

Legacy Roof-Heat-Cable Thermostats Deliver Negligible Savings: A 33-Community, Per-Circuit Energy-Waste Assessment

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ABSTRACT

Introduction: Rooftop heat cables (HCs) melt snow to prevent ice dams, drawing an average of 1.9–2.8 kW per circuit, but waste energy when unnecessarily active. Air-sensing thermostats (44–50 °F) are widely used to control HCs with the aim of saving energy, yet their performance has not been tested. The objective of this study was to investigate the energy-saving impacts of thermostatic control of HC. We hypothesized that the use of thermostats substantially decrease energy consumption.

Methods: Using 2000–2024 hourly climate normals for 377 U.S. Ski communities apart of the National Ski Association, we assessed per-circuit (i) winter deactivation hours (1 Nov–31 Mar, 3,648 h) and (ii) non-winter activation hours (1 Apr–31 Oct, 5,136 h), with deactivation at mean hourly temperatures ≥ 44 °F. Times when the HCs should be activated vs should not be activated to protect the roofs were determined by whether they were on based on whether the temperature fell below the thermostat setting during winter months (should be on) versus summer months (should be off). The average HC wattage was assumed to be 1.9 kW per circuit. Homeowners in mountain towns and in Great Lakes cities with installed HC were surveyed about their perceptions of the energy-saving capabilities of thermostats controlling HCs, about their practice of manually activating and deactivating their HCs, and about their beliefs about the need for manual activation and deactivation.

Results: During the winter, thermostats would have deactivated HCs a median (IQR) of less than 1.5%(0.1%–4.1%); during non-winter months, thermostats would have activated HCs 19.4%(10.0%–36.1%) of the time. Median (IQR) per-circuit waste was found to be 3.2 MWh (1.7–6.0 MWh) for (1.9 kW) and 4.8 MWh (2.5–8.6 MWh) for (2.8 kW) MWh per year, or 64.4 MWh (33.4–120.2 MWh) for (1.9 kW) and 95 MWh (49–172 MWh) for (2.8 kW) over 20 years—equivalent to 8 U.S. homes' annual use at the high end at 12 MWh/year. Among the 121 survey respondents, 97% of users believed thermostatic control of HCs saves energy. Smart, IoT computer vision-based controls could recover 70–90% of waste (5–14 MWh/year), cutting costs, emissions and providing improved building protection via constant monitoring and alerting to system issues.

Keywords: Ice-dam prevention, heat-trace cable, heat tape, heat cable, hot edge, thermostat efficacy, building energy waste, climate normals, demand response, VPP.

Highlights:

- Analyzed 377 ski communities with 25-year climate normals
- Legacy HC control thermostats set to 44 °F **saves energy** HCs 1.5% (0.1–4.1%) of the year in ski communities

· Same thermostats **waste energy** HCs 19.4%(10.0%–36.1%) of the year in ski communities

· Per-circuit waste 3.2 MWh (1.7–6.0 MWh) for (1.9 kW) and 4.8 MWh (2.5–8.6 MWh) for (2.8 kW) MWh per year, or 64.4 MWh (33.4–120.2 MWh) for (1.9 kW) and 95 MWh (49–172 MWh) for (2.8 kW) over 20 years

Abbreviations:

Term | Definition

HC | Heat cable

OFF-h | Hours thermostat opens circuit

ON-h | Hours circuit active

IQR | Inter-quartile range

MAIN ARTICLE

INTRODUCTION

Ice dams form when snow on a roof melts, flows down the roof to colder eaves, and refreezes, blocking drainage pathways for further melt water.[1] Ice dams damage roofs, gutters, and interiors in snow-belt regions and are estimated to cause \$900-\$6,200 per homeowner in the United States.[2]

To prevent ice dams, heat cables (HCs) are installed on some 20-27M locations. Using market size, volume, and application share data from the Fact.MR report, we projected cumulative sales over a 30-year horizon and adjusted for attrition to estimate the installed base of roof and gutter heat cables. Applying North America's 32% market share and dividing by the typical cable length per home yields an estimated 26.7 million homes with heat cables in 2024. HCs are resistive heating wire systems, installed in zig-zag patterns along eaves, valleys, and gutters(Supplement S3). They maintain warm temperatures on these colder parts of the roof to ensure melt channels are created, allowing meltwater to flow off the roof. A typical 80m circuit draws approx. 1.9–2.8 kW, is often active 24h per day from November to March and consumes significant energy. These systems are prevalent in high-elevation ski resorts (e.g., Aspen, CO), cold Mid-West cities (e.g., Chicago, IL), and throughout New England where heavy snow and freeze-thaw cycles are common.

Ideally, HCs should only turn on when there is new snow or roof-ice obstructing melt channels. Initially, HCs were controlled manually via breakers or left always-on, leading to inefficiencies. In the 1970s, driven by the extreme energy cost of uncontrolled HC systems and following the example of indoor heating control, air-temperature sensing thermostats were introduced to control HCs to keep systems from running in non-winter months or during warm spells in the winter.

These thermostats are binary on-off controllers, often bimetallic with set points typically between 44–50 °F (6.7–10 °C) and a hysteresis of ± 2 °F (± 1.1 °C). They are often installed under shaded eaves to deactivate HCs when ambient temperatures rise to above the set point. They were marketed as a “set-and-forget” energy and cost saver. Without another option for even rudimentary automatic control, thermostatic HC control became popular, building a considerable installed base still widely used with many HCs.

While indoor air temperature is an adequate variable for controlling indoor heating systems to maintain desired comfort levels, **air temperature is a poor surrogate for controlling HCs, because it does not convey critical information:** whether a clear melt channel exists for new meltwater, or if more melting is required. And controlling HCs without taking into account any information on actual conditions is inadequate for protecting buildings.

Furthermore, it is not clear, to what degree thermostatic HC control fulfills its promise of saving energy: During **warm** periods (> 44 °F), (or if the thermostat is exposed to the warming of direct sunlight) thermostats deactivate HCs, allowing new meltwater to encounter existing ice dams, risking leaks and flooding into the building. During **cold** periods, thermostats will activate HCs - but they will do that even when there is no snow or ice on the roof. In addition, in very-**cold** conditions (< 15 °F), thermostats cause HCs to remain on unnecessarily, as no melting can occur at those temperatures, posing no risk of leaks and thus no need for HC operation. Installation errors, such as placing sensors near heat sources or maladjusting the set-points to temperatures above 50 °F, may further increase waste and increase risk of damage.

To our knowledge no peer-reviewed study have validated the claims of energy savings provided by thermostatic heat cable control. The **objective** of this research is to explore whether thermostatic control of HCs actually does save energy when compared to "always-on" or to manually controlled HCs. We **hypothesize** that thermostatic control of HCs will save energy, but only to a very small degree. The primary endpoints of this study are the number of winter hours during which thermostats deactivate HCs and the number of non-winter hours during which thermostats activate HCs. Secondary endpoints include the amount of energy waste associated with these activation/deactivation characteristics and what the perceptions of homeowners with installed HCs are of the energy saving potential of thermostatic control of HCs.

METHODS

Survey of Homeowner's Perceptions and Manual Control of HCs

An online survey was distributed via homeowner associations and contractor mailing lists between March and April 2023 to 121 homeowners with installed HC systems with a response rate of 100%. Survey items captured data on thermostat set-point practices, user-perceived effectiveness, frequency of seasonal disconnection, and experiences with system failures (see Supplement S1).

Estimated Thermostat Activity from Historical Climate Data

Hourly ambient temperature data from 2000-2024 were retrieved from the Open Meteo Hourly Forecast API [3] and for 377 U.S. ski communities that were associated with the National Ski Areas Association [4] and aggregated into regional climate centers according to the National Oceanic and Atmospheric Association [5] (High Plains, Midwest, Northeast, Southeast, South, Southeast, and West) (Supplement S2). Inclusion criteria for weather stations included a minimum of 25 years of data. The selected 377 locations (listed in Table 3) represent a range of snow-prone environments across the United States.

To estimate thermostat activity, we identified two key metrics:

Winter Deactivation hours: This is the number of hours between November 1 and March 31 (3,648 h total) during which the ambient temperature exceeded a set-point of 44 °F (6.7 °C), thereby deactivating the HC system. This was interpreted as energy savings (assuming that all of the deactivation hours were justified, i.e., that there was truly no snow or ice to be melted by HC during those hours). Non-winter Activation hours: This was defined as the number of hours between April 1 and October 31 (5,136 h total) during which the temperature fell below 44 °F (6.7 °C). This was considered energy waste, as it was assumed that there was snow or ice present during those non-winter months that needed to be melted, i.e., the HC activation was unnecessary.

Energy use was estimated by multiplying the number of ON-hours by the typical power draw of an 80-meter HC circuit (either 1.9 kW or 2.8 kW, see Table 1). For lifecycle projections, we assumed stable climate patterns (Appendix A) and a 20-year operational lifetime. Energy savings were calculated as the energy that was not used because thermostatic control deactivated the HCs during the winter months. Notably, this assumes that this deactivation was justified, i.e., that there was no ice or snow that needed melting during those times of winter deactivation. Energy waste was calculated as any energy that was used during thermostatic HC activation during non-winter months.

Summary statistics are reported as medians with interquartile ranges (IQR). To assess the impact of thermostat set-point variation on thermostat performance estimates, we analyzed winter deactivation hours and non-winter activation hours not only at a set-point of 44 °F but also at 47 °F and 50 °F. A warm-winter scenario (+2 °C, or 3.6 °F, mean temperature shift) was included to evaluate climate change impacts. Percentages were presented as the total hours of each category out of the total hours of the year (8,760 h).

Failure Mode Analysis

Survey responses and follow-up interviews with 17 electricians were used to identify and estimate the distribution of common thermostat failure modes (Supplement 4).

RESULTS

Survey of Homeowner's Perceptions and Manual Control of HCs

A total of 121 responses were received for a response rate of 100%. Respondents' geographic distribution was 70% mountain-town residents, 20% urban, and 10% rural. 98% of respondents believed thermostats save energy; 15% acknowledged they had adjusted set-points to above 50 °F (10°C), and 2% used manual breakers seasonally. 98% of respondents reported that no manual action was needed for HC circuits under "thermostatic control."

Estimated Thermostat Activity from Historical Climate Data

The High Plains had a median winter deactivation of 0.0% (0.1–0.2%), and non-winter activation was 44.6% (38.1–53.4%). The Midwest had a median winter deactivation of 2.4% (0.9–1.0%), and non-winter activation was 11.4% (6.9–17.7%). The Northeast had a median winter deactivation of 2.7% (1.1–4.8%), and non-winter activation was 12.2% (8.5–17.7%). The South had a median winter deactivation of 2.9% (1.3–7.0%), and non-winter activation was 24.4% (15.4–30.1%). The Southeast had a median winter deactivation of 12.9% (9.5–25.1%), and non-winter activation was 5.2% (0.9–8.2 %). The West had a median winter deactivation of 0.1% (0.0–1.8%), and non-winter activation was 36.3% (28.1–46.2%). The total had a median winter deactivation of 0.1% (0.0–1.8%), and non-winter activation was 36.3% (28.1–46.2%). (Tables 2 and 3)

The set point variation and warm winter check, an analysis of data from 2000–2024 showed a median 1.65% (0.5–4.7%) change in winter deactivation hours at 44°F (Table S2.1). Higher set-points increased winter deactivation hours but also non-winter activation hours.

Total median non-winter activation 19.4% (10.0–36.1%) occurs during cool nights, especially at elevations > 1800 m, where summer lows often drop below 44-50 °F.

Estimated Energy Use, Savings, and Waste

Annual total median waste was 3.2 MWh (1.7–6.0 MWh) for (1.9 kW) and 4.8 MWh (2.5–8.6 MWh) for (2.8 kW). Over 20 years, waste was 64.4 MWh (33.4–120.2 MWh) for (1.9 kW) and 95 MWh (49–172 MWh) for (2.8 kW), equivalent to 8 U.S. homes' annual use at 12 MWh/year. The annual High Plains region median waste was 7.4 MWh (6.3–8.9 MWh) for (1.9 kW) and 10.9 MWh (9.3–13.1 MWh) for (2.8 kW). The annual Midwest region median waste was 1.9 MWh (1.2–2.9 MWh) for (1.9 kW) and 2.8 MWh (1.7–4.3 MWh) for (2.8 kW). The annual Northeast region median waste was 2.0 MWh (1.4–2.9 MWh) for (1.9 kW) and 3.0 MWh (2.1–4.3 MWh) for (2.8 kW). The annual South region median waste was 4.1 MWh (2.4–5.0 MWh) for (1.9 kW) and 6.0 MWh (3.8–7.4 MWh) for (2.8 kW). The annual Southeast

region median waste was 0.9 MWh (0.1–1.4 MWh) for (1.9 kW) and 1.3 MWh (0.2–2.0 MWh) for (2.8 kW). The annual West region median waste was 6.0 MWh (4.7–7.7 MWh) for (1.9 kW) and 8.9 MWh (6.9–11.3 MWh) for (2.8 kW) (Table 4).

Failure Modes

The survey and follow-up with electricians identified two distinct ways the HC thermostatic control might fail: **Open** (permanently off) and **Closed** (permanently on) positions.

Approximately equal frequencies were reported for each failure mode.

DISCUSSION

The results of this study confirm our initial hypothesis that thermostatic control of HCs, even when set to the correct temperature thresholds, does save energy by deactivating HCs during higher temperatures in the winter - but only to a negligible amount. What is more, these negligible savings are much smaller than the energy wasted in a majority of cases, when thermostats activate HCs during low temperature periods in non-winter months. In the High Plains we saw the largest difference: legacy air-temperature control saves 0.0% in the winter, yet wastes 44.6% in the summer/shoulder season. With the second largest difference being in the West, 0.0% of savings in the winter, and waste being 36.3% in the summer. We see a moderate yet still significant difference in the Midwest, Northeast, and South regions. There is only one region where there is minor gains for energy savings, with a 7.7% difference in the Southeast (Figure 1). There was a total median of 1.5% savings in the winter and 19.4% in the summer/shoulder season.

The set point variation and warm winter check with a median 1.65% (0.5–4.7%) change in winter deactivation hours confirmed the robustness of these estimations. The fact that higher set-points increased winter deactivation hours, but also non-winter activation hours indicates exacerbated waste in high-elevation regions.

The finding that 98% of surveyed users believe that thermostatic control is sufficient (i.e., no manual action is necessary), which is not supported by results in this study, might reflect marketing statements by thermostatic HC control manufacturers.

Rooftop snowmelt systems prevent ice dams in regions with > 2 m annual snowfall, but these HCs (1.9–2.8 kW per circuit) incurs high energy costs. While many circuits are “uncontrolled”, i.e., are only manually switched with breakers, some systems use legacy bimetallic thermostats, placed in shaded roof areas, which rarely exceed 44 °F in winter, yielding winter deactivation rates of less than 2% in ski communities.

Open-mode failures increase the risk of water damage due to uncontrolled snowmelt, while closed-mode failures result in substantial energy waste and premature HC degradation. Notably, no built-in diagnostics or alerts exist in these systems to notify building owners of such malfunctions.

Further, these rudimentary devices offer no monitoring or alerting – breaker trips, HC damage, or wear goes unreported.

Smart IoT computer vision-based controls, which directly detect snow or ice in melt channels and provide real-time monitoring and alerts, reduce runtime by 70–90% (5–14

MWh/year savings),[6] offering quick payback (often < 2 years at \$0.15/kWh [7,8]) and building protection via continuous visual and electrical monitoring and alerting about system anomalies. A Park City, UT, case study showed 85% runtime reduction with computer vision sensors and automatic IoT controls.[6] These systems can be retrofitted to existing HC installations but cost \$500–\$2,000.

Manual timers and roof insulation/ventilation (\$3,100–\$3,900 for a 1.5 story home [9]) are alternatives but require user effort or investment and are not guaranteed to prevent ice damming.

Demand-response programs, like computer vision sensors and automatic IoT controls, could offset costs by curtailing HC use during peak grid demand leading to a shorter payback period.

Limitations

Climate normals may miss extreme weather, though sensitivity tests (Supplement S2) suggest minimal error. A +2 °C scenario showed 5–10% lower non-winter activation hours in ski areas. The survey's residential focus and online distribution may overrepresent affluent users. Future work should use 2024–2025 real-time future data.

CONCLUSIONS

Legacy 44 °F thermostats deactivate HCs less than 1.5% (0.1–4.1%) in winter and activate them 19.4% (10.0–36.1%) in non-winter, wasting 3.2 MWh (1.7–6.0 MWh) for (1.9 kW) and 4.8 MWh (2.5–8.6 MWh) for (2.8 kW) per circuit per year. Sensor-based controls, insulation, and education about the potential of smarter control systems might result in more efficient HC use, enhancing existing snowmelt system efficiency and saving very significant amounts of energy, thereby relieving the US power grids to meet increased energy demand.

Modern smart IoT computer vision-based controls now exist, which directly detect snow or ice in melt channels, provide real-time monitoring and alerts and might provide more precise and targeted HC control.

DECLARATIONS

Credit Authorship: T.C.: Conceptualization, Data curation, Writing—original draft. L.C.: Investigation, Resources. T.C. : Writing—review & editing. D.B.: Supervision.

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Data Availability: Data and scripts available

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Figure 1: Regional Winter Deactivation and Non-Winter Activation

Bar chart showing median winter deactivation and non-winter activation percentages for 44 °F thermostats, calculated from 377 ski areas grouped into six regions (Supplement S2).

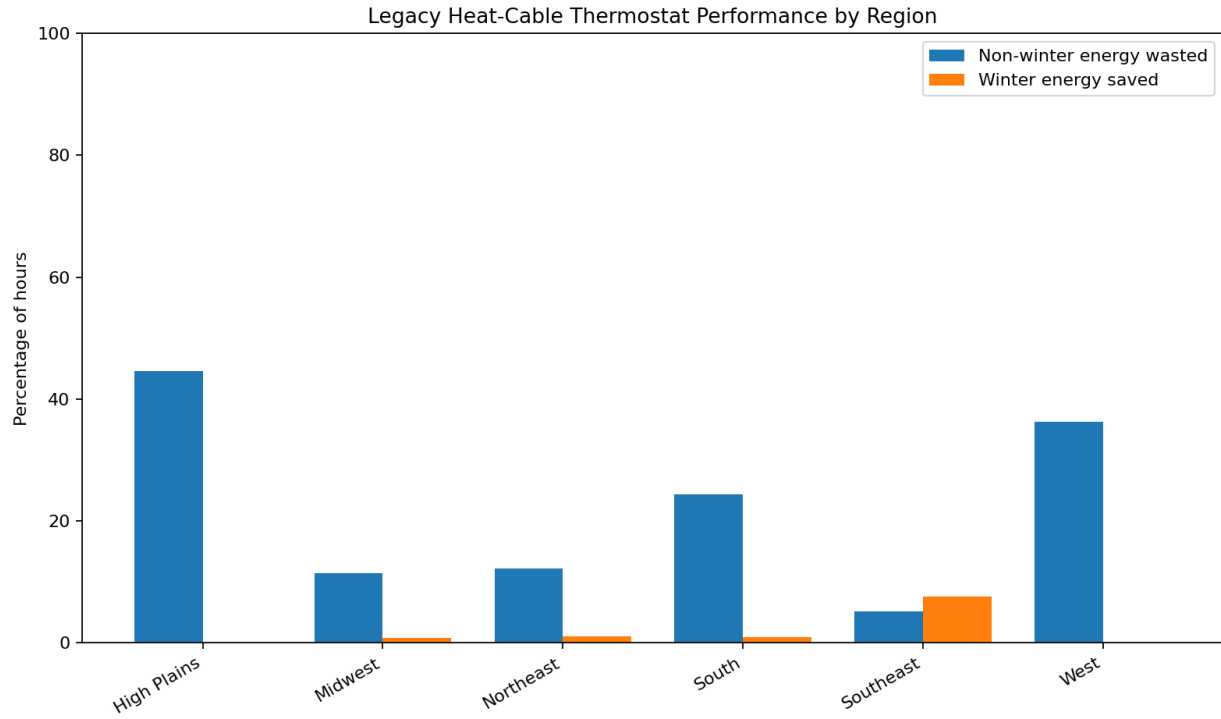


Table 1: Snowmelt System Components

Component	Description
Heat Cable (HC)	Constant-wattage (average of 1.9kW per 80m) or "self-regulating" cable (average of 2.8 kW per 80 m) for snow melting.
Thermostat	Air-sensing, bimetallic, deactivates at 44-50 °F, depending on the setting. Some systems are set above 50F during installation to avoid "call backs" or home/business owner complaints of insufficient melting.

Table 2: Winter Deactivation vs. Non-Winter Activation for 44 °F Thermostats by Region

Region	Winter Deactivation Hours (%)	Non-Winter Activation Hours (%)
High Plains	0 (0.0%)	3908 (44.6%)
Midwest	74 (0.8%)	1003 (11.4%)
Northeast	90 (1.0%)	1065 (12.2%)
South	82 (0.9%)	2140 (24.4%)
Southeast	671 (7.7%)	455 (5.2%)
West	0 (0.0%)	3180 (36.3%)
Total (Median)	132 (1.5%)	1696 (19.4%)

Winter: 1 Nov–31 Mar (3,648 h); Non-winter: 1 Apr–31 Oct (5,136 h). Percent numbers are with respect to total hours in a year (8,760 h).

Table 3: Winter Deactivation vs. Non-Winter Activation for 44 °F Thermostats by Ski Area

Ski Area	Region	Winter Deactivation Hours (%)	Non-Winter Activation Hours (%)
Arapahoe Basin Ski Area	High Plains	0 (0.0%)	6364 (72.6%)
Aspen Highlands	High Plains	0 (0.0%)	3490 (39.8%)
Aspen Mountain	High Plains	0 (0.0%)	3318 (37.9%)
Beaver Creek Resort	High Plains	0 (0.0%)	3756 (42.9%)
Bluebird Backcountry	High Plains	0 (0.0%)	4146 (47.3%)
Breckenridge Ski Resort	High Plains	0 (0.0%)	5244 (59.9%)
Buttermilk	High Plains	0 (0.0%)	3342 (38.2%)
Copper Mountain Resort	High Plains	0 (0.0%)	4884 (55.8%)
Crested Butte Mountain Resort	High Plains	0 (0.0%)	4512 (51.5%)
Deer Mountain Ski Resort	High Plains	0 (0.0%)	2910 (33.2%)
Echo Mountain	High Plains	0 (0.0%)	5234 (59.7%)
Eldora Mountain Resort	High Plains	0 (0.0%)	4540 (51.8%)
Frisco Adventure Park	High Plains	0 (0.0%)	4200 (47.9%)
Frost Fire Park	High Plains	0 (0.0%)	2066 (23.6%)
Granby Ranch	High Plains	0 (0.0%)	3876 (44.2%)
Grand Targhee Resort	High Plains	0 (0.0%)	4716 (53.8%)
Great Bear Ski Valley	High Plains	152 (1.7%)	874 (10.0%)
Hogadon Basin Ski Area	High Plains	0 (0.0%)	3430 (39.2%)
Howelsen Hill Ski Area	High Plains	0 (0.0%)	2942 (33.6%)
Huff Hills Ski Area	High Plains	16 (0.2%)	1596 (18.2%)
Jackson Hole Mountain Resort	High Plains	0 (0.0%)	3442 (39.3%)
Keystone Resort	High Plains	0 (0.0%)	4538 (51.8%)
Lake City Ski Hill	High Plains	0 (0.0%)	3886 (44.4%)
Loveland Ski Area	High Plains	0 (0.0%)	6342 (72.4%)
Meadowlark Ski Lodge	High Plains	0 (0.0%)	4510 (51.5%)
Monarch Mountain	High Plains	0 (0.0%)	5748 (65.6%)
Pine Creek Ski Resort	High Plains	0 (0.0%)	3198 (36.5%)
Powderhorn Mountain Resort	High Plains	0 (0.0%)	2572 (29.4%)
Purgatory Resort	High Plains	0 (0.0%)	3638 (41.5%)
Silverton Mountain	High Plains	0 (0.0%)	5536 (63.2%)
Ski Cooper	High Plains	0 (0.0%)	5990 (68.4%)
Sleeping Giant Ski Area	High Plains	0 (0.0%)	3820 (43.6%)
Snow King Mountain Resort	High Plains	0 (0.0%)	3460 (39.5%)
Snowmass	High Plains	0 (0.0%)	3930 (44.9%)

Snowy Range Ski & Recreation Area	High Plains	0 (0.0%)	4598 (52.5%)
Steamboat Ski & Resort	High Plains	0 (0.0%)	3034 (34.6%)
Sunlight Mountain Resort	High Plains	0 (0.0%)	3572 (40.8%)
Telluride Ski & Golf Resort	High Plains	0 (0.0%)	4358 (49.7%)
Terry Peak Ski Area	High Plains	0 (0.0%)	3124 (35.7%)
Vail Mountain	High Plains	0 (0.0%)	6388 (72.9%)
White Pine Ski Area	High Plains	0 (0.0%)	4670 (53.3%)
Winter Park Resort	High Plains	0 (0.0%)	4618 (52.7%)
Afton Alps Ski Area	Midwest	56 (0.6%)	1048 (12.0%)
Alpine Valley Resort	Midwest	192 (2.2%)	608 (6.9%)
Alpine Valley Ski Area	Midwest	182 (2.1%)	648 (7.4%)
Alpine Valley Ski Area	Midwest	224 (2.6%)	456 (5.2%)
Andes Tower Hills, Inc.	Midwest	0 (0.0%)	1528 (17.4%)
Ausblick Ski Area	Midwest	146 (1.7%)	768 (8.8%)
Big Powderhorn Mountain Resort	Midwest	2 (0.0%)	1748 (20.0%)
Big Snow Resort	Midwest	0 (0.0%)	1816 (20.7%)
Boston Mills/Brandywine Ski Resort	Midwest	416 (4.7%)	232 (2.6%)
Boyne Highlands Resort	Midwest	22 (0.3%)	1412 (16.1%)
Boyne Mountain Resort	Midwest	48 (0.5%)	1212 (13.8%)
Buck Hill Ski & Snowboard Area	Midwest	76 (0.9%)	940 (10.7%)
Buena Vista Ski Area	Midwest	0 (0.0%)	1914 (21.8%)
Caberfae Peaks	Midwest	42 (0.5%)	1230 (14.0%)
Camp 10 Ski Area	Midwest	0 (0.0%)	1642 (18.7%)
Cannonsburg Ski Area	Midwest	180 (2.1%)	650 (7.4%)
Cascade Mountain	Midwest	152 (1.7%)	756 (8.6%)
Chester Bowl	Midwest	0 (0.0%)	2192 (25.0%)
Chestnut Mountain Resort	Midwest	212 (2.4%)	568 (6.5%)
Christie Mountain Snow Area	Midwest	8 (0.1%)	1418 (16.2%)
Crystal Mountain	Midwest	50 (0.6%)	1074 (12.3%)
Detroit Mountain Recreation Area	Midwest	0 (0.0%)	1776 (20.3%)
Devil's Head Resort & Convention Center	Midwest	142 (1.6%)	770 (8.8%)
Giants Ridge	Midwest	0 (0.0%)	2146 (24.5%)
Grand Geneva Resort	Midwest	184 (2.1%)	610 (7.0%)
Granite Peak at Rib Mountain State Park	Midwest	26 (0.3%)	1316 (15.0%)
Heiliger Huegel Ski Club	Midwest	122 (1.4%)	842 (9.6%)
Hickory Hills	Midwest	42 (0.5%)	1194 (13.6%)
Hidden Valley Ski Area	Midwest	1312 (15.0%)	12 (0.1%)
Hyland Hills Ski Area	Midwest	88 (1.0%)	888 (10.1%)

Little Switzerland	Midwest	114 (1.3%)	898 (10.3%)
Lutsen Mountains	Midwest	0 (0.0%)	2542 (29.0%)
Mad River Mountain	Midwest	482 (5.5%)	232 (2.6%)
Marquette Mountain	Midwest	4 (0.0%)	1870 (21.3%)
Mont Du Lac Resort	Midwest	14 (0.2%)	1600 (18.3%)
Mont Ripley Ski Area	Midwest	0 (0.0%)	1938 (22.1%)
Mount Bohemia	Midwest	0 (0.0%)	2266 (25.9%)
Mount Kato Ski Area	Midwest	160 (1.8%)	744 (8.5%)
Mt. Brighton Ski Area	Midwest	194 (2.2%)	620 (7.1%)
Mt. Crescent Ski Area	Midwest	564 (6.4%)	276 (3.2%)
Mt. Holiday	Midwest	72 (0.8%)	1072 (12.2%)
Mt. Holly Ski Resort, Inc.	Midwest	170 (1.9%)	672 (7.7%)
Mt. La Crosse	Midwest	160 (1.8%)	648 (7.4%)
Mt. Ski Gull	Midwest	0 (0.0%)	1624 (18.5%)
Mt. Zion	Midwest	0 (0.0%)	1914 (21.8%)
Nordic Mountain	Midwest	82 (0.9%)	966 (11.0%)
Nub's Nob Ski Area	Midwest	12 (0.1%)	1494 (17.1%)
Otsego Resort	Midwest	14 (0.2%)	1538 (17.6%)
Paoli Peaks, Inc.	Midwest	1124 (12.8%)	32 (0.4%)
Perfect North Slopes	Midwest	1104 (12.6%)	30 (0.3%)
Pine Mountain Ski Resort	Midwest	4 (0.0%)	1714 (19.6%)
Powder Ridge Ski Area	Midwest	28 (0.3%)	1262 (14.4%)
Powers Bluff Park - Wood County Parks and Forestry Department	Midwest	32 (0.4%)	1276 (14.6%)
Seven Oaks Recreation	Midwest	446 (5.1%)	338 (3.9%)
Shanty Creek Resort	Midwest	46 (0.5%)	1164 (13.3%)
Ski Brule	Midwest	0 (0.0%)	2010 (22.9%)
Ski Snowstar Winter Sports Park	Midwest	490 (5.6%)	230 (2.6%)
Sleepy Hollow Sports Park, Inc.	Midwest	512 (5.8%)	276 (3.2%)
Snow Creek Ski Area	Midwest	1052 (12.0%)	50 (0.6%)
Snow Snake Ski & Golf	Midwest	72 (0.8%)	1136 (13.0%)
Snow Trails	Midwest	390 (4.5%)	268 (3.1%)
Spirit Mountain Recreation Area	Midwest	0 (0.0%)	1994 (22.8%)
Sunburst Sports Park	Midwest	116 (1.3%)	880 (10.0%)
Sundown Mountain Ski and Snowboard Resort	Midwest	182 (2.1%)	594 (6.8%)
Swiss Valley Ski & Board Area	Midwest	196 (2.2%)	586 (6.7%)
The Homestead	Midwest	48 (0.5%)	1240 (14.2%)
The Rock Snowpark	Midwest	156 (1.8%)	724 (8.3%)
Timber Ridge Ski Area	Midwest	218 (2.5%)	536 (6.1%)

Treetops Resort	Midwest	20 (0.2%)	1554 (17.7%)
Trollhaugen Winter Recreation Area	Midwest	36 (0.4%)	1178 (13.4%)
Tyrol Basin Ski & Snowboard Area	Midwest	190 (2.2%)	606 (6.9%)
Villa Olivia Ski Area	Midwest	300 (3.4%)	452 (5.2%)
Welch Village Ski Area, Inc.	Midwest	118 (1.3%)	826 (9.4%)
Whitecap Mountains Resort	Midwest	0 (0.0%)	1876 (21.4%)
Wild Mountain	Midwest	56 (0.6%)	1040 (11.9%)
Wilmot Mountain	Midwest	214 (2.4%)	516 (5.9%)
Abenaki Ski Area	Northeast	104 (1.2%)	1062 (12.1%)
Arrowhead Recreation Area	Northeast	108 (1.2%)	1074 (12.3%)
Attitash Mountain Resort	Northeast	56 (0.6%)	1418 (16.2%)
Bear Creek Mountain Resort	Northeast	522 (6.0%)	350 (4.0%)
Belleayre Mountain	Northeast	14 (0.2%)	1588 (18.1%)
Berkshire East Mountain Resort	Northeast	196 (2.2%)	828 (9.5%)
Big Boulder Ski Area	Northeast	116 (1.3%)	868 (9.9%)
Big Rock Mountain	Northeast	0 (0.0%)	2088 (23.8%)
Black Mountain Ski Area	Northeast	12 (0.1%)	1800 (20.5%)
Black Mountain of Maine	Northeast	12 (0.1%)	1842 (21.0%)
Blue Knob	Northeast	72 (0.8%)	1138 (13.0%)
Blue Mountain Resort	Northeast	234 (2.7%)	622 (7.1%)
Bolton Valley Resort	Northeast	0 (0.0%)	2242 (25.6%)
Bousquet Ski Area	Northeast	116 (1.3%)	960 (11.0%)
Boyce Park Ski & Tubing Area	Northeast	498 (5.7%)	298 (3.4%)
Bradford Ski Area	Northeast	310 (3.5%)	574 (6.6%)
Bretton Woods Ski Area	Northeast	0 (0.0%)	1978 (22.6%)
Bristol Mountain Resort	Northeast	160 (1.8%)	790 (9.0%)
Bromley Mountain Resort	Northeast	10 (0.1%)	1794 (20.5%)
Burke Mountain Resort LLC	Northeast	2 (0.0%)	1792 (20.5%)
Camden Snow Bowl	Northeast	92 (1.1%)	1118 (12.8%)
Camelback Resort	Northeast	228 (2.6%)	600 (6.8%)
Campton Mountain	Northeast	18 (0.2%)	1628 (18.6%)
Canaan Valley Resort	Northeast	146 (1.7%)	1096 (12.5%)
Cannon Mountain	Northeast	0 (0.0%)	2122 (24.2%)
Catamount Mountain Resort	Northeast	156 (1.8%)	840 (9.6%)
Cochrans Ski Area	Northeast	36 (0.4%)	1054 (12.0%)
Cockaigne Resort LLC	Northeast	86 (1.0%)	980 (11.2%)
Cranmore Mountain Resort	Northeast	74 (0.8%)	1370 (15.6%)
Crotched Mountain Ski & Ride	Northeast	96 (1.1%)	1124 (12.8%)
Dartmouth Skiway	Northeast	36 (0.4%)	1406 (16.1%)
Double H Ranch	Northeast	82 (0.9%)	1086 (12.4%)

Eagle Rock Ski Area	Northeast	142 (1.6%)	820 (9.4%)
Eaglebrook School	Northeast	220 (2.5%)	784 (8.9%)
Eastman Cross Country	Northeast	46 (0.5%)	1376 (15.7%)
Elk Mountain Ski Resort, Inc.	Northeast	94 (1.1%)	1076 (12.3%)
Four Seasons Golf and Ski Center	Northeast	170 (1.9%)	676 (7.7%)
Gateway Hills Snow Park	Northeast	258 (2.9%)	692 (7.9%)
Gore Mountain	Northeast	16 (0.2%)	1552 (17.7%)
Granite Gorge Ski Area	Northeast	100 (1.1%)	1046 (11.9%)
Greek Peak Mountain Resort	Northeast	88 (1.0%)	1032 (11.8%)
Gunstock Mountain Resort	Northeast	60 (0.7%)	1284 (14.7%)
Hidden Valley Resort	Northeast	124 (1.4%)	952 (10.9%)
HoliMont Ski Area	Northeast	76 (0.9%)	1076 (12.3%)
Holiday Mountain Ski Area	Northeast	202 (2.3%)	722 (8.2%)
Holiday Valley Resort	Northeast	78 (0.9%)	1054 (12.0%)
Hunter Mountain	Northeast	10 (0.1%)	1696 (19.4%)
Jack Frost Mountain	Northeast	110 (1.3%)	930 (10.6%)
Jay Peak Resort	Northeast	0 (0.0%)	2130 (24.3%)
Jiminy Peak Mountain Resort	Northeast	86 (1.0%)	1068 (12.2%)
Killington Resort	Northeast	0 (0.0%)	2050 (23.4%)
King Pine Ski Area	Northeast	76 (0.9%)	1244 (14.2%)
Kissing Bridge Corp.	Northeast	120 (1.4%)	858 (9.8%)
Laurel Mountain	Northeast	100 (1.1%)	1016 (11.6%)
Liberty Mountain Resort	Northeast	842 (9.6%)	138 (1.6%)
Loon Mountain Recreation Corp.	Northeast	28 (0.3%)	1404 (16.0%)
Lost Valley Ski Area	Northeast	86 (1.0%)	1122 (12.8%)
Mad River Glen	Northeast	0 (0.0%)	1896 (21.6%)
Magic Mountain	Northeast	46 (0.5%)	1370 (15.6%)
Maple Ski Ridge	Northeast	142 (1.6%)	864 (9.9%)
McCauley Mtn. Ski Center	Northeast	0 (0.0%)	1646 (18.8%)
McIntyre Ski Area	Northeast	188 (2.1%)	850 (9.7%)
Middlebury College Snow Bowl	Northeast	0 (0.0%)	1834 (20.9%)
Mohawk Mountain Ski Area	Northeast	226 (2.6%)	644 (7.4%)
Montage Mountain	Northeast	120 (1.4%)	880 (10.0%)
Mount Lakeridge Ski & Board Center	Northeast	24 (0.3%)	1304 (14.9%)
Mount Peter	Northeast	234 (2.7%)	640 (7.3%)
Mount Pleasant of Edinboro	Northeast	174 (2.0%)	610 (7.0%)
Mount Snow Resort	Northeast	20 (0.2%)	1542 (17.6%)
Mount Southington Ski Area	Northeast	472 (5.4%)	402 (4.6%)
Mount Sunapee Resort	Northeast	42 (0.5%)	1386 (15.8%)

Mountain Creek Resort	Northeast	418 (4.8%)	384 (4.4%)
Mt. Abram Ski Area	Northeast	16 (0.2%)	1734 (19.8%)
Nashoba Valley Ski Area	Northeast	316 (3.6%)	590 (6.7%)
Oak Mountain	Northeast	4 (0.0%)	1700 (19.4%)
Oglebay Resort	Northeast	550 (6.3%)	228 (2.6%)
Okemo Mountain Resort	Northeast	26 (0.3%)	1510 (17.2%)
Otis Ridge	Northeast	126 (1.4%)	922 (10.5%)
Pats Peak	Northeast	138 (1.6%)	956 (10.9%)
Peek'n Peak Resort	Northeast	114 (1.3%)	792 (9.0%)
Pico Mountain	Northeast	0 (0.0%)	1980 (22.6%)
Plymouth Notch	Northeast	22 (0.3%)	1552 (17.7%)
Pocono Ranch Lands Property Owners	Northeast	256 (2.9%)	604 (6.9%)
Powder Ridge Mountain Park & Resort	Northeast	418 (4.8%)	478 (5.5%)
Proctor Ski Area	Northeast	114 (1.3%)	1052 (12.0%)
Quechee Ski Area	Northeast	68 (0.8%)	1226 (14.0%)
Ragged Mountain Resort	Northeast	46 (0.5%)	1360 (15.5%)
Roundtop Mountain Resort	Northeast	594 (6.8%)	270 (3.1%)
Saddleback Maine	Northeast	0 (0.0%)	2798 (31.9%)
Seven Springs Mountain Resort	Northeast	160 (1.8%)	862 (9.8%)
Shawnee Mountain Ski Area	Northeast	408 (4.7%)	398 (4.5%)
Shawnee Peak Ski Area	Northeast	66 (0.8%)	1364 (15.6%)
Ski Big Bear at Masthope Mountain	Northeast	180 (2.1%)	794 (9.1%)
Ski Butternut	Northeast	176 (2.0%)	726 (8.3%)
Ski Campgaw Management, Inc., LLC	Northeast	492 (5.6%)	296 (3.4%)
Ski Plattekill	Northeast	0 (0.0%)	1696 (19.4%)
Ski Sawmill Family Resort	Northeast	118 (1.3%)	944 (10.8%)
Ski Sundown	Northeast	284 (3.2%)	610 (7.0%)
Ski Ward Ski Area	Northeast	298 (3.4%)	594 (6.8%)
Smugglers' Notch Resort	Northeast	8 (0.1%)	1542 (17.6%)
Snow Ridge Resort	Northeast	18 (0.2%)	1374 (15.7%)
Snowshoe	Northeast	4 (0.0%)	1732 (19.8%)
Song Mountain Resort	Northeast	86 (1.0%)	970 (11.1%)
Storrs Hill Ski Area	Northeast	82 (0.9%)	1148 (13.1%)
Stowe Mountain Resort	Northeast	0 (0.0%)	1916 (21.9%)
Stratton	Northeast	4 (0.0%)	1788 (20.4%)
Sugarbush Resort	Northeast	4 (0.0%)	1798 (20.5%)
Sugarloaf	Northeast	0 (0.0%)	4154 (47.4%)
Suicide Six Ski Area	Northeast	68 (0.8%)	1274 (14.5%)

Sunday River Resort	Northeast	16 (0.2%)	1742 (19.9%)
Swain Resort	Northeast	112 (1.3%)	970 (11.1%)
The Balsams Resort	Northeast	0 (0.0%)	2252 (25.7%)
The Villas at Tree Tops and Fairway			
White Lightning Snow Tubing	Northeast	470 (5.4%)	334 (3.8%)
Thunder Ridge Ski Area	Northeast	372 (4.2%)	456 (5.2%)
Timberline Mountain	Northeast	174 (2.0%)	964 (11.0%)
Titus Mountain Family Ski Center, LLC	Northeast	18 (0.2%)	1404 (16.0%)
Tussey Mountain Ski Area	Northeast	248 (2.8%)	632 (7.2%)
Victor Constant Ski Area	Northeast	406 (4.6%)	398 (4.5%)
Wachusett Mountain Ski Area	Northeast	146 (1.7%)	904 (10.3%)
Waterville Valley Resort	Northeast	0 (0.0%)	2034 (23.2%)
Whiteface Mountain	Northeast	0 (0.0%)	4124 (47.1%)
Whitetail Resort	Northeast	684 (7.8%)	220 (2.5%)
Wildcat Mountain	Northeast	0 (0.0%)	2248 (25.7%)
Windham Mountain	Northeast	64 (0.7%)	1252 (14.3%)
Winterplace Ski Resort	Northeast	438 (5.0%)	570 (6.5%)
Wisp Resort	Northeast	212 (2.4%)	694 (7.9%)
Woods Valley Ski Area	Northeast	94 (1.1%)	962 (11.0%)
Yawgoo Valley Ski Area & Waterpark	Northeast	556 (6.3%)	390 (4.5%)
Angel Fire Resort	South	90 (1.0%)	2142 (24.5%)
Ober Gatlinburg Ski Area	South	1456 (16.6%)	36 (0.4%)
Pajarito Mountain Ski Area	South	38 (0.4%)	2586 (29.5%)
Red River Ski & Summer Area	South	66 (0.8%)	2300 (26.3%)
Sandia Peak Ski Area	South	200 (2.3%)	1474 (16.8%)
Sipapu Ski & Summer Resort	South	88 (1.0%)	1812 (20.7%)
Ski Apache Resort	South	76 (0.9%)	2138 (24.4%)
Ski Cloudcroft	South	632 (7.2%)	958 (10.9%)
Ski Santa Fe	South	0 (0.0%)	3690 (42.1%)
Taos Ski Valley, Inc.	South	0 (0.0%)	2774 (31.7%)
Appalachian Ski Mtn.	Southeast	664 (7.6%)	370 (4.2%)
Beech Mountain Resort	Southeast	314 (3.6%)	906 (10.3%)
Bryce Resort	Southeast	872 (10.0%)	170 (1.9%)
Cataloochee Ski Area	Southeast	678 (7.7%)	682 (7.8%)
Cloudmont Ski	Southeast	2774 (31.7%)	0 (0.0%)
Hawksnest Snow Tubing	Southeast	418 (4.8%)	756 (8.6%)
Liberty Mountain Snowflex Centre	Southeast	1488 (17.0%)	28 (0.3%)
Massanutten Resort	Southeast	1060 (12.1%)	124 (1.4%)
Sapphire Valley Ski Area	Southeast	1398 (16.0%)	58 (0.7%)

Sugar Mountain Resort	Southeast	504 (5.8%)	564 (6.4%)
Wintergreen Resort	Southeast	370 (4.2%)	732 (8.4%)
Wolf Ridge Ski Resort	Southeast	550 (6.3%)	540 (6.2%)
49 Degree North Ski Area	West	0 (0.0%)	2396 (27.4%)
Alta Sierra Ski Resort & Terrain Park	West	404 (4.6%)	1738 (19.8%)
Alta Ski Area	West	0 (0.0%)	4198 (47.9%)
Alyeska Resort	West	0 (0.0%)	3814 (43.5%)
Anthony Lakes	West	0 (0.0%)	4610 (52.6%)
Arctic Valley Ski Area	West	0 (0.0%)	5734 (65.5%)
Arizona Snowbowl	West	14 (0.2%)	2672 (30.5%)
Bear Mountain Resort	West	964 (11.0%)	848 (9.7%)
Bear Valley Mountain	West	22 (0.3%)	3542 (40.4%)
Beaver Mountain Ski Area	West	0 (0.0%)	3332 (38.0%)
Big Sky Resort	West	0 (0.0%)	4752 (54.2%)
Blacktail Mountain Ski Area	West	0 (0.0%)	4832 (55.2%)
Bluewood Ski Area	West	0 (0.0%)	2446 (27.9%)
Bogus Basin Mountain Recreation Area	West	740 (8.4%)	524 (6.0%)
Boreal Mountain Resort	West	38 (0.4%)	3162 (36.1%)
Brian Head Resort	West	0 (0.0%)	3836 (43.8%)
Bridger Bowl Ski Area	West	0 (0.0%)	3718 (42.4%)
Brighton Ski Resort	West	0 (0.0%)	4386 (50.1%)
Brundage Mountain Resort	West	0 (0.0%)	4042 (46.1%)
Cherry Peak Resort	West	6 (0.1%)	2054 (23.4%)
China Peak Mountain Resort	West	138 (1.6%)	2796 (31.9%)
Cooper Spur Mountain Resort	West	4 (0.0%)	1982 (22.6%)
Crystal Mountain Resort	West	0 (0.0%)	6644 (75.8%)
DNC Parks & Resorts at Yosemite, Inc.	West	84 (1.0%)	3040 (34.7%)
Deer Valley Resort	West	0 (0.0%)	3276 (37.4%)
Diamond Peak Ski Resort	West	46 (0.5%)	2282 (26.1%)
Discovery Ski Area	West	0 (0.0%)	4860 (55.5%)
Dodge Ridge Ski Area	West	152 (1.7%)	2654 (30.3%)
Donner Ski Ranch	West	28 (0.3%)	3042 (34.7%)
Eagle Point Resort	West	0 (0.0%)	4146 (47.3%)
Eaglecrest Ski Area	West	0 (0.0%)	4110 (46.9%)
Elk Ridge Ski & Outdoor Recreation Area	West	450 (5.1%)	1378 (15.7%)
Granlibakken Tahoe Ski Area	West	70 (0.8%)	2330 (26.6%)
Great Divide Ski Area	West	0 (0.0%)	4022 (45.9%)

Hatcher Alpine Xperience dba			
Skeetawk Ski Area	West	0 (0.0%)	4610 (52.6%)
Heavenly Mountain Resort	West	24 (0.3%)	3150 (36.0%)
Hillberg Ski Area	West	0 (0.0%)	3176 (36.3%)
Hilltop Ski Area	West	0 (0.0%)	4040 (46.1%)
Homewood Mountain Resort	West	84 (1.0%)	2270 (25.9%)
Hoodoo Ski Area	West	0 (0.0%)	3448 (39.4%)
Hurricane Ridge Ski Area	West	0 (0.0%)	5120 (58.4%)
June Mountain	West	78 (0.9%)	2782 (31.8%)
Kingvale Snow Schoolers	West	136 (1.6%)	2192 (25.0%)
Kirkwood Mountain Resort	West	14 (0.2%)	3586 (40.9%)
Lee Canyon	West	76 (0.9%)	1742 (19.9%)
Lookout Pass Ski & Recreation Area	West	0 (0.0%)	3466 (39.6%)
Lost Trail Ski Area, Inc.	West	0 (0.0%)	4754 (54.3%)
Loup Loup Ski Bowl	West	0 (0.0%)	3160 (36.1%)
Magic Mountain Resort	West	0 (0.0%)	2720 (31.1%)
Mammoth Mountain Ski Area	West	0 (0.0%)	4106 (46.9%)
Maverick Mountain Resort	West	0 (0.0%)	4422 (50.5%)
Mission Ridge Ski & Board Resort	West	0 (0.0%)	3438 (39.2%)
Montana Snowbowl	West	0 (0.0%)	3180 (36.3%)
Mountain High Resort	West	852 (9.7%)	892 (10.2%)
Mt. Ashland	West	0 (0.0%)	3836 (43.8%)
Mt. Bachelor LLC	West	0 (0.0%)	4404 (50.3%)
Mt. Baker Ski Area	West	0 (0.0%)	4090 (46.7%)
Mt. Baldy Ski Lifts	West	1032 (11.8%)	898 (10.3%)
Mt. Eyak Ski Area	West	0 (0.0%)	4056 (46.3%)
Mt. Hood Meadows	West	0 (0.0%)	4154 (47.4%)
Mt. Hood Skibowl	West	0 (0.0%)	2616 (29.9%)
Mt. Lemmon Ski Valley	West	728 (8.3%)	880 (10.0%)
Mt. Rose - Ski Tahoe	West	0 (0.0%)	3634 (41.5%)
Mt. Shasta Ski Park	West	60 (0.7%)	2302 (26.3%)
Mt. Spokane Ski & Snowboard Park	West	0 (0.0%)	2856 (32.6%)
Mt. Waterman Ski Lift, LLC	West	808 (9.2%)	988 (11.3%)
Nordic Valley Recreation, LP	West	72 (0.8%)	1696 (19.4%)
Northstar California	West	72 (0.8%)	2344 (26.8%)
Park City Mountain Resort	West	0 (0.0%)	3168 (36.2%)
Payette Lakes Ski Club	West	0 (0.0%)	3272 (37.4%)
Pebble Creek Ski Area	West	0 (0.0%)	3040 (34.7%)
Pomerelle Mountain Resort	West	0 (0.0%)	3490 (39.8%)
Powder Mountain	West	0 (0.0%)	4100 (46.8%)

Red Lodge Mountain	West	0 (0.0%)	4730 (54.0%)
Rotarun Ski Club, Inc.	West	0 (0.0%)	2484 (28.4%)
Royal Gorge Cross Country Ski Resort	West	40 (0.5%)	2874 (32.8%)
Schweitzer	West	0 (0.0%)	3218 (36.7%)
Showdown Montana	West	0 (0.0%)	4838 (55.2%)
Sierra-at-Tahoe	West	30 (0.3%)	3232 (36.9%)
Silver Mountain Ski and Year Round Waterpark Resort!	West	80 (0.9%)	1394 (15.9%)
Ski Land	West	0 (0.0%)	5090 (58.1%)
Sky Tavern	West	0 (0.0%)	3196 (36.5%)
Snow Schoolers @ Kingvale	West	136 (1.6%)	2192 (25.0%)
Snow Summit Mountain Resort	West	958 (10.9%)	850 (9.7%)
Snow Valley Mountain Resort	West	1196 (13.7%)	764 (8.7%)
Snowbasin Resort Co.	West	0 (0.0%)	2662 (30.4%)
Snowbird	West	0 (0.0%)	3808 (43.5%)
Snowhaven	West	0 (0.0%)	3458 (39.5%)
Soda Springs Ski Area	West	62 (0.7%)	2800 (32.0%)
Soldier Mountain Ski Area	West	0 (0.0%)	2896 (33.1%)
Solitude Mountain Ski Area	West	0 (0.0%)	3872 (44.2%)
Squaw Valley / Alpine Meadows	West	90 (1.0%)	2282 (26.1%)
Stevens Pass	West	0 (0.0%)	4106 (46.9%)
Sugar Bowl Resort	West	30 (0.3%)	3032 (34.6%)
Summit Ski Area	West	0 (0.0%)	2986 (34.1%)
Sun Valley Resort	West	0 (0.0%)	3184 (36.3%)
Sundance	West	16 (0.2%)	2248 (25.7%)
Sunrise Park Resort	West	120 (1.4%)	2226 (25.4%)
Tahoe Donner Ski Resort	West	52 (0.6%)	2806 (32.0%)
Tamarack Resort	West	0 (0.0%)	3054 (34.9%)
Teton Pass Ski Area	West	0 (0.0%)	4964 (56.7%)
The Summit At Snoqualmie	West	0 (0.0%)	2780 (31.7%)
Timberline Lodge & Ski Area	West	0 (0.0%)	4916 (56.1%)
Utah Olympic Park	West	0 (0.0%)	2976 (34.0%)
White Pass Ski Area	West	0 (0.0%)	3860 (44.1%)
Whitefish Mountain Resort	West	0 (0.0%)	3430 (39.2%)
Willamette Pass Resort	West	0 (0.0%)	3342 (38.2%)
Woodward Park City	West	4 (0.0%)	2762 (31.5%)
Yellowstone Mountain Club	West	0 (0.0%)	5038 (57.5%)

Winter: 1 Nov–31 Mar (3,648 h); Non-winter: 1 Apr–31 Oct (5,136 h) as a percentage of total hours in a year (8760 h).

Table 4: Energy Waste by Region

Region	Cable Wattage (kW)	Median Waste (MWh)	Quartile 1 Waste (MWh)	Quartile 3 Waste (MWh)
High Plains	1.9	7.4	6.3	8.9
	2.8	10.9	9.3	13.1
Midwest	1.9	1.9	1.2	2.9
	2.8	2.8	1.7	4.3
Northeast	1.9	2.0	1.4	2.9
	2.8	3.0	2.1	4.3
South	1.9	4.1	2.4	5.0
	2.8	6.0	3.8	7.4
Southeast	1.9	0.9	0.1	1.4
	2.8	1.3	0.2	2.0
West	1.9	6.0	4.7	7.7
	2.8	8.9	6.9	11.3
Total	1.9	3.22	1.67	6.01
(Median)	2.8	4.75	2.45	8.60

inter: 1 Nov–31 Mar (3,648 h); Non-winter: 1 Apr–31 Oct (5,136 h) as a percentage of total hours in a year (8760 h).

SUPPLEMENT

- S1: Survey questions and respondent demographics
- S2: Station list and set-point analysis (44, 47, 50 °F)
- S3: 26.7 million homes analysis
- S4: Electricians survey

S1: Survey questions and respondent demographics

Category	Response	Percentage	Respondent Count
Geographic Region	Snowy mountain town	73%	88
	Urban / city	17%	21
	Rural	10%	12
Thermostat Installed	Yes	100%	121
Does this save you energy / cost in running your heat cables	Yes	98%	119
	No / unsure	2%	2
User Ever Adjusted Thermostat Set-point	Yes	15%	18
	No	85%	103
Ever turn off your circuit breaker controlling your heat cable?	Yes	2%	2
	No	98%	119
Do you need to intervene in the operation or manually turn anything on or off	Yes	97%	117
	No / Some Intervention Required	3%	4
Do you need to do anything to aid this system?	Yes	0%	0
	No	100%	121

Supplement S2: Weather Station List and Thermostat Set-Point Sensitivity Analysis

This supplement provides details on the 377 ski communities used for hourly climate normals (2000–2024) in the analysis of heat cable (HC) thermostat performance across U.S. ski areas, as described in “Legacy Roof-Heat-Cable Thermostats Deliver Negligible Savings: A 377-Ski Communities, Per-Circuit Energy-Waste Assessment.”

Ski communities were selected from the National Ski Association and sourced from Open-Meteo Weather Forecast API (https://open-meteo.com/en/docs?location_mode=csv_coordinates) (U.S.), with ≥ 25 years of data.

Thermostat Set-Point Sensitivity Analysis

To assess the robustness of thermostat performance estimates, we analyzed winter deactivation hours (OFF-h, 1 Nov–31 Mar, 3,648 h) and non-winter activation hours (ON-h, 1 Apr–313, 5,136 h) as a percentage of total hours in a year (8760 h) at set-points of 44 °F, 47 °F, and 50 °F for each. A warm-winter scenario (+2 °C, or 3.6 °F, mean temperature shift) was included to evaluate climate change impacts. The 2000–2024 sensitivity test confirmed 1.65% (0.5–4.7%) change in OFF-h at 44 °F. Higher set-points increase winter OFF-h but also non-winter ON-h, exacerbating waste in high-elevation regions.

Table S2.1: Sensitivity Analysis of Thermostat Set-Points

Region	Set Point (°F)	Winter Deactivation Hours (%)	Non-Winter Activation Hours	Warm Winter Deactivation Hours
High Plains	44	0 (0.0%)	3908 (44.6%)	43 (0.5%)
	47	0 (0.0%)	4823 (55.1%)	0 (0%)
	50	0 (0.0%)	5716 (65.3%)	0 (0%)
Midwest	44	212 (2.4%)	1003 (11.4%)	601 (6.9%)
	47	74 (0.8%)	1513 (17.3%)	256 (2.9%)
	50	8 (0.1%)	2131 (24.3%)	105 (1.2%)
Northeast	44	239 (1.7%)	1065 (12.2%)	635 (7.2%)
	47	90 (0.5%)	1637 (18.7%)	282 (3.2%)
	50	15 (0.2%)	2278 (26.0%)	112 (1.3%)
South	44	254 (2.9%)	2140 (24.4%)	650 (7.4%)
	47	82 (0.9%)	2830 (32.3%)	318 (3.6%)
	50	10 (0.1%)	3789 (43.3%)	104 (1.2%)
Southeast	44	1129 (12.9%)	455 (5.2%)	2134 (24.4%)
	47	671 (7.7%)	968 (11.1%)	1254 (14.3%)
	50	309 (3.5%)	1578 (18.0%)	752 (8.6%)
West	44	12 (0.1%)	3180 (36.3%)	114 (1.3%)
	47	0 (0.0%)	3954 (45.1%)	30 (0.3%)
	50	0 (0.0%)	3180 (54.4%)	0 (0.0%)
Total (Median)	44	132 (1.5%)	1696 (19.4%)	398 (3.2%)
	47	32 (0.4%)	2312 (26.4%)	158 (0.6%)
	50	0 (0.0%)	2972 (33.9%)	46 (0.1%)

Note: Winter OFF-h and Non-Winter ON-h calculated using 2000–2024 climate normals. Warm-winter scenario assumes a +2 °C (3.6 °F) shift in mean hourly temperatures.

Supplement S3: 26.7 Million Homes Analysis

Based on market data from the Fact.MR report, the global heat cable market in 2020 was valued at approximately \$1.24 billion, corresponding to about 1,432 million meters, or 4,698 million feet, of cable sold. Between 2020 and 2030, the market is projected to grow at an annual rate of 5.85% in value and 5.59% in volume resulting in 2024, annual global sales of about \$1.55 billion, with 5,842 million feet sold. This reflects a steady expansion of both sales volume and installed length.

A significant share of this market is devoted to roof and gutter heating. In 2020, roughly 16.3% of all heat cables sold were used in this application, corresponding, in 2024, to about 952 million feet worldwide. To estimate the installed base, we assume that installations accumulate over a 30-year horizon, with a small annual growth net rate after attrition. On this basis, the global installed base of roof and gutter heating cables amounts to approximately 27.5 billion feet.

North America represents about 32% of the global market. Applying this regional share yields an installed base of roughly 8.9 billion feet across the continent. To translate this into the number of homes, we assume that an average installation uses around 332 feet of cable. Dividing the total installed footage by this per-home estimate suggests that approximately 26.7 million homes in North America have heat cables installed today.

This analysis demonstrates that roof and gutter heat cables are far from a niche technology. With tens of millions of homes already equipped, the installed base represents both a significant energy consumer and a major opportunity for innovation in energy efficiency and smart control.

Ref: Heating Cable Market, Forecast, Trend, Analysis & Competition Tracking - Global Market Insights 2020 to 2030. Fact.MR 2021 (Maryland)

Supplement S4: Electricians Survey