TECHNICAL WHITE PAPER | OCTOBER 2026

Powder Watts Energy Investment and Carbon Performance

Executive results and investment comparison

Smart control of a large heat-cable load can return thousands of dollars to the owner each year. In the winter-only model, a three-switch home returns $2,089 annually after the Powder Watts Protect allowance; a twenty-circuit commercial installation returns $19,184. Both figures use $0.15/kWh and exclude incentives.

The investment decision has three dimensions: how much annual cash each dollar of capital produces, how quickly the installation pays back, and how many dollars the project returns to the budget. The graph places all three measures together.

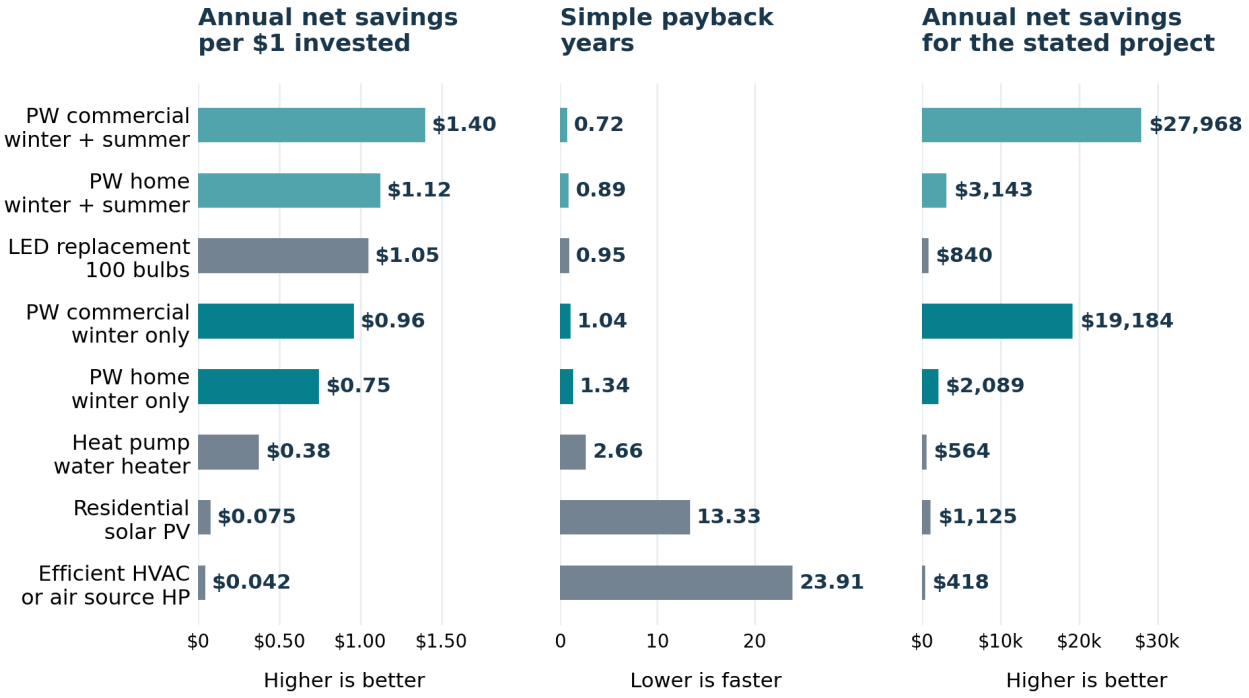


Figure 1. Reference investment scenarios at a common $0.15/kWh, before incentives. Teal bars show Powder Watts; gray bars show comparators. Powder Watts savings are net of the annual Powder Watts Protect and maintenance allowance. Comparator cases assume no recurring incremental cost. Project sizes and cost bases are specified below. [1,4,12,16-17]

At $0.26/kWh, the same three-switch winter-only home returns $3,885 annually and pays back in 0.72 years at the maximum $2,800 installed price. The $0.15/kWh payback is 1.34 years. Larger loads increase the dollars recovered; the return per dollar and payback show whether the capital is productive.

Home: three switches, $2,800 maximum installed. Commercial: twenty circuits, $20,000 assumed installed. Winter + summer means all modeled summer hours would otherwise remain energized. LED: 100 × the $8, 56-kWh reference bulb; no additional labor cost assumed. Heat pump water heater: $1,503 incremental replacement cost. PV and HVAC costs and yields remain stated screening assumptions. Full definitions, external benchmarks, and twenty technology families follow.

Executive summary of savings scale and owner value

A large existing expense brought under smart control

The three-switch home reference controls 5.7 kW of winter load. The utility baseline is 24-hour operation through a 152-day winter: 20,794 kWh and $3,119 at $0.15/kWh. The twenty-circuit commercial reference controls 50 kW, with a $27,360 winter electricity baseline. Bringing those existing loads under smart control releases meaningful annual cash. [1,36]

Application at $0.15/kWh	Installed cost	Prior annual energy bill	Net annual savings	Payback	Five-year net gain
Home winter only	$2,800	$3,119	$2,089	1.34 years	$7,645
Home winter + summer	$2,800	$4,173	$3,143	0.89 years	$12,916
Commercial winter only	$20,000	$27,360	$19,184	1.04 years	$75,922
Commercial winter + summer	$20,000	$36,144	$27,968	0.72 years	$119,842

Net annual savings are after Powder Watts Protect and maintenance: $360/home or $2,400/commercial. Five-year net gain = five years of net savings less the installed investment. It is undiscounted, before incentives, financing, taxes, or renewals, with constant rates, costs, and maintained savings. Prior bills include only the modeled heat-cable load; they are not whole-building bills.

Rapid payback continues to return cash after recovery

At $0.15/kWh, the commercial winter + summer case returns $1.40 annually for every $1 installed, repays the modeled investment in 0.72 years, and produces $119,842 of five-year net gain. The winter-only commercial case returns $0.96 per installed dollar annually and produces $75,922 of five-year net gain. Summer savings apply only where the baseline operation is documented.

Three-switch home at $0.26/kWh	Net annual savings	Payback	Five-year net gain
Winter only	$3,885	0.72 years	$16,625
Winter + documented summer operation	$5,712	0.49 years	$25,760

Carbon reduction and roof protection accompany the cash return

The winter-only home avoids 16.33 MWh annually, or 5.83 MWh per $1,000 installed. At the paper's NWPP non-baseload screening factor, that corresponds to 11.95 metric tonnes of annual avoided operational CO_2 and 4.27 tonnes per $1,000. Geography and the timing of savings determine a project's carbon result. [5-6]

Powder Watts also combines direct melt-zone imagery, automated switching, circuit-level electrical data, and fault alerts. This gives the owner active oversight of the roof-protection system. The financial results above assign no dollar value to avoided roof damage, demand-charge reductions, maintenance labor savings, or grid-service revenue. [18-19]

An eligible $1,000 residential rebate reduces the winter-only home payback at $0.15/kWh to 0.86 years. Eligibility and the applicable tariff must be established for the same property. Annual savings per dollar is a cash-productivity ratio, not an internal rate of return; its reciprocal is simple payback under the same assumptions. [7]

1 Why heat cable control produces large savings

Heat cable performs a specific task: maintaining drainage paths at roof edges, valleys, gutters, and downspouts. Continued snow cover does not establish that more heating is needed. A drainage channel may already be open beneath a bridge of snow while energized cable continues consuming electricity. Powder Watts observes the melt zone and controls the associated circuit according to the protective task. [1]

A small control investment governs a large electrical load

At the residential reference draw of 1.9 kW, the utility baseline of 152 winter days at 24 hours per day produces 6,931 kWh per circuit. Applying the study's 79% reduction avoids 5,476 kWh before control-system consumption. A 20-circuit commercial installation at 2.5 kW per circuit has a 182,400 kWh winter baseline and avoids 144,096 kWh on the same basis. [1,36]

The platform combines roof imagery, switching, circuit-level electrical data, and remote supervision. Fault alerts and operating histories support maintenance response while control reduces unnecessary heating. Self-regulating cable changes its power with thermal conditions; it does not necessarily disconnect itself when heating is unnecessary. Measured on-state power therefore belongs in each seasonal calculation. [3,10]

Field research and independent verification

Evidence	What it establishes	Application
NSF SBIR award 2224907	$274,922 Phase I award for vision-enhanced heat-cable controls	Research support, 2023–2024 [28]
Published two-winter field study	79% overall reduction; 70%–90% range	Winter scenario input [1]
WattCarbon M&V plan	Hourly device data and seasonal baseline reconciliation	Independent verification method [3]
Rocky Mountain Power AI category	AI learning with Rooftop CV Monitor imagery	Current program recognition [7]

Powder Watts' technical records document savings audits by Rocky Mountain Power and WattCarbon. The published two-winter field study supplies the 79% reduction used in this paper's investment model. Field research, independent verification, and utility program recognition support the investment case. [1-3,7]

2 How the system fits an existing building

Powder Watts upgrades an existing roof heat-cable system with observation, automated switching, and operational visibility. Rooftop CV Monitors observe representative melt zones; switches control the associated circuits; a hub links the devices to the Powder Watts cloud platform and the owner interface. [18-19]



Figure 2. Powder Watts system components, shown with an earlier Rooftop CV Monitor housing. The smart outlet is at lower left; the center and right boxes are hub packaging. [25]

System element	Function
Rooftop CV Monitor	Observe the heat cable and its surrounding melt zone
Smart outlet and metering	Control circuit power and record electrical operation
Communication hub	Connect field devices with the Powder Watts cloud platform

Retrofit scope follows the roof and circuit layout

The existing cable performs the heating. Powder Watts determines when heating is needed and makes system condition visible. Site design associates Rooftop CV Monitor coverage with controlled zones and verifies electrical capacity, communications, drainage paths, and commissioning. The residential financial example uses three switches, each controlling one circuit breaker's worth of heat tape, at a maximum $2,800 installed price. [1,17-19]

3 From roof observation to verified operation

The system connects a physical protective task to a measurable electrical action. Roof images establish melt-zone conditions, switching changes cable operation, and circuit data records energy use and equipment status. The owner receives views and alerts that support maintenance response. [3,18-19]

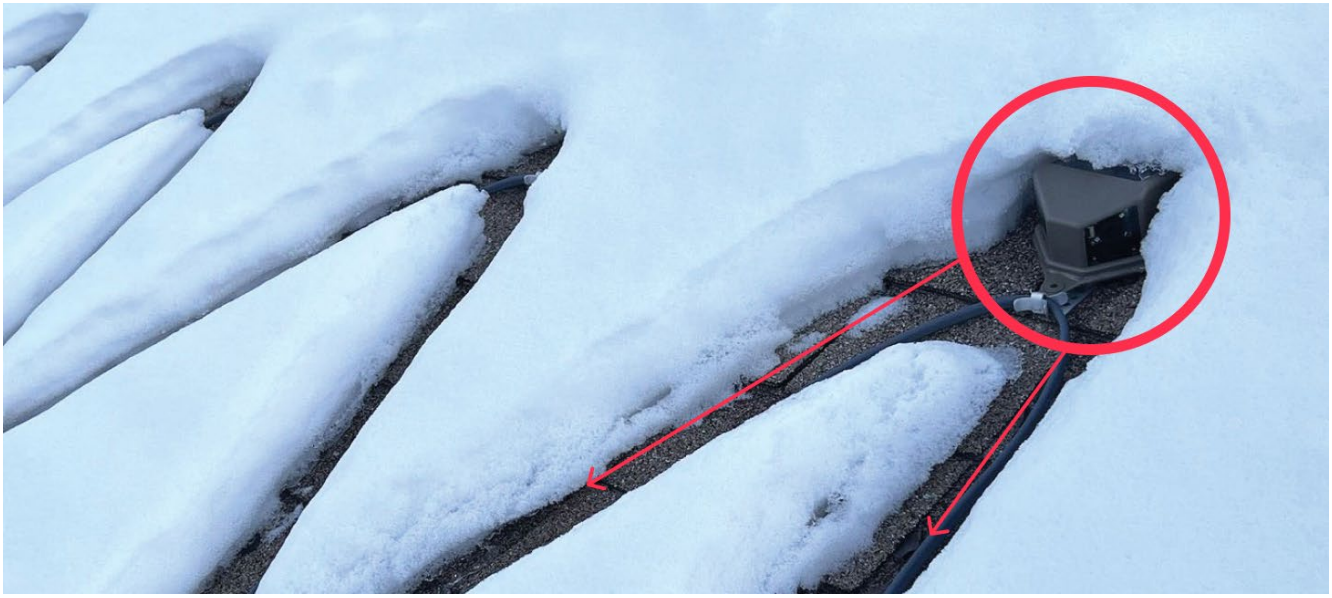


Figure 3. A Powder Watts Rooftop CV Monitor beside heat cable on a snow-covered roof. Visible melt channels follow the cable while snow remains between them. Red markings identify the monitor and melt channels. [27]

The operating sequence

1 Observe the melt zone. The Rooftop CV Monitor records the local roof condition, including snow, ice, and the channel surrounding the cable.

2 Determine whether heating is needed. Cloud analysis evaluates the observed condition and communicates the switching decision through the hub.

3 Operate and measure the circuit. The smart switch controls cable power; circuit-level electrical data records consumption and operating behavior.

4 Maintain visibility. Roof images, operating history, and alerts give owners and facilities staff information for maintenance response.

Operating sequence: [3,19]. Roof imagery and circuit data connect visible melt-zone conditions with measured electrical operation.

Combining imagery with circuit data helps identify when heating is needed and when a circuit requires attention. Owners receive both direct roof visibility and a record of electrical operation.

4 Energy savings with active building protection

Powder Watts adds a distinctive building-protection benefit to the efficiency investment: direct melt-zone visibility combined with heat-cable control, circuit-level electrical data, and fault alerts. Owners can see the conditions the system serves and identify operating concerns while reducing unnecessary electricity use. [18-19]



Figure 4. Rooftop CV Monitor views dated 26 January 2024. The left view shows an open cavity beneath bridged snow; the right view shows the roof surface, heat cable, and surrounding snow. These views reveal local melt-zone conditions beneath and beside the snow cover. [26]

Protection function	Operational benefit
Observe melt-zone conditions	Support drainage-path maintenance with direct roof visibility
Identify cable or circuit concerns	Alert staff to faults, loss of operation, or abnormal conditions
Record operating history	Help maintenance teams locate and investigate problems
Reduce unnecessary energization	Limit waste while preserving the required heating task

Direct roof visibility, circuit data, and fault alerts help facilities teams identify operating concerns and support maintenance response. Avoided leaks, restoration work, and disruption add potential owner value beyond the electricity savings quantified here. The headline payback includes energy savings and the stated service allowance; it assigns no dollar value to avoided property damage.

5 Why direct roof observation changes the control task

A roof may still be covered in snow after a drainage channel has opened. The useful control question is whether the protected melt zone needs more heating. Rooftop CV Monitor placement connects the decision to that physical condition and gives facilities staff an image they can interpret. [18-19]

Issued patents support the control architecture

Powder Watts combines Rooftop CV Monitor observations, automated switching, and measured electrical operation in a coordinated control system. Its issued patent suite includes U.S. Patents 12,006,689 B2 and 12,492,559 B2, both titled Efficient control of a heating element. The architecture connects the roof's protective task with the timing and measurement of heat-cable power. [18-19,34-35]

Utility winter baseline and operating hours

The utility winter baseline used in this analysis is 152 days of 24-hour operation, equivalent to 3,648 hours. At high-altitude ski resorts, the winter period extends to six months; the resort engineering example uses 4,380 hours. Baseline energy equals circuit count multiplied by winter on-state kW and winter hours. Powder Watts savings are calculated against that baseline using the stated reduction, with control-system consumption deducted from net savings. [1,9,36]

Utility incentives reduce the initial investment

For residential installations, Rocky Mountain Power's Utah AI program specifies rooftop visual monitoring and AI learning. The $500-per-unit incentive category provides up to $1,000 for two eligible units per home. The three-switch home example applies that $1,000 incentive to the $2,800 installed price. Participating-contractor installation and program approval apply. [7]

Rocky Mountain Power commercial custom incentives are up to $0.15 per kWh saved in the first year. Idaho Power offers $0.20 per first-year kWh saved for approved commercial and industrial capital projects. Both programs apply a 70% eligible-cost cap; the applicable program terms determine the approved award. [8,20]

6 Winter and summer create distinct savings streams

Winter optimization and summer shutdown address different operating conditions. In winter, Powder Watts ends unnecessary heating after the required melt task. In summer, reliable shutdown eliminates cable consumption at sites where circuits would otherwise remain on. Distributed panels, inaccessible switches, seasonal handoffs, and unoccupied buildings can make manual shutdown inconsistent. [2,9]

Commercial properties must allocate labor to locate snowmelt circuits, shut them off in the offseason, and restore operation in the fall. Idaho Power's snowmelt study reported that 100% of commercial respondents left heat tape energized year-round. Powder Watts automates seasonal shutdown, addressing both the electricity expense and the recurring operating task. [36]

Input	Three-circuit home	Twenty-circuit commercial
Winter on-state load	3 × 1.9 kW	20 × 2.5 kW
Winter period and reduction	3,648 hours; 79%	3,648 hours; 79%
Summer on-state draw per circuit	0.8 kW assumed	1.0 kW assumed
Summer period	2,928 hours	2,928 hours
Added controls consumption	100 kWh/year	200 kWh/year
Gross installed investment	$2,800 maximum	$20,000 assumed
Annual Powder Watts Protect and maintenance	$360 assumed	$2,400 assumed

The residential model uses the maximum $2,800 installed price for three switches confirmed by Powder Watts. The twenty-switch commercial model retains a $20,000 installed-cost assumption. Annual service, summer draw, and control-power allowances remain model inputs. Winter inputs follow the study; no savings are credited for the remaining 91 days. [1-2,4,17]

Net annual savings	Summer already off	Half of summer on	All summer on
Three-circuit home	16,327 kWh	19,841 kWh	23,354 kWh
Twenty-circuit commercial	143,896 kWh	173,176 kWh	202,456 kWh

Summer fractions refer to baseline energized circuit-hours, not the percentage of customers. Post-control summer cable use is zero in these shutdown scenarios. Annual values include the added controls-energy deduction.

Winter savings establish the core investment return. The summer scenarios quantify the additional value of eliminating energized summer hours, using the on-state power and operating fractions shown above.

7 Winter savings earn the investment case

Using the 152-day utility winter baseline, the three-switch model avoids 16,327 kWh annually after control-system consumption. At the $2,800 installed maximum, each $1,000 of initial capital supports 5.83 MWh of annual avoided electricity. Summer shutdown adds the separate savings shown in Section 6.

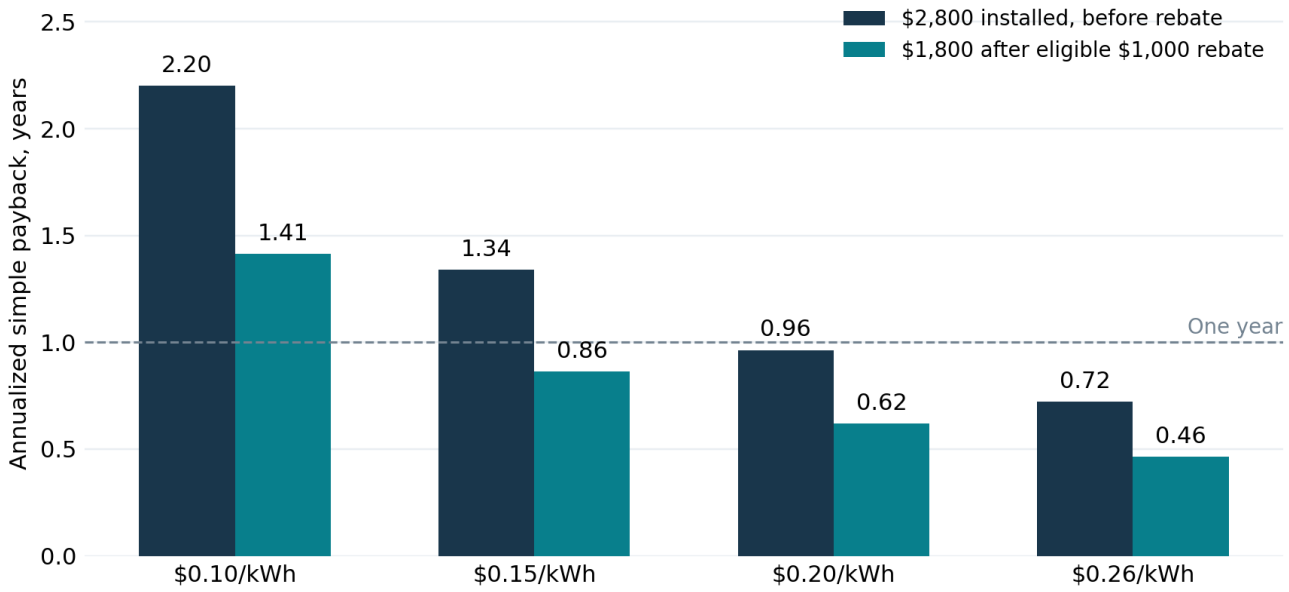


Figure 5. Winter-only home payback after the $360 annual Powder Watts Protect and maintenance allowance. All bars use three switches at $2,800 total installed cost. Rebate bars show an eligible $1,000 incentive and $1,800 customer investment. Electricity-rate and incentive cases are identified separately. [7,17]

First-winter investment recovery

At $0.26/kWh, modeled first-year net savings of $3,885 exceed the entire $2,800 installation price. At $0.15/kWh with an eligible $1,000 rebate, net savings of $2,089 exceed the $1,800 customer investment. These cases can recover the investment through the first operating winter when the modeled load and savings are realized and the incentive is received.

The $0.26 scenario is relevant to high-cost markets. EIA's August 2026 residential averages were 27.64 cents/kWh in New Hampshire, 28.65 cents in New York, and 30.48 cents in Massachusetts. State averages establish context; a project must use the marginal charges its saved kWh actually avoids. [32]

Summer shutdown and operating benefits add to the return

Summer shutdown, demand-charge reductions, maintenance efficiencies, and grid-service payments can add to the owner's return. The winter-only results above are based on energy savings after the annual Powder Watts Protect and maintenance allowance. Additional value streams are accounted for separately.

8 How the result compares with published evidence

Powder Watts' winter-only home scenario delivers 1.34-year payback at $0.15/kWh and 0.72-year payback at $0.26/kWh, before incentives. The table places those results alongside published benchmarks for building commissioning, energy management, HVAC controls, and heat pump water heating.

Measure and evidence	Published or modeled payback	Scope and interpretation
Powder Watts three-switch home — this paper	1.34 years at $0.15/kWh; 0.72 at $0.26	Winter-only model; full $2,800 installed cost; annual Powder Watts Protect allowance; no rebate
Existing-building commissioning — LBNL, 2020	1.7-year median; 0.8–3.5-year interquartile range	Historical multi-building evidence; prices and building conditions vary [29]
Energy-management information systems — LBNL, 2020	2-year median	104 organizations; 6,500 buildings; energy information and fault diagnostics [30]
Advanced rooftop HVAC controls — PNNL, 2013	1.0–4.2 years across eight sites at $0.15/kWh	Controller and installation; adding metering/monitoring increased the range to 1.5–10.2 years [31]
Heat pump water heater — ENERGY STAR	2.7 years in the published example	Four-person household; 3,760 kWh/year; $1,503 incremental replacement cost [12]

Powder Watts values are calculated from this paper's winter model. External values retain the project scopes, cost bases, and publication dates of the cited studies. Each row identifies its comparison basis. [1,12,29-31]

Rapid capital recovery with ongoing owner value

Powder Watts combines rapid investment recovery with direct roof-protection oversight. In the winter-only reference model, a three-switch home returns $2,089 annually after the stated service allowance at $0.15/kWh. Once the investment is recovered, continuing reductions in electricity expense return cash to the owner each operating season.

Compare total savings alongside payback

The opening graph places annual savings per invested dollar, payback time, and total annual savings together. This makes the size of the heat-cable expense visible alongside capital efficiency. The broader comparison in Sections 15 and 16 covers twenty technology families and their financial and energy mechanisms.

9 Payback after service costs and incentives

Simple payback divides installed investment, less approved incentives, by annual net cash savings after Powder Watts Protect and incremental maintenance. Reference cases exclude demand charges, grid payments, labor savings, and avoided damage. All home cases use three switches at the maximum $2,800 installed price; commercial cases use twenty switches at an assumed $20,000.

Reference case at $0.15 per kWh	Annual net cash	Gross payback	After rebate
Home with summer already off	$2,089	1.34 years	0.86 years
Home with half of summer on	$2,616	1.07 years	0.69 years
Home with all summer on	$3,143	0.89 years	0.57 years
Commercial with summer already off	$19,184	1.04 years	Not assumed
Commercial with half of summer on	$23,576	0.85 years	Not assumed
Commercial with all summer on	$27,968	0.72 years	Not assumed

The residential incentive example uses two eligible $500 AI units, reducing the customer investment from $2,800 to $1,800. The program permits a maximum of two AI units per home in this incentive calculation. [7]

Three-switch home across electricity rates

Simple payback in years before incentives, at the maximum $2,800 total installed price and the existing $360 annual Powder Watts Protect and maintenance allowance. Only the electricity rate changes across columns.

Prior summer operation	$0.10/kWh	$0.15/kWh	$0.20/kWh	$0.26/kWh
Already off	2.20 years	1.34 years	0.96 years	0.72 years
Half of summer on	1.72 years	1.07 years	0.78 years	0.58 years
All summer on	1.42 years	0.89 years	0.65 years	0.49 years

At $0.26/kWh, annual net home savings are $3,885 with summer already off and $5,712 with all summer on. With the eligible $1,000 rebate, paybacks become 0.46 and 0.32 years, respectively. The same rate produces commercial paybacks of 0.57 and 0.40 years before incentives.

For Utah custom non-lighting retrofits, Schedule 140 specifies up to $0.15 per annual kWh saved, a 70% cost cap, and incentive adjustment to prevent payback below one year. Utility approval governs the award. [8]

Rates represent avoidable energy charges; fixed charges are excluded. Annualized payback is not a calendar recovery date. Installation timing, seasonal bills, incentive receipt, and financing determine actual cash recovery.

10 Payback sensitivity to operating and cost inputs

This sensitivity analysis quantifies the effects of winter reduction, season length, circuit power, and annual service costs on payback. It holds the three-switch installed price at its $2,800 maximum and includes winter energy savings only.

Winter-only sensitivity	Net annual kWh	$0.15/kWh	$0.26/kWh
Reference winter case	16,327	1.34 years	0.72 years
Lower winter reduction: 70%	14,456	1.55 years	0.82 years
Lower winter reduction: 50%	10,297	2.36 years	1.21 years
Shorter energized season: 120 days	12,869	1.78 years	0.94 years
Lower on-state draw: 1.0 kW per circuit	8,546	3.04 years	1.50 years
Higher annual Powder Watts Protect / maintenance: $720	16,327	1.62 years	0.79 years
Combined downside: 1.0 kW; 120 days; 50%	4,220	10.26 years	3.80 years

One input changes at a time except the combined downside row. All rows deduct 100 kWh/year for controls. The 50% case is a sensitivity below the field-study reference range, not a new measured result. The $720 allowance tests cost exposure; it is not a quoted fee.

Energy savings required for first-year recovery

Net installed investment	Required net annual savings at $0.15	Required net annual savings at $0.26
$2,800 before rebate	21,067 kWh	12,154 kWh
$1,800 after eligible $1,000 rebate	14,400 kWh	8,308 kWh

Threshold = (net installed investment + $360 annual Powder Watts Protect and maintenance) ÷ avoidable electricity rate. Annual savings are after controls consumption. The 16,327 kWh reference clears three of these four thresholds.

At $0.26/kWh, 12,154 kWh of net annual energy savings recovers the full $2,800 installation price after the $360 annual Powder Watts Protect and maintenance allowance. The winter reference produces 16,327 kWh. At $0.15/kWh with the eligible $1,000 rebate, the recovery threshold is 14,400 kWh, also below the winter reference.

11 Carbon reduction per dollar and over time

This review uses EPA eGRID2023 revised summary-table data for the NWPP subregion: 1,613.4 lb CO_2 per MWh for non-baseload output, equivalent to 0.731826 metric tonnes per MWh. This is an avoided-grid-emissions screening factor. It is distinct from the 631.7 lb/MWh total-output factor used for a different accounting purpose. [5-6]

Reference case	Annual avoided CO_2	Tonnes per $1,000 initial capital
Home with summer already off	11.95 metric tonnes	4.27
Home with all summer on	17.09 metric tonnes	6.10
Commercial with summer already off	105.31 metric tonnes	5.27
Commercial with all summer on	148.16 metric tonnes	7.41

The carbon calculation uses the NWPP non-baseload factor for avoided operational emissions. Regional or hourly factors connect the same energy calculation to other geographies and operating periods. EPA's AVERT provides an hourly framework for evaluating efficiency, renewable generation, and storage. Corporate Scope 2 inventory reporting uses its applicable electricity-accounting method. [5-6,33]

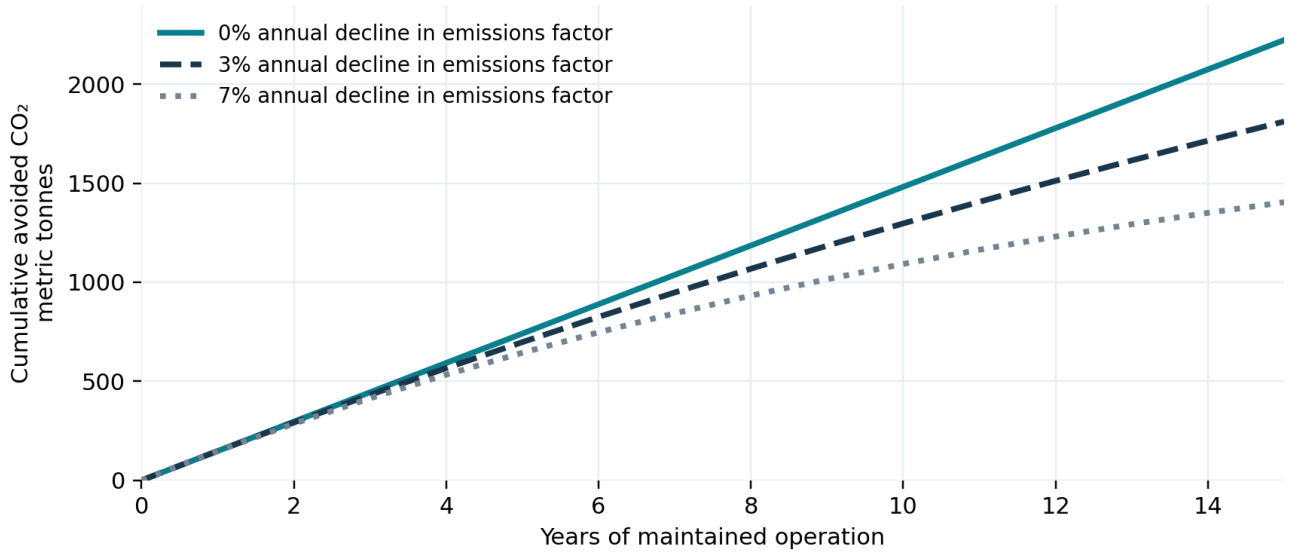


Figure 6. Commercial summer scenario at constant annual energy savings over 15 years. Emissions-factor declines of 0%, 3%, and 7% are sensitivities, not grid forecasts. They produce approximately 2,222, 1,811, and 1,404 metric tonnes, respectively. No physical tonnes are financially discounted.

Early deployment captures emissions reductions before another operating season passes. The winter-only commercial scenario avoids approximately 105 metric tonnes of operational CO_2 annually at the stated NWPP factor. The measures reported here are annual avoided emissions and emissions avoided per invested dollar.

12 Capital productivity and long-term owner return

A low installed cost per MWh shows how productively initial capital is deployed. A complete investment decision also includes service costs, renewal, and timing. This analysis uses a 15-year horizon, a 6% real discount rate, constant real energy prices, and a renewal allowance of 25% of initial cost in year eight. Residential installed cost uses the maximum $2,800 for three switches.

Metric	Home winter only	Commercial with summer
Gross initial cost	$2,800	$20,000
Annual Powder Watts Protect and maintenance allowance	$360	$2,400
Year-eight component renewal allowance	$700	$5,000
Initial capital per 15-year MWh	$11.43/MWh	$6.59/MWh
Discounted ownership cost per MWh	$42.48/MWh	$23.62/MWh
15-year net present value at $0.15/kWh	$17,050	$248,499
15-year net present value at $0.26/kWh	$34,493	$464,792
Net financial cost per tonne at $0.15/kWh	−$95/t CO_2	−$112/t CO_2
Net financial cost per tonne at $0.26/kWh	−$192/t CO_2	−$209/t CO_2

No incentives, taxes, financing, demand savings, labor savings, or grid-service income. Renewal is a budgeting assumption, not a component-life assertion. Constant physical savings require maintained service. Net financial cost per tonne divides discounted net owner cost by undiscounted operational tonnes at the constant NWPP factor.

Carbon reduction with positive owner economics

Negative net financial cost per tonne means the present value of electricity savings exceeds the modeled ownership costs. The owner earns a positive net return while reducing operational emissions. This is a more useful economic result than an upfront carbon-cost ratio alone because it recognizes that the investment returns cash.

The commercial summer Powder Watts case leads the stated numerical reference cases on first-year energy impact per initial dollar and simple payback. The ownership-cost analysis includes annual service and component renewal, allowing the initial capital return and the long-term owner return to be evaluated together.

Service and renewal assumptions

The 15-year analysis uses the annual Powder Watts Protect and maintenance allowance and the year-eight renewal allowance shown in the table. A ten-year period, a different renewal budget, or a declining emissions factor can be evaluated with the same equations. Annual savings and simple payback are calculated independently of the 15-year horizon.

13 Deer Valley demonstrates the operating opportunity

The Deer Valley Resort customer account describes a concrete problem: ice dams, roof leaks, and limited visibility into failed heat cable. The resort installed Powder Watts across its day lodges, coupling energy control with the maintenance visibility its team needed. [19]

Published winter outcome	Reported value	Interpretation
Avoided electricity	344,531 kWh	Published customer estimate for one winter
Avoided energy charges	$13,976	Energy savings stated in the account
Avoided demand charges	About $10,000	Separate estimated demand benefit
Utility project support	85% of project cost	Historical project-specific support; not a current general incentive

Source: Deer Valley Resort customer account published on Powder Watts' Technology page. Energy savings, demand-charge savings, and historical utility support are shown separately. [19]

The protection problem and the energy problem are connected

Deer Valley's account connects energy savings with improved visibility into heat-cable operation. Facilities staff can locate operating concerns while reducing unnecessary load. Roof-protection oversight adds operational value alongside the reported energy and demand-charge savings.

Six-month resort engineering example

The October 2026 resort engineering example uses 46 switches and 111 kW of cable over a six-month, 4,380-hour winter baseline. Applying an 86% reduction produces 418,115 kWh of calculated savings. This engineering example explains the scale of the resort load; the published customer outcome remains 344,531 kWh in the table above. [9]

Use current program terms for the next installation

Rocky Mountain Power's current Utah custom retrofit schedule offers up to $0.15 per annual kWh saved, subject to a 70% project-cost cap and a one-year minimum payback after the incentive. Approved incentives reduce the customer's initial investment; the applicable tariff and project scope determine the award. [8]

Portfolio deployment repeats the same operating model across buildings: establish the circuit inventory and utility baseline, commission the system, verify savings, and direct roof or circuit alerts to the responsible facilities team.

14 Grid services and deployment timing add value

Powder Watts can coordinate the timing of necessary heat-cable operation with utility needs. Its FlexiWatt architecture supports scheduled no-energization windows, peak avoidance, and dispatch while direct rooftop observation informs the protective task. The operating envelope extends to 72 hours where roof conditions permit that deferral. [1,4]

Value stream	Quantity to establish	Economic treatment
Persistent efficiency	Baseline-adjusted annual kWh	Energy-bill savings and avoided emissions
Customer demand reduction	Reduction in tariff-defined billed peaks	Demand-charge savings
Event demand response	Incremental event kW versus approved baseline	Contracted program payments
Utility capacity value	Accredited available kW and duration	Utility resource-planning value

Energy savings, event response, and capacity value use separate accounting quantities. Persistent efficiency is measured in annual avoided kWh; event response is measured in incremental kW against the program baseline; capacity accreditation specifies available kW, duration, and delivery requirements.

Seasonal shutdown reduces the baseline summer electricity expense. Utility-directed scheduling determines when necessary heating returns to the grid. Metering and dispatch records support the valuation of each service and keep annual energy savings distinct from event and capacity quantities.

Deploy early enough to capture the next savings season

A controls retrofit begins delivering savings when commissioned on an operating heat-cable system. Equipment availability, electrical work, communications, and commissioning establish the deployment schedule. Completing the retrofit before winter captures the coming season’s energy savings.

For the modeled 20-circuit winter-only installation, missing one full winter forgoes about 143.9 MWh of net savings, worth $21,584 at $0.15/kWh before recurring service. That cost of delay is a concrete reason to evaluate heat cable before the next winter capital cycle.

Deploy savings and reinvest the return

The comparison of net annual savings, capital productivity, carbon reduction, and commissioning time supports a clear investment sequence. Rapid heat-cable savings release cash that owners can reinvest in additional efficiency, envelope, or generation projects.

15 Complete numerical reference comparison

The comparison covers sixteen technology families using defined investment cases. The Powder Watts home cases use the confirmed $2,800 maximum installed price for three switches. Other costs and energy values are screening assumptions except the cited ENERGY STAR water-heater benchmark; they are not national averages or current bids. Mixed-fuel savings require fuel-specific modeling. [4,12,16-17]

Technology or application	Annual kWh	Initial cost	MWh per $1,000
Smart thermostat	303	$150	2.02
LED bulb retrofit	56	$8	7.00
Smart power strip	50	$40	1.25
Window film or low-e retrofit	500	$1,500	0.33
Air sealing	800	$1,200	0.67
Duct sealing	700	$1,000	0.70
Insulation upgrade	1,200	$3,500	0.34
Residential solar PV	7,500	$15,000	0.50
PW home winter only	16,327	$2,800	5.83
PW home with summer	23,354	$2,800	8.34
PW commercial with summer	202,456	$20,000	10.12
Geothermal heat pump	4,500	$30,000	0.15
High-efficiency HVAC or ASHP	2,788	$10,000	0.28
Heat pump water heater	3,760	$1,503	2.50
High-efficiency motor	20,000	$8,000	2.50
Community solar subscription	7,500	Contract	Not ranked
Energy recovery ventilator	650	$3,000	0.22
Solar hot water	3,300	$8,000	0.41

Initial cost is total installed cost except heat pump water heating: ENERGY STAR's four-person example uses $1,503 incremental cost and 3,760 kWh/year relative to a standard electric replacement. Community solar is a subscription and is not assigned a zero-dollar investment ranking. [12]

The PV case assumes 7,500 kWh/year from a 5-kW installation; production needs location-specific modeling, and bill value depends on self-consumption and export compensation. [14] Batteries primarily move energy in time and provide capacity or backup. Evaluate their economics using a dispatch model, charging losses, and the applicable tariff and service revenues.

Comparator cases exclude rebates. Initial cost and annual benefit use the stated equipment or replacement scope. Storage economics are evaluated through charging, dispatch, tariff, and service-revenue inputs.

16 Additional technologies in the investment decision

A complete capital review also considers storage and operational controls. These four families expand the paper to twenty technologies. Their economics depend on dispatch, existing equipment, tariffs, and implementation scope. The following criteria establish the project evidence needed to compare their energy, financial, and carbon performance. [21-24]

Technology	Energy and financial mechanism	Evidence needed for a fair comparison
Battery storage	Shift electricity purchases; reduce peaks; provide backup when configured	Installed kW and kWh, efficiency, cycles, degradation, tariff, contracted revenues
Thermal energy storage	Shift heating or cooling; may change HVAC efficiency and peak demand	Thermal capacity, charging profile, HVAC efficiency, losses, seasonal operation
Variable-speed drives	Match fan or pump speed to load instead of wasting power through flow restriction	Motor size, duty cycle, measured input power, flow requirements, drive efficiency
Building automation and re-tuning	Correct schedules, setpoints, simultaneous heating and cooling, and operational faults	Existing control capability, trend data, implementation labor, verified persistence

Energy investment with direct roof protection

Powder Watts combines a large reduction in heat-cable electricity expense with direct melt-zone visibility, circuit-level electrical data, automated switching, and fault alerts. The Rooftop CV Monitor connects the investment to the condition of the roof it protects. [18-19]

The numerical comparison captures energy and financial performance. Roof visibility, operating history, and fault alerts add an operational benefit for owners and facilities teams. The financial results assign no dollar value to avoided roof damage, so that benefit is additional to the energy return.

17 Calculation methods and verification

Energy and cash equations

Winter avoided kWh = circuits × representative winter on-state kW × utility winter baseline hours × winter savings fraction. The standard case uses 152 days × 24 hours = 3,648 hours. The high-altitude resort example uses a six-month winter represented by 4,380 hours. [1,9,36]

Summer avoided kWh = circuits × measured summer on-state kW × summer hours × baseline on-fraction − post-control summer cable kWh. Use a separate summer load; cold-start current and winter wet-cable power are not warm-weather averages.

Annual net kWh = winter avoided kWh + summer avoided kWh + separately established shoulder savings − incremental control-system kWh. In the reference cases, shoulder savings are zero. Assign every interval once.

Annual net cash = avoided energy charges + verified demand savings + contracted grid income + documented cash operating savings − Powder Watts Protect and incremental maintenance. Customer payback = (installed cost − approved incentive) ÷ annual net cash. Headline examples use energy savings only.

Carbon and life-cycle equations

Annual avoided tonnes CO_2 = net avoided MWh × 1,613.4 lb/MWh × 0.45359237 kg/lb ÷ 1,000 kg/tonne. The metric is CO_2, not CO_2e; it excludes upstream and embodied emissions.

Discounted ownership cost per MWh = present value of installation, service, and renewal costs ÷ present value of avoided MWh. Net present value = present value of bill savings and other counted cash benefits − present value of costs. Annual cash flows occur at year end; installation occurs at year zero.

Net financial abatement cost = discounted net owner cost ÷ cumulative undiscounted avoided operational tonnes. A negative value indicates net savings to the owner. Use a utility avoided-cost framework for a utility cost-effectiveness test; retail bill savings are not a substitute for system benefits.

Evidence retained with each result

Project verification retains the circuit inventory, utility baseline period, measured consumption, seasonal power, data completeness, and commissioning date. WattCarbon’s published plan uses hourly device and socket records and reconciles independently calculated savings with submitted totals. Powder Watts also documents thermal variability and missing reporting hours. [3,15]

A financial result also retains the installation quote, service agreement, incentive approval, billing-period rates, and any demand-charge calculation. A carbon result retains geography, factor source, factor year, and the reporting purpose. Use utility billing-interval data for billed peaks and event-interval telemetry for demand response. DOE measurement and verification protocols provide the broader evaluation framework. [13]

Calculations use unrounded inputs; rounded table totals may differ by one unit. Installation cost, service allowance, utility baseline, incentive treatment, and emissions factor are identified with each reference case.

Sources and technical references

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[26] Powder Watts. Rooftop CV Monitor imagery dated 26 January 2024. Paired views of the melt zone beneath bridged snow and the adjacent roof surface, reproduced in Figure 4.

[27] Powder Watts. Rooftop CV Monitor installed in snow. Installation photograph showing heat cable and melt channels. Figure 3 retains the image's red circle and arrows.

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Research references and interpretation

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Basis for use

This paper evaluates energy savings, cash return, and avoided operational emissions for buildings with electric heat cable. Reference calculations use the installation sizes, utility baseline periods, electricity rates, service allowances, and emissions factors stated in the model. Published field-study results, customer outcomes, and external technology benchmarks are identified in the corresponding sections.