United States National Science Foundation Sponsored Snowmelt Study

The largest known multi customer field study of electric building snowmelt control

Advanced AI Computer Vision control for energy savings and building protection

Abstract

The Powder Watts two-winter snowmelt research program achieved 79% energy savings across hundreds of customers, with savings ranging from 70% to 90%. The program generated millions of data points across six states and included ski resorts, commercial buildings, town and municipal facilities, and homes. Supported by the United States National Science Foundation, it addressed a major source of electricity waste and a critical gap in building protection: heat cables were consuming substantial energy without owners knowing whether they were doing useful work—or working at all. To our knowledge, this is the largest multi-customer field study of electric building snowmelt control undertaken. [1,2]

The central finding was that snow remaining on a roof does not establish that its heat cables need to remain on. Beneath the snow, the cables may already have created the open channels needed to drain meltwater safely. Continued heating can consume electricity long after that protective task is complete. A failed cable can also remain unnoticed until an ice dam or a leak reveals the problem. Unlike a failed air conditioner, which occupants often notice quickly, roof snowmelt frequently fails out of sight, with damage from ice damming providing the first warning.

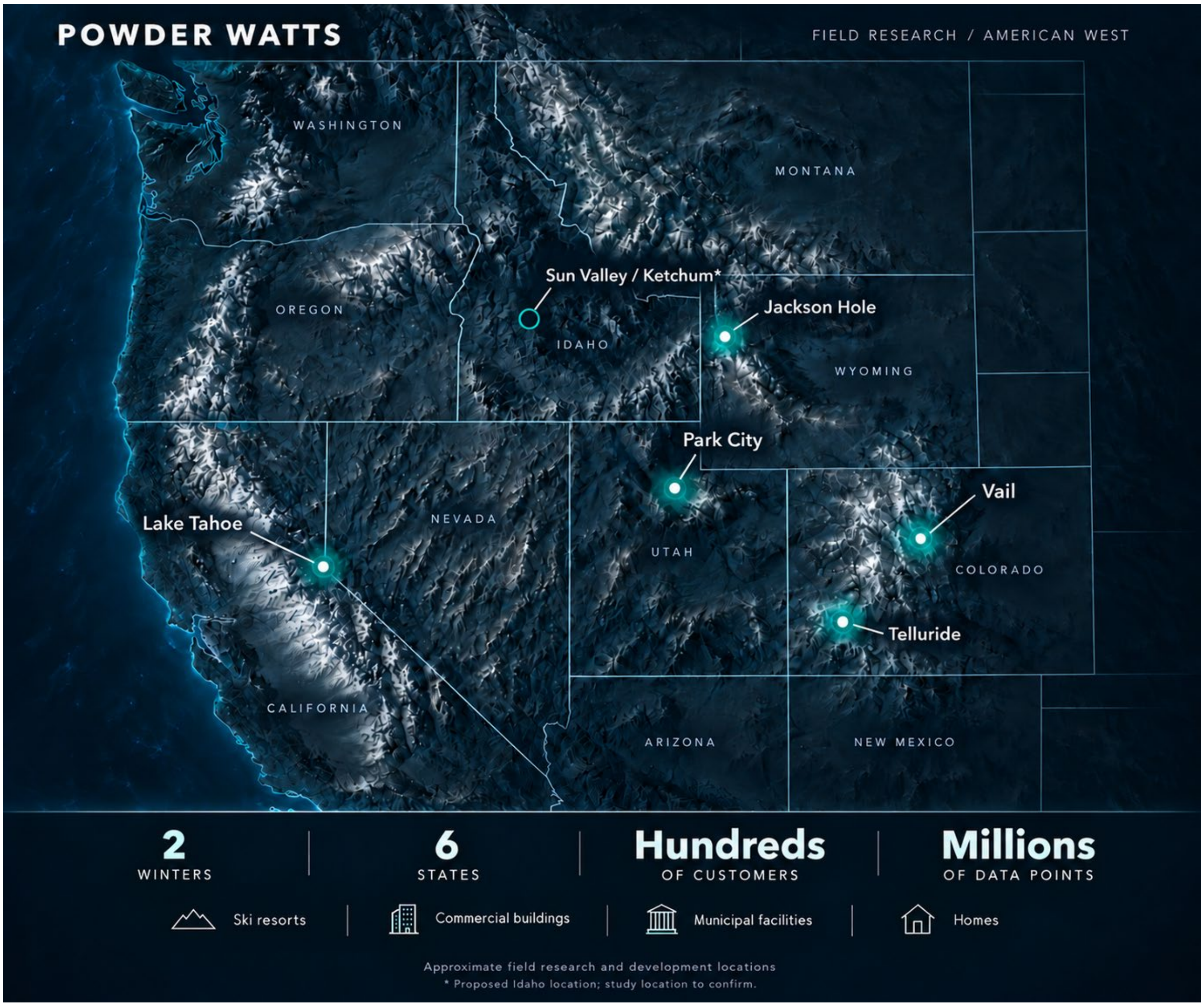
We developed the Powder Watts Advanced AI Computer Vision control energy savings and protection system to close this information gap. The system observes the melt zone, controls the associated electrical circuit, verifies its operation, and alerts the owner or operator to conditions requiring attention. It places the cable in standby when its work is complete and restores operation when melting is needed. Energy savings and improved protection follow from the same engineering advance: knowing the condition of the protective system and controlling it accordingly.

The implications extend beyond individual buildings. An estimated 135 TWh of annual North American heat-cable consumption was identified in the NSF project's market framing. Applying the study's savings rate gives a full-adoption energy opportunity of approximately 107 TWh per year. Through FlexiWatt, coordinated control also provides utilities with dispatchable load management, including up to 72 hours of continuous support where site conditions permit. Project Olaf is the proposed Department of Energy national deployment across 276,000 sites and more than 1 GW of connected load. Development is ongoing and funding for Olaf is not yet finalized. [1,2]

For building owners, the result is lower operating cost and visibility into a system that protects the property. For engineers, it is a control method tied to the physical result of heating. For utilities, it is a path to measurable energy savings and control of a large winter load.

The study across the American West

Across two winters, our field program generated millions of data points across six states, spanning ski resorts, commercial properties, municipal facilities, and homes. Before-and-after and side-by-side comparisons connected electrical performance to the condition of the protective melt channel. [2,3]



Approximate field research and development locations.

Geographic reference: Natural Earth and Esri World Hillshade.

1 The research question

Heat cables are installed because uncontrolled snow and ice frequently damage buildings. The cables create drainage paths along roof edges, valleys, gutters, and downspouts so meltwater can leave the structure. That protective function often leads owners to leave the system energized throughout winter, even after the cable has completed the useful melting within reach of its installed path.

We began with a practical question: how much electricity consumption could be eliminated if control decisions were based on the condition the cable was installed to create? Answering it required understanding energy use, the installed market, prior control approaches, roof behavior, electrical performance, and the information building owners need to maintain protection.

NSF support and field development

The United States National Science Foundation supported the work through award 2224907, effective July 1, 2023. The research objectives included evaluating performance, protection, and energy consumption against historical and modeled baselines, examining weather and roof characteristics, and developing the economics of deployment. [1]

Our broader field program extended across two winters and continued through 2025. Development activity included Utah, California, Nevada, Colorado, Idaho, and Wyoming. By completion in 2025, the NSF-supported pilot had reached approximately 4.3 times its original deployment target. This scale exposed the technology to the building and operating variations it would encounter across the snowbelt. [2,3]

Research objective	Practical question
Energy consumption	How much energy does the installed snowmelt load consume, and under what conditions?
Baseline and prior controls	When do seasonal switching, thermostats, timers, and other controls energize the system?
Protective performance	Is the required melt channel present, and is the cable performing its assigned task?
Control and verification	Can the system act on the actual roof condition and confirm electrical response?
Market and deployment	What scale of savings can existing installations support, and how can the technology be rolled out?
Utility value	How can the remaining necessary runtime be coordinated with grid needs?

Commercialization research

The technical program was complemented by market research through NSF’s Commercialization Planning Program. Dawnbreaker’s November 2024 and spring 2025 assessments examined snow-and-ice management markets, emerging technologies, and suppliers. Together, the field work and commercialization research addressed both the engineering problem and the route to a deployable product. [2,4]

The resulting architecture treats protection, energy use, and grid control as connected functions. The observation that permits an unnecessary heating cycle to end also gives the building operator evidence of the roof’s condition and protection, and gives the utility a controllable electrical endpoint.

Field study settings and comparative evaluation

Two winters across six states and hundreds of customers

The research program brought snowmelt control into ski resorts, commercial buildings, town and municipal facilities, and homes. These were operating properties where roof protection, maintenance, electricity costs, and service continuity mattered every winter. The breadth of the program made the findings relevant to the buildings and communities where snowmelt is already an essential protective load. [2]

Geographic reach and operating conditions

Early prototype, pilot, and field development extended from Park City, Utah, to the Lake Tahoe region of California and Nevada, Vail and Telluride in Colorado, Idaho, and Jackson Hole, Wyoming. Across these locations, roof materials and slopes, cable layouts, sunlight, snow behavior, electrical configurations, and communications conditions varied. The control system had to recognize the same protective outcome across those different settings: a usable meltwater drainage path at the installed cable. [2,3]

Resorts and commercial buildings brought complex roof areas and the consequences of interrupted operations into the engineering problem. Town and municipal facilities connected the work to public assets and maintenance responsibilities. Homes extended the evaluation to residential installations and the limited visibility owners have into equipment above their normal line of sight.

Before and after and side by side

The study included before-and-after evaluations and side-by-side comparisons of snowmelt control approaches. Before-and-after evaluation examines the change in operation when control is introduced. Side-by-side comparison examines the differences between approaches operating alongside one another. Together, these methods connect the savings question to the behavior of installed equipment. [2]

Circuit-level records of amps, volts, watts, and kWh supported performance evaluation alongside observations of the melt zone. Meaningful comparison accounts for weather, observation period, cable configuration, and the control being replaced. The energy-accounting method in Section 5 defines how those factors enter the baseline and savings calculation. [2,13]

Repeated field observation and refinement

The program generated millions of data points. Images collected across multiple winters were labeled and used to refine recognition of melt channels, snow bridges, ice, debris, and changing light. Repeated observation and electrical records connected roof conditions with operating behavior. This work developed the specialized knowledge needed for Advanced AI Computer Vision control to determine when melting was required, when it was complete, and when performance required attention. [2,3]

2 The discovery beneath the snow

The presence of snow above a heat cable can conceal the condition that matters most. A cable may melt a cavity at the roof surface while snow bridges over that cavity. From outside, the roof still appears snow-covered. Inside, an open channel may already provide the drainage the system was installed to maintain.

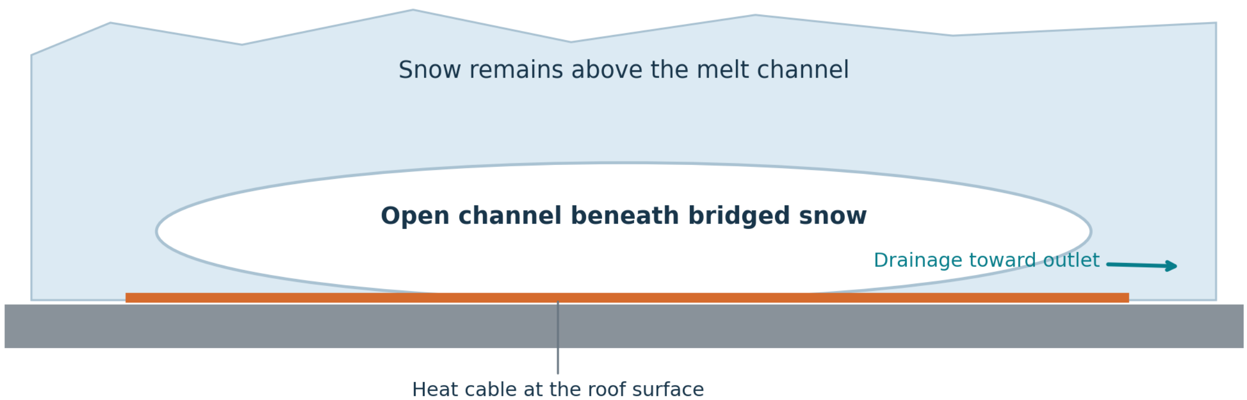


Figure 1. Snow can remain above a functioning melt channel. Observing the channel allows control to follow the protective task. Conceptual roof section; not to scale.

Temperature, moisture, humidity, and a distant view of the roof cannot establish the condition at the heat cable. The same outdoor temperature can coincide with a clear channel, an ice dam, fresh snow, incoming meltwater, or electrical failure. These conditions require different responses. Direct observation at the melt zone provides the information needed to choose the correct action.

Control the useful work

We placed observation at the heat-cable melt zone and connected that information to circuit control. When heating is needed, the system activates the cable. When the protective melt task is complete, it can enter standby. New snow, moving ice, refreezing, and changing meltwater conditions can renew the need for operation. [3,6]

Self-regulating cable increases its output as its thermal environment becomes colder, but continues consuming electricity while energized. In severe cold, heat loss can prevent useful melting even at increased output. A controller must determine whether the circuit is accomplishing its protective task, not simply whether the cable is cold. [7,14]

A physical basis for the control strategy

The operating objective is a clear drainage path through the protected roof zone. Heat cable melts near its installed path; it is not designed to remove the entire roof's snow cover. Melting requires substantial energy to change ice into water. Further heating and evaporation consume additional energy without necessarily improving drainage. The major efficiency opportunity is therefore to use the required melt energy when needed and enter standby once the protective task is complete. The governing question is whether a clear melt channel allows new meltwater to leave the roof safely. Our patented observation and control loops connect that physical condition to the next operating decision. [16]

3 Building protection and the cost of hidden failure

A snowmelt system protects the building only when the installed equipment performs its intended function. A switch in the on position is not enough. A circuit drawing some current is useful evidence, but it does not by itself show that melting is occurring where it is needed or that water has a clear route off the roof.

Ice dams form when meltwater refreezes at a colder eave or another obstruction. Water can back up beneath roofing and enter the building, damaging interiors and interrupting operations. Air sealing, insulation, and ventilation address building heat loss, but do not eliminate melting driven by sunshine or changing weather. Control and monitoring must establish whether the installed heat-cable system is maintaining the required drainage path. [5]

Why the warning can arrive too late

An air-conditioning or furnace failure often produces a near-immediate complaint: the room becomes uncomfortable. Roof heat-cable failure can remain silent. The equipment may be above the normal line of sight, concealed beneath snow, or spread across inaccessible roof areas. A leak and the resulting damage can become the first visible sign that protection has been lost.

For a hotel, resort, multifamily building, or commercial property, the consequences can include interior repair, damaged contents, unavailable rooms or occupied space, disrupted business, and lost revenue. Reducing the interval between failure and corrective action is therefore a central part of the value of monitoring.

<u>Heat cable is a finite-life asset. Aging, thermal cycling, ultraviolet exposure, and physical damage make failure an expected lifecycle concern. Detecting loss of protection before the next damaging melt event belongs in routine building management.</u>

Observed condition	Operational significance
Heat commanded with no expected electrical response	A circuit breaker may have tripped. Investigate the circuit, power supply, and switching equipment.
Power present without expected melt progress	Cable may be worn, degraded, or damaged. Compare measured current with historical draw in the Powder Watts system and inspect the melt zone.
New snow or ice entering the melt zone	The computer vision engine calls for the Powder Watts smart switch to activate the required heating.
Open channel with completed melt task	The Powder Watts computer vision system commands the smart switch to energy-saving standby.
Obstructed view or stale communications	Visibility has degraded and requires the configured exception response.

Protection and efficiency improve together

The Powder Watts Advanced AI Computer Vision system automates observation, switching, and electrical verification while reducing unnecessary operation. Owners and operators receive operating visibility and alerts when conditions require attention. [6]

The automated protection record tracks melt completion, detected faults, and notifications; repair times and damage incidents extend that record into maintenance and avoided-loss analysis. These measures complement kWh savings. (See Powder Werks.)

4 Advancing beyond legacy proxy controls

Legacy proxy controls respond to temperature, moisture, or elapsed time without establishing whether the heat cable's protective task is complete. They cannot independently confirm an open melt channel or determine that continued heating is useful. [7,8]

Control approach	Information used	Limit of the control signal
Manual or seasonal switching	Operator judgment and season	No automatic confirmation of protection or completion of the melt task.
Timer or fixed schedule	Time of day or elapsed runtime	Time cannot establish melt need. Unnecessary restarts add thermal cycling and cold-start electrical demand.
Ambient thermostat	Temperature at the sensor	Air temperature cannot verify a clear channel. A closed thermostat can sustain winter and shoulder-season waste.
Moisture and temperature control	Conditions at a precipitation or moisture sensor	Wetness at a sensor cannot verify drainage along the cable. Pooled water can prolong operation.
"Self-regulating" cable	Local thermal response of the cable	Output rises as the cable becomes colder, even when useful melting is not achieved. No confirmation of the protective result.
Electrical monitoring and BMS	Current, power, operating state and alarms	Establishes electrical behavior rather than the physical result of melting.
Powder Watts Advanced AI Computer Vision control	Melt-zone observation integrated with electrical feedback	Automates melt-need assessment, switching, verification, standby, protection monitoring, and energy reporting.

The importance of observing the right variable

An ambient thermostat can remain closed through most of a cold winter after useful melting has ended, or energize cable in cool weather with no snow to melt. Our supporting research examined these patterns through hourly-weather analysis and a comprehensive survey of 121 building owners. [10]

Pooling water in gutters can keep a moisture sensor calling for heat after the required melt channel is open. Sensor wetness cannot establish the protective condition along the cable's path.

Our contribution is to observe the governing variable—the melt-zone condition—and automate the decision, smart-switch response, verification, and reporting.

Measure the result as well as the input

Rated power, assumed hours, weather models, and whole-building bills cannot fully describe performance at the protective load. Per-circuit metering paired with observed roof condition connects electricity consumption to the work delivered.

Actual current draw in amps, voltage, power in watts, and energy in kWh were recorded and analyzed at the circuit level as the basis for performance evaluations. [2]

5 System architecture and performance measurement

The system connects an Advanced AI Computer Vision rooftop monitor, a metered smart switch for the controlled circuit, and a communications hub to the Powder Watts Cloud platform. The control cycle follows the protective task: observe conditions, determine melt need, switch the circuit, verify electrical response, assess progress, and return to standby when appropriate. [3,6]

System function	Engineering role
Visual assessment	Evaluate snow, ice, and the melt channel at the monitored roof zone.
Circuit control and metering	Command operation and retain electrical energy and operating history.
Communication and records	Connect field devices, retain observations and commands, and provide operator access.
Monitoring and alerts	Identify abnormal electrical or visual behavior and changes in data availability.
Portfolio coordination	Apply approved utility schedules, verify event behavior, and coordinate recovery.

Visual observations recur hourly in the described operating configuration. Alert timing depends on the observation cycle, communications, and decision logic. Commissioning establishes the monitored zones, circuit mapping, operating settings, and response to a loss of reliable visibility. [6]

Electrical and operating characteristics

Our reference engineering cases use 1.9 kW of warmed demand per residential circuit and 2.5 kW per commercial circuit, with typical heat-cable designs in the 6–12 W/ft range. Three circuits illustrate a residential installation and twenty circuits a commercial installation. Actual circuit inventories and measured power determine site calculations. [12]

Typical melt events last approximately 4–6 hours, with prolonged snowfall capable of extending operation toward 24 hours. Cable power also changes during startup and with its thermal environment. Energy accounting therefore uses measured real power over time wherever available.

Energy accounting

Energy in kWh = sum of interval power in kW × interval hours
Avoided energy = adjusted baseline energy − controlled energy
Energy savings fraction = avoided energy ÷ adjusted baseline energy

The baseline represents the operation being replaced. Historical consumption or a calibrated model must account for weather, prior control, circuit configuration, and the reporting period. Per-circuit metering follows the system-level retrofit-isolation approach described in DOE measurement and verification guidance. [13]

Portfolio energy savings, median site savings, and ranges describe different statistics. The study result presented here is 79% overall savings, with a 70–90% range. Subsequent fleet performance and engineering scenarios are identified by their own operating assumptions. [2,12]

6 Energy savings and customer economics

The two-winter program achieved 79% overall energy savings, with savings ranging from 70% to 90%. For every 100 baseline energy units, advanced control used 21. The result demonstrates the scale of unnecessary consumption that can be removed while adding oversight of the protective system. [2]

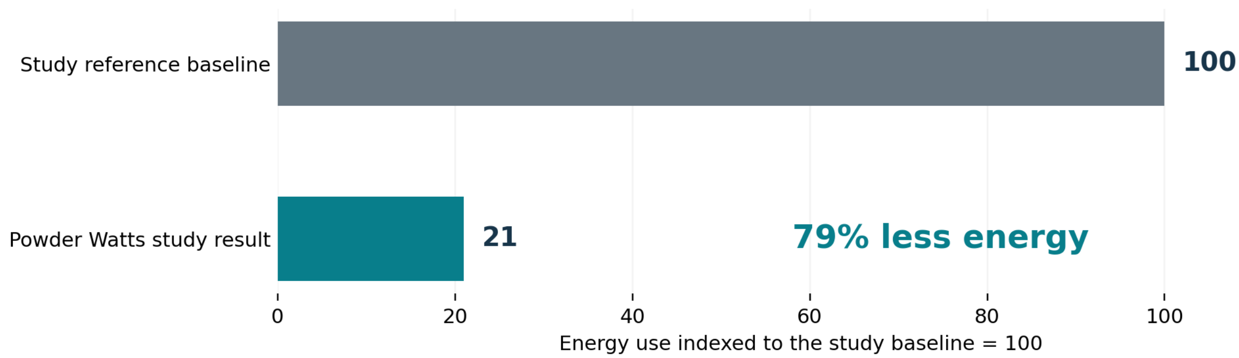


Figure 2. Study energy result normalized to a baseline of 100. Controlled consumption is 21, corresponding to 79% savings.

Winter reference cases

A 152-day winter contains 3,648 hours. Applying the study's 79% savings rate to a baseline of winter-energized systems gives the following engineering reference cases. Each baseline is the stated circuit power multiplied by 3,648 hours; these calculations translate the study result into familiar installation sizes.

Installation	Baseline MWh	Avoided MWh	Energy value
One residential circuit at 1.9 kW	6.931	5.476	$734
Three-circuit home at 5.7 kW	20.794	16.427	$2,201
One commercial circuit at 2.5 kW	9.120	7.205	$965
Twenty-circuit building at 50 kW	182.400	144.096	$19,309

Energy value uses $0.134/kWh. It excludes demand charges, incentives, subscription, and maintenance. For a three-circuit home, the modeled avoided electricity is approximately 16.4 MWh per winter; for a twenty-circuit commercial building, it is approximately 144.1 MWh.

Performance beyond the original study

Our later 86% winter fleet reference corresponds to 5.961 MWh avoided per residential circuit on the same baseline, supporting a rounded planning value of approximately 6 MWh per circuit-year. Eliminating accidental off-season operation adds value at sites where it occurs. Its contribution is calculated from the off-season consumption being prevented. [12]

Customer economics combine energy savings with avoided demand charges, applicable incentives, ongoing service costs, and the operating value of monitored protection. A commercial property with high coincident demand can realize meaningful savings beyond the energy-only table.

7 Storm demand and the importance of fleet control

A large winter storm can cause the entire fleet to operate at the same time. A low annual energy requirement does not imply a low demand during that storm. For utility planning, the relevant case includes full activation and the higher electrical draw that can occur when cable is cold and wet.

Manufacturer data illustrate the thermal effect: Raychem specifies 36 W/m in ice water and 18 W/m in air at 0°C. Power can therefore differ by a factor of two at the same temperature because the cable's immediate environment changes heat transfer. [14]

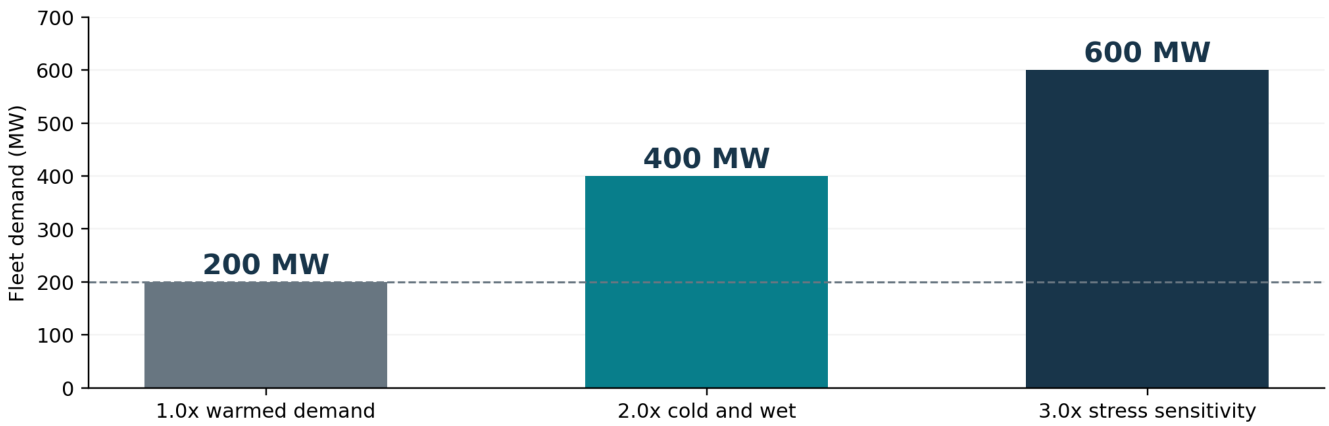


Figure 3. Engineering sensitivity for a fleet rated at 200 MW of warmed operating demand, with every circuit active. The 2.0x and 3.0x cases represent sustained power multipliers, not measured fleet averages.

A 200 MW fleet operating at twice its warmed reference demand draws 400 MW. At three times that reference, it draws 600 MW. The modeled exposure is materially larger than the nominal enrollment figure. Utility control can prevent eligible circuits from joining the peak and coordinate the return to operation afterward.

Cold start and billed demand

Observed example startup profiles reach approximately 80 A, fall toward 60 A within about five seconds, then toward 30 A over the next tens of seconds, and settle toward 10–12 A over approximately 30–90 minutes. Circuit design and switching equipment must accommodate the applicable cable and manufacturer requirements. [12]

Momentary inrush and sustained demand serve different engineering purposes. Billing demand is calculated over the tariff's measurement interval; a 15-minute value integrates power over 900 seconds. A brief spike cannot be treated as a sustained 600 MW load. Elevated cold and wet operation lasting through the interval can, however, materially increase billed or coincident demand.

A direct demand-charge mechanism

For illustration, reducing the billing peak by 50 kW in a month priced at $20/kW-month saves $1,000, provided that reduction changes the tariff's billed demand. Peak timing, other building loads, and ratchets determine the actual result. Coordinating operation and restart gives the platform a way to address those demand costs as well as annual energy use.

8 National energy and capital productivity

The NSF project's market framing identified an estimated 8 billion installed feet of rooftop and gutter heat cable consuming 135 TWh annually across North America. At the study's 79% savings rate, full technical adoption corresponds to approximately 106.65 TWh of annual avoided consumption. [1]

Adoption of the reference market	Annual avoided energy at 79%
1%	1.067 TWh
5%	5.333 TWh
10%	10.665 TWh
25%	26.663 TWh
100%	106.650 TWh

At $0.134/kWh, the full-adoption reference case represents approximately $14.29 billion in annual electricity value. A 10% share represents approximately $1.43 billion. Local rates and actual baseline consumption determine the value realized in each deployment.

An installed market ready for better control

Our market work places the addressable building population at approximately 20–27 million locations. The opportunity spans homes, resorts, hotels, multifamily buildings, commercial properties, and municipal facilities. The equipment is already connected to the grid; adding control changes how that existing load behaves. [10–12]

A consistent market calculation separates buildings, circuits, cable length, connected power, and annual energy. For each segment, the calculation is buildings × circuits per building × baseline energy per circuit × achievable savings. Regional differences in snow, temperature, prior controls, and accidental off-season operation determine the result.

High energy savings from a modest control investment

Our comparative technical review evaluated sixteen energy-saving and grid-interactive technologies. It identified exceptionally strong capital productivity for heat-cable control, particularly where unnecessary operation extends beyond winter. The underlying advantage is straightforward: a relatively small control investment governs an electrical load that can consume thousands of kWh each year. [12]

The following section develops that comparison using explicit service-life and capital assumptions. For utility procurement, the same analysis can be extended to measured persistence, ongoing operating costs, and the additional value of controlling coincident demand.

The national significance is both cumulative and immediate. Annual efficiency reduces energy requirements over the season. Coordinated control determines whether participating circuits add to a critical peak on a particular day. These benefits can be evaluated together while retaining separate energy and capacity accounts.

9 Comparative energy and carbon performance

Applying the study's 79% savings rate to the winter portion of our comparative engineering cases produces capital costs of approximately $4.39 per lifetime MWh for the second-home case and $3.34/MWh for the commercial case with year-round unnecessary baseline operation. These are the strongest capital-productivity results among the selected cases below. [12]

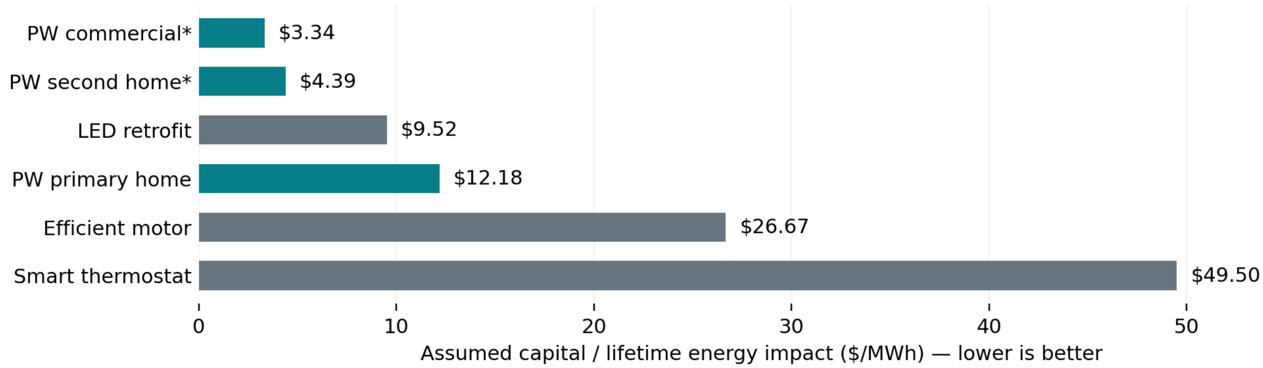


Figure 4. Selected cases from the sixteen-technology comparison. Powder Watts values use 79% winter savings. Asterisks identify cases with continuous off-season baseline operation at the reference power.

Powder Watts case	Annual MWh saved	Capital per lifetime MWh	Lifetime CO2 per dollar
Primary home with 3 circuits	16.427	$12.18	124.4 lb
Second home with 3 circuits*	45.565	$4.39	344.9 lb
Commercial with 20 circuits*	399.696	$3.34	453.9 lb

The calculation uses $1,000 installed per circuit, a 15-year life, and reference power of 1.9 kW per residential circuit or 2.5 kW per commercial circuit. Winter lasts 3,648 hours. The starred cases add 5,112 hours of prevented off-season operation at the stated power. Measured off-season consumption replaces this constant-power assumption in site-specific analysis.

Cost and carbon on a common denominator

Capital productivity equals installed capital divided by lifetime avoided MWh. It is a capital-only measure; subscriptions, maintenance, replacement, financing, and discounting belong in a full lifecycle cost assessment. The winter-only home remains highly productive at $12.18/MWh, while the LED reference is $9.52/MWh.

Using the comparison's fixed 1,514 lb CO2/MWh factor, the second-home case avoids approximately 345 lifetime pounds of CO2 per installed dollar and the commercial case approximately 454 pounds per dollar. A 6 MWh annual saving corresponds to 4.54 U.S. short tons, or 4.12 metric tonnes, of avoided CO2 at that factor. [12,15]

Geography- and time-specific emissions factors support project accounting. A complete greenhouse-gas assessment also incorporates non-CO2 gases and lifecycle emissions. Grid-event timing and infrastructure effects can add further value, evaluated against their own hourly and planning counterfactuals.

10 FlexiWatt and extended utility support

FlexiWatt coordinates the Powder Watts fleet as a virtual power plant. Each installed control point contributes measurement, operating visibility, and an ability to manage when the associated heat cable consumes electricity. The platform combines persistent efficiency with utility-directed control of eligible load. [11,12]

Up to 72 hours of continuous support

An open drainage channel can continue providing its protective function while the cable remains in standby. That physical condition creates flexibility in the timing of future operation. Where site conditions permit, FlexiWatt can maintain a no-energization window for up to 72 hours, providing extended support through a utility stress event. [2]

The available duration follows the protective condition, expected meltwater and snowfall, and the site's operating requirements. Dispatch qualification establishes which circuits can participate and for how long. The severe storm case in Figure 3 and a full 72-hour interruption are separate operating cases; their compatibility must be established for the participating sites.

Utility measure	Definition
Connected nominal MW	Sum of the circuit reference powers in the enrolled portfolio
Event counterfactual MW	Demand expected during the event without the control intervention
Delivered reduction	Accepted event baseline minus measured event demand
No-energization performance	Verified compliance with the contracted off window
Accredited capacity	Capacity recognized under the utility or market's availability and performance rules

Prevent demand before it reaches the peak

Utility value includes circuits already operating and circuits that would otherwise start during the event. Preventing a startup can avoid coincident demand even when there is no instantaneous load to shed at dispatch. This matters when a storm reaches multiple service areas and would otherwise activate a large share of the fleet together.

Our planning basis includes approximately ten-minute dispatch notice and scheduled utility lockouts. Event operation combines eligibility, command acknowledgment, telemetry, operating exceptions, and staged recovery. Coordinating restart controls cold-start exposure while restoring required melting. [12]

A sustained average reduction of 200 MW for 72 hours equals 14.4 GWh of avoided consumption during that window. Delivery is measured against the event counterfactual. Permanent efficiency and event reduction use a common accounting boundary so the same avoided electricity is counted once.

11 Project Olaf and national deployment

Project Olaf is our proposed Department of Energy national deployment across 276,000 sites and more than 1 GW of connected nominal load. Development with the U.S. Department of Energy is ongoing, and funding is not yet finalized. Its purpose is to bring the field-developed control architecture to a scale that matters for national energy consumption and utility capacity. [2]

The reference project model includes 556,000 controlled circuits. At 1.9 kW per circuit, that portfolio represents approximately 1.06 GW of connected nominal load. The current site scope and reference circuit count imply approximately 2.014 circuits per site. [17]

Deployment measure	Engineering reference case
Proposed locations	276,000 sites
Reference controlled circuits	556,000 circuits
Connected nominal load	1,056.4 MW
Annual avoided winter energy at 79%	3.044 TWh
Annual energy at 6 MWh per circuit	3.336 TWh
Gross winter energy value at $0.134/kWh	$407.96 million per year

Full-deployment calculations use 3,648 winter hours and the stated reference power. The 79% study-rate case and the 6 MWh planning case are alternative energy scenarios. Dollar values use unrounded modeled energy and exclude demand savings and delivery costs.

Scale the evidence with the fleet

Each installation adds a defined circuit, a monitored protection zone, an energy record, and an operational history. At portfolio scale, those records support customer reporting, utility measurement, maintenance, and dispatch verification. Deployment quality depends on carrying the connection between the electrical control point and its protective task through every installation.

The technology is supported by issued U.S. Patents 12,006,689 and 12,492,559 addressing intelligent heating-element control through visual and electrical feedback. The field program developed the observations, operating methods, hardware, and software needed to apply that approach across real buildings. [3,16]

Engineering conclusion

The research established a practical way to reduce snowmelt energy consumption while improving visibility into building protection. The 79% study result demonstrates the significance of controlling heating according to actual melt need. The monitoring architecture gives owners and operators a way to recognize failures and changing conditions before they develop into larger problems.

For utilities, the same system turns an existing winter load into a measured and controllable resource. For the nation, broad adoption offers a substantial reduction in avoidable electricity use alongside a scalable source of demand flexibility. The route to that outcome begins at the building: observe the protective task, control the energy needed to perform it, and verify the result.

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Calculation conventions

All dollar amounts are U.S. dollars. One MWh equals 1,000 kWh; one TWh equals one million MWh. A 152-day winter contains 3,648 hours; its non-leap-year complement is 213 days or 5,112 hours. A U.S. short ton contains 2,000 lb and a metric tonne contains 1,000 kg. Calculations use unrounded inputs. Control-platform energy belongs in net project energy accounting.

Engineering reference cases translate operating inputs into installation and fleet scale. Capital productivity uses stated capital and service-life assumptions; project financial analysis adds recurring costs and discounting. The 70–90% study range describes the range of savings, not a statistical confidence interval.

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Powder Watts technology supports energy management, monitoring, and building protection but does not eliminate all risks of equipment failure, ice formation, water intrusion, property damage, or business interruption. Monitoring, control, and alerts may be affected by power or communications interruptions, visibility, hardware or software faults, and other conditions; they do not guarantee detection of every fault or uninterrupted operation. The technology does not replace appropriate building design, inspections, maintenance, timely response to alerts, or insurance.

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