



Using Thermostats to Greatly Reduce Energy Use: A Seventh Day Toolkit

Not wasting energy heating or cooling rooms that are unoccupied is a simple no-cost way to greatly reduce your energy bills. With this easy practice, congregations, businesses, schools and households have cut their energy use and bills by 20% to 50%.

This toolkit walks you through a process that will determine precisely how your congregation building also can glean substantial savings. Because misinformation on this topic is abundant, the toolkit also contains answers to frequently asked questions (FAQs) and numerous authoritative sources on why and how this is effective. The information and articles can help you answer questions from your building manager, house committee and governing body. Of course, the *Seventh Day* team also welcomes your questions and comments at info@seventhdayinitiative.org.

This toolkit contains the following:

- A Step-by-Step Guide to Using Thermostat Set Points to Greatly Reduce Energy Use
- FAQs: Answers to Frequently Asked Questions about Using Thermostat Set Points
- “Swing Low, Sweet Thermostat”, Andrew Rudin, Interfaith Coalition on Energy
- Setting Your Thermostat in Summer: Sources
- “Guidelines for Pipe Organ Temperature Control”, American Institute of Organbuilders

A Step-by-Step Guide to Using Thermostat Set Points to Greatly Reduce Energy Use

Not wasting energy heating or cooling rooms that are unoccupied is a simple no-cost way to greatly reduce your energy bills. This exercise will walk you through precisely how your building might glean substantial savings – 20% to 50% – from this practice. The product will be a schedule that you will use to program your programmable thermostat(s). If your building does not yet have a programmable thermostat, replacing each existing thermostat with a programmable one should pay for itself in under a year. After that, it will produce substantial savings year after year.

- 1) **Identify your building's heating / cooling zones and record here which rooms and hallways are included in each and where the thermostat is that controls each.** A heating / cooling zone is an area that is heated and cooled using one set of HVAC (heating, ventilation and air conditioning equipment) equipment and its own thermostat. If possible, obtain a plan of your building and mark the zones on it.

Zone 1:

Zone 2:

Zone 3:

Zone 4:

Zone 5:

Zone 6:

- 2) **Determine which zones or groups of zones can be cooled and heated separately from others.**

Which zones can currently be closed off from all other zones by closing doors? _____

Which groups of zones cannot currently be separated from each other? _____

- 3) **Interview staff and leaders to determine: a) when zones are occupied, b) for what purposes and c) what temperatures are acceptable for those uses.** Record this information in Table 1 at the end of this document.

Identify each person with whom you should speak to learn when and for what the building is in use. This might include the administrator, the clergy person, the person who opens the building for worship services, the preschool director, the person who organizes gatherings for retirees, etc. Ask them: a) the days of the week or month the space is used, b) the start and end times of this use, and c) the activity. Ask staff what temperatures they themselves feel they can manage in winter, if they wear appropriately warm clothes, and in summer, if they dress lightly. Ask the leadership what temperatures they want the rooms heated or cooled when a service or program is taking place. Leave a paper trail: type up and file your notes for future use. Explain that you want to deeply reduce energy bills by using less energy when the building or parts of the building are vacant.

- 4) **Adapt Sample Table 1 at the end of this document to fit your own building as follows:**

Zones: Enter your building's zones putting zones that cannot be separated for heating and cooling in adjacent rows. You might shade these in the same color. For example, Table 1 is for a building with four HVAC zones in which Zones 1 and 3 cannot be closed off from each other.

Days: Unless your building use is identical for certain days of the week, prepare a separate table for each week day. For example, Table 1 is for a building used in the same way Mon. and Thurs.

Time periods: In the top row, include the time periods that make sense for your building, for example, the time period when your building is always unoccupied or always has only staff. Table 1 is for a building that is always empty from 10 pm to 7 am.

5) **Enter the information you gathered into your tables:**

- Enter “A” for a program, service, or gathering and “B” if only staff, volunteers or children are in a zone. Leave the space blank if the zone is unoccupied.
- Add an “M” to show that an event does not take place every week. For example, Table 1 shows that on Mon. and Thurs., Zone 4 is used by staff or volunteers – “B” – only from 7 to 10 p.m. monthly – “M”.

Also note in a table like this one what temperatures zones will be set to when: a) staff or volunteers only are present, b) a program or service is going on, and c) the zone is unoccupied.

Preferred Thermostat Settings

	Heating setting	Cooling setting
A. Program or service is going on	68	72
B. Staff or volunteers are present	66	75
Unoccupied	50	88

- 6) **For each zone, note the time of day when the zone is always unoccupied until the next day: even when there is an unscheduled activity, the zone will be unoccupied by this hour.** Sometimes your building may be used at a time that is not included in your schedule, for example, for a special event. People will override the settings to warm up or cool down the zone and they may forget to turn the thermostat back to the original setting when they leave. Therefore, for each zone, you need to determine a time after which everyone certainly will always have left. You will program the thermostat to revert to its usual unoccupied setting at that hour just in case someone has manually overridden the unoccupied setting. For example, perhaps on almost all Wednesdays, your library is empty from 2 PM until the next day. However, every once in a while a committee schedules a meeting for Wednesday evening in the library. The meetings always end well before 10:30 PM. So, your thermostat should be programmed to its unoccupied setting at 2 PM and **then again** at 10:30 PM. On the few days that a committee chair manually overrides the thermostat for a meeting, the thermostat will go back to its unoccupied setting at 10:30.
- 7) **Note that you will want to reset the thermostats prior to periods when the building use pattern changes.** For example, there’s no point in heating the pre-school wing every weekday during a two-week winter break!

You now have all the information you need to program each zone’s thermostat. You can stop heating and cooling empty rooms and save your congregation a lot!

Important Tips

- 1) Beware! Some thermostats can be set on HOLD, which will override the settings that you **programmed** until the HOLD is taken off. For some thermostats, you can purchase a plastic see-through locked box that still allows anyone to override the **current** setting but prevents them from pushing the HOLD button or changing the underlying program settings.
- 2) When the public has access to the thermostats, someone may on purpose or accidentally change the programmed settings. It is important to have someone reliable regularly check the programs on the thermostats. Remotely-controlled thermostats that can be checked and changed from a computer or smart phone. These have come way down in price and can help a lot.
- 3) Ideally, all the thermostats should be the same make and model. This facilitates learning how to set and efficiently maintain them. Most spaces in a house of worship may require a seven-day model whereby the daily settings can differ. For spaces like offices, a week day / weekend model may suffice.
- 4) When thermostats are installed on outside walls, they may partly measure the outdoor temperature. They may overshoot the desired room temperature in the winter and may undershoot in the summer.
- 5) Each space differs with regard to how long it takes to get to the desired temperature after it has been in setback mode. This will depend on factors such as the size of the space, the size of the HVAC unit, and the outside temperature. The person responsible for the thermostats will have to experiment to learn how long before the space is occupied the thermostat needs to reach the set temperature.
- 6) Note thermostats should be set to start heating or cooling well before the space is occupied so that is the desired temperature when they arrive. Similarly, the thermostat can be set in setback mode well before an event is over – even when it begins! - since the space can coast at a constant temperature for some time before anyone will become uncomfortable. Too, when setting the temperature, remember that rooms heat up when lights are on and people are present.

Install a new door? In the example below, zones 1 and 3 are not separated by a door. You can see that the furnace and AC for zone 1 is unnecessarily heating and cooling zone 3 from 7 Am to 4 PM every Monday and Thursday. Your property committee might want to consider whether it would be feasible and save congregational funds to install a door between zones 1 and 3.

Which type of thermostat is best for us? If a zone is expected to be used exactly the same way each week day and exactly the same way both weekend days, then you can use a 5 day-2 day thermostat. It has just two programs, one for five days and one for the other two. If your building use varies from day to day, then a 7-day thermostat would suit you better. Some congregations would prefer to have a thermostat that can be controlled by a designated person from the internet or a mobile phone. When an unusual meeting or event takes place, a remotely controlled thermostat – which is more expensive - enables this person to turn the heat or AC on ahead of time from offsite so that the space is warm or cool when the first person arrives.

Table 1. Sample Building Use Table for Monday and Thursday

Zone	10 pm – 7am	7 am – 8 am	8 am – 9 am	9 am – 10 am	10 am – 11 am	11 am – 12 pm	12 pm – 1 pm	1 pm – 2 pm	2 pm – 3 pm	3 pm – 4 pm	4 pm – 5 pm	5 pm – 7 pm	7 pm – 8 pm	8 pm – 9 pm	9 pm – 10 pm
1		B	A	A	A	A	A	A	A	B					
3													A	A	
2				B	B	B	B	B	B	B	B				
4													B M	B M	B M

Key:

A – program, worship service, event or meeting

B – in use by staff, volunteers or children only

M - monthly or periodic, not every week

Note: You may find it helpful to add to this key some abbreviations for different types of events – for example, PS for preschool – and then add these into the table. Determining seasonally what changes need to be made to your thermostat programs may be easier if you know what specifically is going on during each period. For example, if your table indicates that the preschool is occupying a space, then you can know to change that in June if the preschool doesn't meet during the summer.

FAQS: Answers to Frequently Asked Questions

How does lowering the thermostat set point in winter and increasing it in summer affect furnaces and AC units?

Lowering the thermostat set point in winter and increasing it in summer *lengthens* the life of HVAC equipment. The smaller the difference between the outside temperature and the thermostat temperature inside, the less hard the HVAC equipment needs to work and the less frequently it has to switch on and off.

How does lowering the thermostat set point in winter and increasing it in summer affect our building's energy use?

Lowering the thermostat set point in winter and increasing it in summer saves energy. The greater the difference in temperature between the inside and outside, the more heat loss or cooling gain. For example, in winter, it takes *less* energy to warm the space back to a comfortable temperature after the thermostat has been set back than to keep it at that temperature throughout. In fact, as soon as the building drops below its normal temperature, its loss of energy to the surrounding environment slows down. The lower the interior temperature, the slower the heat loss. So the longer your building remains at the lower temperature, the more energy you save. The same concept applies to raising your thermostat setting in the summer -- a higher interior temperature will slow the flow of heat into your building, saving energy on air conditioning. (U.S. Department of Energy)

What effect will large temperature changes have on our organ?

According to the American Institute of Organbuilders, organs are safe in temperatures from 40° to 100° F. However, if no heat is used for the entire week during freezing weather, it is important to slowly raise the temperature incrementally over at least a 24-hour period. Although temperature does affect organ tuning, the tuning reverts back to normal when the temperature returns to the original setting. So, an organ should be tuned at the temperature at which it will be played. Organs require a humidity level between 30% and 80%. In winter, lowering the temperature to 40° to 55° during the week helps prevent overly-dry conditions. If humidity exceeds 80%, a dehumidifier should be used.

Using much less air conditioning in unoccupied parts of our building in the summer can increase the relative humidity. What can we do about that?

You will want to control the summer humidity in infrequently-used spaces, especially those that are below ground level. Rather than wasting energy by air conditioning the space even when it's not in use, you can:

- use a dehumidifier in problem areas. This especially makes energy sense if the AC unit covers a larger area than the problem area. Note: Many dehumidifiers have unreliable humidity detectors such that the dehumidifier will run for much longer than needed. Therefore, you may want to set the dehumidifier to run for a few hours daily during the humid months rather than setting it to run until it reduces the humidity to a set level.
- Alternatively, you can set your programmable thermostat to cool the space for an hour or two in the early morning, before outside temperature begins to rise. An AC unit does dehumidify. However, it uses more energy to do so than a dehumidifier. For an unoccupied space, using a dehumidifier makes more energy and financial sense.

Swing Low, Sweet Thermostat

by Andrew Rudin, Project Coordinator, The Interfaith Coalition on Energy, Philadelphia

Lower Winter Interior Temperatures Imitate Conditions in Other Seasons

Since it began ten years ago, the Interfaith Coalition on Energy (ICE) has been recommending that congregations set back the temperature as low as 45F inside their buildings when they are not in use in the heating season.

Some members of congregations believe that changing the temperature inside the house of worship can harm organs, pianos, woodwork, and many other artifacts as well as the fabric of the building itself.

This article summarizes the readings from a circular chart recorder in a typical church to record the actual swings in relative humidity and temperature for more thirteen months. Our hypothesis was that similar changes in temperature and humidity occur all year. The swings in temperature caused by a clock thermostat during the winter may be similar to the swings that occur during the spring, summer, and fall. When a congregation tries to eliminate these changes in temperature and humidity in the winter by maintaining warmer than necessary temperatures, they are wasting large sums of money, while drying the building fabric and contents. We wanted to prove the futility of minimizing the swings in the winter but allowing the same swings to occur during the heating season that occur the rest of the year.

Temple Lutheran Church

We chose the Temple Lutheran Church in Havertown, Pennsylvania because Pastor Reimet and the members of the congregation said they could tolerate having the chart recorder for a year, allowing ICE access to change the charts each month. The church is in fine architectural shape. Other than what you would expect from a building that was 71 years old, there is no evidence of any problems with either the interior or exterior parts of the building. Our recorder was installed on February 2, 1990 in the organ and choir loft at the rear of the sanctuary. The probe for the chart recorder was suspended over the balcony so that it could sense the condition of the moving air in the room. It was not near an outside wall. The sanctuary is used mostly for Sunday worship services and for unscheduled events during the week. The room is heated by a steam boiler. A steam valve is controlled by a clock thermostat near the front of the room. All in all, it seems to be typical of many churches in the Philadelphia area.

Interpretation of the Results

We collected the charts each month or so for a little less than 13 months. The data from the chart for each day was recorded in a computer spreadsheet—the highest and lowest temperature for each day and the highest and lowest relative humidity each day. A sample chart is shown on the next page. Several times, the blue pen that recorded changes in relative humidity did not write clearly. We left the relative humidity data blank for those days.

Table 1 (below) shows the results. There are seven columns of figures for each month. The three columns on the right show the maximum highest and lowest temperature for each month and the difference between the high and low. Note that the least of these monthly temperature extremes is 18F and that the maximum is 35 F. The maximum daily temperature difference occurred in March (35 F), followed by April (34 F) February, 1991 (31 F). Maximum daily differences of 25 to 27 occurred in June, July, September, October, December and January— half the year.

While the columns on the right show the highest and lowest temperature each month, the numbers in the pair of center columns shows the average of the maximum daily changes in both temperature and relative humidity for all the readings each month. The maximum difference in high

Table 1. Changes in Temperature and Relative Humidity							
	Average of Daily Swings		Maximum Swings		Temperatures		
	Temperature	Humidity	Temperature	Humidity	High	Low	Difference
Feb.	10	9%	23	18%	77	47	30
Mar.	9	7%	23	18%	85	50	35
Apr.	8	7%	16	14%	92	58	34
May	8	7%	14	14%	80	62	18
June	8	7%	14	18%	94	68	26
July	7	7%	12	15%	97	71	26
Aug.	7	8%	11	21%	91	69	22
Sept.	7	7%	12	19%	88	62	26
Oct.	8	9%	15	21%	84	58	26
Nov.	9	9%	22	24%	80	48	32
Dec.	9	11%	18	26%	76	51	25
Jan.	9	12%	22	29%	76	49	27
Feb.	10	9%	25	18%	77	46	31
Avg.	8	8%	17	20%	84	57	28

and low temperature readings is greater in the winter, but the difference in relative humidity is greater in the summer, fall and early winter.

The pair of columns on the left shows the average of the daily differences between the maximum and minimum temperature and relative humidity for each month. This is the monthly average of the differences between the high and low readings of each day. These figures show that the swings in temperature and relative humidity are roughly the same all year, not just in the winter.

Conclusions

Our hypotheses are correct. The average difference between the high and low temperatures each month is 27F. If the clock thermostat can control the heating system to maintain 72F during occupied periods, then a 27F setback to 45F is typical of the changes in temperature that occur all year.

Most experts agree, however, that relative humidity has a greater effect on the contents of a building than does temperature. The maximum daily change in relative humidity was typically greater in the summer and fall. The maximum swings for the winter were roughly the same as those for the spring.

Most months, the average daily change in relative humidity was 7% to 9% each day. In January the average was 12%. In December the average was 11%. The average change in relative humidity was the same, however, in February, October and November (9%). The average change in temperature over each month was 7F to 9F. In both Februaries, the average change was only 3F greater than in the summer.

While it is true that the daily changes in temperature and relative humidity are slightly greater in the winter, the daily changes occur all year long. If the pipe organ, piano, woodwork, plaster, paint, and all the other contents of a building of a building can tolerate a 27-degree change in temperature in the spring summer and fall, then they can tolerate the same difference in the winter. If comfortable temperatures are 72F, then a lower temperature during vacant periods can be 45F, which is 27 degrees lower.

It is very expensive and non-productive to prevent natural changes in relative humidity and temperature by using heating or air conditioning when not necessary for occupants.

Setting Your Thermostat in Summer: Sources

Turn up your thermostat

Set your thermostat to 78 degrees when you are home and 85 degrees or off when you are away. Using ceiling or room fans allows you to set the thermostat higher because the air movement will cool the room. Always take into account health considerations and be sure to drink plenty of fluids in warm weather. (Save: 1 - 3 percent per degree, for each degree the thermostat is set above 72 degrees)

Consumer Energy Center <http://www.consumerenergycenter.org/tips/summer.html>

OPERATE YOUR THERMOSTAT EFFICIENTLY

- Set your thermostat as high as comfortably possible in the summer. The smaller the difference between the indoor and outdoor temperatures, the lower your overall cooling bill will be.
- Keep your house warmer than normal when you are away, and lower the thermostat setting to 78°F (26°C) only when you are at home and need cooling...
- Avoid setting your thermostat at a colder setting than normal when you turn on your air conditioner. It will not cool your home any faster and could result in excessive cooling and unnecessary expense.

U.S. Department of Energy, <http://energy.gov/energysaver/articles/spring-and-summer-energy-saving-tips>

In the summer months, the air conditioner's thermostat should not be set any lower than 78 degrees Fahrenheit. Likewise, the settings should not be any higher than 68 degrees Fahrenheit in the winter. Keeping to these guidelines will help maximize energy savings.

<http://saveenergy.about.com/od/homecooling/qt/thermostatsetin.htm>

Raise your Air Conditioner's Thermostat

Benefits

- Save 25% - 50% on your summer cooling costs.
- Your A/C will last longer as it will need to run less often

Summary

Each additional degree that you lower your AC thermostat uses quite a bit more energy than the previous degree, so raising your summer thermostat by a few degrees can make significant impact on energy use. Even if you are not willing to raise it a lot, just a degree or two can lead to real savings with little noticeable decrease in comfort. You can also keep your house warmer than normal when you are away and then lower the thermostat setting only when you are at home and need cooling. Although thermostats can be adjusted manually, programmable thermostats will avoid any discomfort by returning temperatures to normal as you wake or return home. It is a common misconception associated with thermostats is that an AC works harder than normal to cool the space back to a comfortable temperature after the thermostat has been set high, resulting in little or no savings. In fact, a higher interior temperature will slow the flow of heat into your house, saving energy on air conditioning.

Energy Impact Illinois energyimpactillinois.org/waystosave/raise-your-thermostat-this-summer/

Guidelines for Pipe Organ Temperature Control

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As energy costs continue to rise, many pipe organ owners will be re-examining how they heat and cool their worship spaces throughout the week. These guidelines are intended as a common-sense approach to climate control that can reduce utility bills while still avoiding the extreme conditions that may damage sensitive organ components. Extremes in temperature and humidity can be avoided without having to constantly run heating or air conditioning systems.

How temperature and humidity affect the organ

Organ pipes are like every other wind instrument: their pitch varies with the temperature. When the air is cool, pipes will sound flat. When the air is warm, pipes will sound sharp. This is because the air inside the pipe is less dense when it is warm and therefore oscillates faster. Expansion and contraction of the pipe metal itself is negligible.

Regardless of how raucous the organ sounds when it is extremely hot or cold, it will quickly come back into tune at the designated temperature used during worship services. Of course, that same temperature needs to be maintained whenever your organ technician is tuning the organ.

While temperature extremes are not a big concern, excessive seasonal variations in humidity can cause problems with certain organ components. Wood expands, contracts, and twists as humidity rises and falls. Good organ design can compensate for most problems with wood movement, but extreme dryness caused by continuous winter heating for several days at a time can lead to serious wood cracking. A humidity gauge placed inside the organ should generally stay above 30% during the winter and below 80% during the summer.

General temperature control procedures

- Bring the worship space to your normal designated temperature only when it will be occupied for public services.
- Turn on the heating/cooling ("HVAC") system sufficiently far in advance to allow each part of the organ to reach its normal temperature. If your HVAC system was designed with good air circulation patterns in mind, stable temperatures can usually be achieved inside the organ three to six hours after turning on the system. Allow extra time when outside temperatures are extreme or if air does not circulate freely through all parts of the organ.
- If the worship space is unoccupied for most of the week, lowering the winter midweek heat setting to around 40 degrees (or slightly higher in mild climates) will naturally keep the relative humidity high enough that a humidifier may be unnecessary. If no heat is used for the entire week during freezing weather, it is important to slowly raise the temperature incrementally over at least a 24-hour period.

Possible upgrades to your HVAC system for improved temperature stability and energy efficiency

- Ask your organ technician to install extra return-air duct lines or a small, quiet centrifugal blower within the organ to pull air through all parts of the organ. If any organ pipes are near uninsulated roof decks, it is especially important to pull stratified air out of those areas. Increase the size of HVAC grilles and/or remove metal grates to quiet the rush of air. Do not add supply registers near organ pipes, since air blowing directly on them can cause wide temperature swings as the system cycles on and off. Remove organ grille cloth wherever feasible to promote better air circulation.
- Develop a page of clear HVAC operating procedures and post it on the wall next to the controls. Consider replacing overly complicated system controls. Relocate any thermostat that is exposed to sunlight or too close to exterior doors and windows. Thermostats need to be fairly close to the large return-air grilles within the worship space.
- HEATING: If the heat must be on for more than an entire day and there are prolonged humidity readings below 30% inside the organ, install a humidifier. Humidifiers should ideally be a part of the main HVAC system; if a separate unit must be placed in the organ chamber, great care must be taken to ensure that water cannot drip on any organ parts. Malfunctioning humidifiers and overflowing dehumidifiers can severely damage organ pipes and windchests. Never place a humidifier near the blower intake area of the organ.

- **COOLING:** If summer humidity readings are often above 80%, a dehumidifier in the duct line may be needed to help the primary compressor remove enough moisture from the air. If the primary compressor is severely oversized and therefore not able to run long enough during off-peak times to lower humidity, consider adding a smaller secondary compressor. Running only the secondary compressor for a few hours during the week may be all that is needed to maintain summer humidity levels below 80%. As long as humidity remains generally below 80%, organ components should be fine even though temperatures during the week may be around 100 degrees during the hottest weather.

Since these guidelines cannot anticipate every situation, it would be wise to talk with your pipe organ technician about any special conditions in your worship space that may require unique climate control procedures and remedies. Pipe organ technicians are often the best source of information regarding HVAC controls because they have seen what does and doesn't work in a wide variety of buildings throughout your region.

About the AIO

The American Institute of Organbuilders is an educational organization dedicated to advancing the art of organbuilding “by discussion, inquiry, research, experiment and other means.” Among the Institute’s 385 members are professional organ builders, service technicians and suppliers who subscribe to AIO objectives and its code of ethics. Conventions are held each year in cities throughout the United States and Canada. These meetings are structured around a full schedule of technical lectures, visits to local organ shops and instruments, product exhibits and business meetings. AIO small-group seminars provide another valuable opportunity for professional growth. Held in organ shops throughout the country, these sessions offer hands-on training in specific organ building skills. Further information and online resources are available at www.pipeorgan.org