CoolBot®

How to Build a CoolBot Powered Cheese Cave

Introduction

For small dairy farmers and cheese makers, cold storage can mean the difference between profitability and losing time, labor, and money. Dairy products need to be kept cool; no one wants to find that their product has gone bad due to faulty refrigeration.

Cold storage enables you to store your cheese and allow it to age until you've got a perfect gouda or an extra funky blue cheese.

This guide teaches you everything you need to know to build your own walk-in cooler from scratch using a CoolBot temperature controller and an air conditioner.

Here's what you'll learn:

- What it costs to build your own CoolBot-powered walk-in cooler
- Where on your property to put your cooler
- How to insulate a room
- How to seal your cooler
- How to hook up electricity and lighting How
- to select the right air conditioner
- How to install your air conditioner
- How to install your CoolBot

How Much You'll Save with a CoolBot-Powered Walk-In Cooler

The CoolBot makes cold storage accessible for farms of all sizes. Depending on the size, a traditional walk-in cooler can cost between $6,000 and $10,000. In addition to this upfront cost, you also need to consider the operating costs (energy) and service, which usually requires a specially trained technician.

In contrast, the CoolBot provides a solution that's not only more affordable upfront, but also saves you money over the long run.

Our customers on average spend about $3,000 in total building their walk-in coolers.

That **$3,000** includes all equipment and insulation. For additional savings, many fromagers repurpose lumber and insulation, which allows them to build their cooler for less than $1,000.

And the savings don't stop there. Since it uses roughly 40% less energy than a traditional cooler, the CoolBot continues to save you money every month. And you'll never need to call a maintenance technician. Our customer support team is available to help you by phone and email to solve any problems that might arise.

The chart below shows the economic advantages of a CoolBot over a traditional system.

	CoolBot + 18K BTU A/C	Traditional Walk-in Cooler Refrigeration System	Savings
Refrigeration Unit Upfront Cost[1]	CoolBot $349 18K BTU window A/C $559 Total: $908	Top-mount self-contained refrigeration unit (1.5 HP) $3,140	**$2,252 (72%)**
Installation[2]	Designed for easy installation by end users	Requires expensive professional installation	**$1,500**
Operating Costs[3]	Uses up to 42% less energy compared to a traditional walk-in cooler refrigeration system		**Potentially $100s per year**
Service	Customer support team available by phone and email	At least $150 to have a refrigeration technician take a look; potentially more expensive to resolve any issues	**Potentially $100s per year**

Notes:

1. 18K BTU LG air conditioner available on Store It Cold website
2. Quote in Denver, Colorado for a standard walk-in cooler refrigeration system installation [quote received on 5/17/2016]
3. 41.7% energy savings when comparing a CoolBot-driven system versus a conventional refrigeration system for a simulated cooler. The simulated cooler was 250 square feet, located in Albany, and set at 41 degrees Fahrenheit. See page 13 of the NYSERDA report: Evaluation of the CoolBot Low-Cost Walk-In Cooler Concept

You need three things to build your walk-in cooler:

- A well-insulated room
- An air conditioner
- A CoolBot

The rest of this guide provides details about these three key components.

Where Should You Put Your Walk-In Cooler?

Choosing the location is one of your cooler is the most important decisions you will make. This is especially true if you live in a hot climate.

Just like you're more comfortable in the shade during the middle of summer, your cooler is much happier out of direct sunlight. This is critical for energy savings. Coolers in direct sunlight require approximately 70% more electricity than coolers in the shade.

For the most efficient performance set up your cheese cave in a protected area:

- Inside an existing building (best!)
- On the north side of a barn or shed
- Under an overhang on an existing structure

If you are considering building your cheese cave outside, consider the length of time you will need to age your cheeses and your climate during the winter. If you live in a climate that gets below your desired cooler temperature or below freezing, you can still use the CoolBot, but you will need to place a pass-through thermostat and small heater in your cooler. The heater will further reduce the humidity in the cooler and you will need to take measures to counteract this. If you have the option to keep your cheese cave indoors, we highly recommend it

If you build an overhang for your cooler, be sure to build an openly vented roof that keeps the sun off the insulated ceiling of the cooler.

Flat roofs on a small cooler may still be structurally sound in wind, rain, and snow loads, but they don't protect from sun exposure. Building a standard peaked roof with ventilation over the insulated cooler ceiling will shade the cooler and provide passive ventilation that will keep air circulating over your cooler and help you save money on cooling costs..

**Note: Heat rises, which is why in a house we put twice as much insulation on the roof as the walls. Cold air sinks, so if you keep your cooler roof out of direct sunlight, you can put the same insulation in the roof as you did in the walls. This will save you money in both upfront construction and long-term operating costs

Insulation

Insulation helps you keep both your cooler temperature and your electricity bill down. Insulation is measured by its **R-value**, which tells you the capacity of the insulation to resist heat. The higher the value, the more effective the insulation.

The industry standard for walk-in coolers is R25. Going up to R30 will save you even more money, especially if you are keeping your cooler at 40°F or below.

Recommended insulation: Rigid foam

There are several types of insulation you can use in your walk-in cooler. We recommend using rigid foam whenever possible -- polyisocyanurate on the walls and ceiling and extruded polystyrene on the floor.

Polyisocyanurate Best choice for walls and ceiling	• Grey or yellow • R-value of ~6.8 per inch (can vary among brands) • After 5-10 years: R-value of 5.5 per inch (where it stays) • Comes in 4′ x 8′ sheets • Available at Lowe's and Home Depot
Use at least 4 inches. If it has foil backing, be sure it faces the outside. This product can be irritating to skin, so be sure to wear long sleeves when working with it.	
Extruded Polystyrene (XPS) Best choice for floor	• Pink or blue • After 5-10 years: R-value of ~6 per inch (where it • stays) • Comes in 4' x 8' sheets Available at Lowe's and Home Depot
Use at least 4 inches in the walls.	

This guide tells you how to work with our recommended rigid foam insulation. Visit our website for information about using alternative insulation solutions, including spray-in-place foam, roxul mineral wool, and cellulose.

WARNING: Do not use fiberglass batt insulation!

Even with a vapor barrier, moisture seeps into the fiberglass insulation. This will create a moldy nightmare and also allow cold air to leak out, resulting in higher electricity bills.

How to insulate a room

This section provides tips for insulating and sealing your room.

Select insulation of at least R25

When purchasing insulation, remember that the higher your R-value, the lower your electricity bill. You only purchase insulation once, while electricity is an ongoing expense. Spending a little more money upfront will save you a lot more down the road.

Also keep in mind that the R-value of insulation is additive. So, depending on the insulation you use, you may need multiple layers. For example, you could use two layers of R10 plus one layer of R5 to achieve R25.

Make sure your cooler is airtight

Before you insulate, you'll want to make sure your cooler is airtight. This will allow it to cool down faster and to lower temperatures, while also keeping your electricity bill down by preventing the cold air from escaping.

Use several cans of spray foam and caulk to seal the following:

- Cracks
- Seams between insulation sheets
- Under the door (use a door sweep as well for extra seal)
- Every corner

Sealing around the air conditioner

This is a common place for hot air to sneak in. For this area, we recommend using pipe insulation instead of spray foam. This way, if you ever need to pull the A/C unit out, you don't have to carve away the spray foam.

Pipe insulation is available at the hardware store. It's soft and pliable, but still has a "closed cell" structure, so water can't get in and air can't pass through. Look for pipe insulation in 6' strips that you can cut to the size you need before stuffing it into the gap between the wall and the air conditioner.

Attach insulation over the studs, not in between

Tack the rigid foam up on the **outside** of the studs, not in between them. Cutting up your insulation to go in between studs will not only leave gaps and holes, but no matter how careful you are, polyisocyanurate and polyurethane will shrink a bit over time, exposing your cooler even more.

Overlap the seams on multiple layers of insulation

If you're using multiple layers of insulation (e.g., 2' x 2' layers) to achieve your target R-value, stagger the seam locations and overlap the insulation. This will create a more effective barrier compared with having all the seams lined up on top of one another.

Prepare and insulate the floor

Since cold air falls, insulating the floor of your cooler traps the cold air. This keeps your electricity bill lower and reduces the load on your A/C.

For perched floors:

Coolers built on a deck need at least as much (preferably more) insulation in the floor as in the walls. If you build on a deck instead of a slab, you need to insulate the floor to at least R25 (and R30 would be even better).

If you have an untreated wood floor under your cooler, you will need to put in a vapor barrier. Here's a method we've found successful:

1. Put three layers of carpenter plastic between the Styrofoam and the top layer of plywood. As an alternative, you can use a single pond liner.
2. Stretch the plastic out into a "bathtub floor" that goes up the walls a couple inches.
3. Screw roof edge about 3" above the floor all the way around the wall like a metal baseboard and gather the plastic under it.
4. Caulk the entire top of the roof edge so the water dripping off of the walls won't slip between the plastic and the wall, pooling up under the floor.

For concrete slab and dirt floors:

Whether or not it makes sense to insulate a concrete or dirt floor depends on your targeted cooler temperature. On average, adding a floor will increase the efficiency of your cooler by about 15%.

Above 45°F / 7.2°C	Insulating the floor isn't worth the investment.
Down to 38°F / 3.3°C	If you live in a hotter region, you might want to insulate the floor, but typically you can still reach 38°F / 3.3°C without it.
Below 38°F / 3.3°C	Floor insulation is required. Even just 2" of insulation makes a big difference.

If the concrete pad extends beyond the cooler, the pad can absorb radiant heat. In this case, you'll need to insulate the floor.

How to insulate the floor

Whether you're building up on an existing trailer deck, above a basement, or on a slab, you don't need to frame out a floor. Simply follow this two-step process:

1. Place rigid foam directly on the floor.
2. Lay ¾" plywood painted with porch paint (or any exterior paint) directly on top of the rigid foam.

The plywood spreads the load out enough over the rigid foam. Even after 10 years, your insulation will still be holding strong.

In fact, if you were to stud out your floor, you would risk decreasing the effectiveness of the insulation, because the studs can create thermal bridges where the cool air flows out through the less-insulated studs, between small gaps in your insulation.

Do you need drainage?

For a cooler that will just be used for produce, you shouldn't need to install a drain. There likely won't be enough water accumulating and putting one in would just compromise the integrity of the cooler. The only thing the drain will really let out is the cold air!

Instead, we recommend you tilt the floor toward the door so that any water that gathers due to condensation or dripping veggies can drain out.

It's also important that you site your structure so the water has someplace to go once it leaves the door. If you're building on a trailer or a deck-type floor, this is easy to do. If you're pouring a new slab, build it a little bit above grade and put your formwork a barely noticeable "off-level" toward the door.

Sheathing

Finally, you may want to install sheathing to protect the insulation. The safest option is to put both interior and exterior sheathing on your cooler. However, if you're careful (and don't have employees carrying boxes in and out and banging them on the walls), you should be fine with just the exposed solid Styrofoam insulation.

Inner sheathing

An easy and inexpensive option for inner sheathing is oriented strand board (OSB), which is similar to particle board. If you use this material (or untreated plywood), be sure to seal it before installation.

Another option for inner sheathing is fiberglass reinforced plastic (FRP), which is durable, sanitary, and easy to clean.

Outer sheathing

If you built your cooler inside an existing structure, you don't need to sheath it. If it's outside, the sheathing will help protect the insulation from the sun. An affordable way to do this is by splitting sheets of CDX plywood into 1'x8'-foot strips to make your own overlap siding.

How to Seal Your Cooler

Proper sealing is essential for your cooler to function efficiently. This includes sealing joints between the walls, floor, and ceiling. You should also regularly check the gaskets on your door.

For sealing insulation, we recommend using spray foam, like Great Stuff. You can also use weather stripping or a rubber gasket if your door doesn't have a nice tight seal. Other options include caulking, pool toy floaties, and the same soft foam pipe insulation you used to insulate between the air conditioner cabinet and the walls.

The sealing step must be completed before you turn on your cooler for the first time.

**Note: It's important to take your time sealing the room. Even the smallest hole can have a large impact on your cooler's energy efficiency.

Your cooler door

The door is another essential tool for keeping the cold air in. We recommend you use a pre-hung insulated exterior door without windows. This type of door seals up tight.

Here are a few tips for getting the most out of your door:

- Make sure your door opens to the outside of the cooler. As you build your cooler, ensure that it's slightly above the surrounding ground level so the door can swing freely.
- Glue another layer of 2″ rigid foam to the inside of the door, as most doors are only about R18.
- If you plan on hosing down your cooler, remove the bottom metal piece of the pre-hung door so it doesn't create a dam for the water inside your cooler. You'll also have to cut the sides of the door down so the bottom stays flush against the floor.
- You can add a door sweep to help seal out any drafts that may be sneaking in at the bottom of the door. This M-D Building Products door bottom with drip cap is inexpensive and effective.
- To limit cold air loss when the door opens, use plastic curtains and automatic door closers.

Electricity & Lighting

Because a cooler can be a moist environment, we recommend using outdoor rated light sockets and outlets.

This is less about the fixture than about the perforations that wires make when they come into the cooler. A vacuum effect can be caused by the warm outside air being sucked in through the back of the outlet box by the cold cooler air. This can result in moisture gathering, which could cause the circuit to trip.

Here's the solution:

1. Take the cover off the outlet.
2. Find where the wire enters the back of the outlet box.
3. If there are any gaps where the wires enter the box, seal them so no air can move through using silicone caulk, clay, or feldspar.
4. Replace the cover.

Humidity

Cheese needs humidity to ripen, without it, you will end up with sad milk and no one wants that. To ensure that you hit the right humidity levels in your CoolBot powered cooler, we have a couple of tips.

In coolers that are insulated to R25 with closed cell foam, are airtight, have properly a properly sized A/C, door openings are less than 5 times an hour, and the cooler is at least half full, we see the relative humidity come in about 80% on average. The more product, the higher the humidity. More door openings, means more humidity (and any way we introduce warm ambient air). Another way to keep the humidity up will be to oversize your A/C. A larger unit will be able to cool the room faster, meaning the compressor (which dries out the air) will not have to run as often.

You may find that at certain times of the year you may need to use a humidifier in your cooler, usually during the winter. In addition to using a humidifier, our friends at New England Cheesemaking Supply have some tips on keeping the humidity levels up.

"The humidity can be controlled by simply using a pan of water with a partial cover. By simply adjusting the cover opening, you should be able to control the amount of humidity. At times you may need to seriously increase the amount of moisture in the box, especially when starting out. In this case, you may need to spray the inside with sterile water or provide a damp towel. You will also notice that as the seasons change, you will have abrupt changes in the moisture level. The amount of cheese inside the cave will also affect the amount of moisture needed because there is less of a problem when it is filled with moist cheeses."

How to Select the Right Air Conditioner

Important: A/Cs must have digital controls to work with the CoolBot.

The CoolBot works with most standard air conditioners. The right one for you depends on three elements:

- A/C size in BTUs
- Unit type – window unit or mini split A/C
- brand

This section of the guide will walk you through these three elements.

A/C sizing

Air conditioner size is measured in BTUs, which is a unit of heat. The chart below shows our recommendations for A/C size based on cooler size, using a desired temperature range for produce of 38°F / 3°C.

**Note: These A/C sizing suggestions are based on an airtight cooler with an 8' ceiling, insulated to at least R25 and opened no more than six times per hour.

Cooler Dimensions	A/C Size
4' x 4'	6,000 BTU
6' x 6'	8,000 BTU
6' x 8'	10,000 BTU
8' x 8'	12,000 BTU
8' x 10'	15,000 BTU
8' x 12'	18,000 BTU
10' x 14'	24,000 BTU
Larger coolers may require multiple A/C units and CoolBots. Please call us for more information: 888-871-5723.	

A/C unit type

Important: For your CoolBot to function your A/C must have a digital display.

There are several different types of air conditioners. Here's how the different A/Cs work with the CoolBot.

Window A/C - Highly recommended

The window unit is our preferred type of A/C because it's durable and efficient. Whether you're building a standing cooler on your property or a mobile cooler to take to market, a window unit will deliver the best performance.

Readily available in the United States, window units are also affordable and will work even if you're installing the A/C in an 11" thick wall.

Mini-split A/C - Recommended

If you lack the space for a window unit, or live in a country where window A/Cs are hard to find or expensive, a mini-split will work in a pinch. In the United States, mini-splits can cost twice as much as a window unit, but they're also more efficient and can confer higher energy savings.

Through-the-wall A/C - Recommended with reservations

Through-the-wall units tend to be twice the price of window A/Cs. They also seem to have (slightly) more electrical problems -- not serious or unworkable problems, just unnecessary annoyances. If you already have a through-wall unit, don't hesitate to use it. But if you're purchasing a new A/C, you'd be better off with a window unit or a mini-split.

Portable A/C - Not recommended

Portable A/C units bring too much warm air to the cooler, and they can only get down to 50°F / 10°C. They're also more expensive and consume more electricity than our recommended units.

A/C brand

We, and our customers, have tested the CoolBot with many different brands of air conditioners. Here are our assessments of the most common brands of A/Cs.

LG - Highly recommended

LG is our favorite brand because it's easy to install and provides consistent performance. Thousands of our customers use LG air conditioners. Some of them are still running strong from 2006!

You can buy our preferred LG A/C units on our website:

- LG 8,000 BTU 115 Volt Window Air Conditioner
- LG 10,000 BTU 115 Volt Window Air Conditioner LG
- 12,000 BTU 115 Volt Window Air Conditioner LG
- 15,000 BTU 115 Volt Window Air Conditioner LG
- 18,000 BTU 230 Volt Window Air Conditioner
- LG 24,500 BTU 230 Volt Window Air Conditioner

For all other brands of A/Cs, please visit our website for a full list of supported and unsupported brands.

How to Install Your Air Conditioner

Follow these three basic steps to install your air conditioner:

1. Cut an appropriate-sized hole in the wall of your walk-in cooler.
2. Put the A/C unit into the hole.
3. Use some type of insulation so that you can easily remove the A/C instead of having to carve it out in case you switch units in the future. (See the Insulation section of this guide for more information.)

A/C and CoolBot placement

Here are a few tips for where to place your A/C and CoolBot in your cooler.

Mount it at eye level

The A/C will perform at its best when it's installed so that the bottom of the unit is at eye level. Cold air sinks, so the higher the A/C the better. This also makes maintenance a lot easier.

Make sure the A/C blows down the length of the cooler

If your space is rectangular, then the A/C should be mounted on one of the shorter walls so that it blows down the length of the room. For example, in a 5' x 10' room, mount the A/C on one of the 5' walls.

Mount the CoolBot and the A/C side by side

The CoolBot should be mounted inside the cooler next to the A/C unit. For troubleshooting purposes, mount them right next to each other.

Install the A/C at a slight tilt

Install your A/C so that the back of the unit (outside the cooler) is about an inch lower than the front of the unit (inside the cooler). This is so the condensation that the A/C pulls out of the air can drip out the back rather than freezing inside the unit.

Most air conditioners will keep some water at the back of the pan to help cool the compressor and extend its life. The tilt is important so that the water doesn't get too far forward, where it can freeze.

**Note: Air conditioners must be level left-to-right because they're designed with a trough for water inside.

Allow your A/C to breathe

Air conditioners need at least 2' of clearance overhead on the back side to vent properly. If there's not enough room, your unit will overheat and fail prematurely. Check the specifications of your particular A/C to determine the exact setback required for your model.

How to Install Your CoolBot

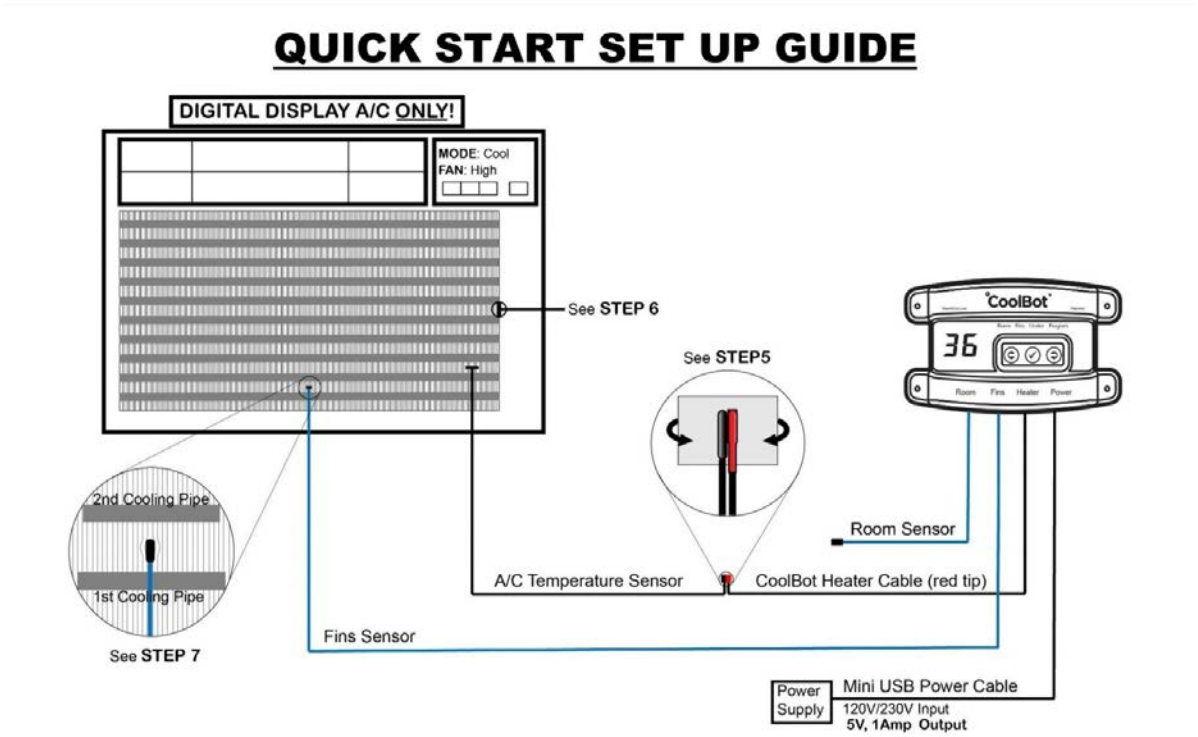
After installing the air conditioner, your final step is to install the CoolBot.

Anyone can install a CoolBot in just a few minutes! You will receive a detailed Installation Manual with your CoolBot, and you can visit our website to watch a short video on how to do it.

Here are step-by-step instructions for installing a CoolBot with a window A/C:

1. Plug the CoolBot into a standard outlet. The CoolBot uses no more electricity than a cell-phone charger, so no special electrical connections are needed.
2. Locate the three labeled wires coming out of the CoolBot:
   - **The wire labeled "Room" measures the temperature of the room.** Let it hang free, but make sure it's not making contact with any metal and is not in the direct pathway of the cold air coming from the A/C.
   - **Place the wire labeled "FIN Sensor" into the front cooling fins of the A/C unit.** Gently place the sensor as low as possible, but ABOVE the first horizontal cooling tube. Use a pen or pencil to widen a space 1-2" up from the bottom and put the fin sensor ⅛" in so that it's not touching the coolant pipes behind them. It should stay there on its own, without tape or screws. You may need to gently pinch the fins closed around the sensor, but be careful not to damage the sensor.
   - **Attach the wire labeled "Heater" to the A/C's temperature sensor.** The temperature sensor comes out of the A/C. On a new unit, the temperature sensor will be mounted on small plastic brackets in front of the fins. Wrap the CoolBot **Heater** wire up with the temperature sensor using a small ½" x 1" piece of aluminum foil (included) to ensure a good thermal connection. Allow this foil pack to hang freely away from any metal and out of the direct pathway of cold air.

Program your CoolBot. The CoolBot comes pre-programmed to cool your room down to 42°F (5.6°C). However, you can set it to whatever temperature you want. Click here to watch a video on how to program your CoolBot.



**If your A/C has a secondary sensor or a mini-split A/C, see our website for installation instructions.