Interactive Dashboard for Analyzing the Wood Pellet Markets in South Korea and Japan

Description and User Manual

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by FutureMetrics

Contents

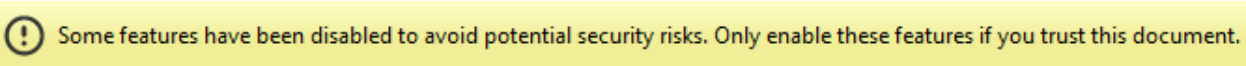
Initially Opening the Dashboard

The dashboard is available online and as a subscription based standalone application that can be installed on a PC.

In both cases, Adobe Flash is required.

When opening online in a web browser, the user will probably have to allow Flash to run by clicking on one or more permission prompts. The dashboard will then run. The "scenario" feature does not work on the online version.

If using as a standalone application, the dashboard is embedded in a PDF file. The local computer must have the Adobe Acrobat or the Adobe PDF Reader and Adobe Flash installed. When the dashboard is initially opened by Adobe Acrobat or Adobe Reader you will be prompted as shown below.



Click on "Trust this document always" and then click once more anywhere in the blank page to allow the dashboard to initialize.

Calculating the Ability to Pay for Pellet Fuel

The dashboard analysis is based on calculating the estimated levelized cost of energy (LCOE) from generating by co-firing with coal and pellets or full firing with 100% pellets, and then comparing that to the estimated revenues from power sales plus the subsidy. If the difference is negative (i.e., revenue minus costs is negative) then the power plant will not have an incentive to use pellet fuel.

The ability to pay for pellet fuel is dependent on several variables. Some of those variables are the same for both Japan and South Korea: the cost of thermal coal, the price for wholesale electricity, the delivered cost of wood pellets, inflation rates, and the co-firing ratio.

In general, the higher the co-firing ratio the more sensitive the generator is to the impacts of the support scheme and the less sensitive they are to the cost of coal and the non-subsidized price for the electricity they sell. For new build dedicated pellet fueled power stations, the cost of coal does not influence the model. The wholesale price of power does matter for a S. Korean power producer but for 100% pellets in Japan all the power sales revenue is from the feed-in-tariff (FiT).

There are many combinations of inputs to calculating the ability to pay. The FutureMetrics dashboard, in real time, allows all of the critical inputs to the model to be varied. In real time, the user can see those scenarios that result in positive outcomes (where power sales revenues exceed the LCOE). For both Japan and S. Korea, the long-term outcomes can be viewed on a chart that also updates in real time with changes to critical inputs. After the user has set up a set of inputs, the scenario can be saved for future reference (the scenario function only works for the subscription based standalone version that is saved on a local PC as an Adobe PDF file).

The Main Input Window

Critical to the pellet producer/supplier, is the cost to the power station of delivered wood pellets. For both S. Korea and Japan, the "gate price" or the price to the pellet producer before all transport costs can be adjusted to see the impact on the net of LCOE and revenues.

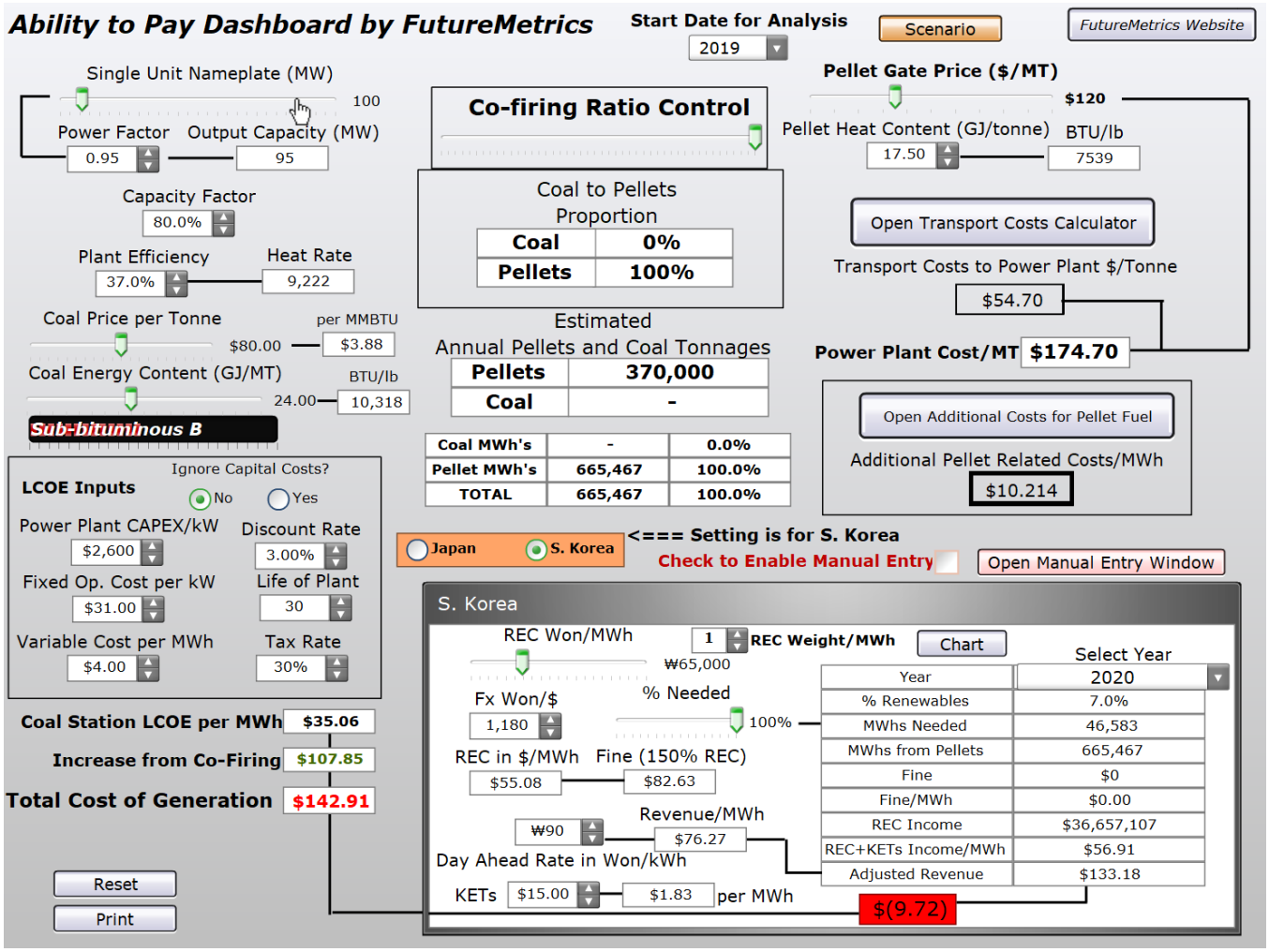
Since there are many possible scenarios, some favorable and others not, only a few potential scenarios will be illustrated. The example scenarios are after the description of the dashboard on the next several pages.

The main input interface with the default settings is shown on the next page. The default settings for the S. Korea analysis show an unfavorable outcome for 100% pellets at the default delivered cost per tonne. Changing critical inputs such as the gate price and transportation costs per tonne, the price of RECs, and the co-firing ratio can move the bottom line from the red (at negative $9.72 per MWh) to the green.

The default starting year for the analysis is 2019. That can be changed using the control at the top of the dashboard.

If using the locally installed subscription version of the dashboard, the default opening screen can be changed using the "**Scenarios**" button in the upper right of the dashboard. **The Scenarios button can also be used to save and load settings that the user has decided to save for future reference**.

The user also has the option to manually enter critical parameters by year rather than the default settings. The default has one initial setting for each critical parameter that changes each year based on the annual adjusters. **Note that the scenario function and the ability to manually enter individual yearly parameters are not available on the free online version**. There is more on the manual option later in this user manual.



Overview of the Dashboard

This dashboard calculates the levelized cost of energy (LCOE) for a coal fueled power station or for a dedicated new build pellet fueled power station. The dashboard calculates the delivered cost of wood pellets. Using the delivered cost of wood pellets, the model calculates the increase in LCOE from blending wood pellet fuel with coal or the LCOE for the new build dedicated pellet fueled station. The dashboard calculates the revenue per megawatt-hour (MWh) for South Korea or Japan based on the feed in tariff (FIT) for Japan, and the renewable energy certificate (REC) revenues and/or the penalties for failure to comply with the renewable portfolio standards (RPS) for S. Korea. If co-firing, the revenue from the coal generated portion of the MWh's is based on the wholesale power price.

The revenue is compared to the cost of generation (per MWh). If the difference is negative (in the red), then there is no incentive to use pellets. If the difference is positive (in the green), then the power station has an incentive to use pellets. The user can adjust all the critical inputs to the model to explore combinations of inputs that result in a positive difference between revenue and cost.

All of the "spinner" controls on the dashboard can be changed using the control's adjustment arrows up or down. They can also be directly changed by clicking into the data display of the spinner control and

typing in the desired value. The controls all have lower and upper limits that may preclude some directly typed in values.

Calculating the LCOE

The levelized cost of energy (LCOE) is one of the utility industry's primary metrics for the cost of electricity produced by a generator. It is calculated by accounting for all of a system's expected lifetime costs (including construction, financing, fuel, maintenance, taxes, etc.), which are then divided by the system's lifetime expected power output. All cost and benefit estimates are adjusted for inflation and discounted to account for the time-value of money.

The dashboard has inputs for the key characteristics of the power station in question. Nameplate capacity, capacity factor, and plant efficiency can be adjusted. Coal price per ton and the type of coal and energy content of the coal can be adjusted. The LCOE inputs also include the coal or pellet fueled plant's original capital cost (CAPEX), the fixed cost per kW, the non-fuel variable cost per MWh, the assumed tax rate, and the inputs for calculating the amortized capital cost (discount rate and assumed life of the asset).

Calculating the Delivered Cost of Pellet Fuel

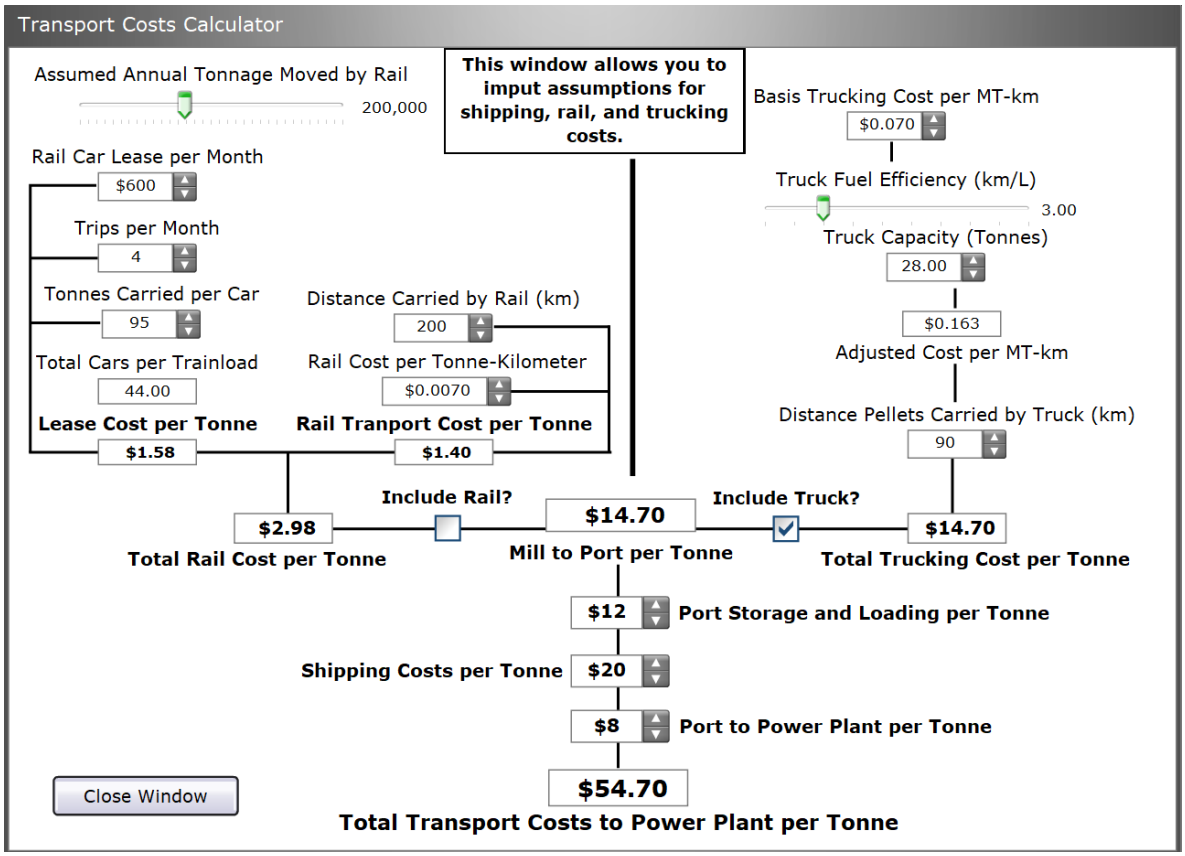
The upper right of the dashboard has the inputs to the delivered cost of fuel. The calculation begins with the gate price of the pellets. The gate price is the price received by the producer before any mill-to-port or port and shipping costs. There is also an adjustment for the energy content, in gigajoule (GJ) per metric tonne of the pellets.

Clicking on the "Transport Costs Calculator" button opens a new window. Transport from the mill to the port can be by either rail or truck or both. The upper portion of the window allows the inputs to be adjusted for calculating the cost per tonne to move the pellets from the pellet mill to the port.

The additional costs per tonne for port storage and loading, shipping, and transport from the foreign port to the power plant can be adjusted. The result is the estimated cost from pellet mill to power plant.

The sum of the gate price and the transport costs yield the delivered cost per tonne to the power plant.

Below is a screenshot of the transport cost calculator.



Calculating the Power Plant Modification and Pellet Fuel Storage Costs

Clicking on the "Open Additional Costs for Pellet Fuel" button opens a new window. The window contains the critical inputs for estimating the cost of a full conversion of a pulverized coal power plant to a plant running on 100% pellets. **Note that if the project being studied is a new build dedicated pellet fueled power plant, the modification cost should be set to zero and the CAPEX per kW on the main input window should be set to reflect the cost to build the new power station.** The storage cost (see following paragraph) is calculated separately for all scenarios.

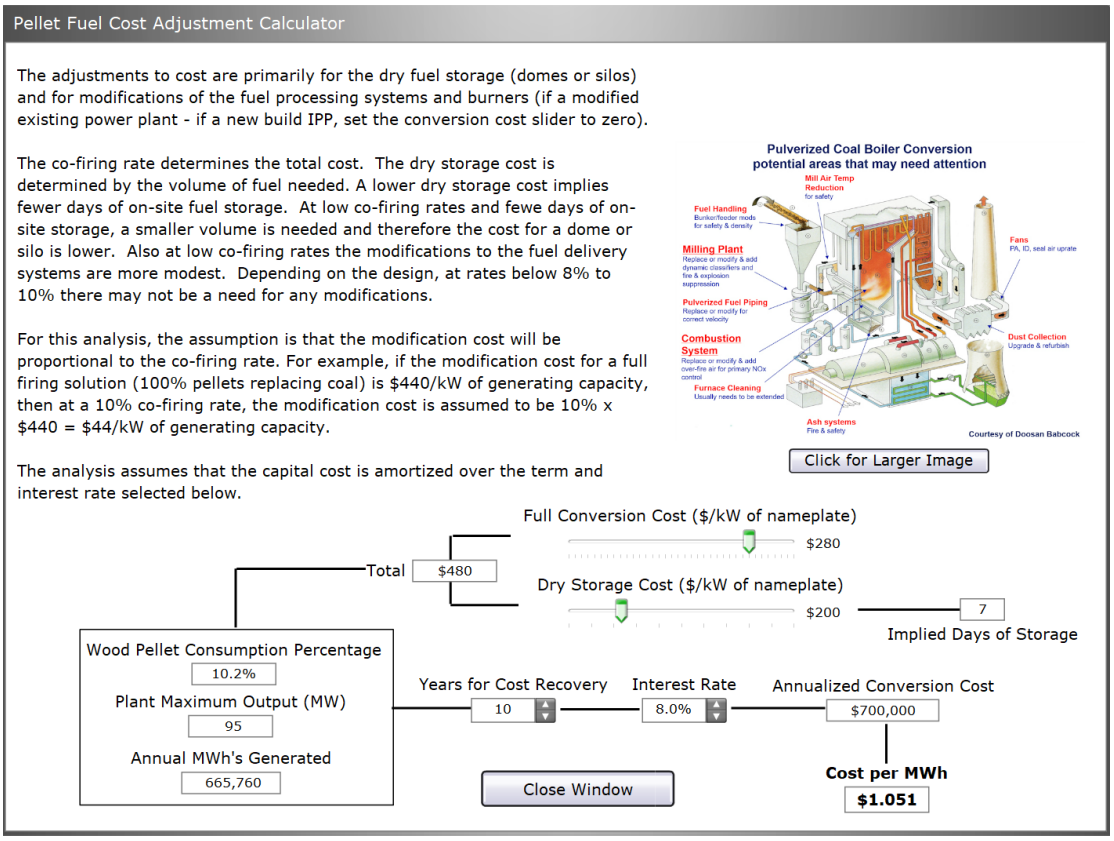
The full conversion cost is used to estimate the costs of modifications for existing PC power plants at all co-firing ratios. The dashboard model simplifies the estimation of the cost per MWh of power plant capacity of the modifications by assuming that the cost is a linear function of the co-firing rate.

The total conversion cost per kW of power plant nameplate capacity is the sum of the in-plant modifications and the cost of building dry fuel storage and handling for the wood pellets.

The estimated cost of the dry storage is a function of the size of the storage solution (domes or silos) expressed in the dashboard as the implied days of fuel storage on site.

The total modification/conversion and storage costs are a function of the co-firing rate. That value is amortized over the number of years selected for cost recovery with the selected discount rate to yield the cost per MWh of modifying the station and building pellet fuel storage. **If the project is a new build dedicated pellet fueled plant, the cost is only that of the pellet fuel storage (be sure to zero out the conversion slider)**.

Below is a screenshot of the modification cost calculator with the co-firing ratio set to about 10% from the main input window.



The Total Cost of Generation

The LCOE based on a 100% PC fueled plant but will adjust as the co-firing ratio is changed. In the case of a new build pellet fueled plant based on 100% wood pellets, the LCOE is added to the cost of co-firing. The cost of co-firing or full firing per MWh includes the fuel costs reflecting the mix of coal and pellets, and the costs to modify the power station and build the pellet fuel storage systems.

The Co-firing Ratio

In the upper center of the main input window of the dashboard is a slider control that changes the coal to pellets ratio. Based on the inputs describing the coal plant and type of coal used as fuel, the estimated annual tonnages are displayed. The annual MWh's generated from coal, pellets, and the total of the two is also displayed. **Set the slider to 100% pellets for a new build dedicated pellet fueled power plant or for a PC plant that in fully converted to operate on 100% pellet fuel**.

The Country Specific Windows for S. Korea or Japan

Either S. Korea or Japan can be selected. Both windows allow for inputs for key criteria for calculating the estimated revenues, in dollars per MWh, to the power plant. The yen or won values are converted into US dollar values using the exchange rate (Fx) controls. The revenues are compared to the total cost of generation. The "day ahead" or spot rates for the wholesale power sales from the power plant can be adjusted.

S. Korea

The S. Korea window is more complicated than the Japan window in terms of calculating the estimated net revenue or loss. The S. Korean's currently do not have a long-term subsidy scheme. There are no fixed rates as with the Japanese FIT scheme.

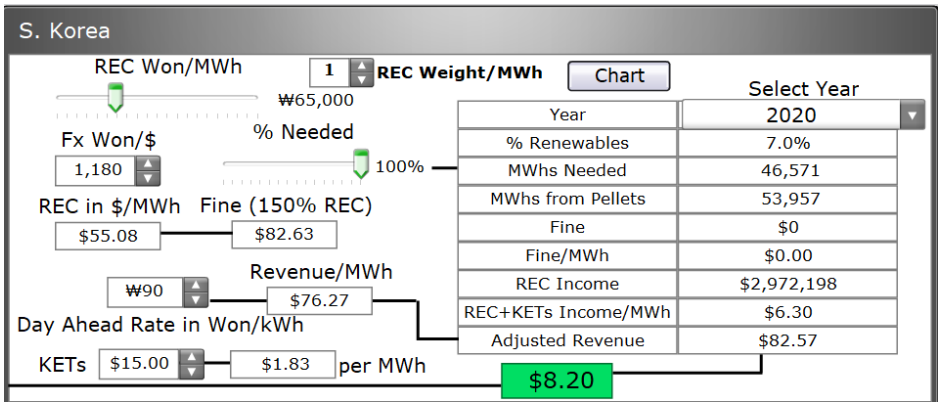
S. Korea incentivizes power producers to produce a certain proportion of power from renewable sources. In the upper right corner of the S. Korea window, the year that is to be investigated can be selected.

There is both a "carrot" and "stick" for the power producers. The carrot is that for every MWh generated from renewable sources (wind, solar, biomass) the producer receives a renewable energy certificate (REC). The stick is that for every MWh that the utility is short of meeting the required proportion of their power generated from renewable sources, the utility must pay a fine equal to 150% of the average previous year's REC price.

The default assumption in the dashboard is that the coal power plant is responsible for compliance to the RPS. That is, the full percent of renewables required by the RPS is the power plant's responsibility. The utility may not need the full percent to be in compliance if its solar and wind generation is producing sufficient MWh's. The percent that the power plant is contributing to the RPS obligation can be adjusted using the "% Needed" slider.

The S. Korea window has inputs of the REC price in won/MWh that can be changed. The 2019, S. Korean REC prices have averaged about 71,000 won. July 2019 REC prices have averaged about 65,000 won.

Note that the REC weight can be adjust from zero to 2.0. In the example below, it is set at 1.0 and the co-firing ratio from the main input window is set to 10%. There is no fine as the MWhs from pellets is greater than the RPS requirement. In this example, the adjusted revenue is greater than the total cost of generation and thus the power station is in the green.



Using the day ahead rate and the REC price, the display shows the estimated revenue in US dollars per MWh to the power plant.

KETs is the Korean Emissions Trading Scheme. It is priced in dollars per tonne of carbon and that price is market derived base on the supply and demand for KETs. The spinner allows this to change and shows the equivalent value in dollars per MWh.

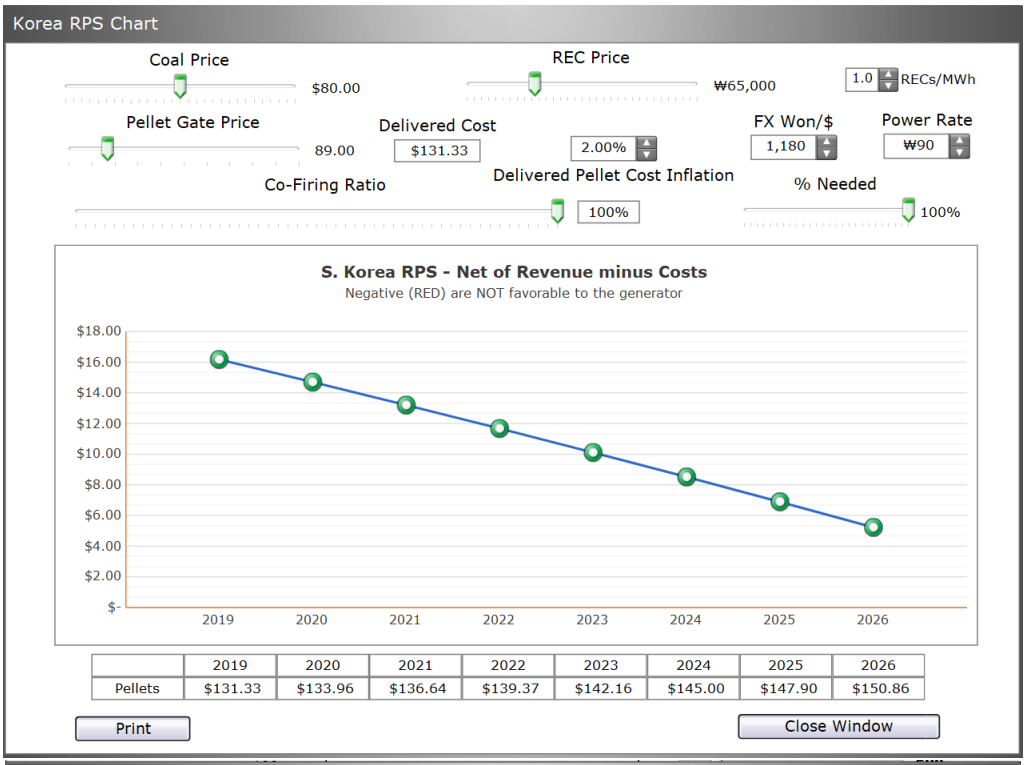
The revenue per MWh is calculated from the day ahead rate. It is then adjusted by the monetary fine, if any, from the shortfall in MWh's under the RPS, the revenue from selling the RECs into the RPS system, and avoided tonnes of carbon into the KETs.

The difference between the estimated revenue and total costs of generation is displayed as red or green (negative or positive).

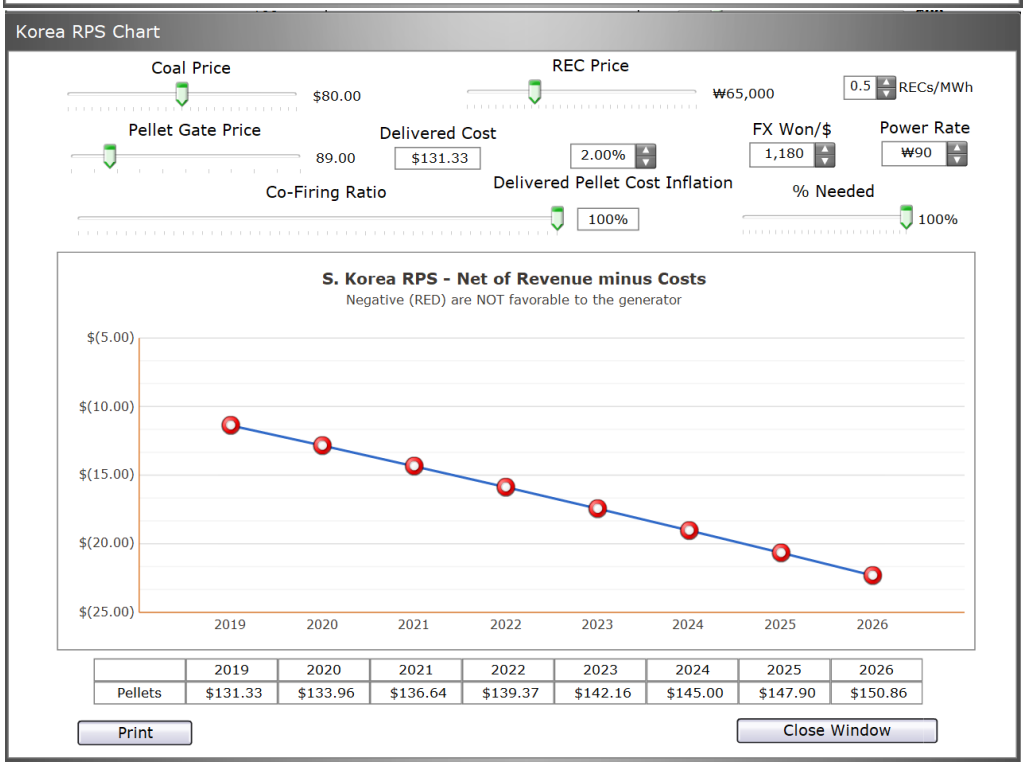
The dashboard allows the adjustment of inputs to find those inputs that yield a positive difference between revenue and cost.

The "Chart" button opens a chart showing the years from the selected starting year. The user can change the model assumptions and observe the impact on the net of revenues minus costs.

The screenshot of the chart below shows that with the REC weighing set to 1.0 REC per MWh, REC price to 65,000 won, and delivered pellets, pre-transport from port to power plant at about the current estimated price (see page 6), the full dedicated conversion (100% pellets) will have positive but declining cash flows. The second chart below shows the same set of input but with the REC weighting set to 0.5 (the new policy value for planned dedicated pellet fueled power plants0.



	2019	2020	2021	2022	2023	2024	2025	2026
Pellets	$131.33	$133.96	$136.64	$139.37	$142.16	$145.00	$147.90	$150.86



	2019	2020	2021	2022	2023	2024	2025	2026
Pellets	$131.33	$133.96	$136.64	$139.37	$142.16	$145.00	$147.90	$150.86

The second case will not happen as the power plant would be losing significant amounts for every MWh generated.

Japan

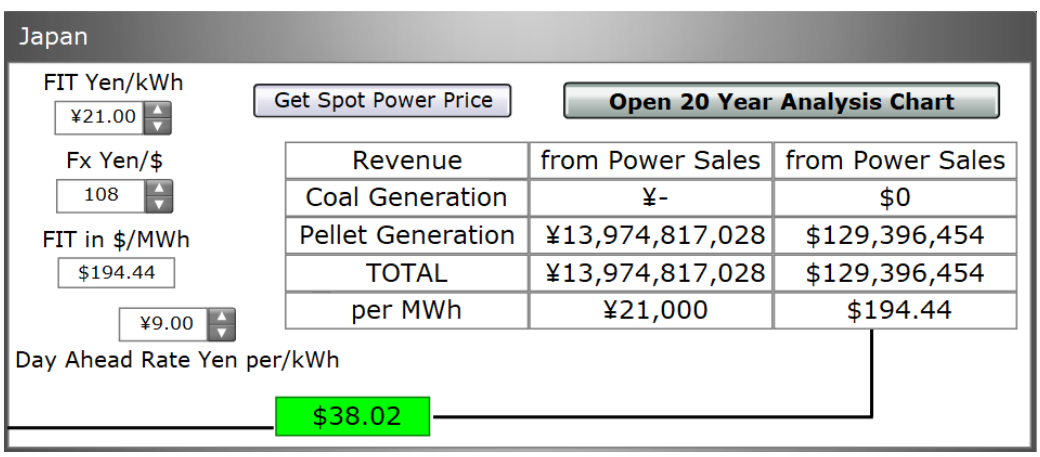
The Japanese feed-in-tariff (FIT) is supporting the use of wood pellet in Japanese power plants. The FIT for power plants using biomass, including wood pellets for some projects was 24 yen/kWh. However, that rate was lowered to 21 yen/kWh beginning in October 2017. The FIT control on the dashboard allows this to be changed. The default is 21 yen/kWh.

Currently only the independent power producers (IPP's) sell power under the FIT. The power plant size slider in the upper left can be moved to reflect the smaller IPP plants. **The co-firing ratio can be set to 100% to model those IPP's that will be using all wood pellets rather than PKS or other biomass fuels. <u>Be sure to also set the modification cost to zero for IPP dedicated new build plants</u>.**

The Japan window displays the estimated revenues to the power plant based on the blend of coal and pellets with the total a weighted average of the day ahead rate and the FIT. Clicking on the "Get Spot Power Price" button will open the web browser to the Japan Electric Power Exchange where real time day ahead rates can be viewed.

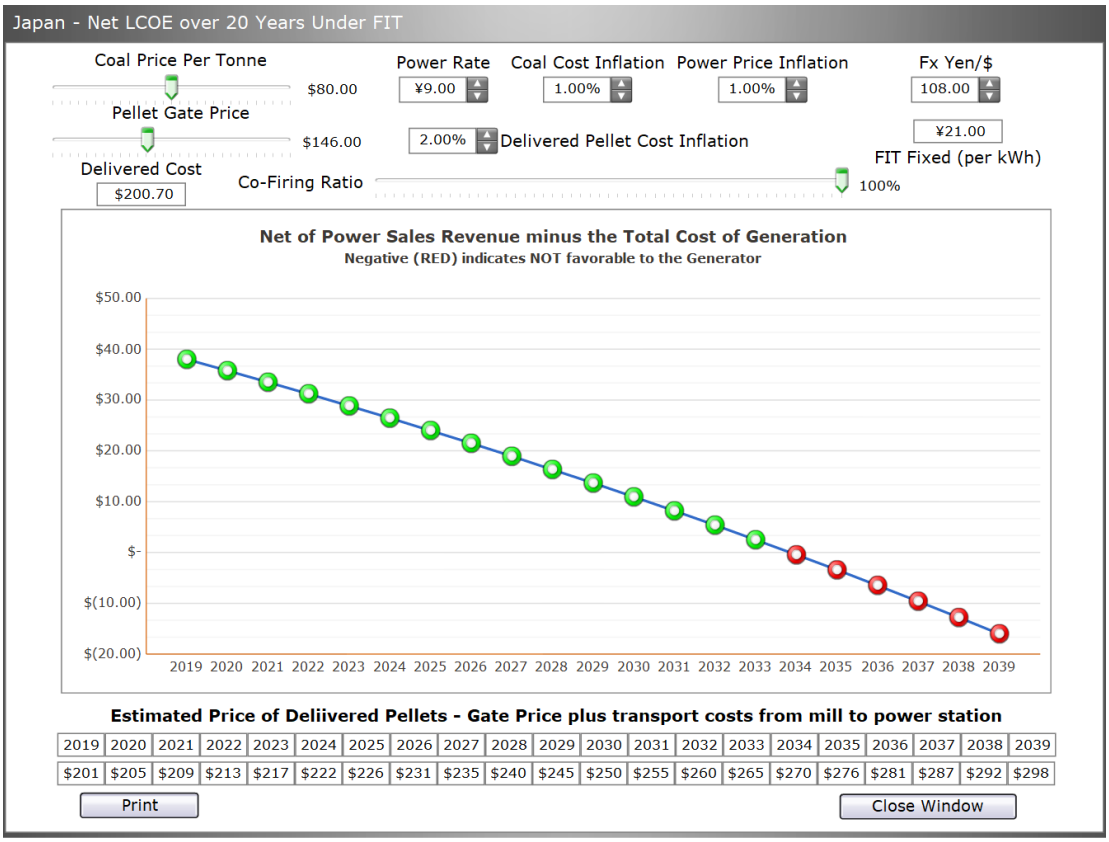
The difference between the estimated revenue and total costs of generation is displayed as red or green (negative or positive). The Japan window seen below shows the power sales from coal and pellet generated electricity in both yen and dollars.

The dashboard allows the adjustment of inputs to find those inputs that yield a positive difference between revenue and cost. In the example below with the delivered price of pellets approximately equal to FutureMetrics' estimate (using the same method as that for the S. Korean estimate on page 6), the Japanese power station using 100% pellets will have a positive cash flow of about $38/MWh.



Because the FIT is fixed (i.e., there is no inflation adjustment over the 20-year term of the FIT), it is important to look at the expected relationships between the costs of generation and the expected revenues over 20 years. The button labeled "Open 20-year Analysis Chart" allows the user to see the impacts of changing the model's assumptions, including inflation rate assumptions. In general, the higher the co-firing ratio and therefore the more important the FIT rate per kWh is to the total revenue, the more likely that the difference between the estimated revenues and the total costs of generation will be negative if costs escalate too much. The chart begins at the selected starting year.

Below is a screenshot of the 20-year analysis chart. In the example, the cash flows go negative in 2034 (about 15 years into the 20-year life of the FiT).



Manual Entry of Key Parameters

This feature is only available in the subscription version of the dashboard.

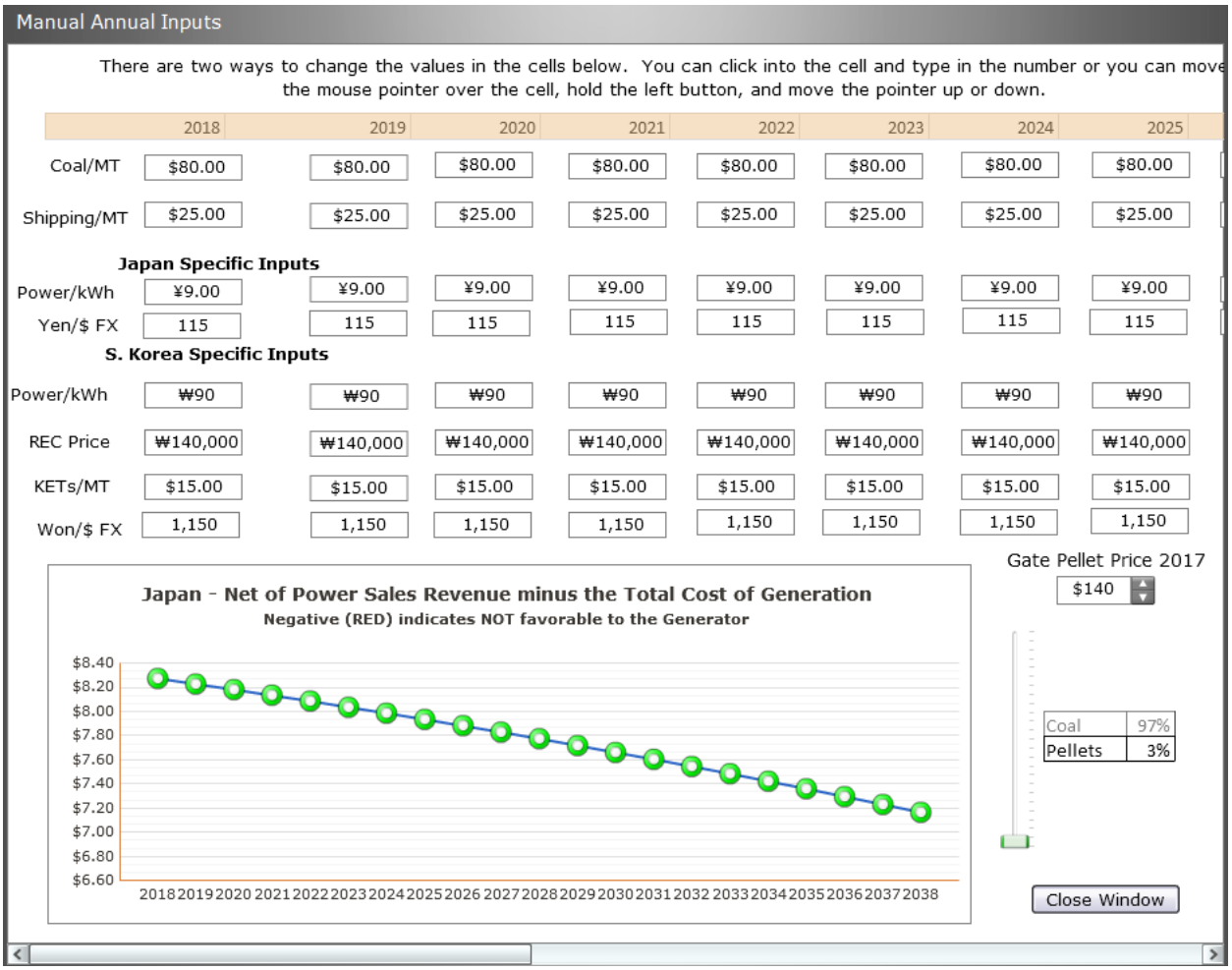
Clicking on the "Check to Enable Manual Entry" button on the main screen changes how the model calculates the annual net cash flows from using starting inputs with set annual adjusters to using inputs for each year and each critical input parameter. Clicking on "Open Manual Entry Window" opens a new window that allows manual entry for the key input parameters for each year. Each cell shown in the image below can be independently changed.

The cells can be changed by double clicking into the cell and typing in the new value or by putting the mouse pointer over the cell, holding down the left mouse button, and moving the mouse up or down to increase or decrease the value.

The co-firing ratio and the gate pellet price can be changed within this window.

Depending on which country is selected, the chart for that country is displayed on the manual entry window so the user can see the impacts on the chart in real time.

Note that the manual entry window has a scroll bar at the bottom. To see the full 20 years of the Japanese FiT period, scroll right to see all of the years in the analysis. That is not required for the S. Koran RPS inputs.



About coal price and the wholesale power price

In all the examples, if the coal price increases, it would be expected that the wholesale power rates will also increase. **The dashboard does not automatically change wholesale power price assumptions when the coal price or coal price inflation rate assumptions are changed.**

For Japan, as the FIT revenues become more dominant at higher co-firing rates, the wholesale price of power matters less to the outcome of the model. At 100% pellets the cost of coal and the wholesale power rate have no impact on the results.

For S. Korea, as co-firing rates increase, REC revenues become increasingly dominant.