments. Please be aware that any change will require some knowledge of GAMS, the model and the concerned parameters.

The java class BuildChart.java is sent all the relevant data to build the chart. BuildChart.createChart() creates the actual bar chart.

GamsParameter.getValue() is used to retrieve the value required. For a two argument parameter e.g. abc(z,ty) where abc is the parameter and z,ty are the arguments, GamsParameter.getValue() has to be passed a string in the following format : z.ty, where z denotes the node name and ty denotes the period number. Studying the code at the beginning of the file will help the developer understand how to retrieve the period set and the country set.



THE JAVA DEVELOPMENT SIDE: OUTPUT MENU

→ COST GRAPHS

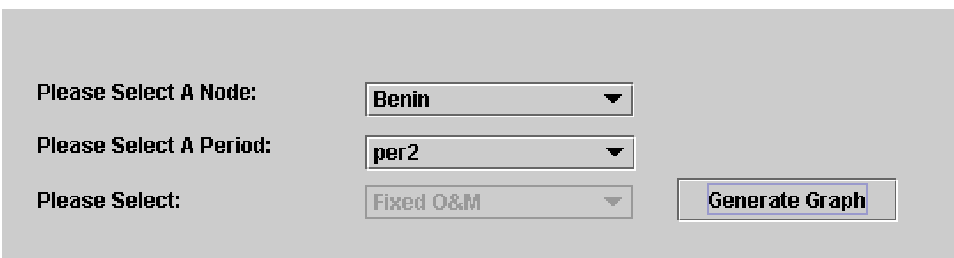
The Cost Graphs have been created to provide a quick glimpse at the differences in costs for a particular node in a particular period or over the entire horizon. This allows the user of interface to get an idea of the proportion of costs which looking at the specific figures in the output files. Cost Graphs also use JFreeChart 9.16 graphics package available at sourceforge.net. Anyone not familiar with JFreeChart 9.16 should refer to these examples and documents before proceeding to change any of the code. Focusing only on the BarChart demos will be sufficient.

The Cost Graphs display costs of 8 different types: Fixed O&M, Fuel Costs, Generation Capital Costs, Transmission Capital Costs, Unserved Energy, Unserved MegaWatts, Variable O&M and Water Costs. Just like the TradeGraphs, there are two vectors in CostGraphs.java which contain the display data and parameter data. JCmbTypeData contains all the display information, whereas JCmbTypeParam contains the parameter data required to extract all the values.

When the Generate Button is pressed on the interface, jBtnGenerate_actionPerformed method is called. Tracing the code from that point will lead to a better understanding of the how the values are extracted. BuildChart.java is called to create the chart once the dataset has been created.

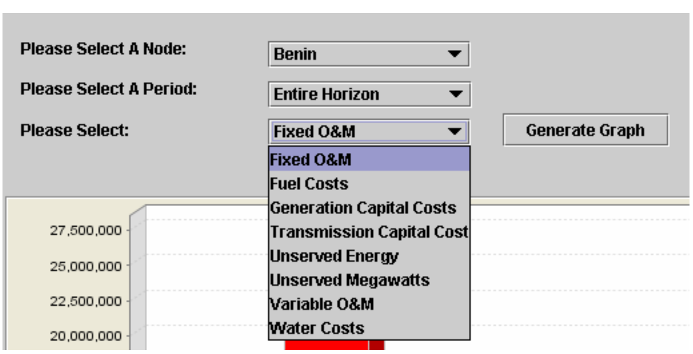
CostGraphs works in two modes:

1. When a node is selected and a period number is selected.



This option will not allow the user to select a particular type of cost type. Instead, all the different cost types will be shown as separate categories on the chart.

2. When a node is selected and Entire Horizon is selected.



This option allows the user to select a particular type of cost. When the graph is generated using this option, the bar's in the bar chart will denote value for each period separately.

getSum(String,String) method is backbone of the entire class. This method calculates the value for a particular parameter, either for the entire horizon or that particular period. If the numbers being displayed on the graph do not look right, this method is the first place to start looking.

As discussed in Trade Graphs section, to extract a value of any parameter, string in the following format has to be constructed: a.b.c for three arguments, or a.b for two arguments. GamsParamete.getParam() queries a flattened hashtable, instead of a three level or a two level nested hashtable.

THE JAVA DEVELOPMENT SIDE: OUTPUT MENU

→ COST SUMMARY

The Cost Summary was created before the Cost Graphs, as a means of tabulating the costs according to their categories. Instead of digging around in the output files, all the relevant costs are now shown in the grid format.

Cost Summary

Region	T.C. w/o G.	T.C. w G.	Fixed O&M	Fuel Costs	G.C.Costs	T.C.Costs	U.E.	U. MW	V O&M	W. Costs
Benin	366.702E6	-8131022.	13.5053E6	173.334E6	127.287E6	11.4024E6	5.32293E6	0	35.0877E6	762493.
Burkina Faso	30.304E6	83.0879E6	0	10.2835E6	0	3.52398E6	3.33402E6	0	12.8185E6	344004.
Togo	227.769E6	130.423E6	7.53144E6	117.291E6	65.3895E6	0	14.8071E6	0	22.1638E6	586322.
Cote D'Ivoire	1.01262E9	793.23E6	35.7928E6	528.474E6	180.957E6	21.5523E6	0	0	237.386E6	8.46098E6
Gambia	76.1155E6	117.647E6	0	13.9898E6	3.513E6	10.7234E6	26.5425E6	0	21.3468E6	0
Ghana	1.12355E9	1.53294E9	56.3958E6	523.609E6	279.093E6	0	186.996E6	0	54.9383E6	22.5154E6
Guinea Bissau	60.007E6	60.007E6	4.64096E6	0	38.9152E6	0	16.2718E6	0	0	179007.
Guinea	1.70539E9	1.54377E9	229.022E6	30.0601E6	1.09802E9	29.1758E6	59.2699E6	150.285E6	98.4303E6	11.1205E6
Liberia	158.703E6	131.939E6	415712.	4.4547E6	3.93109E6	6.76228E6	60.2832E6	81.2219E6	262041.	1.37223E6
Niger	220.426E6	162.008E6	7.13164E6	18.1092E6	186.714E6	0	204754.	0	6.71557E6	1.55149E6
Mali	96.631E6	-4.6983	7.56941E6	9.30299E6	71.9056E6	0	386271.	0	3.74209E6	3.72467E6
Nigeria	9.50541E9	9.98428E9	121.265E6	3.52167E9	2.80486E9	0	1.72151E9	0	1.28501E9	51.1086E6
Senegal	279.201E6	443.556E6	3.23111E6	143.206E6	42.6662E6	13.5875E6	27.1242E6	0	47.7818E6	1.60374E6
Sierra Leone	23.381E6	-4.1557	0	6.84766E6	718645.	3.47224E6	0	0	11.5538E6	788699.
Total	14.8862E9	14.8862E9	486.502E6	5.10063E9	4.90397E9	100.2E6	2.12206E9	231.507E6	1.83723E9	104.118E6

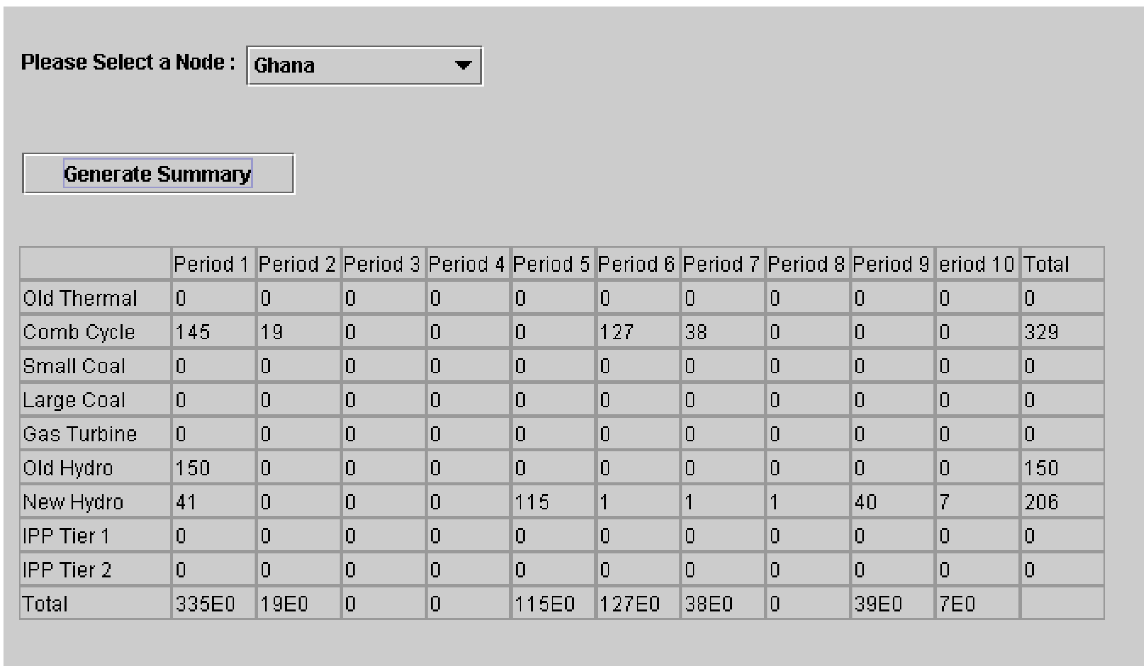
The Cost Summary is powered by the data stored in the following vectors : CostDataType and CostDataTotalType. The class CostData defines the different categories of cost. In order to add a new cost type or remove an existing cost type, the CostData.CostDataType vector and CostData.CostDataParam should be changed. CostDataType contains the cost category to be displayed on the screen, while CostDataParam contains the GAMS parameters of the corresponding cost categories.

Since a grid format was required to show the data, a 2 dimensional array was used to store the data. CostSummary.summary, which is the 2 dimensional array which holds all the data. After populating the summary array, CostSummary.populateFromArray() method is called. This method cycles through all the cells in summary array and pastes the values onto JTextFields and JLabels, so that the data is shown in a tabular format on the screen. The vertical and horizontal positioning of the cells is hard coded at the moment. The hard coded values were used to ensure maximum utilization of the Panel space.

THE JAVA DEVELOPMENT SIDE: OUTPUT MENU

→ CAPACITY SUMMARY

Capacity Summary was created to emulate the Cost Summary output format, but would instead show all the different technology types and their capacities.



	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	eriod 10	Total
Old Thermal	0	0	0	0	0	0	0	0	0	0	0
Comb Cycle	145	19	0	0	0	127	38	0	0	0	329
Small Coal	0	0	0	0	0	0	0	0	0	0	0
Large Coal	0	0	0	0	0	0	0	0	0	0	0
Gas Turbine	0	0	0	0	0	0	0	0	0	0	0
Old Hydro	150	0	0	0	0	0	0	0	0	0	150
New Hydro	41	0	0	0	115	1	1	1	40	7	206
IPP Tier 1	0	0	0	0	0	0	0	0	0	0	0
IPP Tier 2	0	0	0	0	0	0	0	0	0	0	0
Total	335E0	19E0	0	0	115E0	127E0	38E0	0	39E0	7E0	

Capacity Summary follows the same code structure as Cost Summary. There is a class called CapacityData, which contains two vectors expanasionDataType and expansionDataParam. expansionDataType contains the data to be displayed, while expansionDataParam contains the GAMS parameters of the corresponding capacity types. If any of the display names need to be changed, they should be changed in the expansionDataType vector. If any of the GAMS parameters need to be changed, they should be changed in the expansionDataParam vector. Care should be taken that when a new capacity type is added, the parameter and display name should be added at the same index in both the vectors.

CapacitySummary has a 2 dimensional array which contains all the calculated values and the display names. This array is declared with a variable name summary. The method CapacitySummary.populateFromArray() is used to create the visual, tabular structure from the summary array.

TUTORIAL - QUICK START GUIDE

This tutorial will walk you through:

1.) Opening PowerTools v3.
2.) Creating a new model utilizing the template utility.
3.) Modifying the template slightly
4.) Running the modified model
5.) Viewing the results in your default web browser

Step 1.) Double Click on the PowerTools v3 Icon on your desktop. It should look like **Error! Reference source not found.**, below.

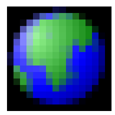


Figure 2

This will bring up the PowerTools v3 Main Screen, as below (**Error! Reference source not found.**).

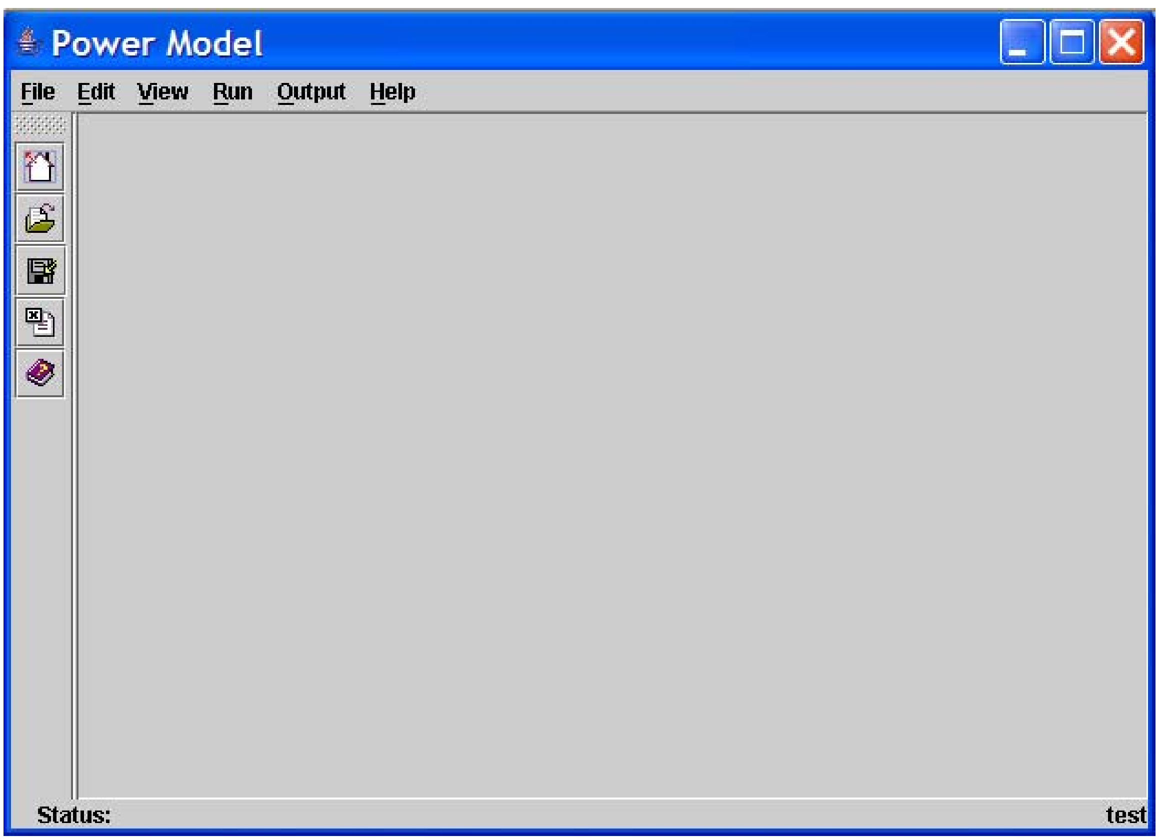


Figure 3: PowerTools v3 Opening Screen

Step 2.) From the File Menu (top of screen) Click on 'File' then 'new' then 'From Template' See

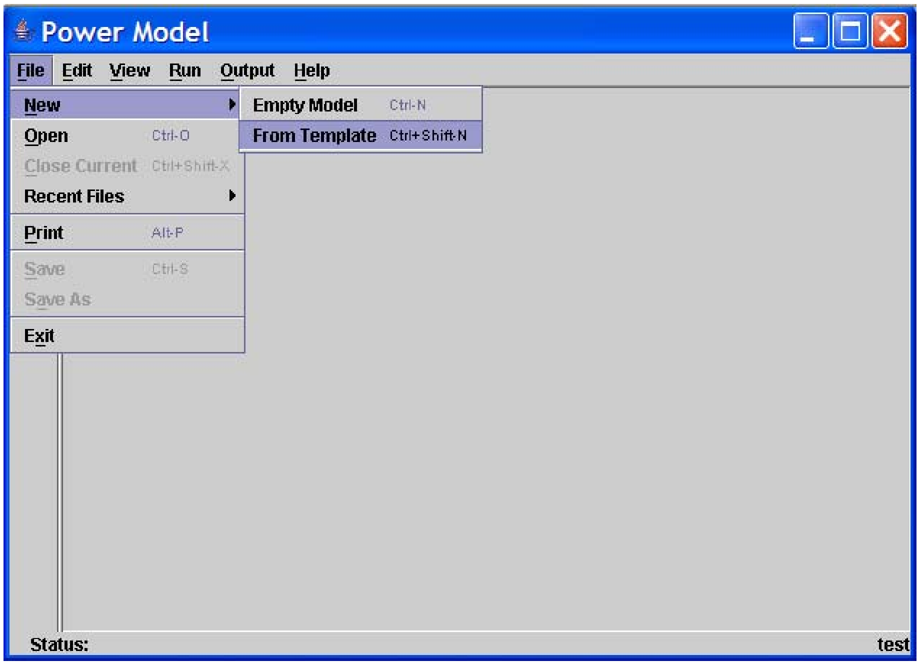


Figure 4: Creating a new model from a Template

This will bring up the 'Open Dialog', allowing you to select from the available templates. Click on '2node-wIPP.template.pt3' and then 'Open' (**Error! Reference source not found.**).

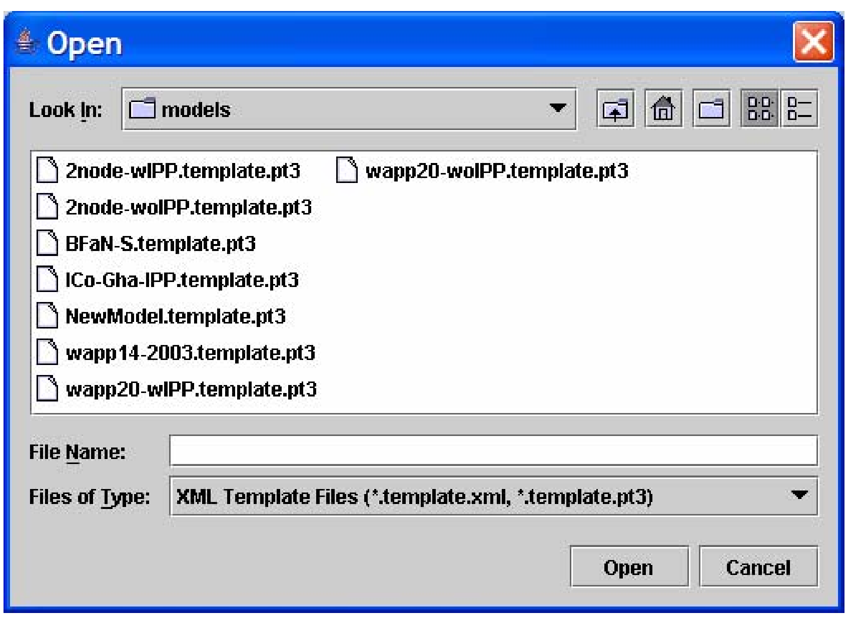


Figure 5: Open Dialog

Once the model is open, the interface will prompt you to save it under a new name. Enter 'quickstart' in the File Name field and click on 'Save' (**Error! Reference source not found.**).

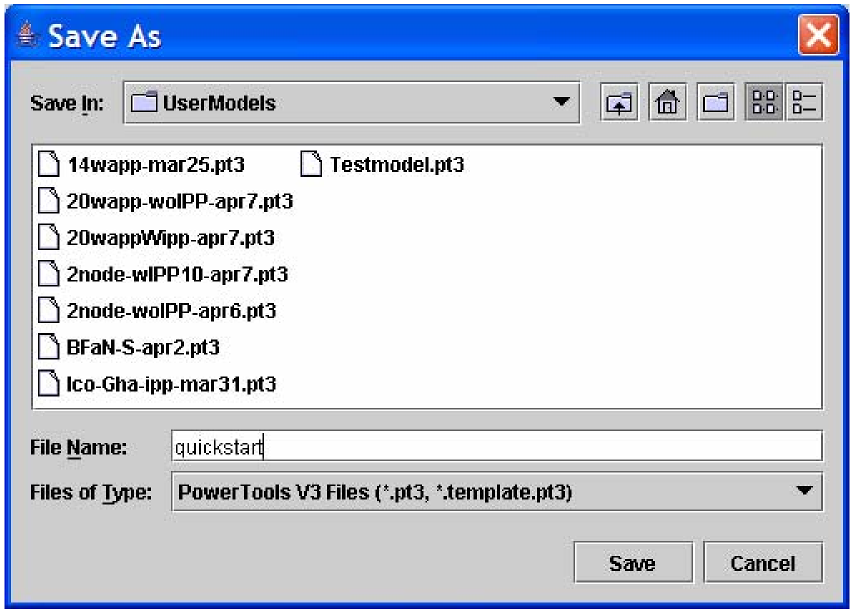


Figure 6: Save As Dialog

This will bring the model into edit mode, and display the Model Summary screen as in **Error! Reference source not found.**:

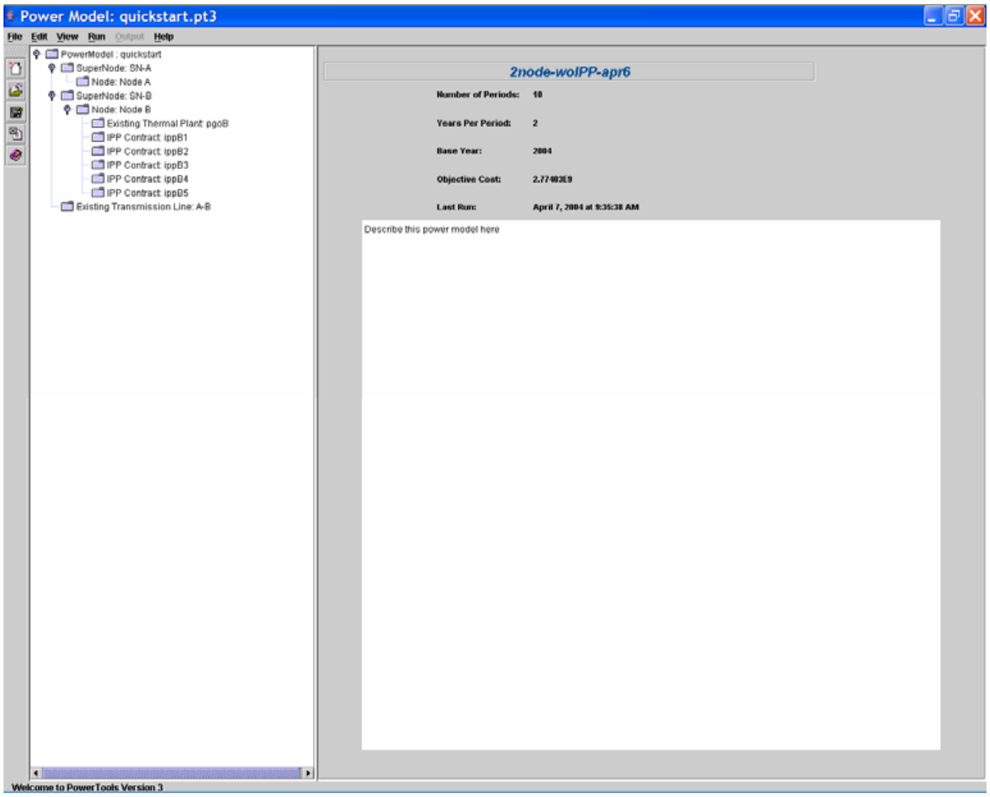


Figure 7: Model Summary Screen

Step 3.) Editing the model.

We are going to make a very simple change to this model. First, click on the 'PowerModel: quickstart' folder in the Tree Pane (the left panel), as highlighted in **Error! Reference source not found.**.

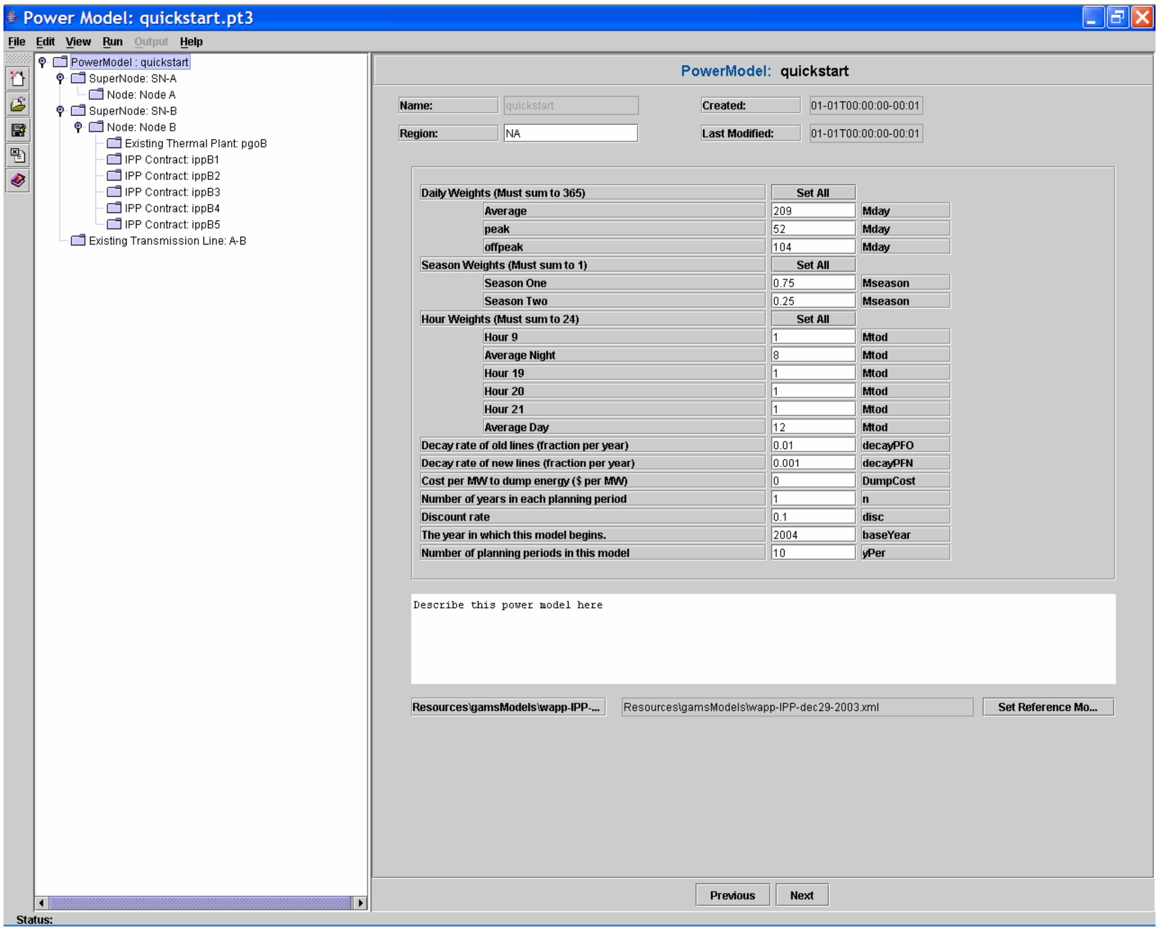


Figure 8: The Main Model Edit Panel

In the Edit Pane (right panel), click in the 'Number of Planning Periods in this model' field, in which the value is currently '10'. The full text will automatically be highlighted. Simply press the '5' key and the value will be replaced. Now save your changes by clicking on the image of the floppy disk on the icon bar (far left).

<u>Step 4.) Running the Modified Model.</u>

Now that the model has been saved, we can run it.
On the File Menu, click on 'Run', then click on the 'Run' sub-item.

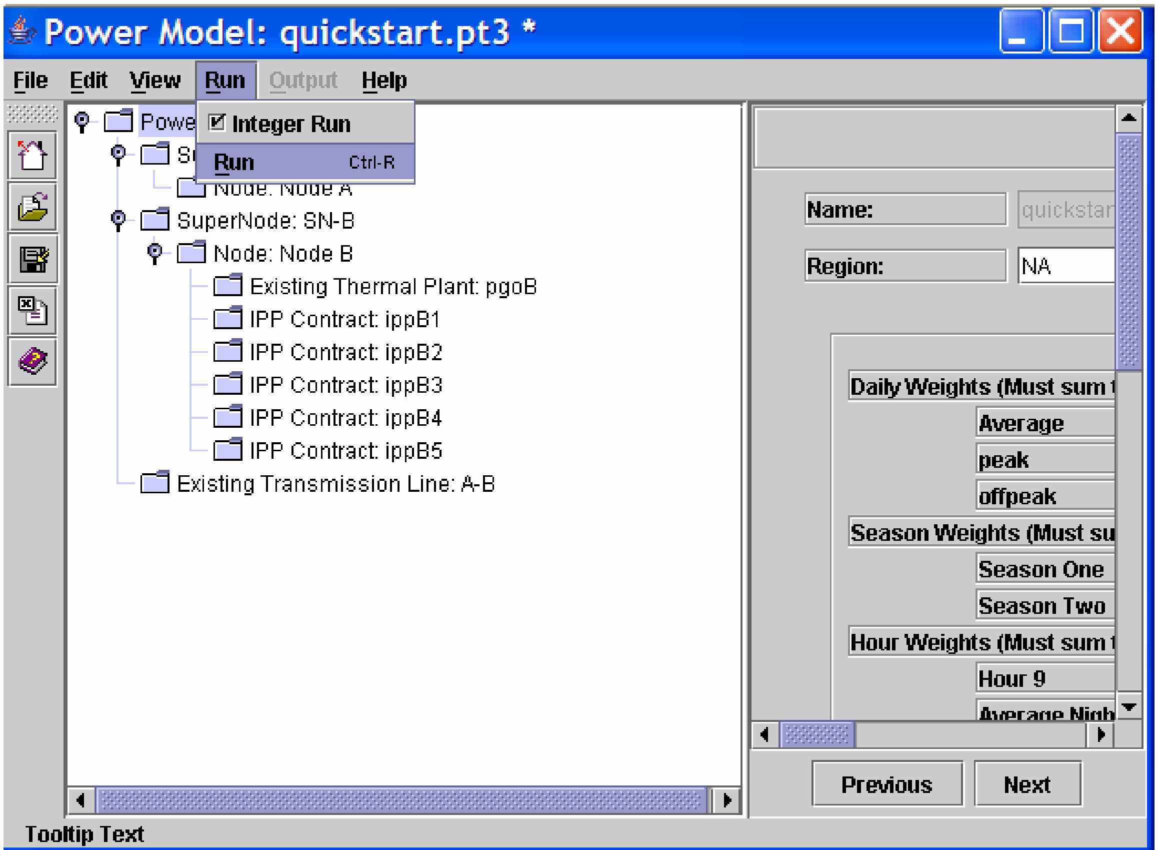


Figure 9: Running the Model

The run screen will pop up and keep you abreast of the progress. Large models can take hours to run. This model should only take a few seconds to a minute. When finished, the completion status dialog will take the progress screens place:

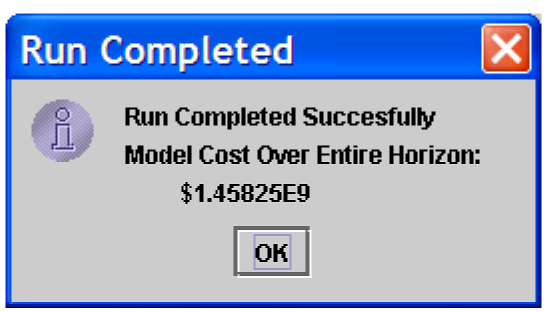


Figure 10: Completion Status Dialog

Congratulations. You have run your first model. Click 'Ok' to continue to the next step.

Step 5.) Viewing the Output.

Now to see your results: back on the main screen you will notice that the 'Output' item on the File Menu is now enabled – because now we have output data, whereas before running the model there was nothing to see. Click on 'Output' then 'Output Files' then on 'Model Summary' (see **Error! Reference source not found.**).

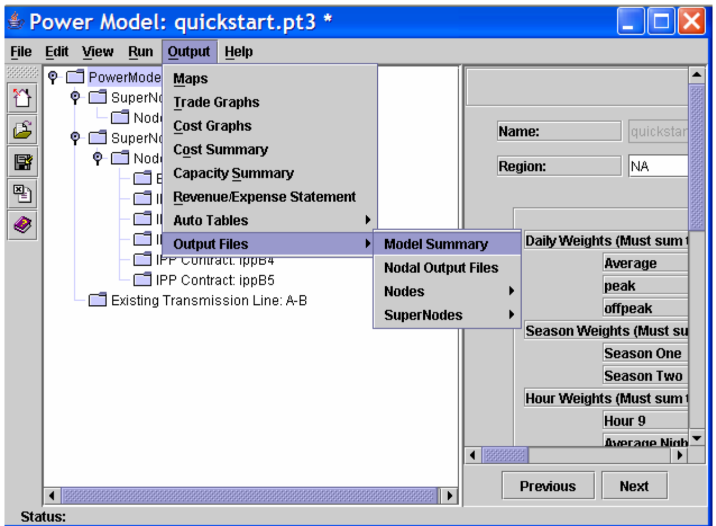


Figure 11: Opening the model summary

This will open your default browser (probably Microsoft's Internet Explorer tm). The screenshot below is from the Opera internet browser, but will be functionally similar:

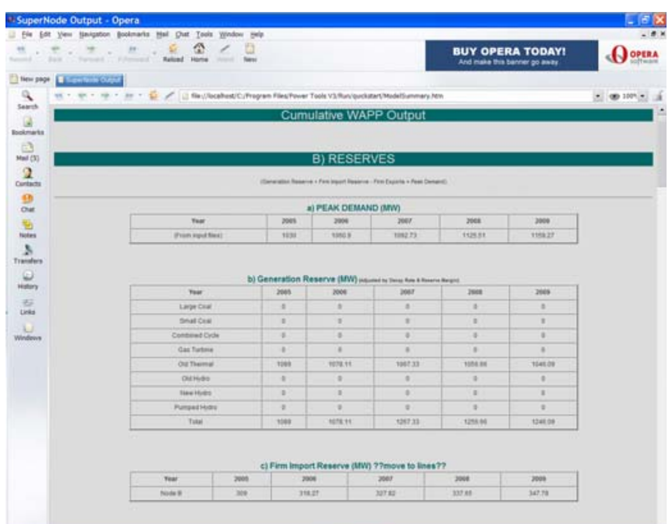


Figure 12: The Model summary

Now you just have to figure out what the numbers mean!
Feel free to play with the other output items in the Output menu.

This concludes the quick start guide. Have fun modeling!