# **AR ${AR}: Install Programmable Thermostats in ${AREA}**

### Recommended Action

Program setback thermostats to set ${AREA} temperatures during off-hours.

### Summary of Estimated Savings and Implementation Costs

|  |  |
| --- | --- |
| Annual Cost Savings | ${ACS} |
| Implementation Cost | ${IC} |
| Payback Period | ${PB} |
| Annual Electricity Savings | ${ES} kWh |
| Annual Natural Gas Savings | ${NGS} MMBtu |
| ARC Number | 2.7261.3 |

### Current Practice and Observations

Comfortable temperatures are maintained within the ${AREA} 24 hours per day throughout the year. The office and administrative areas only operate ${PHR} hours per day, ${PDY} days per week. Much energy is wasted maintaining the set temperatures during unoccupied hours.

### Anticipated Savings

<COOL>For the office area, there are about ${TON} refrigeration tons of HVAC units that can be on programmable thermostat. </COOL>It is proposed that the thermostats in the office and administrative areas be programmed to set back temperature during the night and on weekends to save energy. Smart thermostats could turn down the HVAC units to a very low load when no one is in these areas and turn up the HVAC units one hour before the start of the workday. Installation costs are generally low for these units, since only the thermostat(s) on the wall need to be updated.

### <COOL>Savings from Setback Temperature during the Cooling Season

Estimates for current consumption and costs are based upon the number of cooling degree hours, and an estimate of the energy required to hold one degree of difference. One cooling degree hour in this instance is defined as one degree of temperature difference held between indoors and outdoors for the duration of one hour. Estimates for energy conservation are based upon the number of cooling degree hours saved. Our calculations take into consideration the actual set temperature and hours of the day that the facility is occupied. Historical local temperature data is also used to estimate hourly temperature profiles. The following calculates the power draw, PD, of the HVAC system:

PD = TON × C1 × LF / (EER × C2)

where,

TON = HVAC size; ${TON} tons

C1 = Conversion constant; 12,000 Btu/hr/ton

LF = Load Factor; to represent oversized equipment and the capabilities of the non-programmed thermostat to throttle back load, where the building envelope is approximated assuming the system is designed to keep the building cool on the hottest day of the year with a factor of safety. ${LF}

EER = Energy Efficiency Ratio; ${EER} Btu/hr/W

C2 = Conversion constant; 1,000 W/kW

PD = ${TON} ton × 12,000 Btu/hr/ton × ${LF} / (${EER} Btu/hr/W × 1,000 W/kW)

= ${PD} kW

For a building in ${TOWN} cooled to ${CST}°F, there are approximately ${CDH} cooling degree hours[[1]](#footnote-1). Allowing the set temperature to rise to ${MCST}°F decreases that figure to ${MCDH} cooling degree hours. The energy savings from the reduction of degree days are calculated as follows:

ES = PD × OHE × (1 - MCDH / CDH)

where,

OHE = Existing operating hours; ${OHE} hrs/year (${CHR} hours per day, ${CDY} days per week, ${CWK} weeks per year)

CDH = Cooling degree hours; ${CDH} deg⋅hr/yr

MCDH= Modified cooling degree hours; ${MCDH} deg⋅hr/yr

ES = ${PD} kW × ${OHE} hrs/year × (1 - ${MCDH} / ${CDH})

= ${ES} kWh/yr.</COOL>

### <HEAT>Savings from Setback Temperature during the Heating Season

Heating costs will also be reduced using setback thermostats. In combined HVAC systems, these savings are realized without additional costs. An estimate of the savings which could be realized through installation of the setback timers can be made by using the following approach:

The energy loss from the building is proportional to the temperature difference between the inside and outside. If the temperature is unoccupied building is lowered from ${HST}oF to ${MHST}oF during non-working hours, the resulting natural gas savings, NGS, can be calculated using the following formula:

NGS = NGU × (1 - MHDH / HDH),

where,

HDH = Cooling degree hours; ${HDH} deg⋅hr/yr

MHDH= Modified cooling degree hours; ${MHDH} deg⋅hr/yr

NGU = Estimated natural gas usage for heating in the ${AREA}; ${NGU} MMBtu/yr

NGS = ${NGU} MMBtu/yr × (1 - ${MHDH} deg⋅hr/yr / ${HDH} deg⋅hr/yr)

= ${NGS} MMBtu/yr</HEAT>

Therefore, the annual cost savings, ACS, is:

ACS = <COOL>ES × Electricity Cost</COOL><DOUBLE> + </DOUBLE><HEAT>NGS × Natural Gas Cost</HEAT>

= <COOL>${ES} kWh/yr × ${EC}/kWh</COOL><DOUBLE> + </DOUBLE><HEAT>${NGS} MMBtu/yr × ${NGC}/MMBtu</HEAT>

= <COOL>${ECS}/yr</COOL><DOUBLE> + </DOUBLE><HEAT>${NGCS}/yr</HEAT><DOUBLE>

= ${ACS}/yr</DOUBLE>

### Implementation Cost

The cost for purchasing one programmable thermostat is about ${PT}. There are ${NT} thermostat units installed. Installation is expected to take ${IT} hours for each thermostat, with an in-house labor rate of ${LR} per hour. Materials are therefore expected to cost ${MC}, and labor is expected to cost ${LB}. The total implementation cost is estimated to be ${IC}.

**The <COOL>annual electricity savings for this AR is ${ES} kWh</COOL><DOUBLE> and the </DOUBLE><HEAT>annual natural gas savings is ${NGS} MMBtu</HEAT>. The estimated annual cost savings is ${ACS} and, with an implementation cost of about ${IC}, the payback period will be about ${PB}**.

**Implementation Cost References**

The below links are for implementation cost references. We do not endorse/recommend these brands or products. Furthermore, these products may or may not be suitable for the application. The client should contact a vendor(s) to conduct a detailed study of the process, to determine the best product for the recommended application.

* <https://www.homedepot.com/p/Honeywell-Home-Wi-Fi-7-Day-Programmable-Smart-Thermostat-with-Digital-Backlit-Display-RTH6580WF/203556922>
* <https://www.amazon.com/dp/B09XXS48P8/?tag=thewire06-20&linkCode=xm2&ascsubtag=AwEAAAAAAAAAAlU6>
* <https://www.lowes.com/pd/Google-Nest-Learning-3rd-Gen-Stainless-Steel-Smart-Thermostat-with-Wi-Fi-Compatibility/1001080012?irgwc=1&cm_mmc=aff-_-c-_-prd-_-mdv-_-gdy-_-all-_-0-_-197432-_-0>
* <https://www.bestbuy.com/site/mysa-smart-programmable-wi-fi-thermostat-white/6520815.p?acampID=0&ar=1831734221144674033&cmp=RMX&irgwc=1&loc=Howl+Technologies%2C+Inc.&mpid=376373&nrtv_cid=1336551658d030c68d8ca590d264e1427c06d10f258b8893983a6c4ddc172487&ref=198&skuId=6520815&utm_source=narrativ>

1. <https://meteostat.net/en/> [↑](#footnote-ref-1)