

Hydropower Vision

Senior Design Group 15-08

Final Report

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Project Design

Our objective is to coordinate with the US Department of Energy and the National Renewable Energy Laboratory to help develop a long-term “Hydropower Vision”. The goal of this vision is to establish an analytical basis for responsible growth in domestic hydropower, and become a major source in the renewable energy market.

The project will give a detailed recommendation to the DOE Hydropower Vision. The recommendation will consist of many parts, the first being finding a prime location for Hydropower generation. This will then lead us to several other steps such as developing a power flow model and designing a new transmission line expansion.

Requirements

Technical Requirements:

In order for our project to be considered functional it must meet the following criteria:

- Our models must help in decision making of the expansion of hydropower in the United States and Canada.
- The report/power flow must be developed in a functional and easy-to-use fashion.
- Primarily, we must deliver a solution for each of our five main objectives shown in the following section

Business Requirements:

Although our project isn't directly being used by consumers, there are a couple of non-functional requirements that it should meet:

- It should represent Iowa State students and faculty in a positive manner by being written and developed in a professional manner.

Approaches

Design Approach:

Our main approach for this design is looking at existing hydro-generation facilities and various studies to see how much the facilities cost, their effect on the power grid, and their impact on the surrounding environment.

Validation Approach:

The primary source of validation for our work will be Professor McCalley. This will be done by keeping him updated on the progress of our project, so he can provide sanity checks on our various models and what we extrapolate from research.

System Block Diagram

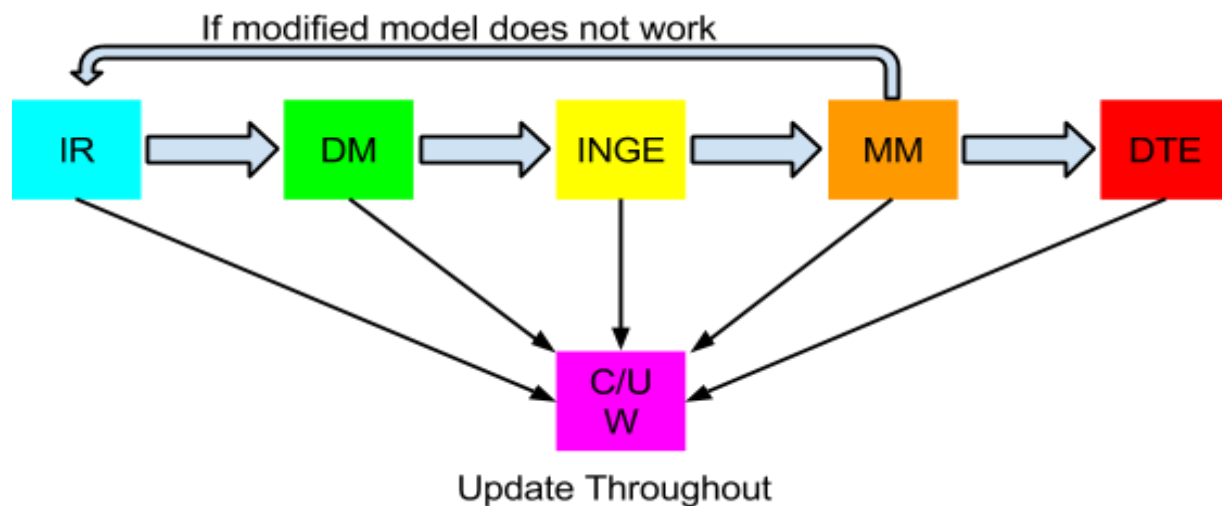


Figure 1: Hydropower Vision System Block Diagram

Identify Region (IR)

- In order to determine the best possible region for hydropower, we looked at a variety of locations, using research from a multitude of sources. After much discussion we decided that the Manitoba region in Canada was our best option.

Develop Model (DM)

- After much discussion with our adviser and other sources we determined that we will be using either a 13 or 62 node model using PLEXOS modeling software. This

will allow us to accurately predict the responses to the grid when developing additional hydropower in the Manitoba region.

Identify Non-hydro Generation Expansion (INGE)

- Look for other generators that are likely to be put in place in the identified region.

Modify Model (MM)

- Add both the new hydro and non-hydro generators to the previously developed power flow model.

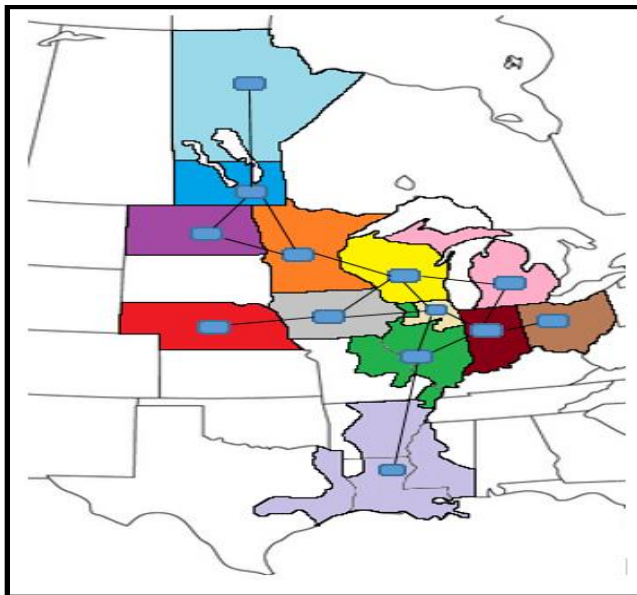
Design Transmission Expansion (DTE)

- Design transmission line expansion to connect new generation sources to the existing system.

Create/Update Website (C/U W)

- Use website to document all progress on the project.

Here is an example of the 13 nodes we used for both models.



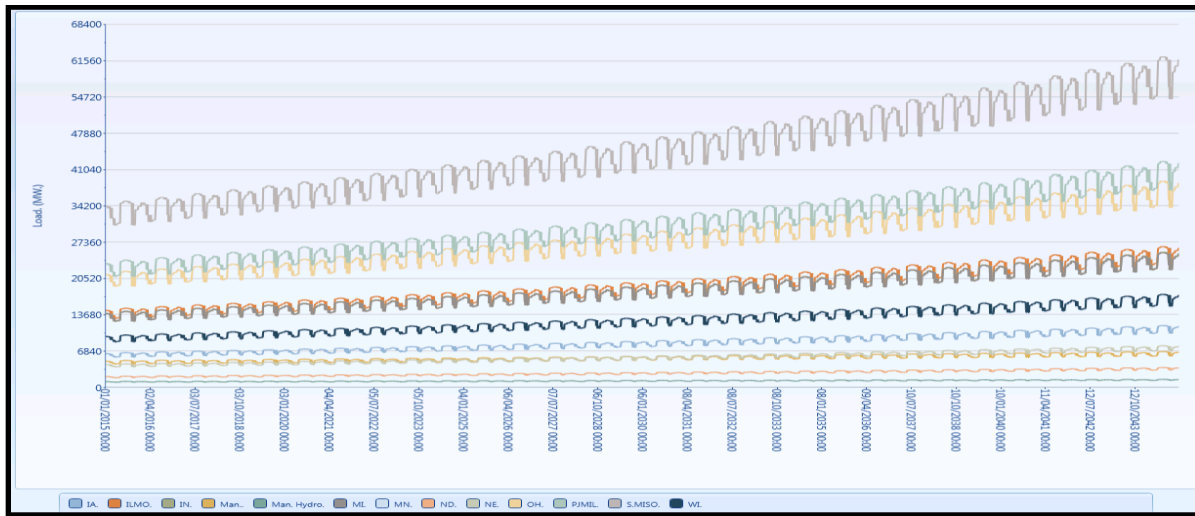
Implementation Details

Our senior design project is a little different in regards to being implemented in a straight-forward way. The best way to implement it is for the DOE and NREL to analyze the information we have developed, and in turn, use that information to help supplement a nationwide long-term hydropower plan.

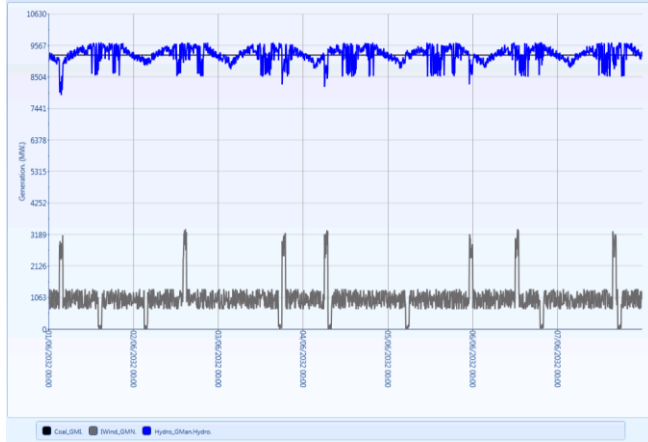
In the end we developed two models, one long term model and one model which ran every 5 minutes daily in 2032. Some of the results are shown below.

Long-term Model:

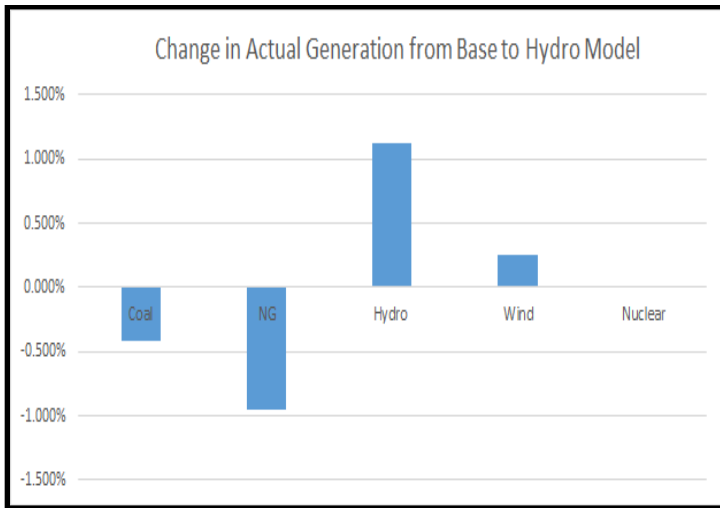
Developed Load Graph



2032 Model:



Generation of hydro, coal, and wind



Testing Process and Testing Results

Our testing process is essentially based upon a series of sanity checks in which we compare the results of our models to predictions made by energy agencies such as the Energy Information Administration (EIA) and Midwest Independent System Operator (MISO).

Appendix I: "Operation Manual"

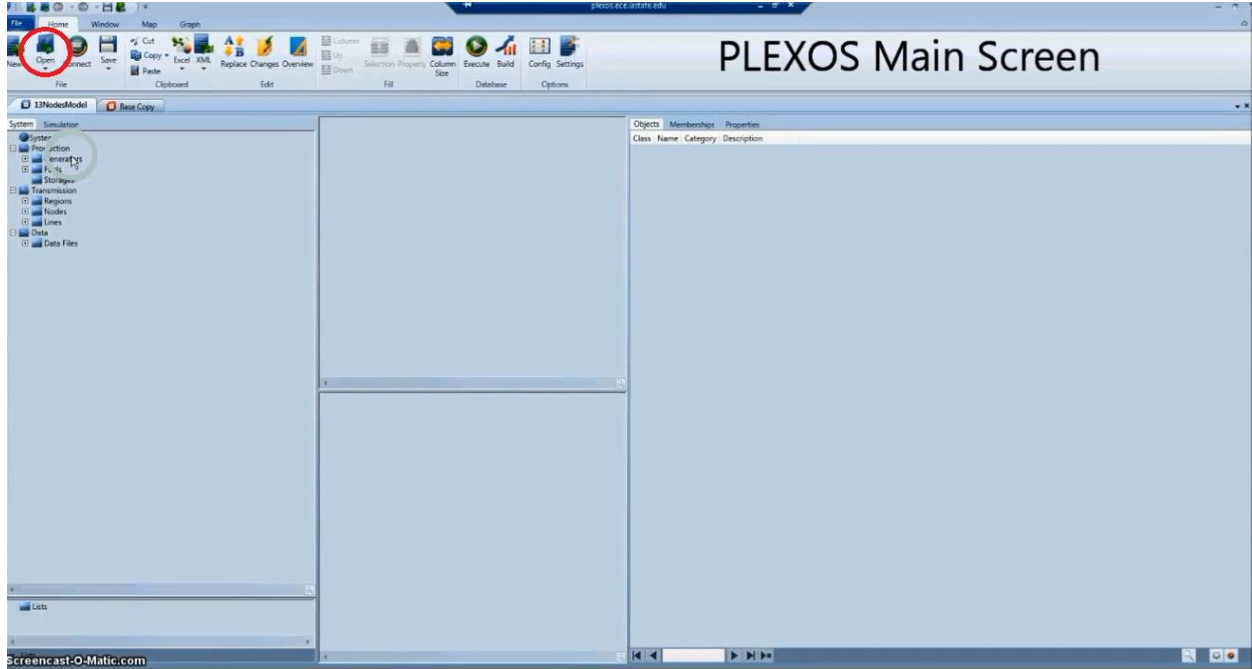
Our project does not contain the typical operation manual as other ones may have because it is essentially just running software. We will give a brief rundown of the process of executing and observing the results of one of our models.

Step One:

Open PLEXOS

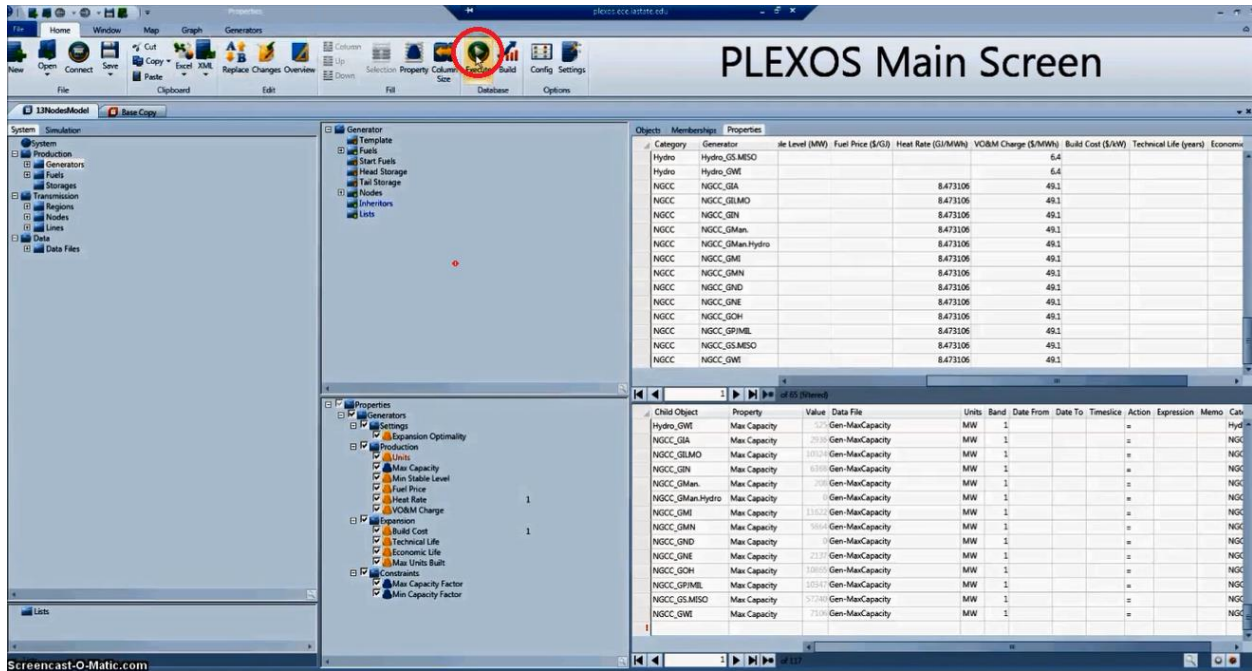
Step Two:

Open .xml file in PLEXOS



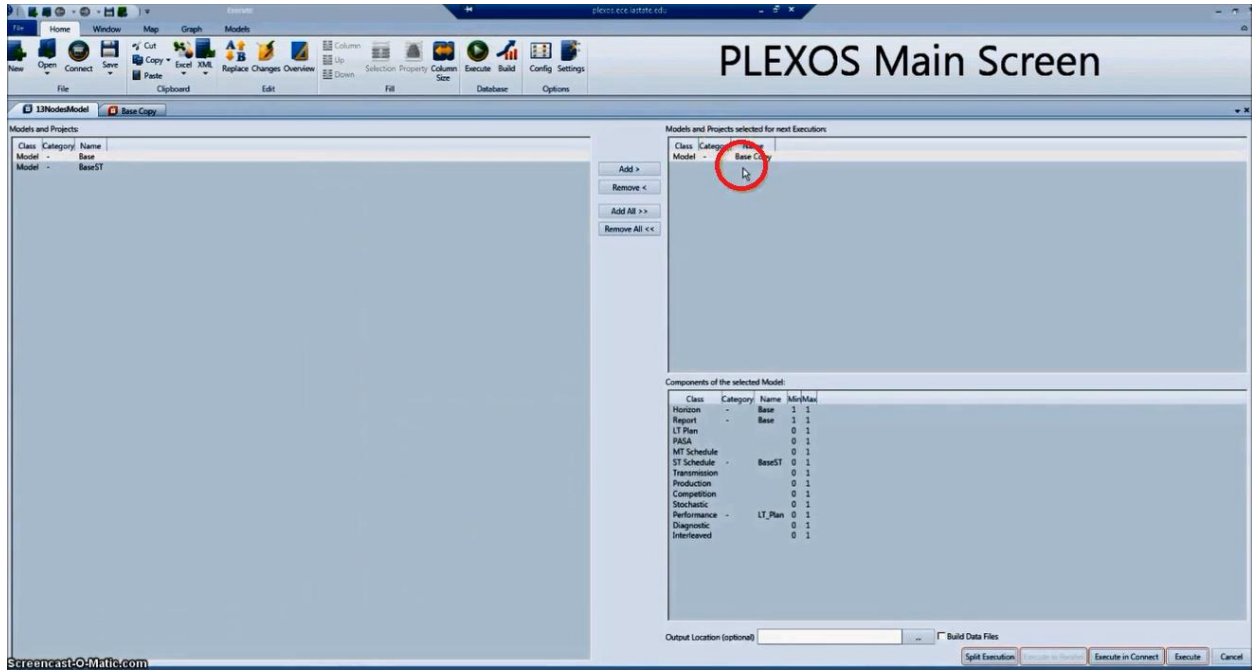
Step Three:

Click the "Execute" button in menu bar



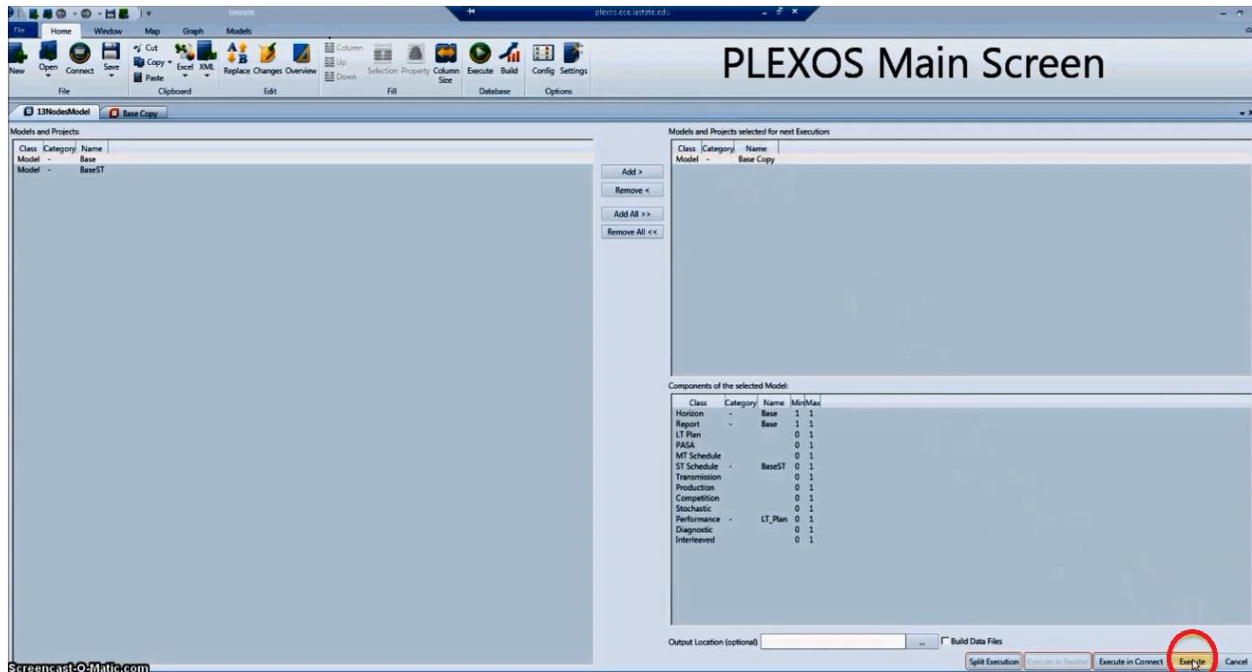
Step Four:

Make sure the “Base Copy” model is being run



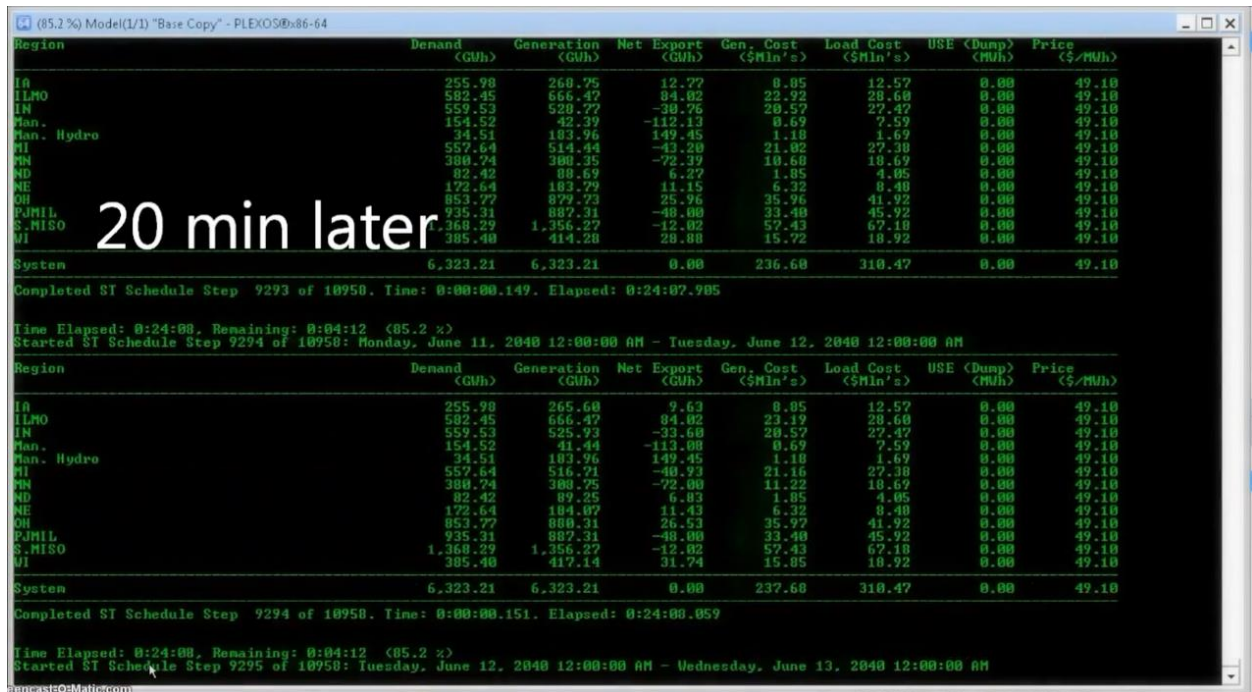
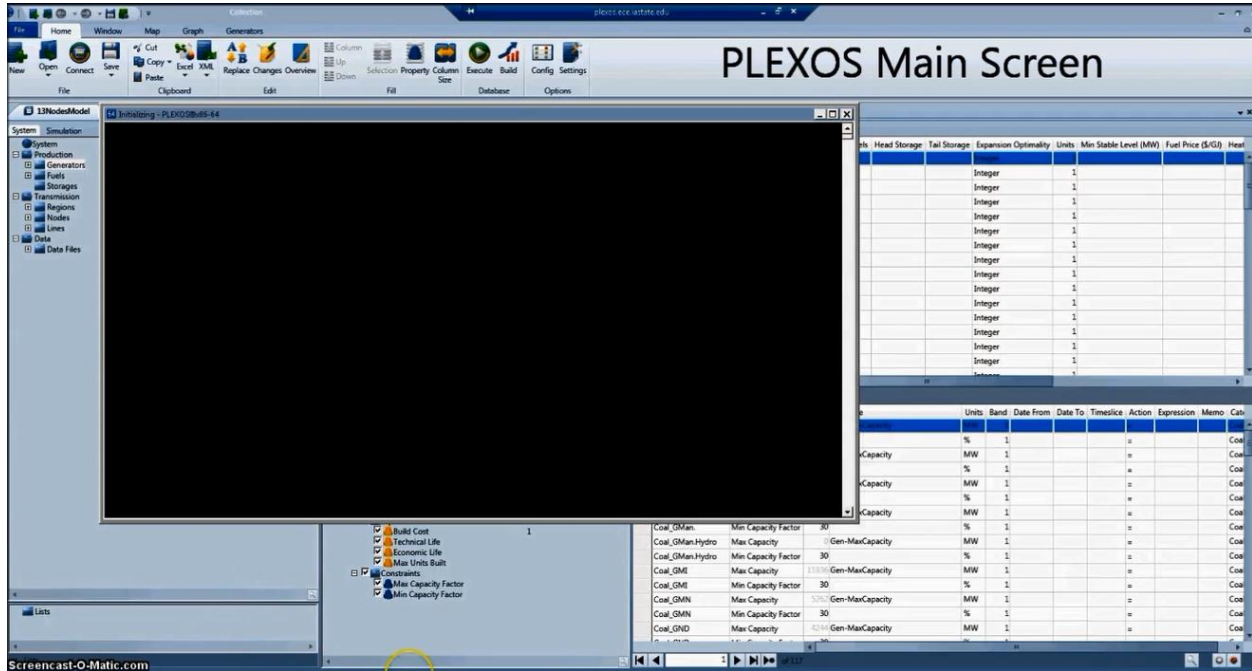
Step Five:

Click the “Execute” button in the bottom right of the program Window



Step Six:

A new Window will open up and run the 2016 or 10958 calculations (depending on model)



Step Seven:

Once done the program will prompt you to close the newer window

Step Eight:

In PLEXOS click “Open” and double click the “Base Copy” folder and double click “Base Copy.zip”

Step Nine:

Click on an aspect of the model you want to view from the middle column (e.g. Generation, Region, and Lines), and then in the most left column click on the information you want about the previously selected aspect (e.g. Price, Load, etc.).

Step Ten:

Hit the “Execute” button in the menu bar or “Execute to .csv” to send information to a separate file.

Step Eleven:

You can view the information in graph form by clicking on the “Chart” tab next to the “Data” tab.

Step Twelve:

Repeat steps Nine through Eleven.

Appendix II

We have learned some valuable info related to the MISO energy market and the overall U.S. power grid. Our group was very interested in this subject to begin with so being able to apply our previous knowledge and do some research was very helpful. We had some laughs along the way, especially with how ridiculous PLEXOS could be at times.