TFTC × EXERGY

The Home MiningPlaybook

Bitcoin Miners as Building Energy Infrastructure

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Contents

PART 1

The Case for Building-Integrated Mining

You Have an Advantage. Use It.

You already know you should be mining. You have thought about it. You concluded it did not make sense at your scale, or was too complicated to even start. The hardware is industrial. The economics seem to favor data centers. The whole thing feels like it happens somewhere else. Entire companies exist to manage it for you via hosting or hashrate rentals. So instead, you held your bitcoin, kept your exchange account, and moved on.

Here's what you missed: your building.

Your building has a heating load. You pay for that heat every month, in propane, in heating oil, in electricity, in whatever your utility charges you to stay warm. You have been doing this for years. It has likely never occurred to you, or anyone else, to describe your heating bill as a Bitcoin mining operation. That changes today.

There is a device that produces the same heat your furnace does and earns Bitcoin while it runs. Every joule it consumes becomes both monetized computation and heat. There's no waste. Only useful heat and sats. Every month you run your current system without one, you're paying for heat twice: once in dollars, once in the Bitcoin you didn't earn.

This works whether your building is 900 square feet or 5,000. Whether you heat with propane, electric resistance, or a gas furnace. Whether you have solar or not. The math is specific to your building, and Part 3 shows you how to run it.

A note on the mining model: all Bitcoin earnings discussed in this document assume pool mining, where you join a cooperative pool of miners that shares block rewards proportionally to contributed hashrate. This is how the math works at residential and commercial scale.

> ***"Every month you pay a heating bill, you are paying for heat twice: once in dollars, once in the Bitcoin you did not earn."***

The Miner That Doesn't Need to Win

Why Industrial Miners Fight a War You Don't Have To

For most people who believe in Bitcoin, mining has become something that happens somewhere else. The hardware is industrial. The power requirements are megawatt-scale. The facilities are purpose-built data centers in places chosen for cheap power. Mining has become intangible: something you know is happening, that you understand abstractly, but that feels completely out of reach for an individual. Maybe you've dabbled with a Bitaxe on your desk, a space heater that earns a few sats. But that's not the ceiling. There's a version of home mining that's actually worth building.

This didn't happen by accident. Industrial miners ask one question: is my revenue per terahash greater than my operating cost per terahash? That math gets harder after every halving and every difficulty adjustment. The surviving operators are the ones who found the cheapest power and the most efficient systems. Over time, the competitive pressure pushed the entire industry toward scale. Away from homes, away from individuals, toward facilities that most Bitcoiners will never see.

The result: Bitcoin mining is increasingly concentrated. Increasingly industrial. Increasingly distant from the individual Bitcoin holder who believes in the network but has no practical path to participate in its security.

That's not a stable end state for a network that exists to be decentralized.

> ***"Industrial miners need to remain profitable to survive. You need a warm house. Those are not the same problem."***

The Structural Edge That Lives Inside Your Building

Think of a Bitcoin miner as a black box: electricity goes in, heat and money come out. That's it. The question is simply where it makes sense to put that box, and the answer is obvious: where you're already paying for heat.

Your building has a heating load to keep you warm. That load exists regardless of Bitcoin price, network difficulty, or hashprice. That demand is non-negotiable. Conveniently, every joule that runs through a miner becomes heat. All of it. If that heat is useful to your building, the miner doesn't need to "win" on mining economics alone.

This changes the calculus entirely. A building-integrated miner doesn't need to be profitable in the industrial sense. It needs to be useful: it heats your building cheaper, more effectively, or with more features than your existing heating system. That's a much lower bar. And it's a bar that millions of buildings can clear.

Take the homeowner paying $1,200 a year in propane. If they can heat the same space with electric mining infrastructure, paying a similar amount in electricity, avoiding periodic propane tank fill ups, and pull in $600 to $700 a year in Bitcoin rewards on top of it, the calculus is obvious. It may not be as obvious for someone already on cheap piped natural gas with a new furnace and expensive electricity: the spread matters, and the math has to work in your specific building. We'll go deep on that math. But here's the point: millions of buildings are poised to clear this bar. The principle, miners as building infrastructure, applies everywhere.

The larger implication: if miners become useful building infrastructure at scale, if they become as standard as heat pumps or solar inverters, a significant percentage of global hashrate may eventually come from buildings rather than data centers. Not because it was mandated or subsidized. Because it made sense for building owners to run them. Decentralized hashrate as a byproduct of distributed heating infrastructure.

The scale is hard to overstate. Nearly a quarter of all global energy consumption goes to space heating and water heating. The entire Bitcoin network runs on a fraction of that. If even a small slice of the world's heating load shifted to hashrate heating, total network hashrate could double, triple, or quadruple. Not from new data centers, but from buildings that were already burning energy to stay warm.

> ***"The question is not whether your miner is profitable. It is whether it is useful. If it heats your building better or cheaper than what you are running now, it is useful. The Bitcoin is the upside."***

The Real Cost of Your Current Energy Stack

Your building is already moving energy. The question is whether you're getting everything out of it. There are three places where most building owners are leaving value on the table. First: as we've already introduced, the heat you're already paying for. Depending on your fuel cost and electricity rate, you may be able to heat cheaper with a miner and earn Bitcoin while you're at it. Second: the solar generation you're giving away. If you have panels, there will be times when you're producing more than the building needs, and a miner can convert that surplus into Bitcoin instead of selling it back to the utility for pennies on the dollar. Third: the profitable mining opportunity you're simply missing. When Bitcoin price runs or network difficulty drops, the economics of mining improve independent of your heating or solar situation, and if you have no miner, that window closes without you.

Each of these leaks is specific to your building. But the goal of a building-integrated miner is the same in every case: maximize the savings and sats flowing into your pocket across all the systems you already have. Heating, solar, and profitable opportunities. That's what makes a building the right place for a miner. Not a data center.

What Your Heating Fuel Is Actually Costing You

Not every building has the same heating system, and not every fuel creates the same energy arbitrage opportunity. But they all share one thing: you're going to keep paying for heat regardless. The furnace runs whether Bitcoin is at $30,000 or $300,000. That demand doesn't care about hashprice. The only question is whether the energy flowing through your building to stay warm could be doing double duty. Here's how the four primary heating fuels rank, from the strongest hashrate heating case to the most challenging:

Electric resistance. The cleanest comparison. You're already paying for electricity to make heat. A miner converts the same electricity to the same heat and earns Bitcoin while it does. The electricity cost is identical. The outcome is not.

If you're on electric resistance heat, you're one integration away from turning your heating bill into a Bitcoin accumulation engine.

Propane. Strong case. Propane is expensive per BTU relative to electricity in most markets and has no grid infrastructure subsidy. Rural properties and off-grid buildings on propane deliveries are paying some of the highest effective heating costs in the country. A miner running on electricity typically produces heat at a similar effective cost per BTU than propane, and earns Bitcoin while it does.

Heating oil. Similar to propane. Heavily regional, concentrated in the Northeast US. High per-BTU cost, delivery-dependent, volatile price. The hashrate heating case is strong wherever stored fuels are the primary heat source.

Heat pumps. Increasingly popular and worth taking seriously. They run on electricity like a miner, but move heat rather than generate it, making them highly efficient in mild climates and less so in the cold. They're expensive to install and mechanically complex. Whether hashrate heat beats a heat pump depends on your electricity rate, your climate, and the system's efficiency rating. In Part 3 we show how to normalize all heating fuels, including heat pumps, to the same unit: effective cost per kWh of delivered heat, with the Bitcoin rebate factored in. Don't assume the heat pump wins. Model it.

Natural gas. The most nuanced case. Piped natural gas is the cheapest heating fuel per BTU in most North American markets. For a building on cheap piped gas with no solar to offset electric costs, the hashrate heating case is weakest on pure cost terms. However: a building owner who has solar may find that hashrate heat offset by Bitcoin earnings, competes with or beats natural gas. Don't rule it out. Model it.

> ***"Your electric resistance heater already costs the same to run as a miner. One of them pays you back. Why are you still running the other one?"***

If You Have Solar, There's a Second Leak

If you heat with fuel, you've seen the first leak in your energy budget. If you have solar, there's a second one, and it runs on a different schedule.

The heating leak is a winter problem. The solar leak is mostly a summer one. When the sun is high and your panels are producing more than the building needs, that excess power has to go somewhere. You can't tell the sun to stop. So it flows out through your meter and onto the grid, and your utility pays you for it, usually somewhere between one and eight cents per kilowatt-hour. The same utility charges you twelve to eighteen cents to buy it back. You're selling a dollar for pennies, on repeat, every sunny afternoon.

There's a second problem with net metering credits that rarely gets discussed: they're credits, not cash. Excess production gets banked against future consumption. The money never leaves the utility's account and can only be spent on future electricity bills. Bitcoin earned from a miner running on that same excess power is liquid: spendable, holdable, yours immediately.

A miner absorbs your excess solar export before it leaves your building and converts it to Bitcoin at hashprice. The heating season and solar season can overlap depending on your climate. Spring and fall are often both. But even where they don't, a miner earns its place twice: once in winter against your heating bill, and again in summer against your solar credits. That's two jobs, one box.

> ***"If you are selling excess solar back to the grid for four cents a kilowatt-hour while paying twelve cents to buy it back, what exactly is the solar deal you made?"***

The Third Leak: Profitable Mining on Your Utility Rate

Heating economics and solar monetization are the two most useful reasons to run a miner in a building. But the third one is obvious: sometimes mining is simply profitable on a standard consumer electricity rate, full stop.

This happens for a few reasons. Time-of-use billing gives you cheap off-peak electricity: nights, weekends, shoulder periods where the math on mining can flip positive even without a heat benefit. Bitcoin price runs up, hashprice follows, and suddenly your utility rate is below the breakeven threshold. Large miners shut off when margins compress, network hashrate drops, difficulty adjusts, and the remaining miners, including the one in your building, earn more per terahash. Any one of these conditions can open a window. Often more than one hits at the same time.

The point isn't that your building will be a consistently profitable mining operation. The point is that those windows open, and when they do, you want a miner running. A hashrate heating system or solar monetization setup that can also recognize a profitable mining opportunity and act on it is a fundamentally more valuable piece of infrastructure than one that only runs when the heat is needed. One device. Three economic drivers. The building that has the miner captures all three. The building that doesn't captures none.

> ***"The profitable mining window will open. The only question is whether you have a miner when it does."***

Your Energy Bills as a Bitcoin Accumulation Opportunity

Three leaks. Three economic drivers. One device that solves all of them.

The heat is going to be purchased regardless. The only question is whether you're earning Bitcoin while you buy it. The sun isn't going to stop producing excess power. The only question is whether it flows into your wallet or your utility's ledger. And the grid will periodically deliver electricity cheap enough to mine profitably. The only question is whether you have a miner running when it does.

A single, well-designed and properly integrated Bitcoin mining system captures all three. Not three separate systems with three separate budgets. One system, sized for your building, integrated into your energy infrastructure, and controlled by logic that knows the difference between each situation: when to run hot and keep the heat inside, when to run full and dump the heat outside, when to throttle back, and when to chase profit. Heat mode. Solar mode. Mining mode. The building's control system makes those decisions in real time, continuously, the same way a hybrid electric car decides when to run the engine and when to run the battery.

The energy budget doesn't change. The outcome does.

Framework: The Useful Miner Principle

Profitability vs. Utility: A Different Question

Industrial mining asks one question: does revenue exceed operating cost? That's the right question for a data center. It's the wrong question for a building.

The industrial miner has no fallback. If hashprice drops below operating cost, it shuts off. It has no alternative use for its electricity, no building that needs its heat, no energy system it's already embedded in. Profitability is the only lens.

You have a different lens: utility. A miner is useful to your building when it does something your building already needs: cheaper heat, captured solar surplus, opportunistic profit when conditions align. A useful miner doesn't need to win on mining economics alone, because its value isn't only measured in Bitcoin earned. It's measured against the alternative: the heating bill you kept paying, the solar credits that never became real money, the profitable windows that opened and closed without you. The right question is never "is this miner profitable?" It's "is this miner more useful than what I'm doing now?"

For many buildings, the answer is a clear yes.

> ***"You do not need a profitable mining operation. You need a useful one. Those are different questions with very different answers."***

Two Reasons to Run a Miner in a Building, and Why Both Matter

Utility-driven: the miner as building infrastructure.

The three energy leaks above are all utility arguments. Cheaper heat. Captured solar. Opportunistic profit when the grid is cheap and hashprice is favorable. In each case, the miner earns its place not by being the most profitable mining operation in the world, but by being more useful than what the building was already doing.

This puts a building-integrated miner in the same category as a solar inverter, a battery bank, or a smart thermostat: useful building technology that pays for itself through the energy system it's already embedded in. And it has a profound implication for Bitcoin's long-term security that the "security budget" doomers consistently miss: a miner that lives in a building because it's *useful* cannot be turned off by a halving. It doesn't shut down when hashprice drops, because it was never running on hashprice alone. It was running because the building needed heat, or had excess solar, or had cheap electricity at 2am. The fee market projections and price-must-go-up arguments assume that mining is exclusively profit-driven. Building-integrated mining breaks that assumption entirely. If even a fraction of global heating load runs on hashrate, Bitcoin's security becomes structurally resilient in a way no data center model can replicate.

What makes this possible now, and specifically with Bitcoin, is the nature of the protocol itself.

Bitcoin mining is not a service. It's not a platform. There's no company you depend on to facilitate the relationship between your building and the network. You plug in a miner, point it at a pool, and the protocol pays you automatically and proportionally to your contributed hashrate. No middleman. No account approval. No revenue share negotiation. The payment mechanism is the network itself.

Because the underlying software is open source, anyone can build systems optimized for exactly this use case. A mining controller designed for building energy integration, one that speaks to your thermostat, reads your solar inverter, and responds to your utility's time-of-use pricing, doesn't require permission from a chip manufacturer or a mining company. The protocol is open. The design space is open. We'll go deep on the open-source mining stack later in this playbook, because it's the infrastructure layer that makes all of this scalable beyond early adopters.

And unlike AI or HPC hardware, where GPUs are designed for data centers and require a company to sit between you and useful compute, Bitcoin miners can be built in any size. A system can be sized precisely for your average heating load, your average solar surplus, your building's specific energy profile. There's no minimum. There's no "data center only" constraint. Because Bitcoin is a protocol, the miner is just a device. Sized for your building, plugged into your energy system, paying you automatically in proportion to what it runs. Open protocol, open source, infinitely scalable sizing. That's why this is a building technology moment, not just a mining moment.

Ideology-driven: the miner as direct network participation.

This one is different, and for many of you, it's the most important.

Every sat earned by a building-integrated miner arrives without KYC. No exchange. No ID. No counterparty between you and the network. The miner connects directly to the Bitcoin protocol: you contribute hashrate, the network pays you in proportion, the payment lands in a wallet you control. No middleman touched it. No identity was attached to it. Run your own node and you control which transactions go into your block templates. You participate directly in the settlement of transactions and the issuance of new coins, on your own terms.

You can't buy that on Coinbase. There's no KYC-clean equivalent.

And consider this: somewhere right now, a single ASIC chip is solving a block. One chip, out of millions, winning the lottery and writing the next page of the ledger. Every ten minutes, that happens again. There's no minimum hashrate required. There's no permission to obtain. You point a miner at the network, the network pays you back proportionally, and the coins land directly in your wallet, straight from the coinbase transaction, untouched.

The economics don't even have to fully pencil for this to matter. The incentives can still align, and often do, but you don't need them to. You're running a miner because you believe in the network, and this is the most direct way to participate in it.

> ***"The economics get you to yes. The sovereignty is why you don't look back."***

Who This Works For (and Who It Doesn't)

Strong candidate, heating-led: Significant winter heating bill on propane, heating oil, or electric resistance anywhere. Cold-climate homes with long heating seasons are the most dramatic examples. Also: natural gas with meaningful solar and poor net metering, where solar arbitrage tips the case.

Strong candidate, energy-led: Solar array on a flat or poor net metering rate ($0.01 to $0.08 per kWh). TOU electricity with a significant off-peak discount. Any building with abundant excess generation at a poor export rate.

Strong candidate, sovereignty-led: Bitcoin conviction is itself a meaningful qualifier. A borderline heating case where the reader values non-KYC sat accumulation and network participation often becomes a clear yes when the sovereignty premium is accounted for.

If you own a commercial building: The economics often strengthen at commercial scale. Higher absolute energy costs mean larger absolute savings. Miner hardware is a depreciable capital asset. Heating cost reduction is an operating expense line item. Run the numbers with your accountant alongside your energy manager. The tax treatment changes the payback math meaningfully.

Genuinely poor fit: Cheap piped natural gas, expensive electricity, no solar to offset, mild climate without a long heating season, no Bitcoin conviction. The heating cost is already low, the demand flexibility case is weak, and there's no sovereignty premium to tip the balance. Also: pure mining profit motivation with no building thermal load and no generation to arbitrage. This playbook is not written for you.

What We Have Seen in the Field

The argument above is not theoretical. Four buildings: three homes and a commercial venue, across different climates, integration approaches, and fuel situations. In every case, once a properly sized miner was integrated into the heating system, the same thing happened: the building operator stopped relying on backup heat.

Not because we told them to. Because the miner was keeping up.

2,400 sq ft Colorado home, gas furnace backup. Miner installed as stage 1 on a two-zone thermostat. Approximately 60 consecutive days of winter operation: the gas furnace rarely triggered. Over that entire period it ran for roughly four hours total. The homeowner is accumulating Bitcoin on the same electricity budget that previously just heated the house.

900 sq ft high-efficiency home, three zone heaters plus a garage unit. The building is heated entirely with hashrate through the winter. The gas furnace sits idle. In summer, a garage miner runs on excess solar generation that would otherwise export to the grid at $0.01 per kWh, earning Bitcoin instead of utility credits. The miner is the heating system in winter and the solar monetization engine in summer.

3,966 sq ft mountain home at over 8,000 ft elevation, no gas on site. The backup system is a 40kW electric boiler: electric resistance, same electricity source as the miner. The miner was installed in late April. The boiler has not fired once since installation. The comparison here is the cleanest possible: same electrons, different outcome.

5,250 sq ft commercial venue, three separate HVAC zones. Miners wired as stage 1 across all three zones, including a hydronic radiant floor system fed by a liquid-cooled mining boiler. Gas furnaces available as stage 2; rarely triggered. Outside the heating season, the system reads solar production data and runs the mining boiler in solar arbitrage mode: excess heat dumps through an outdoor dry cooler while Bitcoin accumulates on power the building would otherwise export.

Four installations. Three backup heat fuel types. Three integration approaches. Buildings from 900 to 5,250 square feet. The outcome is consistent: the miner takes the load.

> ***"One miner can sufficiently heat an entire home."***

Each of these installations began with a thermo-economic audit: modeling the building's annual heating and solar loads, economics, fuel displacement, and expected Bitcoin earnings before any hardware was ordered. The field results matched the models. The case studies in Part 3 document each installation in detail.

PART 2

The Tactical Playbook

Is This Right for Your Building?

Nearly every building has a heating load. Even in warm climates, domestic hot water is a year-round demand. That's why this playbook leads with heat: it's the most universal entry point, and often where the math is most dramatic. But the same device that displaces a heating bill also absorbs excess solar, responds to time-of-use pricing, and earns Bitcoin during any hour it runs. If you have heat, solar, cheap off-peak electricity, or any combination of the three, there's a case to model.

The Four Steps to Knowing If This Works for Your Building

Step 1: Define your optimization target. What problem are you trying to solve? Expensive heating fuel you want to replace or offset? Excess solar generation you're giving away to the utility? A time-of-use electricity rate with cheap off-peak windows worth mining through? Some combination of all three? Your answer to this question determines everything that follows: what you size, how you measure success, and what your baseline comparison is. Start here before running any numbers.

Step 2: Understand your average load, not your peak. This is the sizing question, and the most common mistake is sizing to the wrong number. If you have a 300hp car, you don't add a 300hp electric motor to make it a hybrid. You add a motor sized to cover the average driving load: enough to meaningfully reduce fuel consumption without making the car three times more expensive. The same logic applies here. For heating: look at your monthly fuel bills and find the average load across the heating season, not the coldest week of the year. For solar: look at your monthly export totals and find the average surplus, not the sunniest day in July. Bills are the easiest source for existing buildings. For a new building, you'll need to model it. The goal is a miner that runs near full throttle for as many hours as possible, sized to your average load, with your existing system handling the peaks.

Step 3: Establish your new baseline cost. What are you actually trying to beat? For the heating case: if you were to cover your average heat load with electric resistance at your current electricity rate, what would that cost per month? That's your new comparison point: not your old propane bill, but what switching to electric heat would cost before mining revenue enters the picture. For the solar case: if you sent all that excess generation to the grid at your net metering rate, what would those credits actually be worth each month?

That's the deal you're trying to outperform. Knowing this number gives you a clear target: a line the miner's Bitcoin earnings need to cross to make the math work.

Step 4: Calculate duty cycle and close the economics. With your miner sized to the load and your new baseline established, you can now estimate how often the miner actually runs. Duty cycle is the percentage of time the miner operates at meaningful output: the building equivalent of a data center's uptime target. A miner sized to your average heat load or average solar surplus will naturally run at a high duty cycle, which is the goal. From duty cycle, you can estimate monthly Bitcoin earnings: how many hours the miner runs, multiplied by its hashrate and current hashprice. That Bitcoin figure is your rebate against the new electric heating bill, or the earnings you stack on top of what solar credits would have paid. Subtract the rebate from the new baseline cost, and compare that net number to what you were paying before. That comparison is the answer. This is where the economics either close or they don't, and if they don't, it usually means the miner was sized wrong or the duty cycle is too low to generate enough earnings.

> ***"A 20-minute conversation with Exergy and a copy of your last 12 months of utility bills will tell you more than any amount of general research."***

Hardware: Selecting the Right Miner for the Job

In a data center, you optimize for maximum hashrate per dollar. In a building, you optimize for duty cycle, ROI, heat delivery compatibility, and controllability. Those are different problems that lead to different hardware decisions.

The buddy system philosophy. A building-integrated miner is not a replacement for your existing heating system. It's a partner to it: the same way a hybrid car pairs an electric motor with a gas engine. The miner handles your base or average heating load at high duty cycle, earning Bitcoin continuously. Your existing furnace or boiler handles peak demand and serves as backup. Your hybrid car doesn't send its battery state of charge, electric motor torque, and engine load to General Motors, then wait for the manufacturer to send back what the car should do next. It all happens within the car's brain, its ECU. A building-integrated miner works the same way. This matters for sizing: a traditional heating system is relatively cheap to scale up, just burn more fuel. ASIC miners are expensive, high-performance machines. If you sized your miner to cover the coldest day of the year, you might need five 3,000W units, four of which sit near idle for eleven months and only run flat-out during that one week in February when it hits −20°F. That's a terrible use of capital. Size to the average load. Let the existing system handle the extremes. As a side effect, the existing furnace or boiler runs significantly fewer hours: less wear, less maintenance, longer lifespan. The miner takes the base load; the backup system gets a long rest.

The duty cycle imperative. Duty cycle is the most important variable in hardware selection. More hours running equals more Bitcoin earned equals better economics. If your load analysis says you need 6,000W of average heating capacity, you have choices: two 3,000W miners, one 5,000W miner, or other combinations.

A single 5,000W miner may be cheaper upfront, covers slightly less of the total load, but runs closer to full throttle more often: higher duty cycle, better utilization, simpler system. There's no universal right answer. The goal is to find the configuration where the miner runs as much as possible without being so oversized that it sits idle half the time. That balance is the sweet spot.

The ROI framing. Once you know the wattage and configuration you need, the next question is which generation of hardware to buy. In a data center, you always want the newest, most efficient machine: every joule saved goes straight to profit. In a building, that logic breaks down. Because you're offsetting heat or monetizing solar, not racing to be the most efficient miner on the network, older depreciated hardware often delivers better returns. A miner that sold for $5,000 two years ago and trades today at $500 produces the same heat and earns only marginally less Bitcoin than when it was new. At $500 of capital, the payback math is dramatically more favorable. The sweet spot is determined by the machine's efficiency, your specific electricity rate, and your expected duty cycle: not by what's newest. Model it before you buy.

Heat delivery: air-cooled or water-cooled. The final hardware decision is how the heat actually gets into your building. The mining industry calls this "cooling": air-cooled or liquid-cooled, but in a building context, it's really your heat delivery method. Air-cooled miners blow hot air directly into the space, making them a natural fit for forced-air HVAC systems, zone heaters, and in-duct installations. Liquid-cooled miners transfer heat to water, which can then feed a radiant floor system, a hydronic boiler loop, a hot water tank, a pool, or a spa. A liquid-cooled miner can also deliver hot air if you add a fan coil unit or radiator on the water loop, so the two categories are not mutually exclusive. Know what kind of heat your building needs before selecting hardware. One practical note on noise: the loud air-cooled industrial miners you may have seen in data center videos are not what gets specified for residential and commercial building integration. Quiet miners exist. That's a hardware selection decision, not a soundproofing problem. On immersion cooling: it works, but the practical realities are significant. Dielectric oil fitting compatibility is a persistent headache, the oil leaks, and upfront cost is higher than it first appears. Purpose-built liquid-cooled mining appliances now handle this directly. Immersion will become obsolete as the hardware ecosystem matures. One further consideration: miners change form factors frequently, but heating infrastructure is built to last decades. Without open-source reference designs or industry standards for how mining hardware interfaces with building thermal systems, every integration is currently dependent on the manufacturer's choices. That's a real constraint, and a primary reason why the open-source ecosystem covered later in this playbook matters.

> ***"An ASIC miner never becomes an obsolete heater. It may become a less profitable miner. Those are different problems."***

Integration: Five Ways to Put a Miner in a Building

A Bitcoin miner is a smart building appliance: the same category as a solar inverter, a battery controller, a smart thermostat, or a connected heat pump. Like all of those devices, it needs to connect to the rest of your building's energy infrastructure to reach its full potential. Without that connection, a miner is just a heater. With it, the miner becomes a coordinated part of your building's energy system: heating when heat is needed, mining when power is cheap, absorbing solar when the array overproduces, and backing off when conditions call for it.

That coordination requires a building brain: software that reads inputs from every connected device, understands the state of the building in real time, and makes decisions across systems. Most consumer smart home devices solve this by connecting to the manufacturer's cloud. Your Nest thermostat talks to Google's servers. Your Ring camera sends footage offsite. The convenience trade-off is that your home's data lives on someone else's infrastructure.

For Bitcoin mining, that trade-off is particularly misaligned. The whole point of mining is sovereignty: private earnings, no middleman, no identity attached to your sats. Routing your mining activity through a company's server undermines that. The building brain needs to live in the building.

Fortunately, open-source software exists for exactly this purpose. Home Assistant is a free, self-hosted platform that runs locally on a small computer, a Raspberry Pi is sufficient, and connects to thousands of IoT devices and energy systems without sending data outside your walls. Your solar inverter, battery controller, smart thermostat, and utility meter can all connect to Home Assistant. Exergy built the integration that connects Bitcoin miners to Home Assistant as well. Once connected, the miner appears like any other device: you can read its real-time wattage, hashrate, and temperatures, and you can build automations that let it coordinate with everything else in the building. The miner turns on when the thermostat calls for heat. It ramps up when the solar array starts exporting surplus. It throttles back when off-peak rates end. All of it happens locally. The data stays inside your building's walls.

The integration types below describe the physical configurations: how the miner connects to your building's thermal or electrical systems. Home Assistant is what makes them intelligent.

1. Smart Zone Heaters: The Non-Invasive Entry Point

Lower-wattage miners (roughly 150W to 850W) sit in a room and produce heat. Connected via API to Home Assistant, each unit pairs with a wireless temperature sensor. Home Assistant runs a virtual thermostat: when the room drops below setpoint, the miner turns on; when it reaches setpoint, the miner turns off. True thermostatically controlled zone heat that earns Bitcoin.

No licensed trades required. 120V / 15A service sufficient. Each unit serves roughly one room; whole-home coverage requires multiple units. The upgrade path: once running zone heaters, they can be linked to a whole-home thermostat and configured as stage 1. Standalone plug-in heaters become a distributed primary heat source with the central system as backup.

One of our installations took over the effective heating role of a furnace quoted at $10,000+ to replace. The miners handle the load. The furnace replacement has been deferred indefinitely, and the homeowner accumulates Bitcoin while waiting for a bill that keeps not coming.

> ***"You do not need to touch your HVAC system, hire a plumber, or upgrade your electrical panel. You can start one room at a time."***

2. In-Duct Integration: Working with Your Existing Forced Air System

A miner installs inline with the existing return duct. The miner preheats air flowing through the return before it reaches the air handler. When the thermostat calls for stage 1 heat, the miner comes on. If the miner cannot satisfy the setpoint within the staging delay, stage 2 triggers the furnace. The furnace becomes backup. The miner is primary.

Key considerations: requires HVAC trades for duct penetration. The miner should be installed inline with existing ductwork, not as a new return air penetration that disrupts air balance. When the miner runs as primary heat, it runs longer continuous cycles than a furnace. Factor this into maintenance planning.

> ***"If your home has ductwork, you already have an integration point."***

3. Hydronic and Radiant: The High-Performance Configuration

The dominant installation pattern for hydronic hashrate heating is as a buddy system alongside an existing boiler. The mining appliance handles the base heating load; the existing boiler handles peak demand and provides backup. Adding a mining unit requires little more than plumbing in a heat exchanger and a circulator pump.

The plumbing: the mining appliance is plumbed on the return line, upstream of the traditional boiler, so the miner preheats the return water before it reaches the boiler. When the miner is running well and the building's thermal demand is being met, the return water arrives at the boiler already warm. The boiler sees this and stays off. When the building needs more heat, the boiler reads the temperature deficit and fires to top up. If the miner fails entirely, the boiler operates normally. Redundancy is built into the plumbing.

Off-season operation: a dry cooler, an outdoor fan-coil unit, can connect to the hydronic loop via two small wall penetrations. When the building doesn't need heat but conditions favor mining, the miner runs and the dry cooler dumps the heat outside. The building becomes a year-round mining operation.

> ***"Radiant floor heat is considered the most thermally comfortable delivery system available. A miner heating radiant floors earns Bitcoin at the same time. You are not making a trade-off."***

4. Water, Pool, and Spa Applications

The miner's heat transfers to a water volume via a heat exchanger: a domestic hot water tank, a hot tub, or a pool. Hot tubs and domestic hot water tanks are ideal year-round applications: you want hot water regardless of season, which means the miner runs at a high duty cycle through every month of the year.

A 7-foot cedar hot tub at one of our installations has been held at spa temperature by a Bitcoin miner since early 2026. Anyone who has paid a propane or electric bill to heat a hot tub grasps the comparison immediately.

> ***"Someone is heating your hot tub. It might as well be Bitcoin."***

5. Excess Solar and Cheap Power: The Miner as Dispatchable Load

This is a control layer that applies on top of any integration type above. The miner is powered from the standard AC electrical circuit. When the building's AC circuit is receiving more solar generation than it is consuming, Home Assistant detects the surplus and ramps the miner up to absorb it before it leaves the building. When generation drops, the miner throttles back. The miner becomes a programmable load that earns Bitcoin on energy that would otherwise export at a poor rate.

When your utility charges $0.06 per kWh off-peak and hashprice makes mining profitable at that rate, the miner runs. When the grid will pay more per kWh than the Bitcoin network during a demand response event, the miner throttles and you export. A smart system makes that decision in real time.

> ***"In summer, your miner stops being a heater and starts being a solar arbitrage machine."***

Control: Mining as Building Intelligence

How a building-integrated mining system gets configured depends on your heating setup, your goals, and how much control you want. The thermostat configurations and operating modes below are not an exhaustive list: they're the most common patterns we have implemented and the ones that cover the majority of residential and commercial use cases. Your building may combine elements of several.

Three Thermostat Configurations

Configuration 1: No Thermostat Link, Miner System Managed. The simplest configuration, and the most non-invasive. No changes to your existing thermostats or control wiring required. The miner's firmware manages itself by sensing whether heat is actually being extracted. In a hydronic system, for example, if the radiant floor zone valves are closed and the circulator pumps are off, no water is flowing through the building. The miner tries to heat the water, but with nowhere for that heat to go, water temperature rises, the miner senses it and dials back power, eventually dropping to idle until a zone opens and flow resumes. Just a miner plumbed in alongside the boiler, delivering heat when the building is ready to take it: no building brain required. Note: this configuration requires miners with firmware that supports this self-managed operating mode.

Configuration 2: Digital Thermostat, Combined System. This configuration uses a wireless temperature sensor feeding Home Assistant, which runs a virtual thermostat in software. When the space drops below setpoint, Home Assistant turns the miner on. When it reaches setpoint, the miner turns off. No wall thermostat needs to be replaced or rewired. You can add a miner to a garage, a cold room, or any space that currently has no dedicated heating zone: pair it with a cheap wireless sensor and Home Assistant creates a new heating zone from scratch. Additive, non-invasive, and fully controllable from a single interface. One tradeoff: there's no physical dial or wall control. Temperature setpoints are adjusted through the Home Assistant app. For a garage or utility space, that's rarely a problem. For a living space shared with people who expect a wall thermostat, configuration 3 is the better fit.

Configuration 3: Wall Thermostat, Integrated Systems. This is the full integration: the miner responds to the existing wall thermostat so that anyone in the building can set the temperature as normal, without knowing or caring that a Bitcoin miner is delivering the heat. It requires a smart thermostat that connects to Home Assistant (many popular models already do), and one small wiring change: move the furnace's stage 1 heat wire to stage 2 on the thermostat terminal block. This takes about five minutes. Now stage 1 is unwired. Home Assistant fills that gap digitally: when the thermostat sends a stage 1 call, Home Assistant interprets it and fires the miner. As a bonus, Home Assistant can simultaneously trigger the furnace's air handler blower fan to distribute the miner's heat through the existing ductwork, so you don't have to rely on the miner's own fan. If the miner can't satisfy the setpoint within the staging delay, the thermostat escalates to stage 2, and the furnace fires normally as backup. The homeowner experience is identical to before. The heating source is not.

Configuration 4: Combined Heat, Solar, and Profit — Integrated Systems. The configurations above are primarily heat-led: the miner runs when the building needs warmth. This configuration adds the other two economic drivers: excess solar generation and profitable mining conditions. It builds on configuration 3′s wall thermostat integration and layers in additional inputs from the building's solar inverter, utility rate schedule, and real-time Bitcoin network data: hashprice, difficulty, and Bitcoin price, all feeding into Home Assistant simultaneously.

The logic works in both directions. When the thermostat calls for heat, the miner fires as in configuration 3. But when heat is not needed, Home Assistant can still decide to run the miner based on the other inputs: the solar array is overproducing, off-peak rates are in effect, or hashprice has moved favorably. In those cases, the miner runs, but the heat has to go somewhere other than inside the building.

For forced-air systems, this can be a motorized damper that opens an exhaust path to the outside when the miner is running in non-heating mode. For hydronic systems, it's simpler and less invasive: a dedicated loop runs outside to a dry cooler fan coil, essentially a small outdoor radiator. When Home Assistant calls for heat dump mode, it opens the path to that outdoor loop, starts the circulator pump, turns on the dry cooler fan, and fires the miner. Heat exits the building. Bitcoin enters the wallet. The building runs as a year-round mining operation: heating in winter, solar arbitrage in summer, and profit mining whenever conditions favor it.

The Four Operating Modes

A standard heating appliance has one optimization target: maintain setpoint. On when cold, off when warm. It doesn't know what fuel costs, what Bitcoin is worth, or whether your solar array is producing more than you can use. A building-integrated mining system can be configured with a different optimization target entirely. Choose the mode that matches your goals.

Mode 1: Mine to Heat. Your goal is to maximize Bitcoin accumulation during the heating season. The miner is always stage 1 heat: full stop. There will be months when gas is cheaper per BTU, when hashprice dips, when the purely financial case for running the miner over the furnace gets thin. This mode doesn't care. You have decided that when your building needs heat, it will come from a miner. You mine when you heat. You maximize sats while you stay warm. As a side effect, you minimize local fossil fuel combustion. The backup system is there for when the miner can't keep up, not for when gas gets cheap.

Mode 2: Cheapest BTU. Your goal is to minimize total heating cost, dynamically. Home Assistant monitors real-time mining revenue, your current electricity rate, and the cost of your backup fuel. It calculates the cheapest way to produce a BTU at each moment and routes accordingly. When the miner is cheaper, which is most of the time for buildings on expensive fuels, it runs as primary. When gas or propane genuinely undercuts the net cost of electric mining heat, the system shifts. You don't manage it. The building does.

Mode 3: Solar First, Zero Bill Impact. Your goal is to earn Bitcoin without increasing your electric bill at all. The miner only runs on excess solar generation: energy that would otherwise export to the grid at a poor rate. In heating season, the miner runs when the solar array is overproducing and the building needs heat. In summer, the miner runs on surplus solar and dumps heat outside. If there's no excess solar, the miner sits idle. Bitcoin appears in your wallet when the sun produces more than the building needs. Your electric bill doesn't move.

Mode 4: Always On. Your goal is maximum mining output. You have cheap power, abundant solar, or both, and you want the miner running continuously. When the building calls for heat, the miner provides it: the heat is already being made, so it routes inside. When heat is not needed, it dumps outside through a dry cooler. Backup heat fires only when the miner cannot satisfy the load on its own. Every hour the miner runs, it earns. The building is a mining operation that happens to stay warm.

> ***"A conventional thermostat has one job: maintain setpoint. Your mining system knows your fuel costs, the Bitcoin price, your solar production, and the network hashprice, in real time. The thermostat is now the least intelligent device connected to the mechanical room."***

The Open Source Unlock

Everything described in this playbook is possible today. Four instrumented installations prove it. But it requires expertise that isn't yet packaged into a mainstream product, and that's not an accident: it's a structural problem with the current mining hardware industry.

Every miner available today was designed for a data center. The firmware is largely closed-source. No chip manufacturer sells chips directly to appliance builders. Form factors were optimized for rack-mount density, not mechanical room integration or residential acoustics. The hardware is not UL listed for residential installation. Tradesmen cannot be trained on it without significant lead time. One Chinese company controls roughly 90% of mining hardware and firmware. Four pool operators manage roughly 90% of global hashrate. The infrastructure is, at its core, monopolistic in a way that no other electronics category would tolerate.

This is not how mature technology industries work. Intel and AMD publish reference designs not because they want to be in the laptop business, but because open reference designs let any company build products around their chips, and that competition is what produces laptops, servers, embedded controllers, and medical devices. You don't take a used Lamborghini and rebuild it into a family commuter car. You design the commuter car from the ground up, using standardized components you didn't have to invent. You don't reinvent the combustion engine. You don't negotiate with a monopoly to get aluminum. The building blocks exist, they're open, and thousands of companies build on top of them.

Bitcoin mining doesn't yet have those building blocks. The 256 Foundation is building them.

The 256 Foundation is a 501(c)(3) nonprofit with a single mission: dismantle centralized control over Bitcoin mining infrastructure by funding free and open-source hardware, firmware, and software. Every dollar donated passes through directly to developers. Four projects constitute the stack:

Ember One is an open-source hardware reference design for a Bitcoin mining hash board: the component that actually contains the ASIC chips. There has never been one before. Any company, researcher, or builder can take this design, modify it, manufacture it, and build products around it. This is the foundational layer.

Mujina is open-source Bitcoin mining firmware written in Rust: described by its developers as the Linux kernel of Bitcoin mining firmware. Closed-source firmware can be silently updated, can enforce restrictions, can collect operational data, and can be used as a lever of control. Mujina is auditable, forkable, and censorship-resistant. It runs on Ember One hardware and is also compatible with existing commercial miners.

Libre Board is an open-source control board: the brain that connects hash boards, power supplies, networking, and user interfaces. Critically, the Libre Board was explicitly designed to enable hashrate heating integration, solar mining controllers, and Home Assistant connectivity. It can run a full Bitcoin node, a Stratum server, and Home Assistant simultaneously on the same device. This is the piece that makes a building-native miner, one designed from the ground up for a mechanical room, possible.

Hydrapool is open-source mining pool software. All major pools run on closed-source infrastructure. Hydrapool enables anyone to operate a pool, supports direct coinbase payouts with zero custodial risk, and runs a live public instance at the 256 Foundation today.

Together, these four projects constitute a complete open-source mining stack. When they mature, any company can take an ASIC chip, build on top of open hardware reference designs, flash open firmware, and connect to an open pool protocol. The result is not one building-integrated mining product. It's a competitive market of them: products designed specifically for mechanical rooms, for hydronic loops, for solar arrays, for residential electrical standards, for the trades that install them. Miners become an appliance category. What solar inverters are today, standardized, competitive, installable by a licensed electrician, miners can become.

Exergy is building within this ecosystem. Everything we do is designed to be compatible with and to accelerate the open-source stack. This is not altruism. It's the only path to the outcome that makes building-integrated mining mainstream: hardware that any builder can make, software that any developer can improve, and installations that any trades professional can learn.

> ***"Bitmain is not going to build your furnace buddy system. But if chip manufacturers sell directly and open reference designs exist, someone will, and it will be better than anything designed for a data center."***

PART 3

The Economics & Stack Equation

Two Jobs, One Watt

A miner is not a choice between heating a building or earning Bitcoin. It's both simultaneously with the same electricity. One watt enters the miner. Heat exits into the building. Bitcoin exits into the wallet. Both outputs happen in parallel, not in sequence. Nothing about the second output costs extra.

The economic implication: Bitcoin acts as a subsidy on your electricity cost. What you earn mining reduces the net cost of the heat or solar arbitrage you're producing. How large that subsidy is depends on the miner, the current Bitcoin network conditions, and your electricity rate.

The nuance worth establishing: these two outputs are not always weighted equally, and the optimal weighting shifts depending on conditions. Sometimes you want the heat. It's January, the building is cold, and the miner is your primary heat source. Sometimes you want the Bitcoin. It's May, the building is already warm, and you're running the miner on surplus solar anyway. Sometimes you want both, blended. And sometimes economic conditions make the calculus shift mid-season.

> ***"Every conventional heater does one job with each watt it consumes. A miner does two. The second job does not cost extra."***

The Heating Economics

Before committing to a full analysis, run the quick numbers first. The snapshot heating economics compare your current fuel cost against the effective cost of hashrate heat, based on your electricity rate, miner efficiency, and live Bitcoin network conditions, and tell you within minutes whether you're in interesting territory. This is a moment-in-time read: Bitcoin price and network hashrate both move, and both affect what the miner earns. The calculator at calc.exergyheat.com pulls live conditions and lets you adjust those scenario knobs to stresstest different price and hashrate environments. Two variables drive the hashrate heat side of the comparison: your electricity rate, and your miner's efficiency (W/TH/s, also expressed as J/TH). A watt is simply one joule per second, so the two units are interchangeable. Your fuel cost sets the benchmark you're trying to beat. None of these tools are for sizing: they tell you whether the economics make sense, not how many miners you need. For sizing, use the four-step framework in Part 2 or work with Exergy directly.

The Metric That Changes the Comparison: Effective Dollar per kWh

Every heating fuel has a cost per unit: per therm, per gallon, per kWh. Those units are not comparable on their own. To compare your propane bill against hashrate heat, you need a common basis. That basis is cost per kWh of delivered heat.

For traditional fuels, the conversion accounts for combustion efficiency: not all the energy in a gallon of propane makes it into your living space. A typical propane system converts about 90% of its fuel energy to heat. Natural gas at 92%. Heating oil at 85%. Electric resistance at 100%.

Fuel $/kWh = (3,412 / BTU per unit) × ($ per unit) / Efficiency

Example: propane at $3.00/gallon, 90% efficiency:

Fuel $/kWh = (3,412 / 91,500) × $3.00 / 0.90 = $0.124/kWh

For hashrate heat, the same unit applies, but the mining rebate gets subtracted first:

Effective $/kWh = (Daily Electricity Cost − Daily Mining Revenue) / Daily kWh

Example: 3,000W miner at $0.12/kWh electricity, earning $2.50/day in Bitcoin:

Daily cost = 72 kWh × $0.12 = $8.64
Effective $/kWh = ($8.64 − $2.50) / 72 = $0.085/kWh

Compare $0.085 to $0.124. Hashrate heat wins by 31% in this scenario, before factoring in that the Bitcoin earned is liquid money, not a utility credit.

A note worth making clearly: combustion systems remain popular for a reason. Gas and propane can be cheap per BTU, cheap enough that the monthly bill beats electric alternatives in many markets. Hashrate heat doesn't make sense for everyone. What Effective Dollar per kWh lets you do is compare honestly, in the same unit, across all of them. The math tells you which side of that line you're on.

The calculator at calc.exergyheat.com runs this comparison for any fuel, any miner, and live Bitcoin network conditions. Enter your numbers. The comparison is immediate.

The sensitivity hierarchy: what actually moves the needle:

1. **Electricity rate.** The dominant variable. A $0.05/kWh swing can flip the outcome.
2. **Bitcoin price / hashprice.** Revenue scales directly. BTC doubles, rebate doubles.
3. **Miner efficiency (J/TH).** More efficient miners earn more revenue per watt consumed.

4. **Your fuel rate.** Only affects the benchmark you're beating, not the hashrate heat cost.
5. **Network hashrate.** Inversely affects earnings, largely outside your control.

A note on COPe (economic coefficient of performance): the docs at docs.exergyheat.com also document COPe, a derived metric useful specifically for comparing hashrate heat against heat pumps, which are sold on COP. If you're evaluating a heat pump as an alternative, COPe gives you a direct apples-to-apples comparison on the same published standard.

> ***"The question is not what your miner costs to run. It is what your heat costs after the Bitcoin rebate. That number is what you compare to your fuel bill."***

The Solar Economics

The same snapshot logic applies here. Before modeling your full solar surplus and sizing a system around it, run the quick number first: what does each excess kWh earn through a miner, compared to what your utility pays you to export it? This is a moment-in-time read: Bitcoin price and network hashrate both affect what the miner earns per kWh, and both move. The calculator at calc.exergyheat.com pulls live conditions and lets you adjust those scenario knobs to model different environments. On the solar side, only one variable is in your control: miner efficiency (W/TH/s, also expressed as J/TH). The lower it is, the more dollars each kWh of solar produces. Your net metering rate sets the benchmark you're trying to beat. As with the heating calculator, this tool is not for sizing: it tells you whether the solar monetization case makes sense, not how to build the system.

The Solar Mining Rate: One Number, One Comparison

For the heating economics, you're asking: does mining reduce my electricity cost enough to beat my current fuel? For solar, the question is simpler. The electricity is already paid for. The only question is: **what does each excess kWh earn through a miner, versus what the utility pays me to export it?**

One number answers that:

$$\textbf{Solar mining rate (\$/kWh)} = 1000 \times HP / (24 \times E)$$

- **HP** = hashprice ($/TH/s/day), live Bitcoin network economics
- **E** = miner efficiency (W/TH/s, also expressed as J/TH), your miner's wattage divided by its hashrate

To find E for any miner: take its power draw in watts and divide by its hashrate in TH/s. A miner drawing 3,000W at 150 TH/s has an efficiency of 20 W/TH/s. Lower is better.

That's it. 100W of excess solar or 2,000W of excess solar earns at the same rate per kWh. Power level is irrelevant. Grid rate is irrelevant. The only thing that determines how much your excess solar is worth through a miner is how efficient the miner is and what the Bitcoin network is paying.

Compare your solar mining rate to your net metering rate. If it's higher, mining wins.

Example, miner at 20 J/TH, hashprice $0.05/TH/day:

$$\textbf{Solar mining rate} = 1000 \times 0.05 / (24 \times 20) = \$0.104/\text{kWh}$$

If your utility pays $0.04/kWh for exported solar, the miner earns 2.6x more per kWh. The calculator at calc.exergyheat.com pulls live hashprice and runs this comparison with your miner and your net metering rate.

One note on hardware selection for solar: lower J/TH always wins here. When the electricity is free, a more efficient miner earns more per kWh, full stop. This inverts the typical data center hardware logic, where you balance efficiency against upfront cost and total hashrate. For solar monetization, efficiency is the only spec that matters.

How Your Utility Compensates Solar Exports, and Why It Matters

Not all solar deals are equal. Where yours falls determines how obvious the mining comparison is. There are three real structures in the US:

True net metering, the most common US structure. You receive full retail rate credits that roll forward month to month. Summer overproduction offsets winter consumption. The catch: at year-end, any surplus credits beyond your annual consumption are cashed out at a much lower wholesale rate, typically $0.03 to $0.05/kWh. Xcel Energy in Colorado works exactly this way: credits at $0.15/kWh monthly, annual true-up at the wholesale rate. So does most of the Mountain West and Midwest. The system is generous if you right-size to your annual consumption. The moment you over-produce annually, the marginal excess becomes nearly worthless. That's the kWh a miner should be capturing, earning $0.10+/kWh instead of $0.04.

Net billing (avoided cost), the emerging standard. Exports are decoupled from imports from day one. You sell excess to the utility at wholesale/avoided cost ($0.02 to $0.06/kWh) while buying grid power back at full retail ($0.12 to $0.35/kWh). No 1:1 swap, no monthly rollover. Florida utilities and many others have moved here. The math is simple and unfavorable: you're getting 20 to 30 cents on the dollar for every kWh you export. A miner earning $0.10/kWh on that same energy wins clearly.

Time-varying net billing, California NEM 3.0. A variant of net billing where the export rate fluctuates by hour. Midday solar, when panels produce the most, earns the worst export rates ($0.02 to $0.04/kWh), because the grid is already flooded with solar. Evening peak hours earn the best rates, but there's no sun then without battery storage. The perverse result: the hours when solar production is highest are the hours the utility values it least. Running a miner during peak production hours, consuming locally instead of exporting at $0.02/kWh, is the strongest economic case in any utility structure.

The policy trend is one-directional: net metering rates are moving down, not up. California cut dramatically with NEM 3.0. Other states are following. A building mining its excess solar today is hedging against a trajectory that shows no sign of reversing. And even when the dollar-per-kWh comparison is close, mining has one advantage net metering never will: the output is actually money. Net metering credits are utility account entries, they carry no cash value, may expire, and exist at the utility's regulatory discretion. Bitcoin is cashback. Both reward the same behavior. Only one is spendable.

> ***"Net metering credits are utility account entries. Bitcoin is money. Even when the dollar-per-kWh comparison is close, these are not the same thing."***

The Long-Term Tilt

The snapshot economics answer one question: does this make sense today? But building-integrated mining is not a one-day decision. It is infrastructure you are installing for years.

Over long time horizons, two forces tend to move in your favor. Bitcoin's purchasing power has historically appreciated significantly over multi-year periods. A sat earned today from solar or heating is worth more in three years if that trend continues, and the same economic case that looks marginal at today's price may look obvious in retrospect. You are not just monetizing energy. You are accumulating an asset.

The second force cuts the other way on a shorter timeline: network difficulty tends to increase as more hashrate comes online, which reduces what each TH/s earns. But difficulty growth is not linear, and it is bounded by miner profitability, when prices drop, less efficient miners shut off, difficulty adjusts downward, and earnings per TH/s recover. Building-integrated miners, running on displaced heating costs or free solar, are insulated from this pressure in ways data center miners are not.

When you move beyond snapshot economics to a full annual model, the kind that properly sizes a system and estimates total savings, you will need to make assumptions about how these variables evolve. You can model them independently: a BTC price appreciation rate and a network difficulty growth rate. Or you can simplify by making a single assumption about hashprice over time, since hashprice already encodes both. Either approach is valid. The point is to be explicit about the assumptions rather than treating today's snapshot as a permanent number.

Case Studies

Case Study 1: The Colorado Mountain Home

2,396 sq ft · Forced Air HVAC · Natural Gas Backup · Goal: Mine to Heat

Goal. This homeowner runs Mode 1: Mine to Heat. The objective is to maximize Bitcoin accumulation during the heating season, the miner is stage 1 heat, always, and the gas furnace is backup. Even in months where gas might be cheaper per BTU, the miner runs first. Gas exists to top up on the coldest days. This is a sovereignty-led decision as much as an economic one.

Physical setup. A single water-cooled miner sits in the mechanical room. Hot water from the miner circulates to a radiator installed inside the existing furnace return duct. When the miner runs, the furnace air handler blower turns on and pulls cool return air over the hot radiator, converting it to warm air distributed throughout the home exactly as the furnace would. Silent. No noise from the miner. The existing ductwork does the distribution work.

Control. Configuration 3: Wall Thermostat, Integrated Systems. The furnace's stage 1 wire was moved to stage 2 on the thermostat terminal block, a five-minute job. Home Assistant fills the stage 1 gap digitally: when the thermostat calls for heat, HA fires the miner and triggers the air handler blower. If the building can't reach setpoint within the staging delay, or if the gap between actual and target temperature is large, stage 2 triggers, which means the gas furnace flame fires in addition to the miner still running. The homeowner chose this specifically to maximize hashrate uptime even during stage 2 calls.

Sizing. The miner draws approximately 4,000W at full power. The gas furnace it partners with is rated at roughly 10x that output in BTU equivalent. By the buddy system framework, this is intentional, one miner handles the average base load; the furnace handles peaks and backup. The miner is not trying to replace the furnace. It is trying to run as many hours as possible at high duty cycle.

Results. Across 43 days of heating season, the miner handled 98.6% of total heat-on time, approximately 310 hours, with the gas furnace assisting on only 6 days, totaling roughly 4.4 hours. On the coldest days, stage 2 fired briefly to close the gap; every other day, the miner took the full load. Miner runtime tracked closely with outdoor temperature, running longer on cold nights and easing back on milder days. The furnace wasn't eliminated, it did its job as backup when the temperature dropped hard, but it was nearly idle for the season. This validates the sizing methodology: a single properly sized miner can displace the dominant heating load of a 2,400 sq ft home in a cold climate.

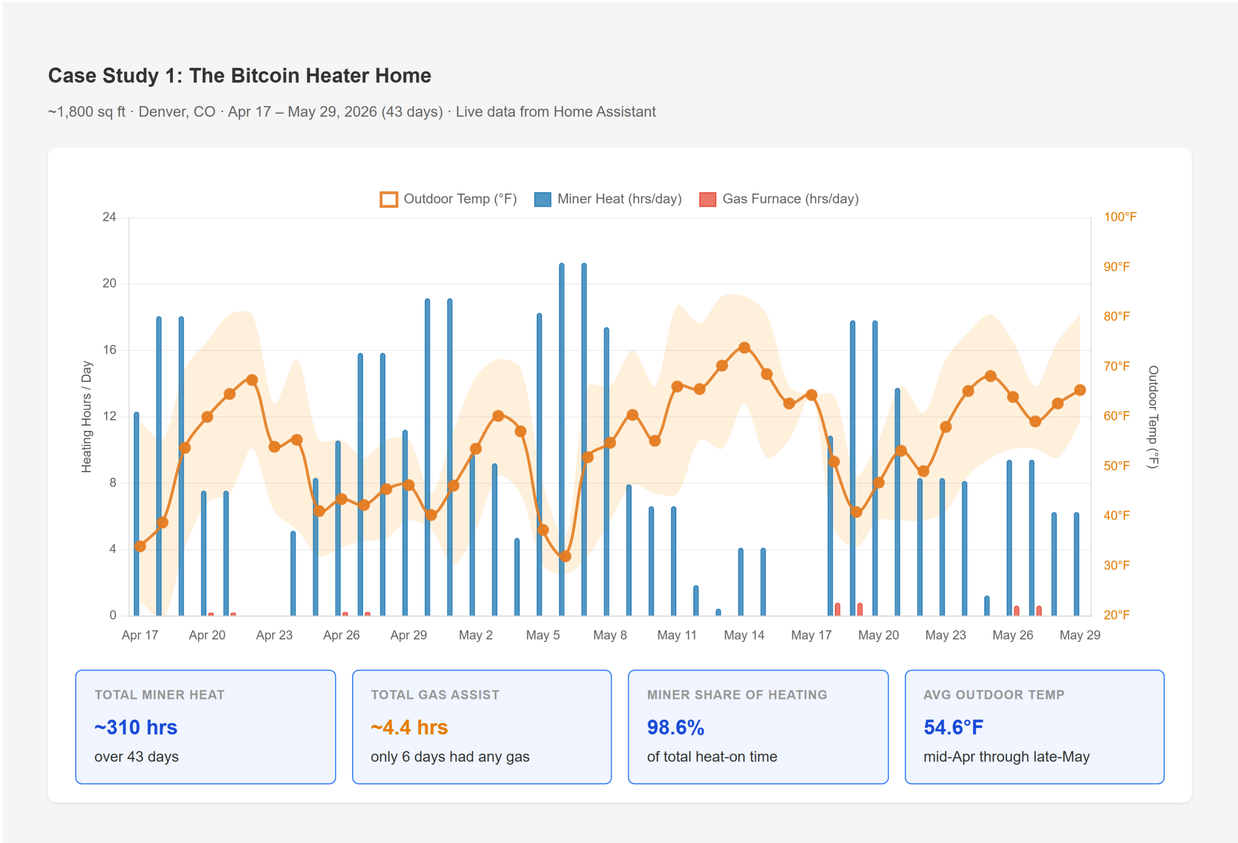


Figure 1: Daily miner-on hours vs. gas-on hours across a full month. Gas line is flat at zero. Miner line tracks with outdoor temperature.

Case Study 2: The All-Electric Mountain Home

3,966 sq ft · Hydronic Radiant Floors · 40kW Electric Boiler · No Gas · No Solar

Goal. Replace electric resistance heat, kilowatt for kilowatt, without increasing the electric bill, and let mining rewards reduce the net cost of heat dramatically. This is the cleanest possible comparison: same electricity source, same delivered heat, different outcome. The question reduces to one number: how much Bitcoin did the miner earn?

Physical setup. Two 3,000W miners sit submerged in an immersion tank filled with dielectric oil. The miners heat the oil directly. A pump circulates that hot oil out of the tank to a heat exchanger installed on the return line of the building's existing radiant floor loop, upstream of the 40kW electric boiler. Heat transfers from the oil into the water loop. That preheated water flows toward the boiler. The boiler senses the incoming water temperature, finds it already warm, and stays off. The radiant floors get their heat from the miners. If the floor zone valves are closed and no water is circulating, meaning the building doesn't need heat, the oil temperature rises in the immersion tank, the miners detect this, dial back wattage, and eventually idle. When a zone calls for heat again, flow resumes and the miners ramp back up.

Control. Configuration 1: No Thermostat Link, Miner System Managed. No Home Assistant necessary. No changes to the building's existing thermostats, wiring, or zone controllers. The entire control logic lives in the miners' firmware. The only installation work was adding the thermal exchange tank to the existing plumbing loop. The building's existing radiant floor control system is completely untouched.

Sizing. 6,000W of mining capacity against a 40kW electric boiler, roughly 7x smaller in power terms. The boiler exists as backup for the coldest days and as insurance if a miner needs service. Day to day, the miners handle the load.

Results. The calculator snapshot tells the story directly. At $0.14/kWh electricity and current network conditions, the 6,000W immersion system produces heat at an effective cost of $0.049/kWh after the mining rebate, a 45% reduction versus straight electric resistance at the same rate. The break-even rate is $0.041/kWh, meaning the system reaches net-zero heating cost at that electricity rate. COPe of 1.83 reflects how this compares against a heat pump on the same delivered-heat basis. The mining subsidy, the share of electricity cost covered by Bitcoin earnings, sits at 45%. No new thermostats, no new wiring, and no contractor beyond a plumber to install the heat exchanger.

CASE STUDY 2

Residential Hashrate Heating

Colorado, US · Custom 6 kW Miner · Compared vs. Electric Resistance

INPUTS	
Power	6,000 W
Hashrate	180 TH/s
Efficiency	33.3 J/TH
Electricity Rate	$0.09/kWh
BTC Price	$73,391
Hashprice	$0.0326/TH/d
Baseline Heat	Resistance @ $0.14/kWh

RESULTS	
Effective Heat Cost True heating cost after subtracting mining revenue from electricity spend	$0.049/kWh
Break-even Rate Electricity rate at which mining fully covers the heating bill	$0.041/kWh
Heating Output	20,472 BTU/h
Savings vs Resistance	+45%
COPe	1.83
Mining Subsidy	45%

Source: calc.exergyheat.com

Figure 2: Calculator screenshot: effective $/kWh of hashrate heat at current network conditions and the building's electricity rate, compared to straight electric resistance.

Data sourced from calc.exergyheat.com

Case Study 3: The Solar Home

900 sq ft · Zone Heaters + Garage Miner · Public Utility · Net Metering at $0.01/kWh

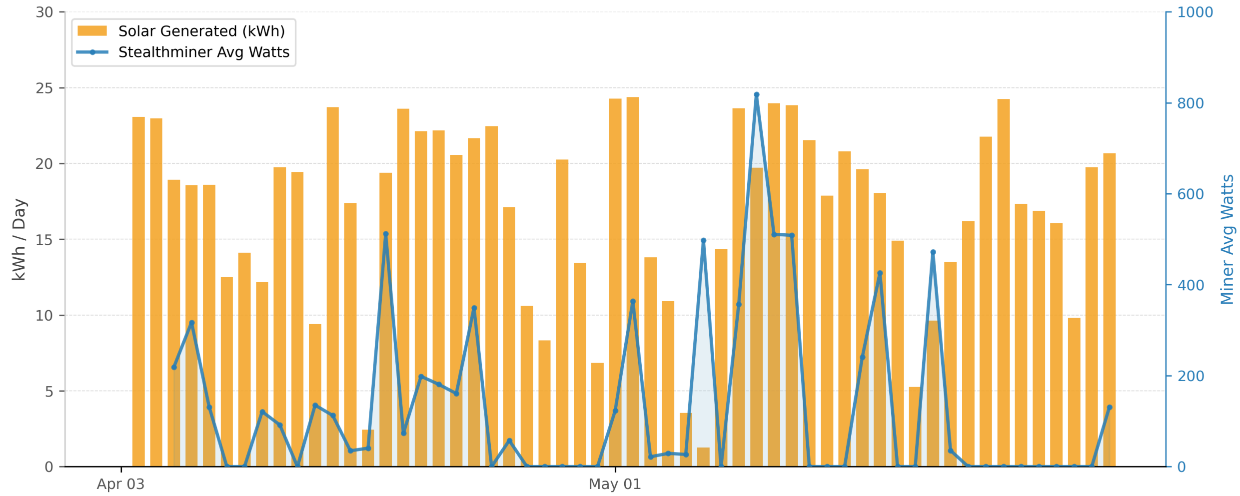
Goal. Extend the life of a failing furnace without a $10,000 replacement, and stop giving excess solar to the utility for a penny a kilowatt-hour. Two problems, one system.

Physical setup. Three 800W mining space heaters are distributed throughout the home, one per primary zone, each paired with a wireless temperature sensor. A fourth miner in the garage is connected to the building's solar inverter via Home Assistant and can dump heat outside through a wall vent when the building doesn't need it, running purely on excess solar generation.

Control. Configuration 2: Digital Thermostat, Combined System. Each space heater is controlled by a virtual thermostat in Home Assistant, fed by its paired wireless sensor. When a zone drops below setpoint, HA turns the miner on. When it reaches setpoint, it turns off. No wall thermostat. Setpoints are managed from the Home Assistant app. The garage miner operates on a separate automation: when the solar inverter reports excess generation above a threshold and there is no active heat call from the indoor zones, the miner powers on and the heat dump vent opens. If the home has a heating demand, the indoor zone miners absorb the solar excess directly by running to meet setpoint, the garage dump miner only activates when there is surplus generation and nowhere inside the building that needs the heat. When solar generation drops, the garage miner throttles back.

Sizing. Three 800W miners total 2,400W of heating capacity across the home. The failing furnace they are supplementing is a standard residential unit, many times larger in rated BTU. Total system cost: approximately $4,000 installed. Furnace replacement quote: $10,000+. The furnace now exists as emergency backup with an indefinite replacement timeline.

Results. Over 57 days, the solar array generated 949 kWh. The chart shows the garage miner activating in response to solar surplus, wattage rising on high-generation days and dropping to zero when clouds or low sun limit production. The same energy that would have earned $6.74 exported to the grid at $0.01/kWh earned $22.24 routed through the miner at current hashprice, a 3.3× improvement per kWh. The furnace did not trigger during the heating season; the indoor zone miners handled the load. The furnace replacement has been deferred indefinitely at a fraction of the $10,000+ replacement cost, and the solar arbitrage runs automatically every day the sun produces more than the building needs.



SOLAR GENERATED	EXPORTED TO GRID	SAME kWh MINING	MINING MULTIPLIER
949 kWh	673 kWh (70%)	$22.24	3.3x
over 57 days	at 0.01/kWh = 6.74	at $0.033/kWh hashprice	more value per exported kWh

Figure 3: Solar PV output overlaid with garage miner wattage: 949 kWh generated over 57 days, 674 kWh exported to grid at $0.01/kWh ($6.74), same kWh through mining worth $22.24, a 3.3× multiplier.

Case Study 4: The Commercial Building

5,250 sq ft Commercial Venue · Three HVAC Zones · Large Solar Array · Commercial TOU Pricing

Goal. Mode 2: Cheapest BTU, in real time, across every energy input the building has. The system knows the cost of gas, the cost of electricity at any hour, the current mining economics, and the state of the solar array. It chooses the cheapest way to produce heat, or dumps heat outside and mines when that's more profitable than any of the alternatives. This is Exergy's demo site: the most fully integrated building we operate, designed to showcase everything simultaneously.

Physical setup. Multiple systems operating in parallel. A 4,000W liquid-cooled Bitcoin boiler heats the building's hydronic radiant floor system, the primary and most comfortable heat delivery method. Three forced-air furnaces each have miners installed in the return duct, with gas as a further backup stage. Bitcoin mining space heaters serve individual offices for zone-level comfort control. A Bitcoin-heated hot tub runs year-round off a dedicated miner. A large rooftop solar array feeds into the building's electrical system. A dry cooler in the backyard connects to the boiler's hydronic loop via two wall penetrations, when the boiler runs but the building doesn't need heat, it pumps to the dry cooler and dumps the heat outside.

Control. Configuration 4: Combined Heat, Solar, and Profit — Integrated Systems. Home Assistant reads: indoor temperature, zone setpoints, solar generation in real time, current TOU electricity rate, current Bitcoin mining economics, and the building's gas cost and furnace efficiency ratings. From these inputs, it calculates the cheapest BTU available at each moment and routes accordingly. Radiant floor heat is prioritized for comfort when the economics are close. Miners in furnaces run as stage 2 heat. Gas furnaces are stage 3, they fire only when they are genuinely the cheapest or when all mining stages fall short of setpoint. During off-peak utility hours overnight, the boiler often runs not for heat but for profit, circulating to the dry cooler and stacking sats while the building sleeps. When peak solar production exceeds building load during the day, the boiler absorbs the surplus and dumps heat outside rather than exporting at net metering rates.

Sizing. The boiler at 4,000W is the single smallest piece of heating equipment in a building with three full-size furnaces. The furnace miners are similarly undersized relative to the furnaces' rated BTU output, intentionally. Gas rarely fires. The economics almost always favor mining thanks to a large solar setup.

Results. The dashboard shows the system in operation: five miners across four zones, each reporting status independently; outdoor temperature and building average feeding the control logic in real time; a mining performance panel tracking pool workers, hashrate, and last share time; and manual override controls for switching between Heat Dump, Max Mining, and Heat Dump Scheduled modes. This is building intelligence operating at a level a conventional thermostat cannot reach, every zone, every input, and every operating mode visible and controllable from a single local interface. The gas furnaces exist in the building but are rarely the cheapest option the system finds. Everything runs on hardware the building owner controls, with no data leaving the local network.

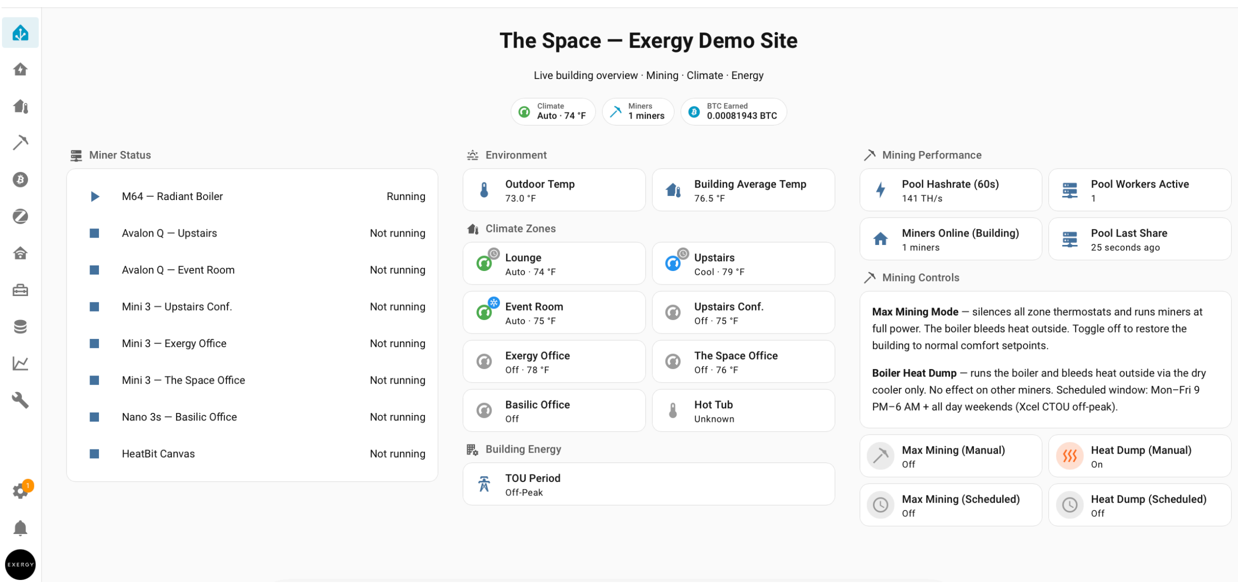


Figure 4: Home Assistant dashboard, The Space Exergy Demo Site, showing all system states in real time: miner status per zone, outdoor temp, building average temperature, solar/mining performance, and operating mode controls.

What the Case Studies Prove

Four buildings. Four different configurations. Four different goals. The same result: a building that heats itself cheaper, earns Bitcoin, and does both autonomously.

The sizing methodology works. A miner sized to the average heating load, not the peak, runs at high duty cycle and handles the dominant share of the building's heat demand. The existing system covers the rest. Across every install, the backup system rarely fired. The buddy system is not a theoretical framework. It is what happened in the field.

Hashrate heat is a viable alternative to conventional equipment upgrades. A $4,000 mining system extended the life of a furnace that would have cost $10,000 to replace. A 6,000W immersion system displaced a 40kW electric boiler. In both cases, the mining system handled the load at a lower effective cost per BTU. If you are facing a heating equipment decision, the comparison belongs in the analysis.

The whole building can be smart at the energy and economics layer, not just the lighting. Home Assistant manages zone temperatures, operating modes, TOU rate response, and solar routing simultaneously. The building makes real-time economic decisions: which fuel is cheapest right now, where is the heat needed, should the excess generation mine or export. This is building intelligence at a level that smart thermostats and connected bulbs do not touch.

That intelligence lives on hardware you own. No cloud dependency. No subscription. No vendor with access to your energy data. The automation logic runs locally, the data stays local, and the system keeps working if the internet goes down.

Every one of these buildings is participating in Bitcoin network security. Each miner contributes hashrate to the global network. The Home Assistant instance running the building's energy automation can also run a Bitcoin node and handle block template construction locally, meaning the building is not just mining, it is participating in how the network operates. Decentralization by default, as a side effect of heating your home.

The aggregate across these four installations: approximately 1.2 PH/s of hashrate added to the Bitcoin network, and more than 0.030 BTC earned, worth over $2,200 at current prices, across the installs to date. None of these systems has been running for a full year. Most were installed between December and April and have not yet completed a full heating season. Four buildings. Not a data center. Not a mining farm. Three homes and a commercial venue that needed to stay warm, and are only getting started.

New Economic Models for Programmable Energy

Every other heating system you could install pays its operating costs in one direction: you pay, it runs. The economics are one-way. A hashrate heating system inverts that. The output is Bitcoin, digital, programmable, internet-native. You can direct it anywhere, split it between parties, automate its destination based on any criteria you choose. No invoice. No ACH transfer. No intermediary. This unlocks economic arrangements that are simply not possible with a gas furnace.

Directed paydown and collateral building. Mining revenue can be automatically routed to pay down a loan on the equipment before it ever touches a spendable wallet. A building owner financing the installation can direct a portion of hashrate earnings toward principal reduction on autopilot. Alternatively, if you carry a Bitcoin-backed loan, that same revenue can flow directly into your collateral position, reducing your liquidation risk in real time while the building heats.

Programmable revenue splits. Because the revenue is digital and the system is internet-connected, different income streams can go to different wallets based on any logic you define. The sats earned from mining on excess solar could pay the wallet of the solar system installer; the sats earned from heating could go to yours. Two systems, two stakeholders, two wallets, no accounting required, no monthly settlement. You could direct 10% of all mining rewards to the installer permanently. You could split rewards across multiple parties by percentage. The customization is essentially unlimited.

The tradesman incentive flip. That 10% to the installer is not just convenient, it changes the entire relationship. The installer now has a passive economic stake in your system staying online. A system that goes down stops paying them. That means they are incentivized to monitor it proactively, catch degraded performance before you notice it, and dispatch a technician before you know there is a problem. Because the system has been paying them continuously, the service call does not come with an invoice. This is a fundamentally different relationship between a building owner and a tradesman than has ever existed. The heating system's ongoing operation funds its own maintenance relationship.

Subsidized hardware, recouped through hashrate. The same logic applies to the hardware itself. A manufacturer or installer can sell equipment below upfront cost and recoup margin over the system's operating life through an agreed hashrate split. The building owner gets a lower barrier to entry. The provider gets a recurring revenue stream, without subscription infrastructure, without billing systems, without collections. The machine pays for itself on both sides of the deal.

Throttleable load means more uptime, lower costs, and more Bitcoin earned. A gas furnace has two states: on and off. Full flame or nothing, the thermostat equivalent of driving with only full throttle and full brake. A Bitcoin miner is throttleable. As a room approaches setpoint, the miner can reduce its wattage output gradually, maintaining temperature within a tight deadband or eliminating the deadband entirely. The building stays at setpoint continuously rather than swinging above and below it. Fewer hard start-stop cycles means less wear on the system, longer equipment lifespan, and lower operating costs. It also means the miner runs more total hours at partial load rather than cycling off completely, which translates directly to more consistent Bitcoin earnings. The same programmability that routes sats to different wallets also controls how many watts the miner draws at any given moment. This is also what makes precise solar absorption possible: the miner can throttle its wattage in real time to match exactly how much excess generation the solar array is producing, not all-or-nothing, but exactly the surplus, so nothing gets exported to the utility at a loss.

> ***"Your heating system has never had an API. This one does."***

The Sovereign Smart Home

Money and privacy belong together. Every financial system that has ever failed its users, frozen accounts, seized assets, surveilled transactions, failed because the users had no alternative. Bitcoin exists to be that alternative. But acquiring Bitcoin privately is only the first layer. A fully integrated hashrate heating system extends sovereignty across four layers simultaneously.

Money. Pool mining is one of the few remaining ways to acquire Bitcoin without an institution in the middle. No exchange account. No identity verification. No counterparty with jurisdiction over your funds. No reporting obligation before the coins are yours. Your building earns it. It goes directly to your wallet. That's the complete chain of custody. For anyone who takes financial privacy seriously, and you should, that is worth something the heating economics alone don't capture.

Energy. Your building generates or purchases electricity, runs it through a productive asset, and captures both thermal and economic value locally. The economics stay inside your building.

Heat. Your heating system is no longer dependent on a commodity supply chain. No propane delivery trucks. No gas utility. No fuel price exposure.

Information. The automation logic that controls your miner, when it heats, when it switches modes, when it responds to solar production, runs on Home Assistant, open-source software on hardware you own. Your building's temperature data, energy flows, and operational state live on your local network. You choose what, if anything, leaves it.

> ***"Acquiring Bitcoin privately is the first layer. A fully integrated system achieves sovereignty at four: money, energy, heat, and information."***

PART 4

Resources & Next Steps

Implementation Checklist

Nothing in this playbook requires proprietary software, closed hardware, or a vendor you have to stay dependent on. The Home Assistant integrations for adding miners to a building control system are open source. The documentation is public. A capable DIYer can build what the case studies describe from scratch using those resources alone.

What follows is the process Exergy uses on every install, the same sequence whether it's a single space heater in a spare bedroom or a multi-zone commercial integration. If you want to work through it yourself, this is the map. If you want Exergy to do it with you or for you, we'll cover that at the end of this section.

Phase 1: Assessment

Phase 1 is your economic go/no-go. Determine whether the math works for your building before you think about hardware.

Step 1: Identify your goal. Are you trying to displace heating costs, monetize excess solar generation, or both? Your goal determines which economics to run and which integration to prioritize.

Step 2: Understand your utility costs. Pull your electricity bills and your heating fuel bills. For electricity: identify your rate structure, flat rate, TOU schedules, demand charges, net metering terms, delivery fees. For heating fuel: calculate your annual spend and cost per unit (gallon, therm, kWh). If you have solar, pull 12 months of generation data and confirm your net metering agreement terms. This is the baseline the mining economics will be compared against.

Step 3: Run the energy arbitrage calculation. Use the calculator at calc.exergyheat.com for a snapshot assessment. Does your effective heating cost after mining revenue beat your current fuel cost? Does your solar export rate lose to hashprice? If the math works, move to Phase 2. If it doesn't, the building may not be a fit at current economics, or the goal needs to be reframed.

Phase 2: Sizing, Selection, and Procurement

Phase 2 is about designing the right system for your building before you order anything.

Step 1: Load assessment and sizing. Run a heat load or excess solar generation assessment for the year. Use this to determine the target wattage for a miner that achieves a high duty cycle against your average load, not sized to the peak, not undersized for the average. This is where the buddy system sizing philosophy from Part 2 gets applied to your specific building.

Step 2: Confirm electrical service capacity. Now that you know your target wattage, confirm your main panel can support it. If a panel upgrade is required, factor that cost into the economics before proceeding. Do this before selecting hardware, not after.

Step 3: Assess physical fit. Identify your heating system type (forced air, hydronic, electric resistance, other) and map where a miner can integrate. Determine which cooling type (air-cooled, water-cooled, immersion) is compatible with your integration path and space constraints.

Step 4: Select your control solution. Your existing heating system often points toward the right answer. A hydronic boiler with dumb zone valve thermostats has no smart control layer to integrate with, firmware-managed control is the natural fit. A forced-air system with a conventional thermostat is a candidate for wall thermostat integration. A building with an existing Home Assistant setup or a solar array to coordinate is a candidate for full building integration. The options are firmware-managed, standalone digital thermostat, and full Home Assistant integration. Your physical setup narrows the field before you choose.

Step 5: Select your mining system. Choose hardware that matches your target wattage, cooling type, and control solution requirements. Open firmware is strongly preferred. Confirm noise level is appropriate for your installation location or if miner modification is required.

Step 6: Select integration components. Depending on your integration type: heat exchanger, circulating pump, expansion tank, radiator for in-duct, new thermostats with API support, dry cooler for year-round operation. These are determined by the miner and integration path selected in Steps 3-5.

Step 7: Order components.

Phase 3: Installation and Commissioning

Step 1: Electrical work. Dedicated circuit(s) sized to miner load. Licensed electrician required. While trades are on site: run any new thermostat wiring and rough in sensor locations. This is the time to do it, before walls are closed and the miner is mounted.

Step 2: Network access. Confirm ethernet or reliable WiFi reaches the mechanical room or wherever the miner will live. This step gets skipped and then causes a second trip into the walls. Do it before the miner goes in.

Step 3: Thermal integration. Plumb the miner into the existing heating system, heat exchanger, circulating pump, tank, and associated plumbing for hydronic; radiator and duct work for forced air. If solar integration requires a dry cooler or heat dump, install that now. Licensed plumber for hydronic; HVAC contractor for duct work. Pressure test and confirm no leaks before the miner powers on.

Step 4: Mount and physically install the miner. With electrical, network, and thermal connections ready, mount the miner in its final position and make all connections.

Step 5: Install auxiliary sensors and thermostats. Mount temperature sensors, flow sensors, and any new smart thermostats with API support. Complete the wiring runs roughed in during Step 1.

Step 6: Configure miner firmware and connect to pool. Set pool credentials, power limits, and thermal targets in the miner firmware. Confirm the pool sees hashrate before moving on.

Step 7: Connect sensors and miners to Home Assistant. Add all devices to Home Assistant. Confirm all sensors are reporting and the miner is controllable from HA.

Step 8: Configure automations and dashboards. Define linked devices, set up operating mode automations, configure any virtual thermostats, and build dashboards for monitoring.

Step 9: Commission and test.

- *Functional test:* Does the miner power on? Does the pool confirm hashrate? Does heat reach the distribution point, air out of the duct, warm water in the loop, setpoint achieved in the zone?
- *Control logic test:* Manually trigger each automation and each operating mode. Confirm the system responds correctly to every condition: heat call, solar surplus, TOU rate change, backup stage trigger. Both tests must pass before the system is live.

Phase 4: Ongoing Monitoring

Once the system is commissioned, what you build on top of it is up to you. Home Assistant supports alerts, notifications, automated reports, and custom dashboards, there is no prescribed process here. Common examples: an alert that fires if a pump is running but the miner is reporting zero hashrate (possible miner failure); a daily log of electricity consumed multiplied by your known rate, compared against Bitcoin accumulated; maintenance reminders; automated pool payout notifications. The system is yours. Build whatever visibility makes sense for how you want to run it.

System Components: What You Need and What to Look For

This section is not a shopping list. It is a map of the building blocks. Every installation is different, the components you need depend on your integration type, control configuration, and existing systems. What every component has in common: a public API or a supported integration. A system you cannot read is a system you cannot control.

Miner hardware. Look for a miner with a public API that exposes hashrate, power draw, and chip temperatures and accepts commands for wattage control. Open firmware is strongly preferred, it enables the throttling and sleep state behavior that makes building integration work. A sleep state matters: you want the miner to idle gracefully when heat is not needed, not get power-cycled like a bang-bang appliance. Match power draw to your target thermal output from Phase 2 sizing. Noise level matters for mechanical rooms in occupied buildings.

Thermal integration components. Size these for the actual thermal job, not just the wattage rating. Heat transfer rates, temperature delta across the exchanger, and flow rates all affect how effectively miner heat reaches the building. For forced-air integrations, account for any vacuum or pressure changes introduced by new penetrations on the return or exhaust side of the duct. For hydronic systems in cold climates, use inhibited propylene glycol, not plain water, to protect the loop from freezing. For immersion systems, verify dielectric oil spec for heat transfer efficiency. Work with a licensed mechanical contractor who understands non-standard heat sources.

Relays, failsafes, and safety components. This category gets skipped and shouldn't. Mixing valves prevent excessively hot water from reaching the loop. Automatic dampers open and close on command, or on a failure signal, to control airflow and prevent heat buildup. Expansion tanks handle pressure changes from thermal cycling. High-temperature cutoffs protect the miner if flow stops. These components protect the miner, the building system, and the building itself. Design them in from the start, not as an afterthought.

Electrical infrastructure. Dedicated circuits sized to miner load. Proper grounding. If the miner is installed near hydronic plumbing or in a potentially wet location, GFCI protection is required. A small UPS on the Home Assistant server keeps automation logic running through power events, if the building brain loses power, the miner operates without oversight until it comes back.

Control and sensing layer. You may need new thermostats even if you already have them, ones with a second stage terminal or a Home Assistant integration. Auxiliary sensors throughout the system (temperature at multiple points, flow rate, pressure) feed automation logic and enable failsafe conditions. A solar inverter with a public API or native Home Assistant integration is required for Solar First mode. Same for any battery management system: it needs to expose real-time state of charge and charge/discharge rate to HA for the automation to make correct decisions.

Automation logic. A few rules that must be explicit in every multi-zone or solar install: heating and cooling must not run simultaneously, if the miner is sending heat through the air handler, the AC compressor must be locked out. Interior heat demand always trumps heat dump or heat bleed, if a zone is calling for heat, that load takes priority over solar absorption or off-peak mining. Build these as explicit conditions in every relevant automation, not assumptions.

Mining pool. Prefer a pool that does not require identity verification to create an account. Look for direct-to-wallet payouts with no custodial holding period. Lightning Network payout support is worth prioritizing for smaller building-scale miners, consistent small payouts rather than waiting to accumulate a threshold on-chain. Transparent fee structure. Open-source pool software is the direction the ecosystem is moving. Peer-to-peer pool protocols like P2Pool V2 are also in development, aiming to offer proportional mining rewards to small miners without any central pool coordination.

Regulatory and Tax Considerations

The One Input, Two Outputs Problem

This system presents a classification question that tax law has not fully settled: you are running an electric heating system, and Bitcoin shows up as a byproduct. How should that be treated? Is Bitcoin earned as a byproduct of building heating treated identically to Bitcoin earned by a purpose-built mining operation?

We are not tax advisors. Consult a tax professional who has specific experience with Bitcoin mining income, not a general CPA who "also does crypto."

What is clear: Bitcoin received through pool mining is generally treated as income at fair market value on the date of receipt for US taxpayers. What remains unsettled is the deductibility of expenses in a dual-use scenario.

For commercial buildings: miner hardware may be depreciable as a capital asset, and heating cost savings may be treatable as OpEx reduction. Raise this explicitly with your accountant.

Permitting, Insurance, and What's Still Being Figured Out

Most residential installs fall under existing electrical permitting frameworks: you are adding a large electrical load, which has a well-worn process. Utilities are accustomed to load additions. HOAs, if relevant, are best addressed with accurate framing, "electric heating system", rather than leading with Bitcoin.

Warranty impact on existing equipment. Integrating a miner into an existing heating system may affect the warranty on that equipment. A forced-air air handler running its blower fan seven hours a day instead of fifteen minutes per hour is operating at a duty cycle it was not designed for. A hydronic boiler that rarely fires because a miner pre-heats the loop is a different scenario than one that cycles normally. These are real considerations. Discuss them explicitly with your HVAC or mechanical contractor before integrating.

Insurance. Adding mining hardware to a building changes the electrical load and introduces equipment that insurers may not have a category for. Inform your insurer. The conversation centers on electrical load, fire risk, and proper licensed installation, all addressable. What makes it harder: Bitcoin mining hardware currently carries no UL or CE safety certifications. That gap is a real obstacle to mainstream building integration and to the insurance conversations that come with it.

The ecosystem working on this. Two organizations are directly addressing the gaps above:

Heatpunks is the practitioner community for the hashrate heating sector, builders, researchers, and installers working on hydronics, hybrid HVAC, safety standards, and building code pathways. They produce open-source tools, educational content, and run an annual summit. If you are installing or building in this space and want to connect with the people doing the same work, this is where that community lives.

The 256 Foundation is a 501(c)(3) nonprofit funding the open-source technical stack that hashrate heating depends on: open hashboard reference designs, open Linux-based mining firmware, open control boards, and open pool software. Their goal is to break the current reality, one manufacturer controlling the majority of mining hardware and firmware, and replace it with open alternatives that can be audited, modified, and built upon. Building-grade hashrate heating at scale requires this stack to exist. The Foundation is building it.

These are the two institutional layers the sector needs: open technical infrastructure and a practitioner community that knows how to apply it. Both are early. Both are necessary.

How to Work with Exergy

Every part of this is open. The Home Assistant integrations are open source. The documentation is public at docs.exergyheat.com. The support forum is open at support.exergyheat.com. A capable DIYer can build this system from scratch using those resources. That is not a problem. It is the point.

What Exergy offers is expertise and execution for the people who want it:

Full-service installation. We design the system, source the hardware, coordinate subcontractors, do the installation, configure the controls, and get it running. You get a working system without managing a project.

Hardware plus consulting. You do the installation. We design the system, source the hardware, and support you remotely through the process. For technically capable owners outside our service area.

DIY with open-source resources. Start at docs.exergyheat.com. Run the calculator at calc.exergyheat.com. Post questions at support.exergyheat.com. Free office hours once a week, open to anyone.

How to Get Started

1. **Run your numbers:** calc.exergyheat.com. Takes 90 seconds. Tells you whether this makes sense for your building before you talk to anyone.
2. **Read the documentation:** docs.exergyheat.com. Open-source integration documentation, component guides, and configuration references.
3. **Ask a question:** support.exergyheat.com. Community forum. Open to anyone.
4. **Attend office hours:** Free, weekly. Show up, ask anything.
5. **Schedule an introduction call:** If you want to talk through your specific building, this is where it starts. Reach out at exergyheat.com

Go Deeper

forum.heatpunks.org, The central gathering place for the hashrate heating industry: hardware developers, HVAC contractors, electricians, miners, and business builders working through the full technical and practical stack. Covers ASIC hardware, firmware, control systems, thermal and electrical management, every integration type from space heaters to hydronic radiant floors, and dedicated tracks for business economics, skilled trades, and legal and regulatory questions. If you are installing a system, building a business around hashrate heating, or just trying to understand how to do this right, this is the community doing that work in public.

forum.256foundation.org, The community hub for the 256 Foundation's open-source mining stack. Discussions are organized around the Foundation's core projects: open firmware, open hashboard reference design, open control board, and self-hostable open mining pool. This is where the open ecosystem gets built in public, for developers, technically sophisticated installers, and anyone who wants full sovereignty over their mining stack without proprietary firmware fees or closed hardware. Fork it, build it, hack it.

> ***The math is specific to your building. Run it.***