**USER’S DOCUMENTATION – OPTIMIZATION MODEL**

**Introduction**

The optimization model was designed as a user-friendly, Excel-based tool to allow for selected inputs to be modified based on the user’s needs. This management decision support tool was also developed to allow for quick and easy sensitivity analysis. The aggregate nature of the tool allows for a macro level view of decisions associated with nine specific potential locations for a biorefinery in the upper portion of the Lower Peninsula of Michigan. It was designed to provide fundamental information regarding optimizing cost, energy, and emissions, as outlined in the earlier sections of the report.

**Entry Screen Key**

The entry screen key is color coded to help denote the meaning of each of the cells. There are three different types of cells in the key: Input Cells, Calculated Cells, and Model Results. The key is shown in Figure O-1.



Figure O-1 Entry Screen Key

**Input Screens**

There are a series of input screens. These include:

* Cost
* Energy
* Emissions
* Availability
* Availability Adjustment Factors
* Facility Size, Conversion Rate, and Biomass Feedstock Requirement

**Cost**

The cost entry screen includes information for stumpage, harvest/processing, and transportation. The transport cost consists of two components: a cost per ton and a cost per ton per mile. At the time of the optimization model development, only transportation cost was available. There are entry boxes for stumpage and harvest.



Figure O-2 Input Screen for Cost Data

**Energy**

The energy screen includes information for harvest/processing and transportation energy consumption.



Figure O-3 Input Screen for Energy Data

**Emissions**

The emissions screen includes information for harvest/processing and transportation emissions.



Figure O-4 Input Screen for Emissions Data

**Availability**

The availability screen includes the region as noted in the map in Figure 10 along with the availability factor for federal, state, and private ownership. These factors can be modified and were provided from Task A1: *Develop a Geospatial Forest Based Biomass Inventory*.



Figure O-5 Input Screen for Availability by General Species and Ownership Type

Availability can further be classified by general characterization of roundwood or forest residues.



Figure O-6 Input Screen to Identify Percentages

The calculation will default the balance to roundwood for total supply of 100%. If residues are entered, the roundwood percentage would be reduced.

**Availability Adjustment Factors**

The adjustment factors were utilized to adjust for known competing uses that will be coming on line and operational in 2012+ timeframe. FRR stands for Frontier Renewable Resources, a biorefinery being constructed in the Eastern portion of the U.P. in Kinross, MI. FRR plans to purchase woody biomass from the upper portion of the Lower Peninsula of Michigan, and the estimated quantity is included in Figure O-7. This amount can be modified. Additionally, an adjustment factor for the planned operation of a biomass fired electric plant in Mancelona assumed to use softwood so the amount available for other uses is 80% of the softwood. Both the soft and hard wood residue and roundwood can be adjusted to account for competing uses.



Figure O-7 Adjustment Factors for Competing Uses

**Facility Size, Conversion Rate, and Biomass Feedstock Requirement**

In this study we used 50 MGY, 40 MGY, and 30 MGY sized facilities. Both the size and conversion rate (gal/ton) can be modified to compute the required biomass feedstock for a particular location. Each location calculation is independent and not all locations at the same time. Multiple location configurations will be shown later.



Figure O-8 Facility Size

**Update Model**

Macros and buttons were created to update the calculations in the model. Select one or more buttons to update the related information.



Figure O-9 Buttons to Update Model

**Model Output**

After updating the model, the Model Output screen will be updated showing average cost (in this example it is for transportation cost only), energy consumption, and emissions.



Figure O-10 Model Output Screen

**Multiple Locations**

There are three examples of possible multiple location configurations shown in Figure O-11. This allows the user to modify the size of the locations as well as the conversion rate for biomass feedstock. This is an advanced function. Given all the possible combinations, if further combinations are required, this will require additional modeling.



Figure O-11 Example Multiple Location Configurations

**Update Model**

Macros and a button were created to update the calculations in the model. Select the button to update the related information.



Figure O-12 Button to Update Model

**Model Output for Multiple Locations**

After updating the model, the Model Output screen will be updated showing average cost (in this example it is for transportation cost only.



Figure O-13 Results for Multiple Location Configurations