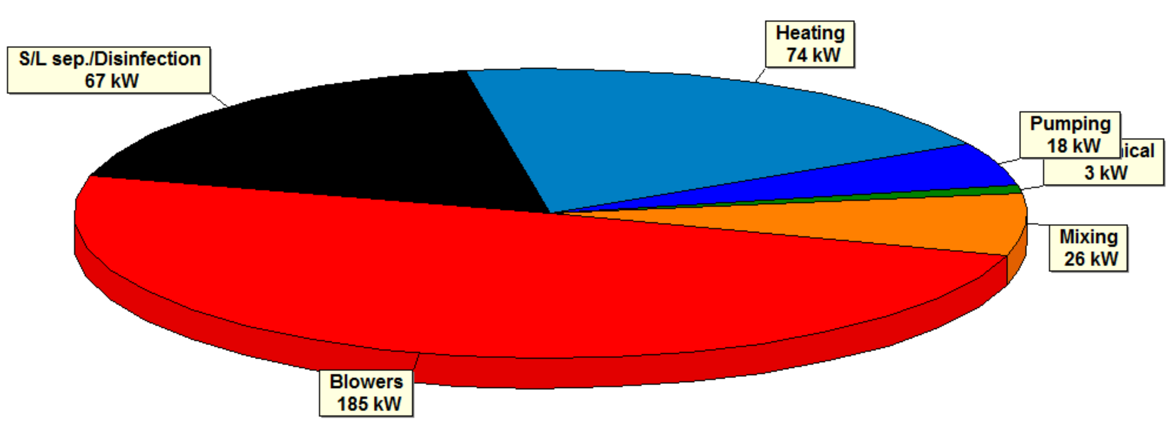
New Developments in BioWin 5.0

BioWin 5.0 contains many exciting new updates. BioWin 5.0 enables users to capture a plant-wide inventory of power demand. For example, BioWin will calculate blower power requirements, taking into account factors such as inlet air temperature and relative humidity, pressure losses in the air delivery system, *etc.* Pumping power may also be tracked, accounting for detailed factors such as pipe material and diameter for dynamic head losses. Miscellaneous mechanical power for various treatment flowsheet elements also may be tracked. To compliment this new functionality, BioWin also includes the facility to easily implement up to three different electricity tariff rates over the day, and these patterns can be different across two "seasons" (*e.g.* summer and winter). With the additional ability to explore onsite power generation and heat recovery via CHP, tracking of other costs including consumables (*e.g.* methanol and metal salts) and sludge disposal, BioWin 5.0 has expanded capability as a plant management tool.

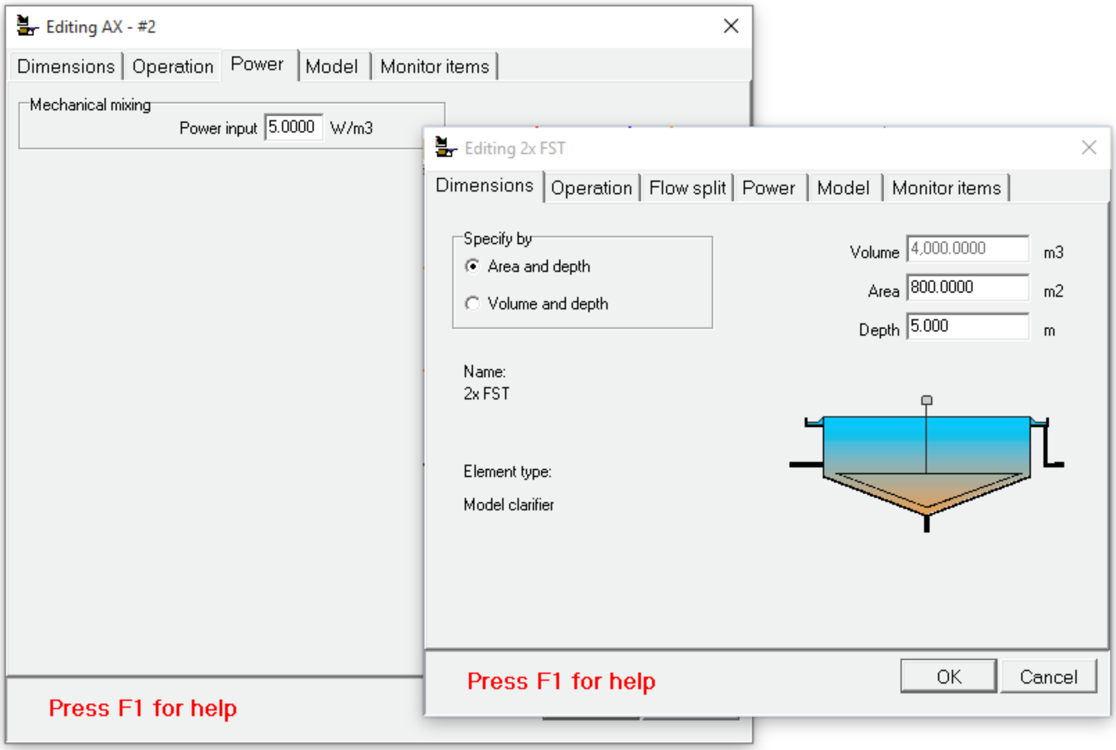
Power Requirements – General Considerations

BioWin now tracks power requirements for a number of categories or sources. For example, Blower Power, Mixing Power, Mechanical Power, Pumping Power, Heating Power, Surface aeration Power, Solid Liquid Separation/Disinfection Power, and Heating Ventilation and Cooling Power. This categorization allows the power requirements to be easily displayed and itemized.

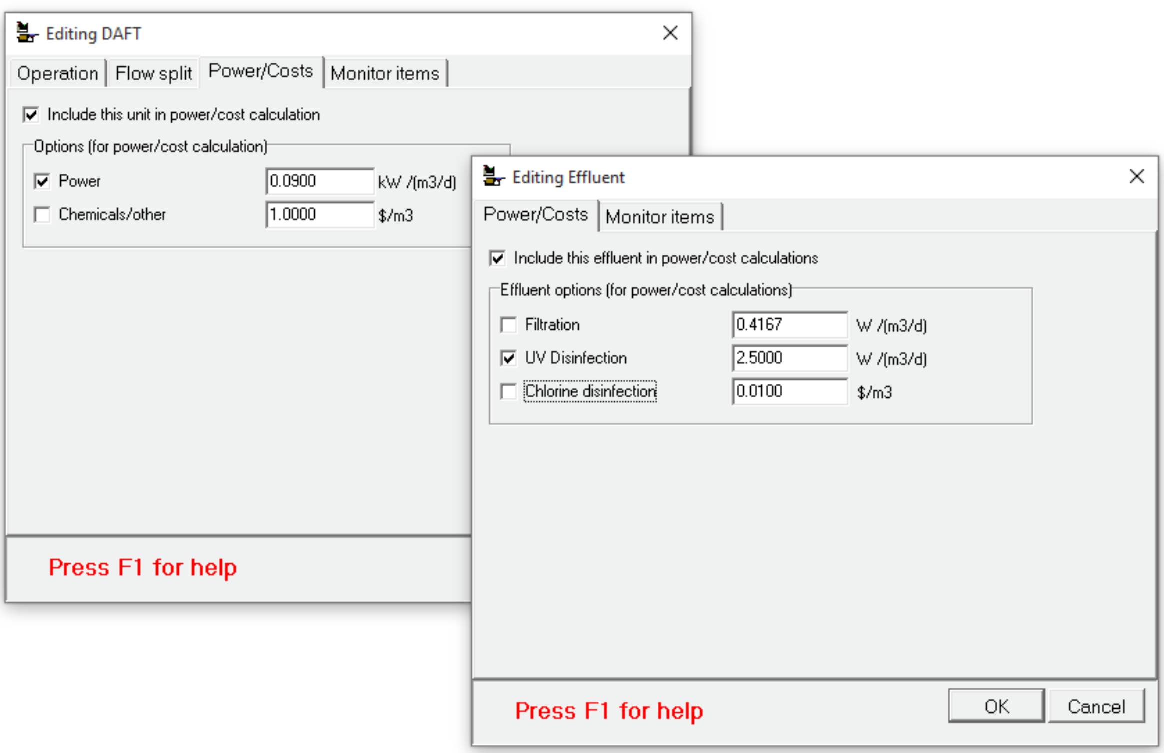
Power Demand Distribution



Power is tracked for elements *via* their Power tabs. In many cases, the power is a constant input, such as the mixing power for a bioreactor or mechanical power (such as for the sludge scraper motor for a secondary clarifier):

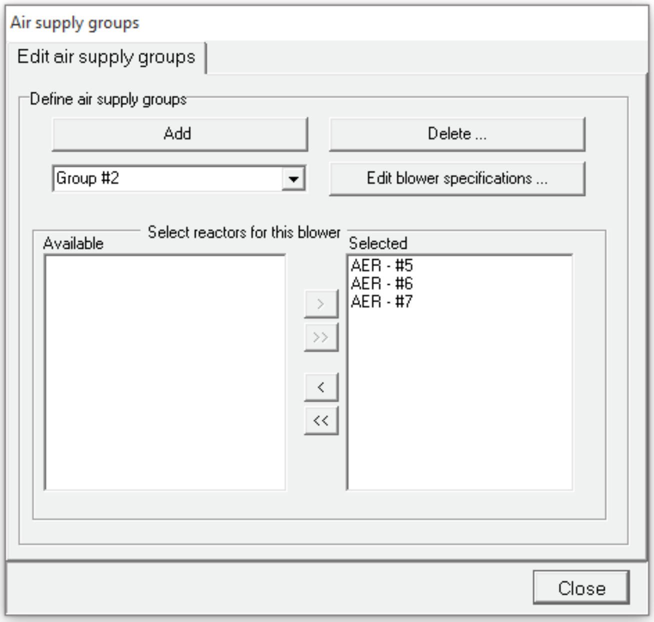


In other cases, the power might depend on the flow going through the element, such as for a dewatering unit or an effluent output:



Power Requirements – Aeration

Aeration is often the single biggest consumer of power in a wastewater treatment plant. BioWin allows you to specify whether an aerated element is part of a group of bioreactors / aerated zones that is supplied by a common blower, by defining as many **Air supply groups** as you like, as shown below:

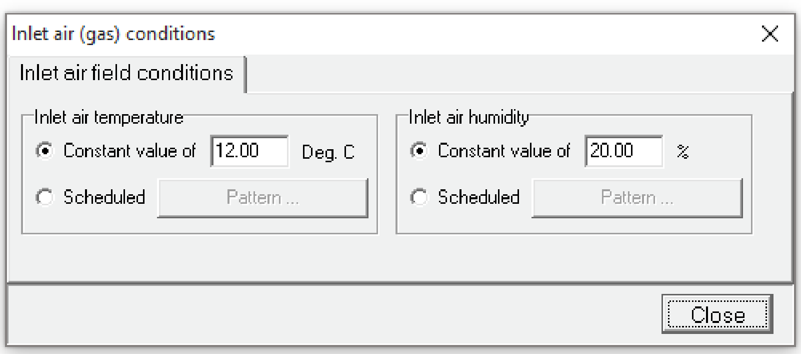


The total air delivered by a blower to a group of reactors is automatically totalized and used to calculate the blower power requirements. You can choose between three methods for calculating blower power requirements:

1. Adiabatic / polytropic power equation (default method);
2. Linear power equation (power is linearly related to air flow and pressure change);
3. User defined equation (users can implement complex equations to account for situations such as "main" and "standby" blowers).

The power calculations account for a number of important aeration system parameters, including:

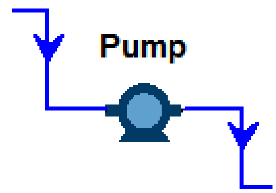
- Blower inlet air conditions (temperature and relative humidity)



- Blower efficiency (which can be set up to vary with air flow)
- Total pressure loss through the air delivery system (*e.g.* piping and valves)
- Pressure loss across the diffusers (which can be set up to vary with air flow)

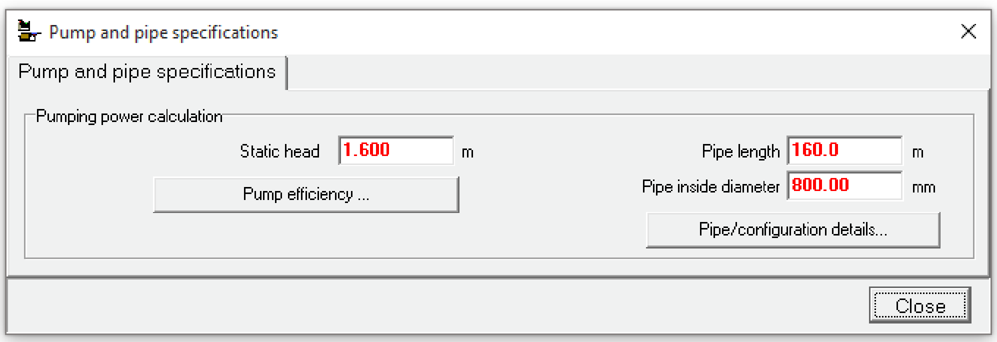
The BioWin 5.0 manual contains more detail and examples on the topic of aeration power requirements.

Power Requirements – Pumping

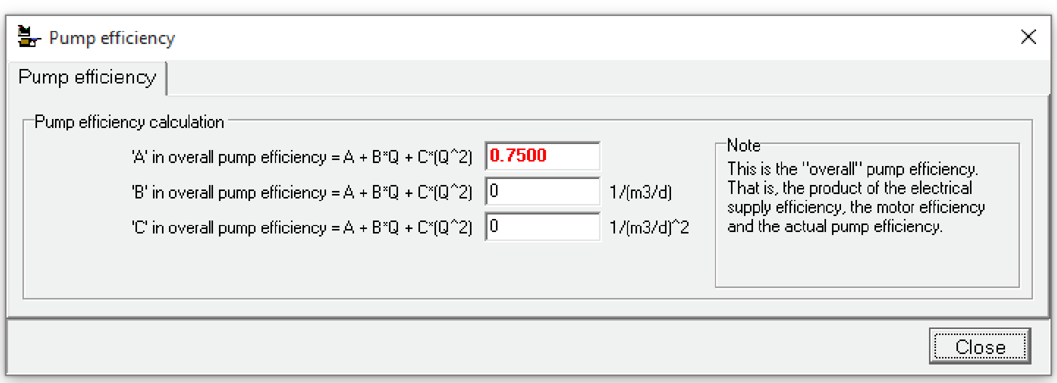


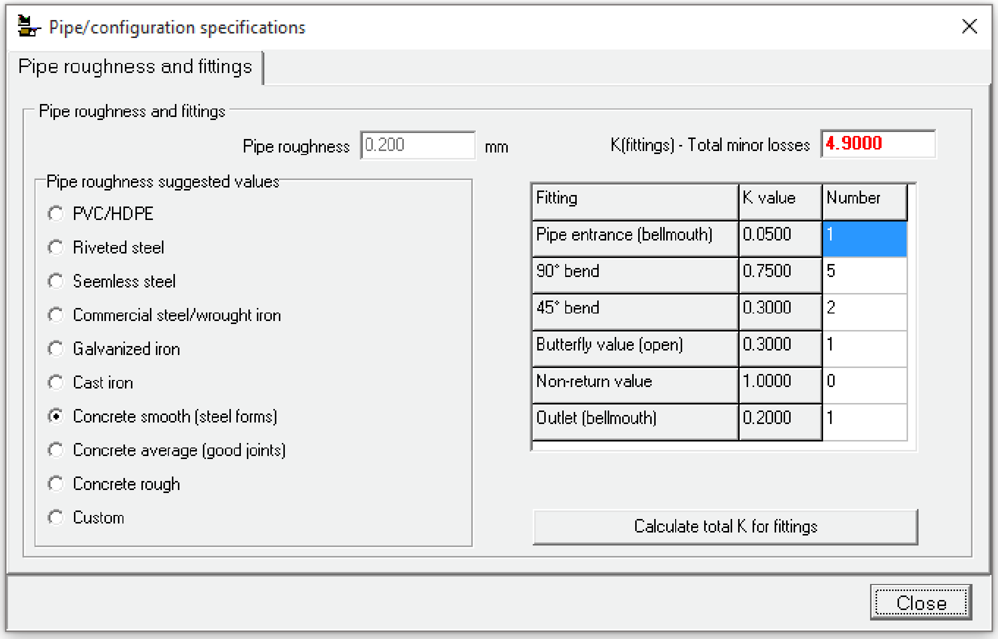
Power requirements to pump various flows for a process flowsheet are tracked via the **new** pump element in BioWin. Pumping power can either be calculated or specified as a constant or scheduled demand for Pump elements.

If you choose to have BioWin calculate the power, BioWin will sum all flows entering the pump element for use in its power calculation. Furthermore, you can enter the static head, pipe length and pipe inside diameter:



You can also provide information on the pump efficiency (*i.e.* whether it is constant or varies with flow) and the pipe characteristics used for calculation of total dynamic head (*e.g.* pipe roughness and minor loss coefficients), as shown below:





Note that BioWin also can account for the impact of high solids concentrations on a pumped stream's viscosity if desired.

Power Requirements / Generation – Anaerobic Digester

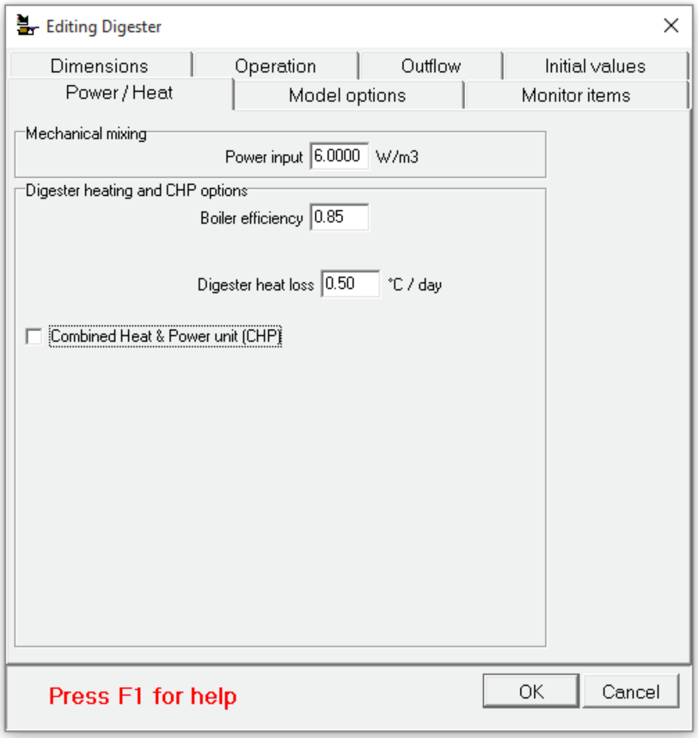
BioWin considers two power requirements for anaerobic digester elements:

1. Mechanical mixing; and
2. Heating.

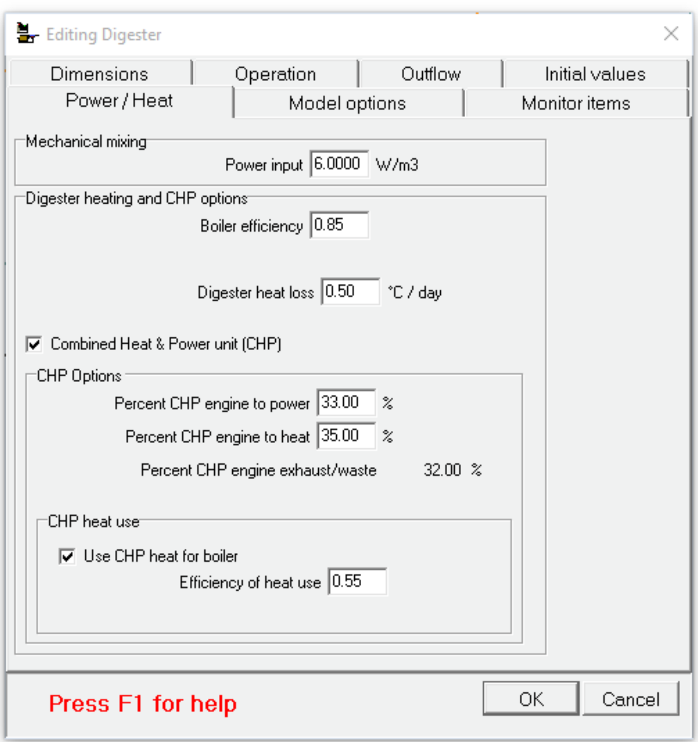
For heating power requirements, BioWin considers the temperature at which the digester is operated, the temperature of the incoming sludge stream, boiler efficiency, and daily heat loss.

> **Note**: In order to use a common unit basis, BioWin calculates digester heating requirements in terms of kilowatts and assumes that a boiler is used to transfer heat to the incoming sludge stream. A user can elect whether or not to include the digester heating requirements in the overall plant energy inventory.

The screen shot below shows the anaerobic Power/Heat input tab:

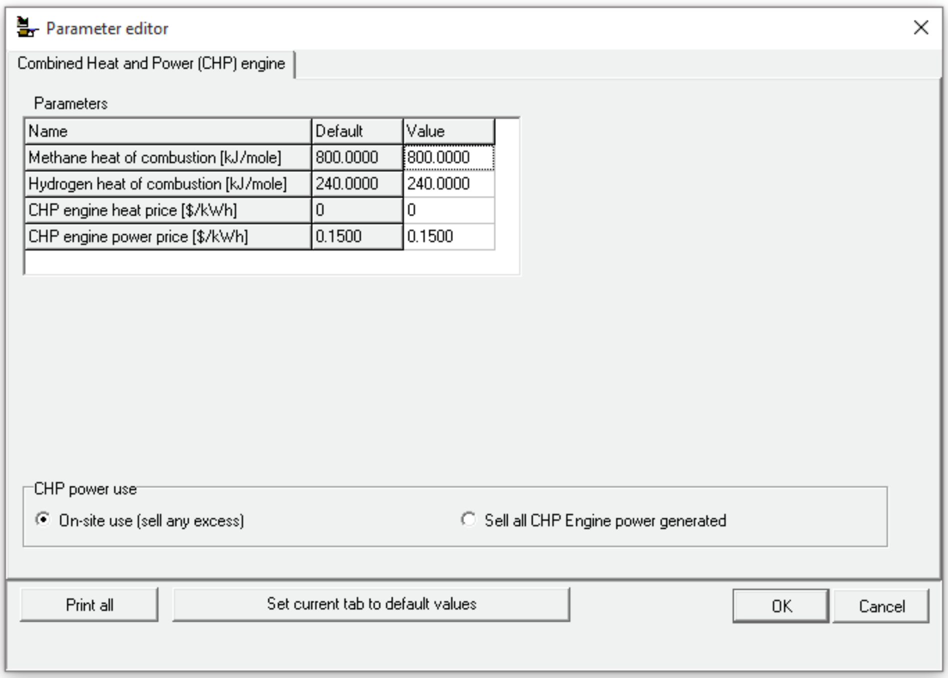


BioWin can also evaluate the impacts of using the biogas generated in an anaerobic digester in a combined heat / power (CHP) engine. This is done by placing a check in the **Combined Heat & Power (CHP)** box, which shows the following expanded interface:

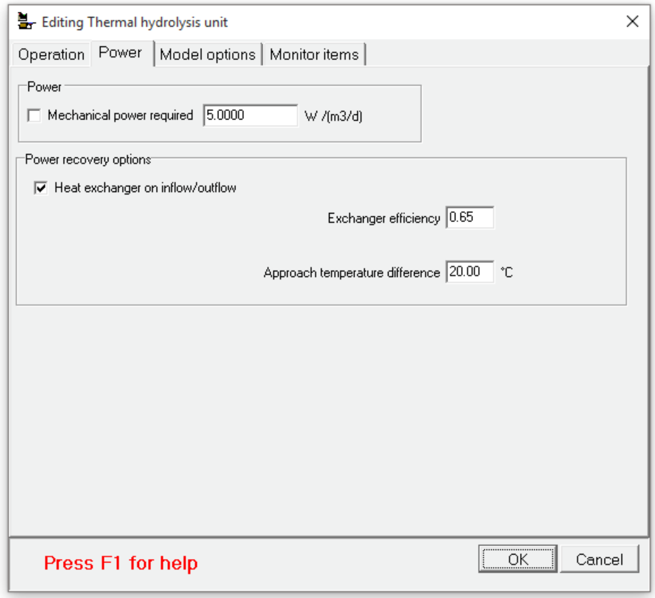


The potential energy in the biogas is calculated using the heat of combustion model parameters for methane and hydrogen, and you can specify the fate of the energy (which is dependent on the type of CHP engine) in terms of power, useable heat, and engine exhaust / waste heat. You can also opt to use the CHP heat to assist the digester heating boiler, thereby offsetting the digester heating power requirements. Finally, you can select how the generated power is used from the following two options:

1. Use the generated power on-site (and sell any excess back to the grid at a user-definable price); or
2. Sell all of the generated power back to the grid at a user-definable price.



Power Requirements – Thermal Hydrolysis



BioWin considers two power requirements for thermal hydrolysis / sludge pretreatment elements:

1. Mechanical power; and
2. Heating.

By default, heat recovery via a heat exchanger is assumed to be on for the thermal hydrolysis unit (although this option can be turned off). For heating power requirements, BioWin considers the temperature at which the unit is operated, the temperature of the incoming sludge stream, and if a heat exchanger is used, the approach temperature (*i.e.* the temperature difference between the sludge stream leaving the heat exchanger and the water/steam stream entering the unit).

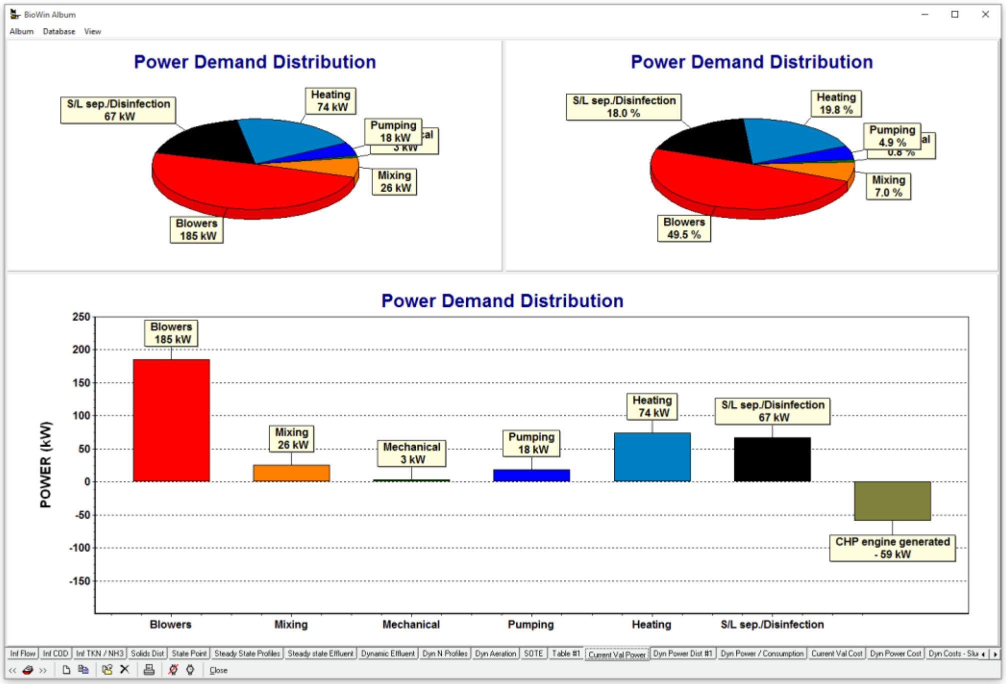
Power Requirements – New Output Functionality

Power/Energy use plots can be generated semi-automatically in BioWin. These include:

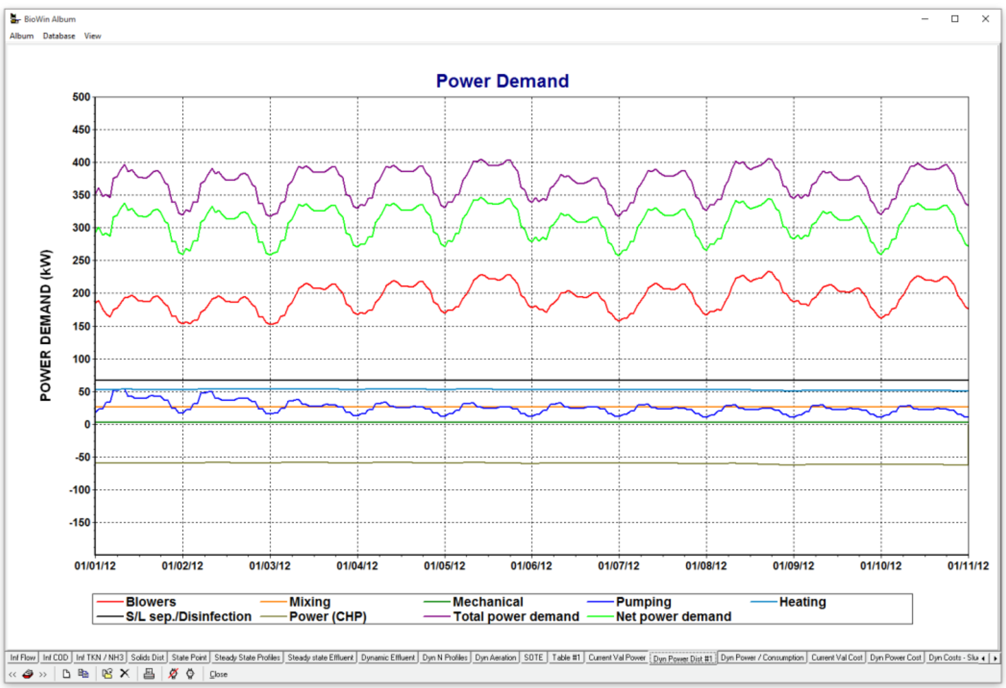
- **Power Demand Distribution** plots
  - Pie plot of instantaneous power demand
  - Bar plot of instantaneous power demand

- **Time Series plots**
  - Instantaneous power by category
  - Total and net instantaneous power
  - Energy consumption (Daily)
  - Energy consumption (Monthly)
  - Energy consumption (Yearly)
  - Energy consumption

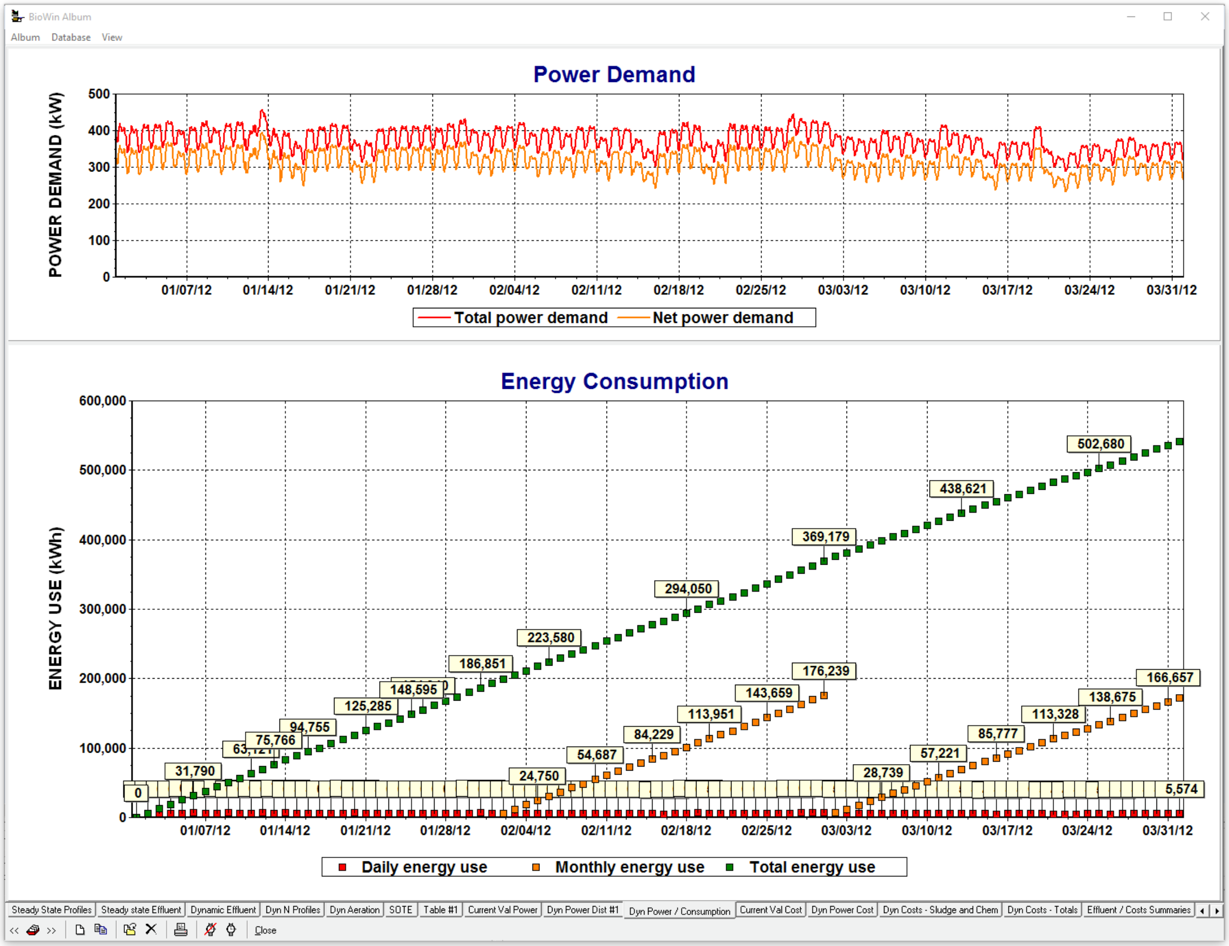
For power demand distribution and time series plots, you are only required to select the elements that you want included in the plots. BioWin then performs the necessary calculations (such as plotting daily, monthly, yearly, and total overall cumulative energy consumption) and generates the plot. You then may customize the appearance of the chart using BioWin's powerful chart and series formatting tools.



BioWin Album
Album Database View
Power Demand Distribution
S/L sep./Disinfection 67 kW
Heating 74 kW
Pumping 18 kW
Mixing 26 kW
Blowers 185 kW
Power Demand Distribution
S/L sep./Disinfection 18.0 %
Heating 19.8 %
Pumping 4.9 %
Mixing 7.0 %
Blowers 49.5 %
Power Demand Distribution
POWER (kW)
Blowers 185 kW
Mixing 26 kW
Mechanical 3 kW
Pumping 18 kW
Heating 74 kW
S/L sep./Disinfection 67 kW
CHP engine generated - 59 kW
Blowers
Mixing
Mechanical
Pumping
Heating
S/L sep./Disinfection



BioWin Album
Album Database View
Power Demand
POWER DEMAND (kW)
01/01/12
01/02/12
01/03/12
01/04/12
01/05/12
01/06/12
01/07/12
01/08/12
01/09/12
01/10/12
01/11/12
Blowers
Mixing
Mechanical
Pumping
Heating
S/L sep./Disinfection
Power (CHP)
Total power demand
Net power demand

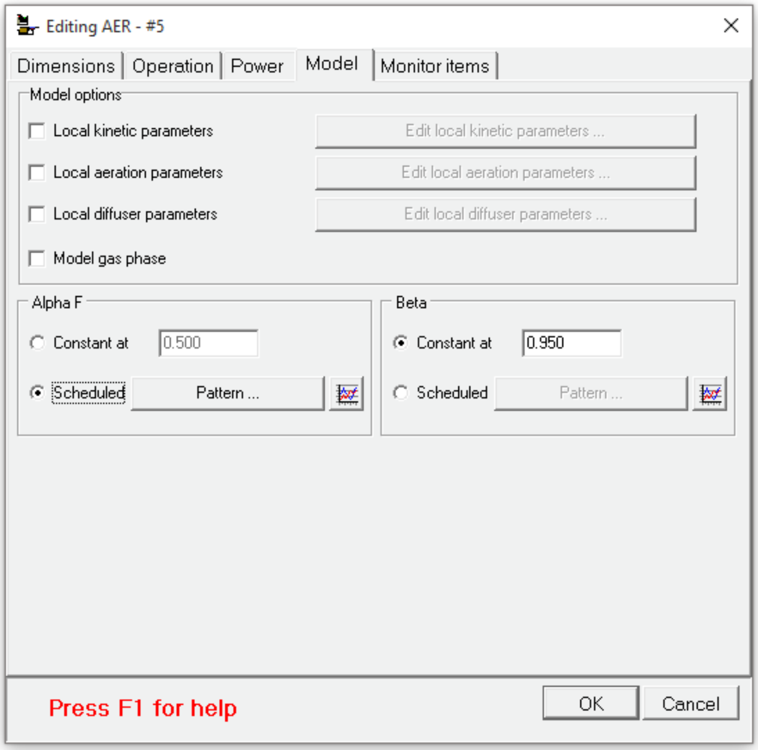


In addition to these plots, you can also add pre-defined power tables to the album (like the one shown below), or build your own custom element-specific power tables.

Power Categories	Power Demand [kW]	Cost (Power Use) [$/hour]
Blowers	185.21	18.89
Mixing	20.00	2.04
Mechanical	3.00	0.31
Pumping	18.38	1.87
S/L sep./Disinfection	67.24	6.86
Total	293.84	29.97
Power (CHP)	-59.46	-----
Net	234.38	-----
System total	374.07	37.11

Variable Alpha & Beta

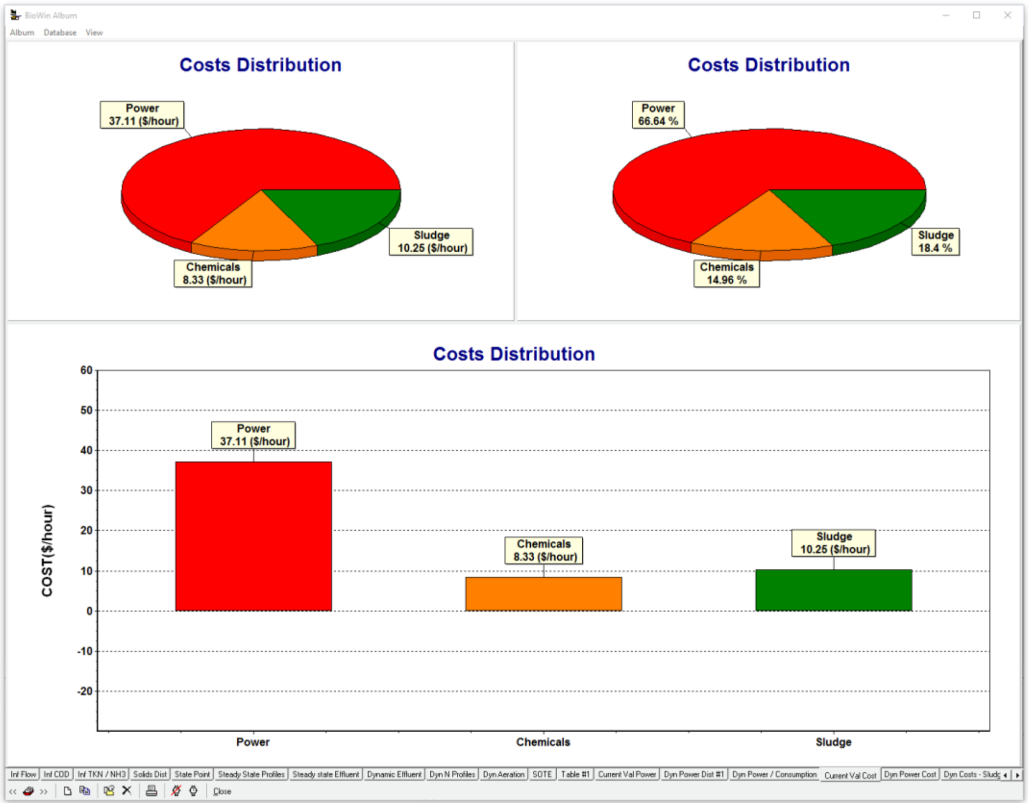
BioWin has the ability to vary the alpha and beta parameters used in its aeration calculations with time. Emerging research and measurement experience has indicated that alpha follows influent loading patterns to some degree. You can use this option to fine-tune calibration of BioWin's aeration model. The small chart buttons can be used to rapidly plot a time series of alpha and/or beta.



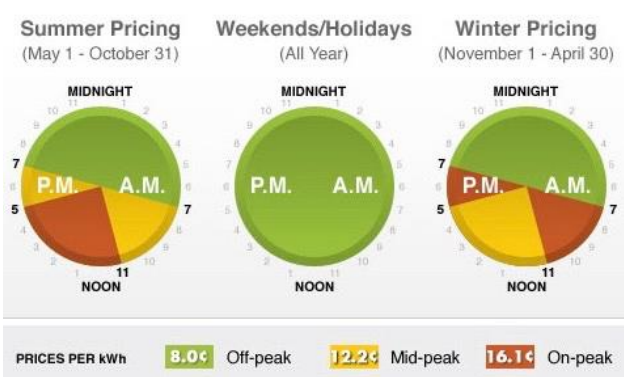
Costing Calculations

BioWin 5.0 has the facility to track and totalize operating costs using localized currency units in three separate categories:

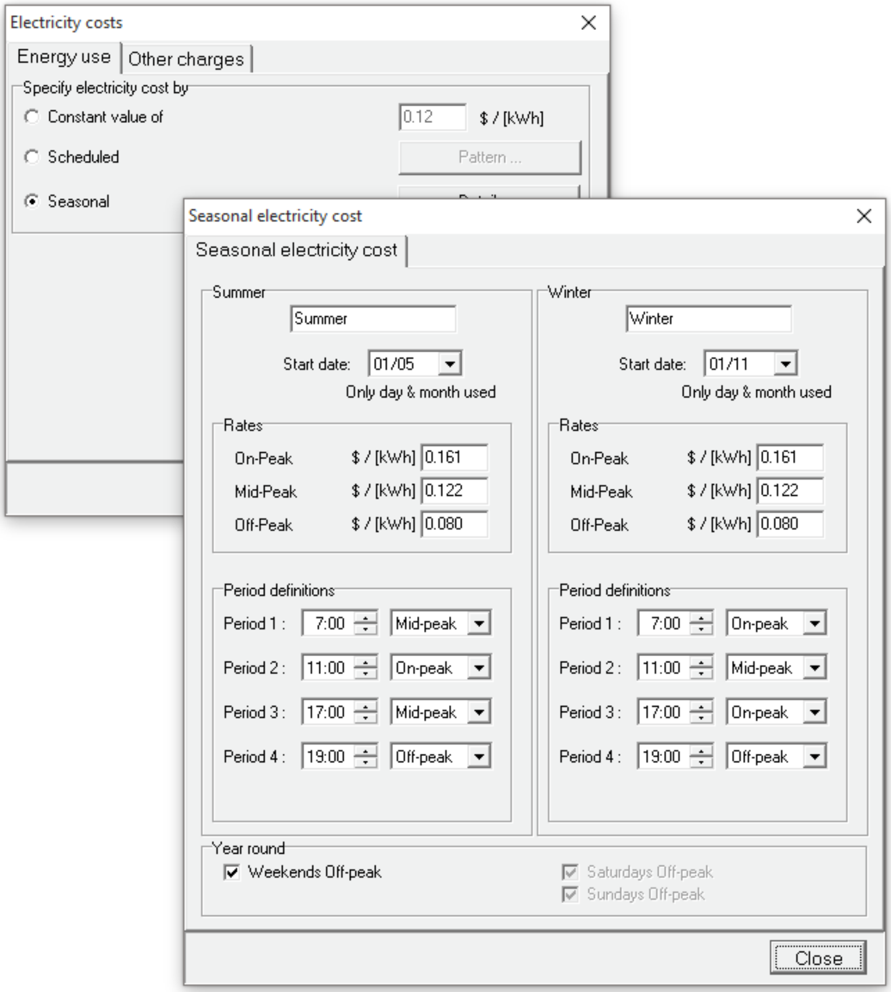
1. Costs associated with energy consumption.
2. Costs associated with consumption of chemicals / consumables.
3. Costs associated with sludge disposal.



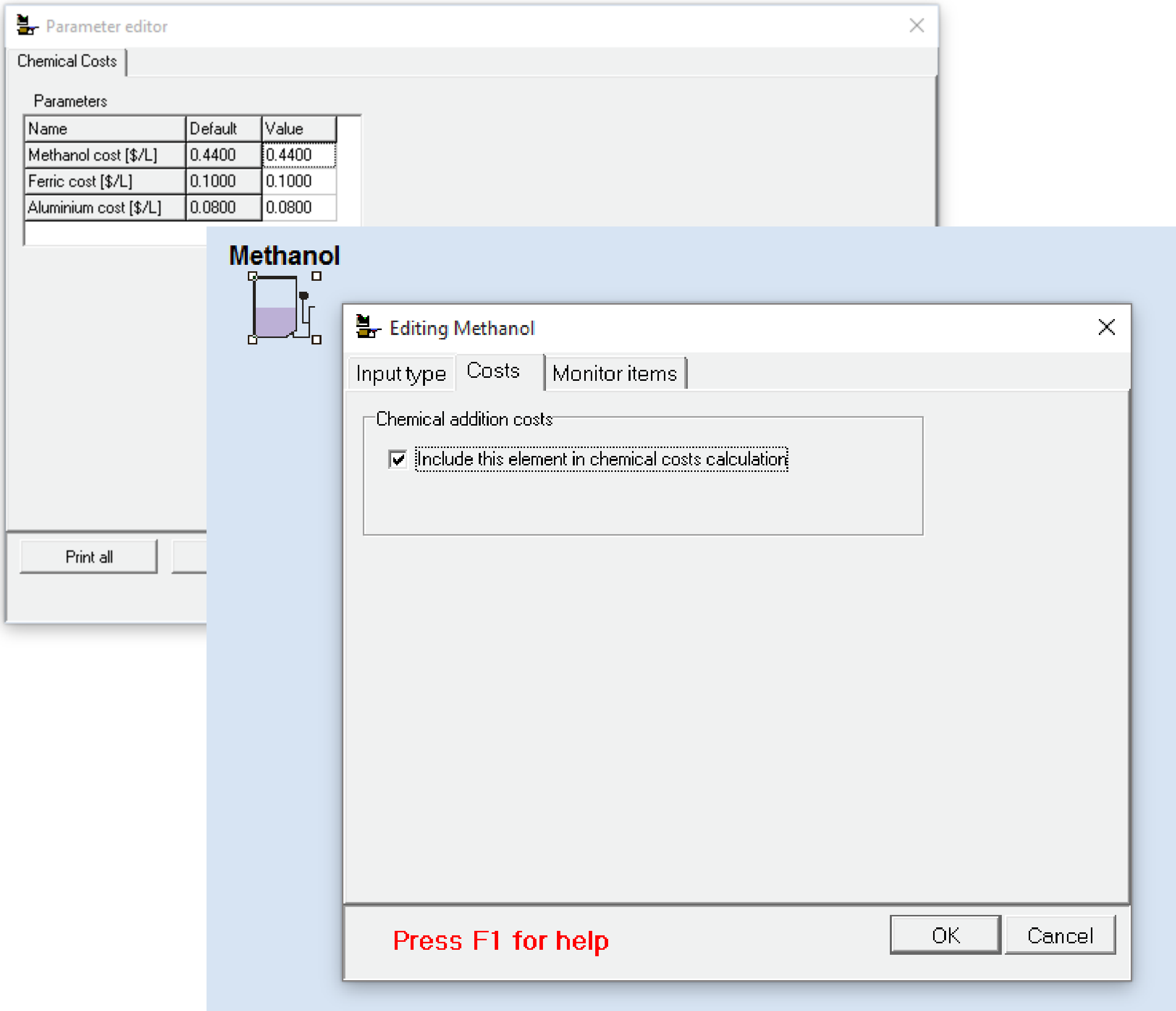
Electricity costs are an important consideration in any operating cost analysis, and BioWin makes it easy to input and account for complex factors such as varying daily rate structures for different seasons and peak demand charges. For example, suppose you want to implement an electricity rate structure such as the one shown below (HydroOne, 2015):



Doing this is simple in BioWin – selecting the seasonal rates option offers a convenient interface for setting up different daily electricity rate structures for different seasons.



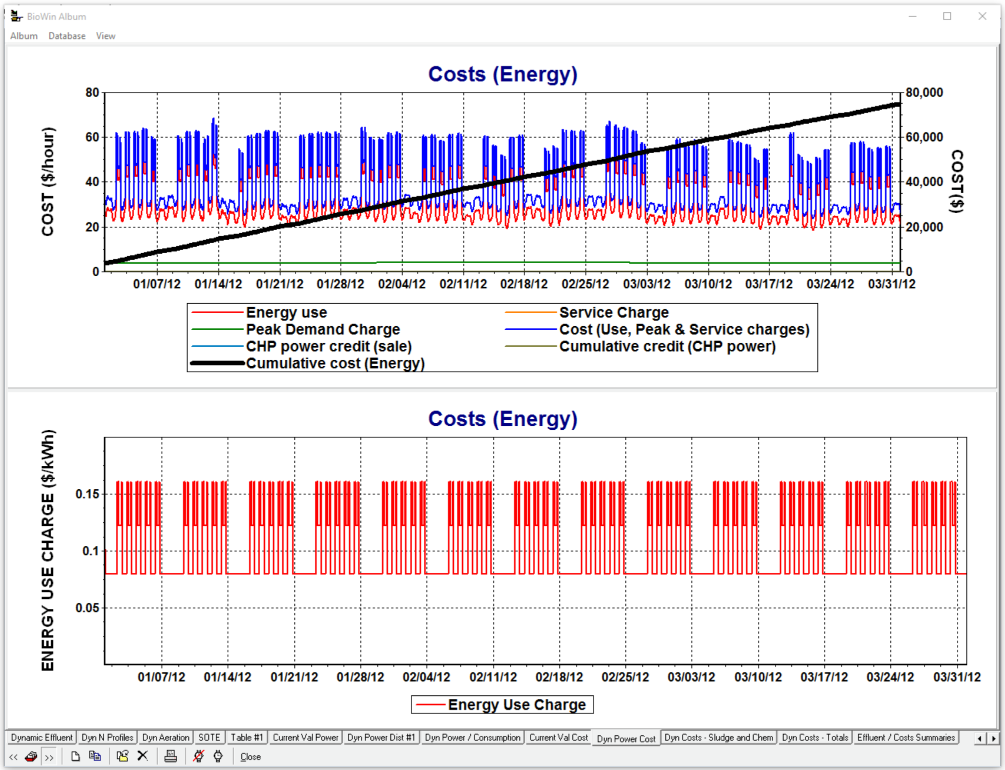
Chemical costs are tracked in BioWin on a global basis for consumables such as methanol or metal salts on a cost per unit volume basis, as shown below. Also, you have the option to include individual elements from your flowsheet in the overall project cost tracking by checking or un-checking the option to include that element on its **Costs** tab.



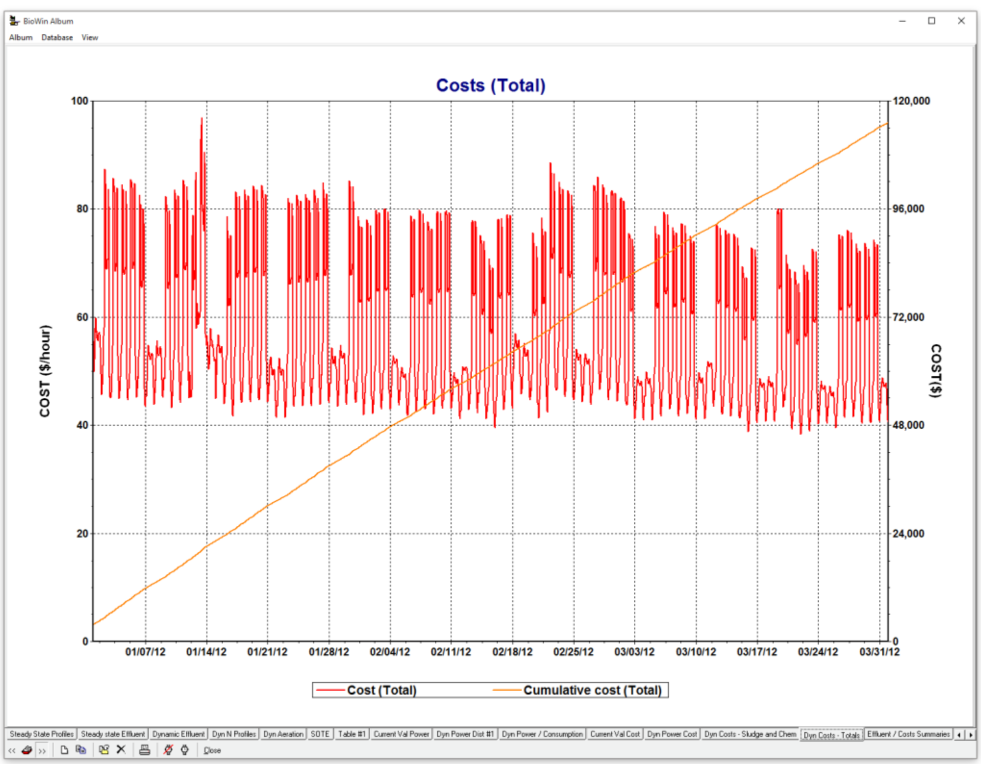
A similar interface is offered for each sludge output element on your flowsheet, to allow for the tracking of sludge disposal costs.

Costing Output

BioWin enables you to look at a detailed dynamic breakdown of “instantaneous” cost for power and energy, taking into account the complexity of varying daily energy costs. Furthermore, BioWin will automatically keep a running tally of the total energy costs to date:



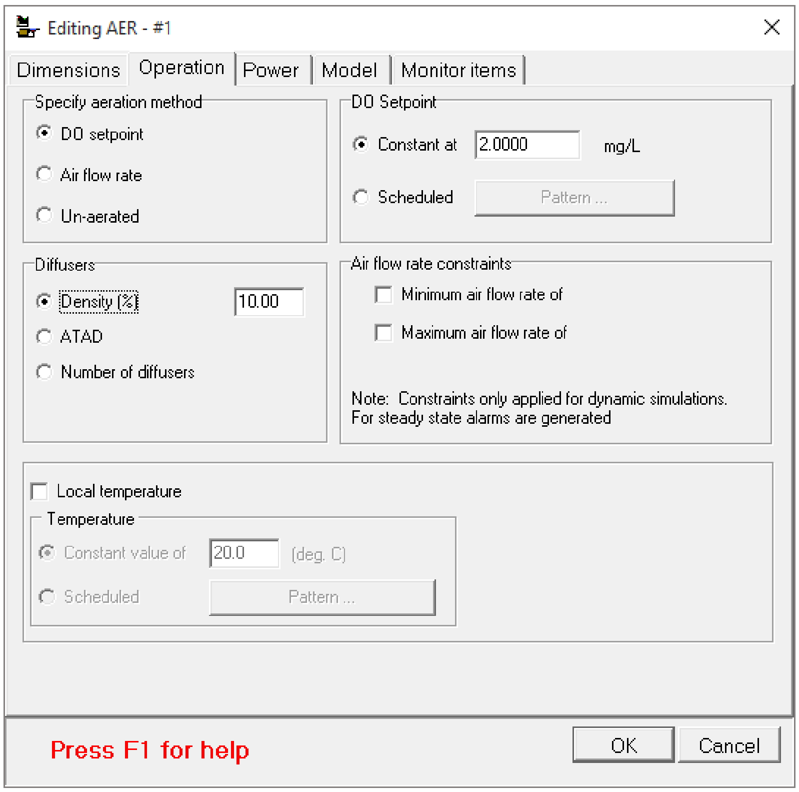
Similarly, BioWin will track both the “instantaneous” and running total costs for the entire facility, including energy, sludge handling, and chemicals:



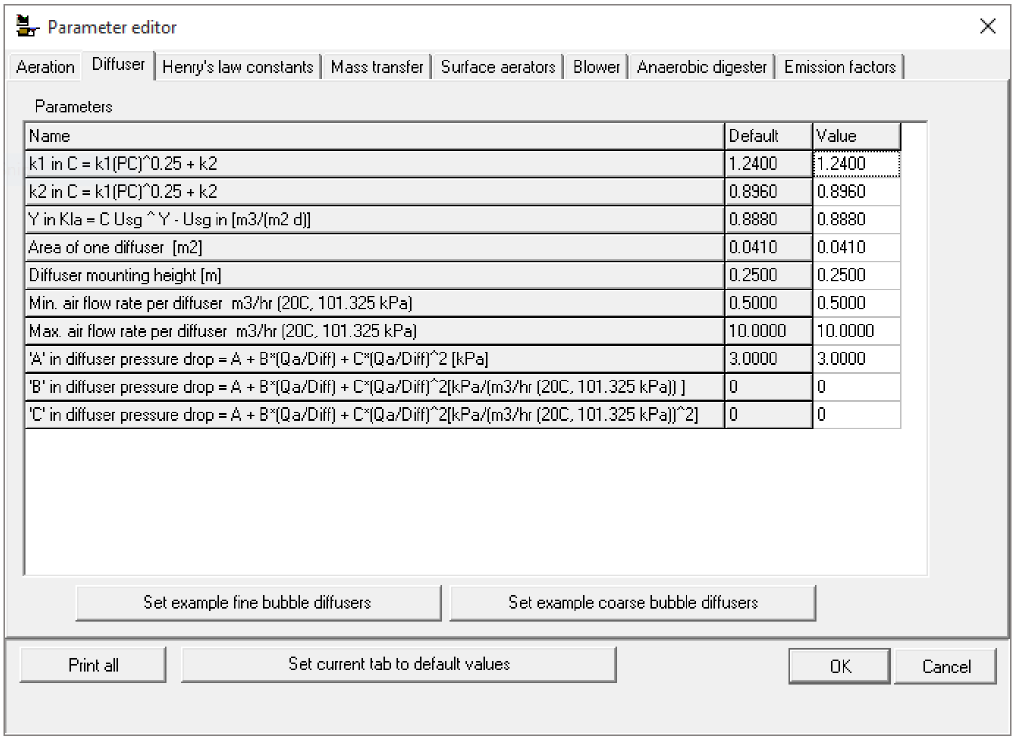
Usability Improvements

In addition to the new features above, a number of usability improvements have been made, including:

- Input diffuser coverage as diffuser density, ATAD, or diffuser count. BioWin automatically converts from one basis to another.



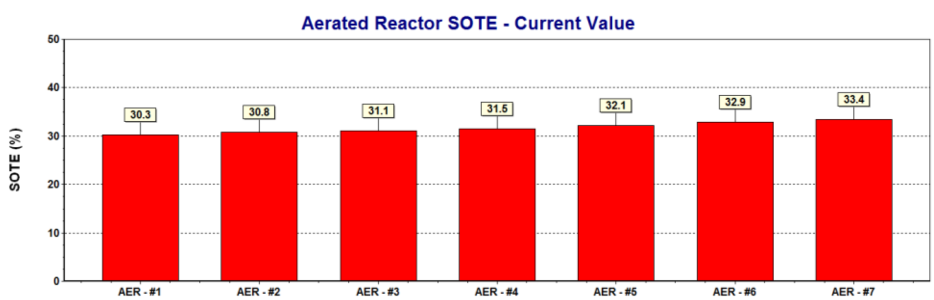
- Diffuser parameters are now globally applied to all bioreactors by default (although they can still be localized if desired). There is now a Diffuser tab under **Project** > **Parameters** > **Aeration/Mass transfer…** that can be used to easily set up the same diffuser characteristics across all bioreactors from one interface.

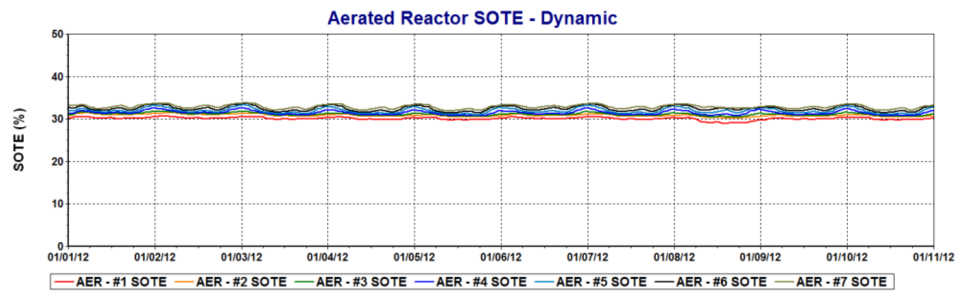


Name	Default	Value
k1 in C = k1(PC)^0.25 + k2	1.2400	1.2400
k2 in C = k1(PC)^0.25 + k2	0.8960	0.8960
Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	0.8880	0.8880
Area of one diffuser [m2]	0.0410	0.0410
Diffuser mounting height [m]	0.2500	0.2500
Min. air flow rate per diffuser m3/hr (20C, 101.325 kPa)	0.5000	0.5000
Max. air flow rate per diffuser m3/hr (20C, 101.325 kPa)	10.0000	10.0000
'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2 [kPa]	3.0000	3.0000
'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2[kPa/(m3/hr (20C, 101.325 kPa))]	0	0
'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2[kPa/(m3/hr (20C, 101.325 kPa))^2]	0	0

- The diffuser parameters can now be quickly toggled between values representative of fine or coarse bubble diffusers, using the **"Set example fine bubble diffusers"** or **"Set example coarse bubble diffusers"** buttons.

- BioWin has new default fine bubble diffuser parameters that are more representative of current diffuser materials and performance.





- Right-clicking on any pattern input to BioWin (e.g. flow, RAS) now offers two options: **Copy** (which copies the pattern ***without*** headings and can be used to copy a pattern from one place to another within BioWin), and **Copy all** (which copies the pattern ***with*** headings and can be used to copy a pattern from BioWin into a Word, PowerPoint, or Excel table).
- Many dialogue boxes have been rationalized, clarified, and rearranged.
- Alarms will be generated for anion/cation limitation conditions.
- Right-click menu for adding a chart contains short-cuts for adding time series and current value series.
- The gas phase is now shown for MBR mass balance windows.
- Parameter temperature correction factors are now highlighted in red if they have been changed from default values.

Further details on all new features in BioWin 5.0 can be found in the Help manual.