Understanding & Calculating Energy Savings for a BOSS Load Controller (Smartplug)

Table of Contents

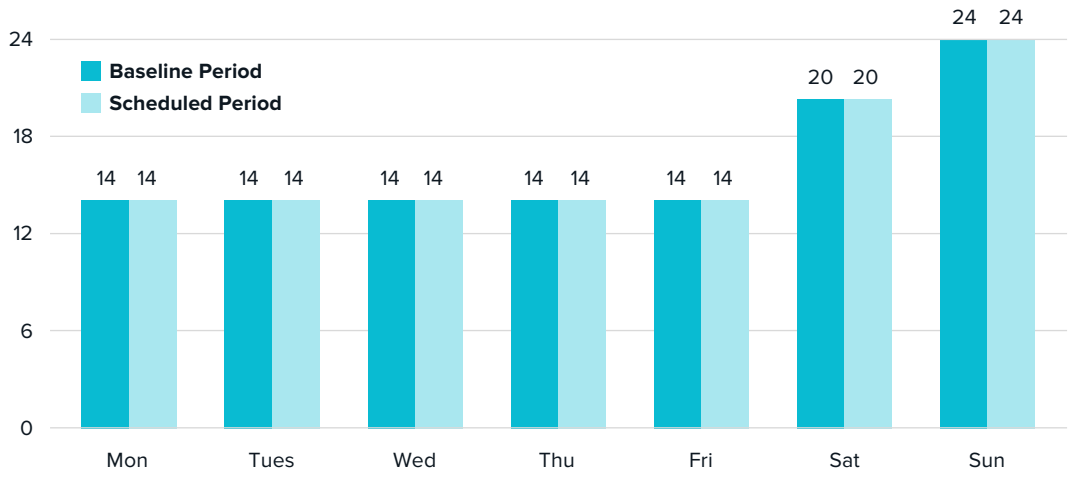
Background

In the first version of the Atmospheres software, the main energy and energy cost savings will result from the use of the Smartplug in the same fashion as a simple wall plug timer, e.g. the plug timer is set to a simple schedule corresponding to “occupied” (Smartplug is “ON”) and “unoccupied” (Smartplug is “OFF”) operating hours of the facility.

The baseline period is the initial period of the pilot where the Smartplug is installed and only monitoring the power / energy of the appliance, and has no schedule programmed. A baseline must be run for a full, consecutive 7 days with normal business hours (no national holidays, teacher days, etc.)

The scheduled period is the successive period of the pilot when the Smartplug is scheduled based on occupied / unoccupied hours. The scheduled period must be run for the exact timeframe (day of the week, hours of the day) that the baseline period was run. Baseline and scheduled weeks do not have to be consecutive, but they must have identical “occupied” and “unoccupied” hours (actual business hour schedules).

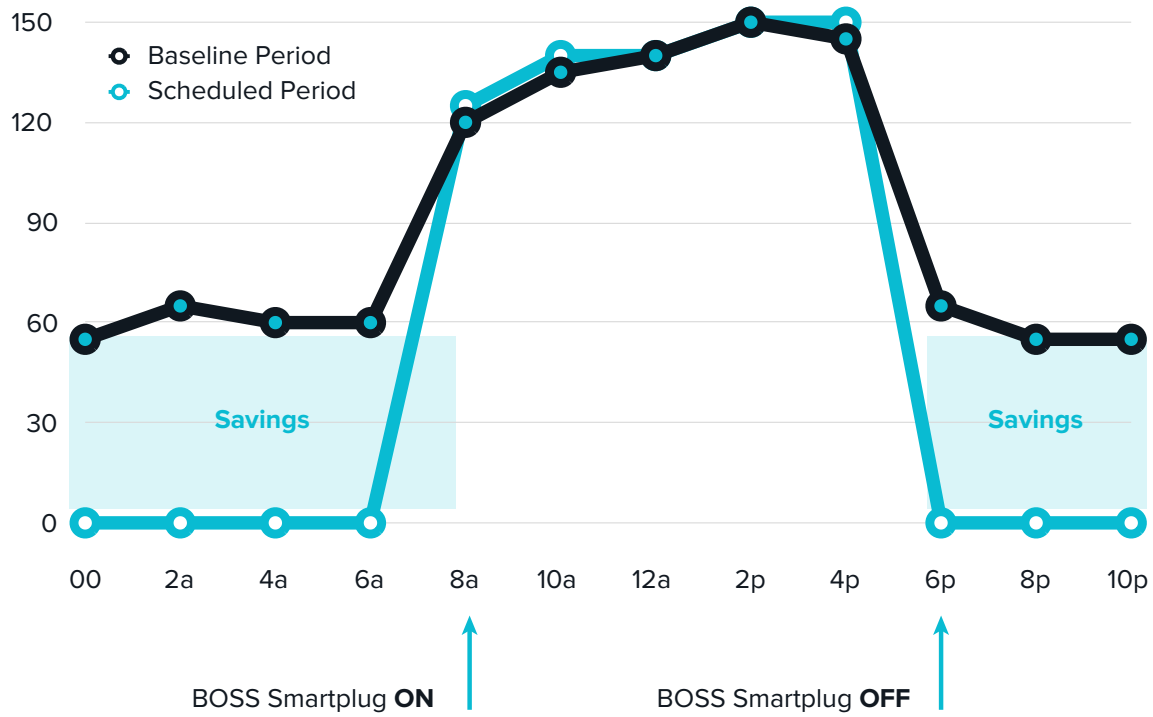
Unoccupied Hours (Baseline Vs. Scheduled Periods)



In order for the savings estimate to be accurate, the baseline period and the scheduled period must have identical unoccupied hours.

What is changing between the baseline period and the scheduled period is the energy consumed during “unoccupied” hours. In the baseline period, the appliance is consuming energy during “unoccupied hours” as if it was being controlled normally (without a BOSS plug). During the scheduled period, the appliance is consuming 0 (zero) energy, because the BOSS plug is “OFF.”

Typical Business Day Comparison
(Average 2 Hour Power Consumption (Watts))



Over a longer timeframe (e.g. one year), the BOSS Smartplug does offer additional savings due to dynamic scheduling, as well as “drift” in manual energy management (i.e. staff do not turn off devices overnight when they are supposed to). E.g. Over the course of the year a maintenance person would be able to change the scheduling of all water fountains on certain floors as schedules change with respect to a school year. If we were to run a baseline for a full year and a scheduled period for a full year we would observe these savings, but for current purposes such a study would be impractical.

Benefits of the BOSS Smartplug vs. a Conventional Plug-In Timer

The BOSS 120 & 220 Smartplugs provide a number of advantages beyond comparison to a simple plug in wall - timer, such as:

- The ability of property staff to control, schedule, re-schedule, and monitor both power (watts) and energy (watt hour) usage of all the plug load controllers from a single desktop or mobile interface.
- The ability to create “virtual groups” of devices that can be controlled, scheduled, monitored and analyzed like any individual BOSS device. This is probably the largest selling point of the product / system: The ability to create a single system to control out of dozens (or hundreds) of individual, smaller electric loads which would otherwise be too labor intensive to manage individually.
- The ability, through analysis of historical power and energy usage, to adjust schedules or note important energy use / equipment use behaviors from building occupants, and further adjust schedules or other building procedures.
- The ability to report to decision makers, with metered energy data, on actual savings, return on investment (ROI), etc.

Typical Digital Wall Timer

BOSS 120 Smartplug

Variables Affecting Energy Savings

For purposes of a short pilot (baseline period = one week to one month), the variables that will affect actual energy savings with the current Atmospheres release are:

- The watts consumed by the appliance during the baseline period during “unoccupied” hours. Because the Smartplug will be “OFF” during “unoccupied hours” of the scheduled period, the watts consumed will be 0 during this time. At this version of the software, we will not be comparing “occupied hours” usage between the baseline period and the scheduled period. Note that future pilots and products will compare occupied hour usage, as future hardware and software features will allow for advanced control during occupied hours.
- Unoccupied hours. (Unoccupied hours for baseline and scheduled period are identical for each device). Each device may have a different schedule for unoccupied vs. occupied hours. E.g. Fitness center equipment may be ON from 5am to 10pm (7 days per week), but the office copier may only be ON from 8am to 6pm (5 days per week).
- Average electric rate at the facility ($ / kWh). (Average electric rate = total cost of electricity in billing year / total kilowatt hours in billing year). Note that this is the simplest analysis of energy cost savings and does not take into account demand type charges (kilowatts) that are common to all commercial facilities. Future pilots and studies will incorporate demand savings / charges.
- Energy Savings is a simple calculation.
  - Energy (watt hours) = power (watts) * time (hours).
  - Energy (watt hours) during UNOCCUPIED BASELINE period = power (watts) * (10 minutes / (60 minutes / 1 hour)). The raw data exported from the BOSS portal is in 10 minute increments.
- Energy usage can be compared between devices, time frames, etc. Energy is analogous to the odometer in your car. It can be added, subtracted, multiplied.
- Power (watts) is an instantaneous (real-time) measurement. You can not easily add power measurements to one another. Power is analogous to the speedometer in your car.

Manipulating Data from the Website

1. We need to calculate the energy consumed by the appliance during the UNOCCUPIED BASELINE period.

- Download the raw data from the cloud portal.
- Separate your baseline period from your scheduled period for each device. Ensure they are the identical times / hours. Ensure data from both periods is one week exactly (same consecutive days with no operating schedule differences).
- Highlight the UNOCCUPIED hours (rows) for the baseline period. (This is the data you are most concerned about).
- Check to make sure that the power measurement for all of the SCHEDULED UNOCCUPIED hours are 0 (zero). Once you check that the scheduled period was behaving as planned, you will not need to do any work with the SCHEDULED period data.
- Return to your BASELINE data.
- Delete the rows for OCCUPIED hours. Again, you do not need this data because we are not comparing OCCUPIED hours between the baseline and scheduled periods.
- Create an Energy Calculation column to the right of the data by multiplying the power column (watts) * (1/6). 1/6 is simply 1/6 of an hour since our data is delivered in 10 minute increments. The resulting calculation gives you watt hours for each 10 minute interval.

2. Now we can calculate total energy saved (kilowatt hours) and estimated cost savings for each device.

- Sum the watt hours (energy column) for your UNOCCUPIED BASELINE period.
- Divide the watt hours by 1000. This gives you kilowatt hours (standard energy unit for electric billing) saved during the baseline period.
- Multiply the energy saved by the number of baseline periods in a year. For the attached spreadsheet my baseline period was just one day, so i multiplied by 365. Your baseline period will be one week so multiply by 52, etc.
- Multiply the annual kilowatt hours saved by the total (blended) electric rate of $0.11 per kilowatt hour. This is your total estimated annual energy savings per device.

Note that the method to estimate savings here is a conservative savings estimates, and the baseline period (establishing a baseline energy use) has been extremely simplified.

Facilities such as schools will have extended UNOCCUPIED periods that will increase savings, while hotels that rarely have UNOCCUPIED periods will have greatly reduced savings.

It's critical to understand the type of facility you are piloting, and ensure that you have an accurate assessment of operating hours for each device that is deployed.

Typical Results

One of the most important concepts to remember is that by shutting off power during UNOCCUPIED periods, we are not simply just saving on phantom power1, we are eliminating the operation (power consumption) of an appliance during UNOCCUPIED hours. E.g. Property staff may be responsible for manually shutting off all TVs in a lounge at closing time each day, but it most likely is not done consistently.

Here are some common ways in which the BOSS Atmospheres system reduces plug load usage.

- Eliminates phantom power completely.
- Reliably powers down equipment set to a schedule.
- It allows for remote control (powering down) of devices based on dynamic schedules: e.g. Monday is a holiday and maintenance can shut everything down from home, Floor 2 is not being used this week (I can shut down all devices on that floor).

Manageable Loads

Here are some typical expected results for a load that can be manually controlled by property staff based on the following assumptions:

Category	Baseline Period (No BOSS)	Scheduled Period (BOSS Engaged)
Weekly unoccupied hours with no control. • Property staff either forget to shut off or have no formal program to shut off. • Space is unoccupied due to a dynamic schedule change (holiday, etc.). • Device is ON, pulling full power.	**36**	**0**
Weekly unoccupied hours with manual control. • Property staff have shut off device overnight. • Device is using phantom power[1].	**78**	**0**

See next page for annual energy savings based on device power and the above assumptions.

[1] Phantom power is the power consumed by an electrical / electronic device even when the device is powered down. E.g. A LCD TV which is turned off may still draw 25 to 30 watts because it is actually in a “low power” mode. BOSS load controllers shut off all power to the device (like unplugging it).

Typical Device	Phantom Power	Average Operating Power	Annual Energy Savings	Annual Energy Cost Savings ($0.11kwh)
Plasma TV, 42”	25	280	626	$69
Plasma TV, 52”	30	400	870	$96
Copier, Large	28	0	114	$12
Computer & Monitor	15	165	370	$41
Cappuccino Machine	32	80	280	$31
Electric Heater, Portable*	1	1500	1082	$119
Window AC**	8	1250	1369	$151

* Based on temperate climate. Colder climates would yield significantly higher savings.

* * Based on temperate climate. Warmer climates would yield significantly higher savings.

Additionally, many appliances are not ever manually controlled by property staff but can be controlled easily with the BOSS platform. These devices are always on during unoccupied hours (approximately 114 hours per week for a typical facility with standard business hours).

Typical Device	Average Operating Power	Annual Energy Savings	Annual Energy Cost Savings ($0.11kwh)
Water Fountain, Wall Mounted	280	1660	$183
Vending Machine, Refrigerated	420	2490	$274
Ice Machine	440	2608	$287

Joe Guido, CEA