EZ SIM – Shows Bonus Energy Savings for County Office Building

When a county building's facility manager wanted to know if it was time to upgrade the building's heat pumps, EZ Sim's detective work helped to uncover more savings in more places than she bargained.

After a series of simple calibrations, the EZ Sim billing analysis software tool allowed Amy Joslin to take a fresh look at her building and to slueth out not only heat pump savings, but also lighting and ventilation savings of up to 34% of the building's current energy use. All this was possible with the building's energy billing history and Stellar Processes' new EZ Sim billing analysis software.

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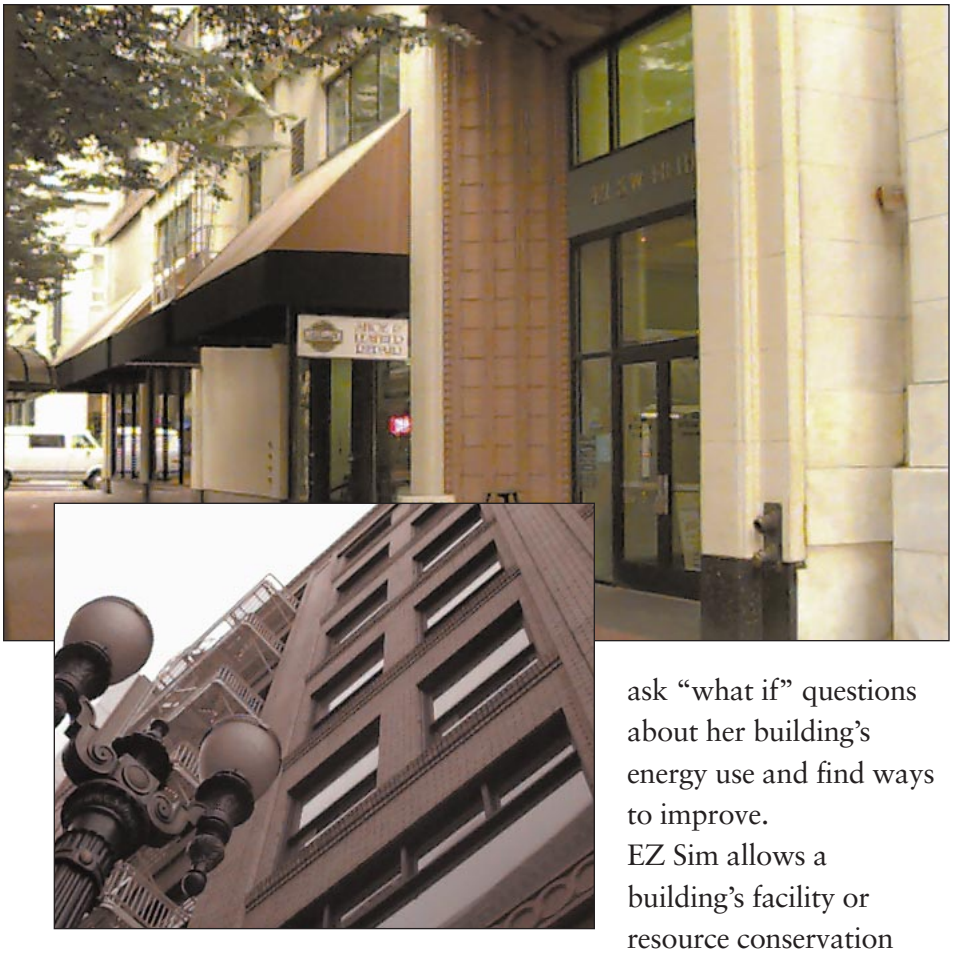

With EZ Sim, Joslin was able to ask "what if" questions about her building's energy use and find ways to improve.

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EZ Sim allows a building's facility or resource conservation manager to:

- Diagnose energy patterns and consumption
- Calibrate savings estimates to agree with the building's actual usage
- Estimate energy end-uses within the facility
- Verify vendor claims for energy products and services
- Generate performance targets and compare against actual utility bills.

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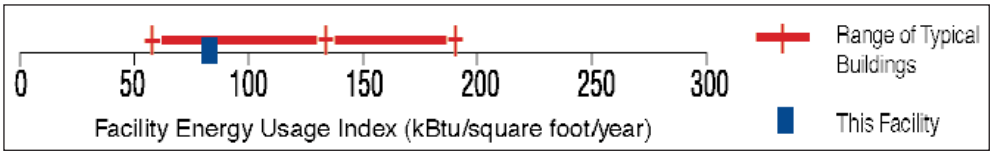
EZ Sim — The Energy Detective

The facility, located in downtown Portland, OR, is an older masonry-faced eight-floor office building. The building is heated and cooled by a circulating heat pump loop. Fresh air is admitted to each floor through windows in a utility room containing the heat pumps for that floor. Because the heat pumps are nearing the end of their planned life, the facility manager wanted to know whether to upgrade to new, more efficient heat pumps, or consider other energy conservation measures.

EZ Sim provides a way to learn what site-specific information is needed in order to firm up estimates for different measures. After arranging on-site measurements to collect the crucial information, Stellar Processes along with the facility manager produced a model incorporating what we learned. The most promising conservation opportunities were efficient lighting, fan controls and VSD pumping.



County building Energy Usage Index (Kbtu per sq. ft. per year)

At first glance, this facility appeared to already be efficient. The Energy Usage Index (EUI) was very good compared to other office facilities. A heat pump loop is inherently efficient — recovered heat can be recycled in another part of the building.

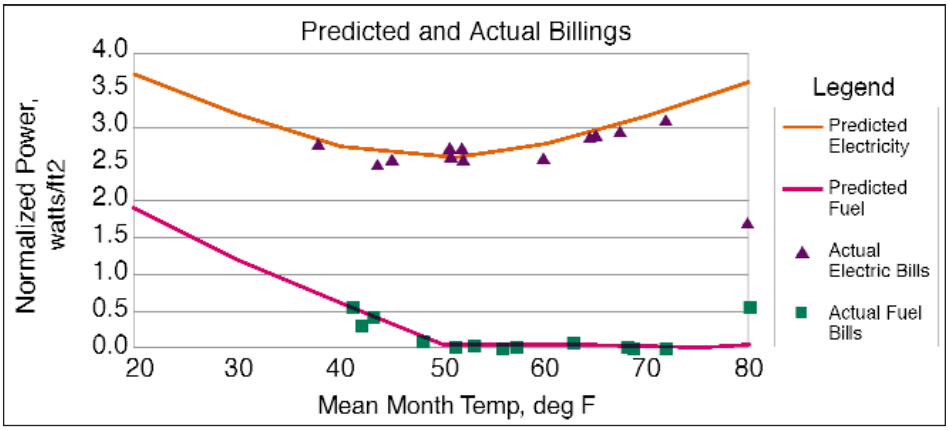


Figure 1. Facility Utility Billing Plot

Tuning EZ Sim

The next step was to look at the pattern of the utility bills as shown in Figure 1. Most of the heating was accomplished by heat recovery, as shown by the low amount of gas used and the fact that gas is not used until temperatures are rather cold. To match this profile, the model suggests either (1) high internal gains and/or (2) poor heat pump efficiency.

To check these two hypotheses, we went on-site to measure key parameters. First was the heat pump COP, which we found typical of older units but inefficient compared to modern heat pumps. At the same time, a lighting survey revealed a moderately high level of installed lighting. We measured ventilation air flows and determined that the ventilation fans and circulation pumps both operated continuously. None of these observations showed a major problem, but together, their interactions increased energy usage.

Further tuning adjustments were revealed from the shape in Figure 1. To match the balance temperature (the temperature where gas heating starts) required adjustment of the solar shading factor. This is consistent with the observation that much of the window area is shaded by nearby buildings or their location inside the atrium.

Cooling is accomplished with a cooling tower connected to the heat pump loop. Since the efficiency of the cooling tower is unknown, the EZ Sim model was adjusted empirically until the cooling slope agrees with the bills. The final model fit is shown in Figure 1.

The Results

"With EZ Sim, we could get the understanding we wanted by using the information we already had — the building's billing history and it's current heating, ventilating and lighting configurations," said Dave Robison, principal, Stellar Processes. "EZ Sim not only showed us that a heat pump was a good idea, it also showed that savings were available in lighting and other measures due to the system interaction of internal gains."

Use of this model suggests the following energy conservation opportunities:

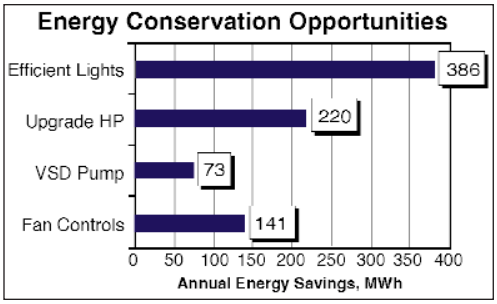


Figure 2. Estimated Energy Savings

As expected, changing the lights offers large savings. There is a huge interaction effect because this building relies so heavily on the heat pump loop. Overall savings are almost twice the savings directly due to lights, with the additional savings coming from reduced consumption by the heat pump loop. Upgrading heat pumps is a good idea because new heat pumps are almost twice as efficient as the existing older models. There are appreciable savings available by adding VSD controls to the circulation pumps. Fan energy savings by reducing ventilation at night could be a low-cost measure. Individually, none of these measures would have seemed compelling. Together, these measures are estimated to provide 34% savings for the entire facility.

This case example shows how the tool can be used to model a complex facility, how that model can be used to explore hypotheses about the building's operation and how those hypotheses can lead to a focused set of on-site measurements to resolve questions about which hypothesis is correct. The completed model provides savings estimates calibrated to match actual operation of the facility.

Modeling Parameters

Model Set-up

- Select Gas Heating, but on Detailed Description page, select Heat Pump Loop as the Stage One heating system.
- Set heating and cooling pumping energy at 0.09 W/sqft for both heating and cooling. This is computed from the observed 20 hp (0.18 W/sq. ft.) of continuously operating pumps.
- Set heat recovery heating COP at 2.4 based on measurement (the mean of heating and cooling COP).
- Set lighting connected load at 1.61 W/sq. ft. based on lighting survey.
- Set fan controls to On/Off with Constant Volume. Set Fan Schedule Delta to 15 hours to reflect the fact that fans operate for 24 hours or 15 hours more than the occupied period.
- Set fan static pressure at 1.5 inches, based on site measurement.
- Other site specific parameters: change shape factor for geometry of this specific building, add estimated cooking loads as process energy, increase usage factors at night for 24-hour operation on one floor.

Model Tuning

- Adjust ventilation rate to 1.3 ACH based on calibration.
- Reduce usage factor on internal loads slightly based on calibration, building is not densely occupied.
- Include right/left balance adjustment based on calibration. Set solar shade factor at 0.35 to reflect the fact that most of the windows are shaded by other nearby buildings.
- Adjust cooling slope based on calibration. Set EER to 5.4, reflecting overall operation of cooling tower to remove rejected heat from the heat pump loop.

Conservation Measures

- Efficient lighting: use 0.70 W/sq. ft. proposed connected load from lighting survey.
- VSD pump: reduce pumping power to 0.05 W/sq. ft. on both heating and cooling.
- Fan control: decrease static pressure to 1 inch, decrease unoccupied ventilation to 0.63 ACH.
- Upgrade heat pump: COP of 3.7 for modern units.

Energy Analysis at your fingertips

EZ Sim billing analysis software

EZ Sim is the next step in energy accounting. Using actual utility bills, it reveals the patterns of use in commercial buildings.

EZ Sim:

- Diagnoses energy patterns and consumption
- Calibrates savings estimates to agree with actual energy usage
- Estimates energy end-uses within the facility
- Verifies vendor claims for energy products and services
- Generates performance targets and compares against actual energy bills

EZ Sim is a quick spreadsheet tool that is equivalent to a sophisticated engineering analysis, but **you don't have to be an engineer to use it.** It's designed for resource conservation managers and facility operators.

EZ Sim uses actual energy bills and available information, so **the cost to operate EZ Sim is almost nothing.**

EZ Sim lets you use utility bills to calibrate a simulation of a commercial building in an interactive graphic window. **Once it matches the building's utility bills, the simulation model provides reliable and realistic estimates of potential conservation savings.**

With EZ Sim, the calibration process reveals how energy is used within the facility to **help diagnose the reasons for excessive consumption or poorly functioning components.**

Best of all, EZ Sim can be used to predict what future utility bills should be and can help you set performance targets to determine if installations are on track. **This is the simplest form of building commissioning — and at very little cost.**

Stellar Processes, Inc.

Stellar Processes is a company of consulting engineers specializing in energy economics, measurement and verification. Experts in monitoring and commissioning large facilities as well as diagnostic evaluation of small buildings.

Support provided by:

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August 1998

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