Armageddon on a Budget

More Affordable Products That Help People Survive In Power Outages

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Two massive electric power outages have slammed Austin and vast parts of Texas in both 2021 and 2023, exposing a large percentage of hapless and helpless customers to health-threatening unprotected frigid temperatures and unsettlingly expensive property damage. The result is a sordid lack of confidence in institutions and experts who designed and operate the power systems. Even the most expertly run utilities are vulnerable to natural and man-made disasters, and more so when poor planning and blind faith in "free market" ideology get in the way.

Many people do not have the funds to install and maintain relatively expensive standby generators at their homes that they can resort to in emergencies. Even when they have the means, residents in apartments and condos usually lack the ability to site them. And natural gas service to fuel them is not infallible to outages either. Less expensive portable generators used as alternatives are also less powerful, more polluting, and usually a noisy nuisance. They are problematic to operate during rainy weather. And they increase fire danger to homes due to liquid-fuel storage requirements.

In this article, the Directory has undertaken the tasks of discussing, and to a degree cataloging, various devices, products, and strategies that can provide critical energy services and physical comfort in a power or energy outage lasting several days or longer.

This author's general philosophy is not "survivalist" or rugged individualism. Quite the opposite: I think people are stronger together as a society. There is, however, a difference between self-isolation and self-reliance. The recent combination of natural disasters and human mistakes that crippled the power grid are a sobering reality check.

Someone reading this article may be confused by its emphasis on products, thinking that it glorifies consumption. There is a profound difference between purchasing products for emergency preparedness and self-sufficiency as opposed to ostentatious wealth.

And while one can never buy absolute security, you can invest in beating the odds.

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1. Portable Storage Batteries/Portable Solar

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Since about 2017, a new type of appliance has been available to consumers: the Portable Storage Battery (PSB). These are relatively light-weight lithium batteries packaged in a sturdy case or cart to provide electric power in remote locations or indoors during outages of conventional electric utilities. Smaller units are also relatively inexpensive.

There are typically several ports that power conventional appliances such as refrigerators and electronics such as cell phones and laptop computers.

While these batteries are often charged through conventional AC power outlets, many models can also be charged with portable DC solar panels and automobiles for (minimal) off-grid independence or stand-alone emergency power back-up.

There are many things these devices can and cannot do. This article will point out their major benefits and limitations, and then detail the key characteristics of two product lines offered to U.S. consumers in January 2025. These are meant as examples; other products and product lines also exist.

1. UPS and EPS: Portable Storage Batteries are Emergency Power Supplies (EPS), which are not the same as Uninterruptible Power Supplies (UPS) for computers and communications. UPS systems are designed to kick on immediately if electricity is lost, whereas most PSB systems intentionally activate between 10 and 30 milliseconds of power failure. This is quick enough for transition of many electric appliances and laptop computers, though not more sensitive equipment such as work stations.

Most small UPS systems also currently use heavy lead batteries as opposed to much lighter lithium storage, thus limiting their portability and capacity. (Lead stores much less energy per unit of weight and size than lithium.) UPS lead batteries also generally have a much shorter life.

2. Sticker Price: The cost for PSBs ranges from less than $200 for smaller (less than 200 watt-hour) units that can handle a few hours of phones, computers, and lighting to thousands of dollars for larger units with several kwh of storage capacity that can run a refrigerator for several days.

3. Volume of Power and Peak Power Output: Units are rated by the amount of total power they store and the amount of "surge" power they release at one time. This is not unlike an electric car, which may be able to travel several hundred miles on a single charge, but can only travel at a limited speed (measured in miles per hour).

Surge power is often needed in appliances such as refrigerators and air conditioners, which require a few milliseconds of "starting power" before ramping down to a much lower average consumption level.

Both volume and peak power can be expanded multiple times by adding additional batteries to the primary PSB.

4. Price Per Volume of Storage (Dollars Per Watt): In addition to the sticker price, another important measurement is the price per stored watt or stored kilowatt hour. For competing units of the same size, this metric highlights the most cost-effective products (though it does not account for the quality of these various units).

5. Length of Time PSB Power Will Last: This is a simple computation based on the amount of storage and the load, but most people do not carry such numbers in their head.

A PSB with 1,000 watt-hour of storage capacity can power an energy-efficient refrigerator for as long as 24 hours, a common (12-watt) LED bulb for 3.5 days, and a cell phone for about 7 days.

6. Weight: All the portable power in the world means nothing if you cannot deliver it where needed. Smaller units can weigh between 5 and 25 pounds and can be carried by hand. But larger units can exceed 100 pounds, so they are often moved into position with the aid of a two-wheeled cart that comes with the product.

7. Number and Type of Charging Ports: In general, PSBs can be charged from 3 different sources: 1) a standard AC wall plug; 2) a peripheral DC solar cell array; 3) a DC automobile plug.

You can charge from all 3 sources at once, though DC will generally be accepted as the priority.

8. Number and Type of Power Ports: Once charged, PSBs can provide power directly to AC wall-plug loads, and to electronic devices through USB-A and USB-C connectors. Powering automobile accessories is also standard on most models. A larger number of ports will service more appliances and devices.

9. Time to Charge: Most smaller PSBs can charge 80 to 100% capacity in less than two hours with a standard AC

Examples of Portable Storage Batteries and Solar Power Supply

Model	Price (January 2025)	Watt Hours Stored	Maximum Watt-Hour Surge	Life	Dollars Per Watt	Weight of Batteries and PVs (Pounds)
Jackery • (888) 502-2236 • jackery.com						
Explorer 300	$189	294	500	500 cycles @80%	$643	7
Explorer 300 Plus	$300	288	600	3,000 cycles @80%	$1,042	8
Explorer 500	$329	518	1,000	500 cycles @80%	$635	13
Explorer 600 Plus	$499	632	1,600	4,000 cycles @70%	$790	16
Explorer 1000 v2	$749	1,070	2,000	4,000 cycles @70%	$700	24
Explorer 1000 Plus	$899	1,264	2,000	4,000 cycles @70%	$711	32
Explorer 2000 v2	$999	2,042	4,400	4,000 cycles @70%	$489	40
Explorer 2000 Plus	$1,499	2,043	6,000	4,000 cycles @70%	$734	62
Explorer 3000 Pro	$1,999	3,024	6,000	2,000 cycles @70%	$661	64
Explorer 5000 Plus	$2,999	5,040	14,400	4,000 cycles @70%	$595	135
Solar Charging – There are various 'packages' of portable storage batteries, solar panels, and accessories. Below are some examples.						
Solar Generator 300 Plus w/1-100w Panel	$400	288	600	3,000 cycles @80%	$1,389	16
Solar Generator 600 Plus w/1-100w Panel	$749	632	1,600	4,000 cycles @70%	$1,185	24
Solar Generator 2000 v2 w/2-200w Panels	$1,499	2,042	4,400	4,000 cycles @70%	$734	67
Solar Generator 2000 Plus Kit (6kWh) w/2-200w Panels	$3,499	2,043	6,000	4,000 cycles @70%	$1,713	89
Solar Generator 3000 Pro w/2-200w Panels	$2,199	3,024	6,000	2,000 cycles @70%	$727	91
Solar Generator 5000 Plus w/2-500w Panels	$4,999	5,040	14,400	4,000 cycles @70%	$992	179
EcoFlow • (800) 368-8604 • ecoflow.com *(Note: Delta models are meant to supply buildings, while River models are more portable.)*						
DELTA mini	$549	882	2,100	800 cycles @80%	$622	24
DELTA (1300)	$799	1,260	3,300	800 cycles @80%	$634	31
DELTA 2	$499	1,024	2,200	3,000 cycles @80%	$487	27
DELTA Pro	$2,199	3,600	7,200	3,500 cycles @80%	$611	99
DELTA 2 Max	$1,099	2,048	3,400	3,000 cycles @80%	$537	50
DELTA Pro 3	$3,262	4,096	8,000	4,000 cycles @80%	$796	114
RIVER mini	$189	210	600	500 cycles @80%	$900	6
RIVER	$349	288	1,200	500 cycles to 80%	$1,212	11
RIVER Plus	$249	360	1,200	800 cycles to 80%	$692	12
RIVER Max	$499	576	1,200	500 cycles to 80%	$866	17
RIVER 2	$199	256	600	3,000 cycles @80%	$777	8
RIVER 2 Max	$349	512	1,000	3,000 cycles @80%	$682	13
RIVER 2 Pro	$569	768	1,600	3,000 cycles @80%	$741	17
RIVER 3	$179	245	600	3,000 cycles @80%	$731	8
RIVER 3 Plus	$209	286	1,200	3,000 cycles @80%	$731	10
Solar Charging – There are various 'packages' of portable storage batteries, solar panels, and accessories. Below are some examples.						
DELTA 2 + 2-220w PV Portable Panels	$1,199	1,024	2,200	3,000 cycles @80%	$1,171	61
DELTA Pro + 4-400w Rigid Solar Panel	$5,299	3,600	7,200	3,500 cycles @80%	$1,472	291
DELTA 2 Max + 2-400w Rigid Solar Panel	$2,559	2,048	3,400	3,000 cycles @80%	$1,250	148

Examples of Portable Storage Batteries and Solar Power Supply (continued)

Model	Power Output Ports	Charge Time in Hours	Warranty (Years) *	Dimensions in Inches W x L x H
Jackery • (888) 502-2236 • jackery.com				
Explorer 300	2 AC; 1 USB-A; 1 USB-C; 1 12VDC	4.5	2	5.2 x 7.8 x 9.1
Explorer 300 Plus	1 AC; 1 USB-A; 2 USB-C; 1 12VDC	2	3	6.1 x 9.1 x 6.6
Explorer 500	1 AC; 3 USB-A; 1 12VDC	7.5	2	7.6 x 11.8 x 9.5
Explorer 600 Plus	2 AC; 1 USB-A; 2 USB-C; 1 12VDC	1.6	3	8.6 x 11.8 x 7.8
Explorer 1000 v2	3 AC; 1 USB-A; 2 USB-C; 1 12VDC	1.7	3	8.8 x 12.9 x 9.7
Explorer 1000 Plus	3 AC; 1 USB-A; 2 USB-C; 1 12VDC	1.7	3	10.2 x 14 x 11.1
Explorer 2000 v2	3 AC; 1 USB-A; 2 USB-C; 1 12VDC	2	3	10.4 x 11.5 x 13.2
Explorer 2000 Plus	5 AC; 2 USB-A; 2 USB-C; 1 12VDC	2	3	18.6 x 14.7 x 14
Explorer 3000 Pro	4 AC; 2 USB-A; 2 USB-C; 1 12VDC	2.4	3	14.7 x 18.6 x 14
Explorer 5000 Plus	4 AC; 2 USB-A; 2 USB-C; 1 12VDC	3.5	5	15.5 x 25 x 16.5
Solar charging time typically decreases with additional solar panels.				
Solar Generator 300 Plus 1-100w Panel	1 AC; 1 USB-A; 2 USB-C; 1 12VDC	9.5	3	1 panel 5.8 sf
Solar Generator 600 Plus 1-100w Panel	2 AC; 1 USB-A; 2 USB-C; 1 12VDC	8.5	3	1 panel 7 sf
Solar Generator 2000 v2 w/2-200w Panels	3 AC; 1 USB-A; 2 USB-C; 1 12VDC	7.5	3	2 panels 14 sf each
Solar Generator 2000 Plus Kit (6 kWh) w/2-200w Panels	5 AC; 2 USB-A; 2 USB-C; 1 12VDC	6	3	2 panels 13.9 sf each
Solar Generator 3000 Pro w/2-200w Panels	4 AC; 2 USB-A; 2 USB-C; 1 12VDC	3 to 4	3	2 panels 13.9 each
Solar Generator 5000 Plus w/2-500w Panels	4 AC; 2 USB-A; 2 USB-C; 1 12VDC	6.5	5	2 panels 27 sf each
EcoFlow • (800) 368-8604 • ecoflow.com				
DELTA mini	5 AC; 3 USB-A; 1 USB-C; 2 12VDC	1.6	2	7.2 x 14.9 x 9.4
DELTA (1300)	6 AC; 4 USB-A; 2 USB-C; 1 12VDC	1.6	2	8.3 x 15.7 x 10.6
DELTA 2	6 AC; 4 USB-A; 2 USB-C; 3 12VDC	1.3	5	8.3 x 15.7 x 11.1
DELTA Pro	5 AC; 4 USB-A; 2 USB-C; 3 12VDC	1.9	5	11.2 x 25 x 16.4
DELTA 2 Max	6 AC; 4 USB-A; 2 USB-C; 3 12VDC	1.5	5	9.5 x 19.6 x 12
DELTA Pro 3	7 AC; 2 USB-A; 2 USB-C; 1 12VDC	1.8	5	13.4 x 16.2 x 27.3
RIVER mini	2 AC; 3 USB-A; 1 USB-C; 1 12VDC	1.5	2	5.5 x 9.8 x 5.2
RIVER	3 AC; 3 USB-A; 1 USB-C; 3 12VDC	1.6	2	7.3 x 11.3 x 7.7
RIVER Plus	3 AC; 3 USB-A; 1 USB-C; 1 12VDC	1.6	2	7.1 x 11.4 x 7.7
RIVER Max	3 AC; 3 USB-A; 1 USB-C; 3 12VDC	1.6	2	7.3 x 11.4 x 9.3
RIVER 2	1 AC; 1 USB-A; 1 USB-C; 2 12VDC	1	5	8.5 x 9.6 x 5.7
RIVER 2 Max	1 AC; 1 USB-A; 1 USB-C; 2 12VDC	1	5	10.2 x 10.6 x 7.7
RIVER 2 Pro	1 AC; 1 USB-A; 1 USB-C; 2 12VDC	1.2	5	10.2 x 10.6 x 8.9
RIVER 3	2 AC; 2 USB-A; 1 USB-C; 1 12VDC	1	2	8.3 x 10 x 4.4
RIVER 3 Plus	3 AC; 2 USB-A; 1 USB-C; 1 12VDC	1	2	9.2 x 9.1 x 5.8
Solar charging time typically decreases with additional solar panels.				
DELTA 2 + 2-220w PV Portable Panels	6 AC; 4 USB-A; 2 USB-C; 3 12VDC	3 to 6	5/battery; 1/PV	2 panels 16 sf each
DELTA Pro + 4-400w Rigid Solar Panel	5 AC; 4 USB-A; 2 USB-C; 3 12VDC	2.8 to 5.6	5/battery; 10/PV	4 panels 21 sf each
DELTA 2 Max + 2-400w Rigid Solar Panel	6 AC; 4 USB-A; 2 USB-C; 3 12VDC	2.8	5/battery; 10/PV	2 panels 21 sf each
*Extended warranties are sometimes reflected in this column, which can add to cost with warranties over 2 years.				

wall plug or an appropriately sized peripheral solar array. However, charging can take as long as 12 hours with an automobile adapter. Larger units can take as long as several days to fully charge with a solar array (depending on the size of the array).

10. Solar Ready: Many models of PSBs can use supplemental solar panels as a form of charging, and can even use solar as a dual-charge supplement to charging with conventional electricity at the same time. You can also use the battery at the same time the solar is charging it.

11. Packaging: PSBs are packaged in a plastic case meant to be durable as well as portable. The handles or carts are meant to easily locate the units. Sometimes auxiliary cases/bags carry collateral equipment such as supply and charging cables. Electronic monitoring screens and indicators allow for getting current information on both the amount of energy stored and consumed.

Some units also have protective guards to protect plugs and ports from dirt and sand. Since PSBs are often used when camping, this feature can be particularly useful.

12. Pure Sine-Wave Inverter: Not all electricity is created equal. Some PSBs produce an uneven "choppy" current, while others supply quality electricity with pure sine waves. While certain applications such as laptops can tolerate choppy power, others such as motorized blenders, vacuums, and power tools can be vulnerable to inconsistent speeds, heat buildup, and can even be damaged by poor current flows.

13. Warranty: Two-year warranties are common for PSBs. However, some companies offer extended warranties up to 3 years longer, though sometimes a premium is charged for this.

14. Capacity Fade: Lithium batteries are expected to lose capacity over time, with about a 20-30% degradation over their rated life. And depending on the battery chemistry, the life (down to 70-80% capacity) can be anywhere from 500 to 4,000 charge/discharge cycles.

15. Parasitic Losses: Efficiency is not often at the top of people's minds when they are desperately trying to keep essential communications and appliances operating. However, it is interesting to note that PSBs will not provide 100% of the electricity during usage that was originally supplied to them.

Typically, lithium batteries lose at least 10% of original power supply in the charging and discharging process. One of the more prominent PSB manufacturers, Jackery, has estimated an additional power loss of 5% a month if the units remain dormant with stored electricity. Even more can be lost during operation due to the power load of the cooling fan and other internal power consumption.

Peripheral DC solar arrays have direct charging losses of about 25% (in addition to losses in PSBs).

16. Exposure to Weather: PSBs can discharge power at low temperatures between about -4˚ and 32˚F and high temperatures of between 104˚ and 140˚F. However, for prolonged periods of use, PSBs can be damaged if they operate at temperature extremes. Also, like most electrical equipment, they are hydrophobic. Shelter from rain.

17. Other Interesting Information:

• PSBs cannot jump start an automobile with a dead battery, but they can *recharge* an automobile battery if the battery can retain a charge.

• PSBs generally have too much power to be allowed on airline flights, though laptop/cell phone batteries are usually fine.

• Some of these appliances are "library" quiet.

• As in all product categories, some companies have a better reputation than others in product quality and customer service. Consumers should check reliable rating sources to better determine this.

A product list completed in January 2025 from two prominent Portable Storage Battery manufacturers, with description of product characteristics, is on pages 22 and 23.

2. Hand-Crank and Pedal Generators

Turning human-powered generators to get any sizeable amount of power can be a humbling experience. It would take about 10 monotonous hours with a bicycle pedal generator to power an energy-efficient refrigerator for a day (not considering the surgewatts necessary to get it started). People-powered machines, however, can be reliable alternatives for emergencies, camping, etc.

Crank equipment is usually larger than hand cranks in weather radios and portable lighting, and can provide more power in a shorter amount of time. They can recharge small electronic equipment, power light bulbs for several hours, and can even recharge car batteries. One key quality is that these more powerful generators can often bring a cell-phone battery back from a dead state.

Production ranges from about 20 watts to as much as 100 watts. (At least one bicycle generator boasts 500 watts of output at peak, but it would be difficult for operators to sustain this for very long.) Pedal generators are generally more powerful than hand-operated units because legs are more powerful than arms.

In January 2025, costs for hand generators made with metal casing started at less than $35, and ranged up to several hundred dollars. Bicycle generators can cost over $1,000. Sometimes Portable Storage Batteries (discussed previously in this article) will be required to store the harvest.

Below is a chart of some of the higher-qualitymodels.

Human-Powered Generation			
	Price (January 2025)	Weight (pounds)	Watts /Hours
K-Tor • k-tor.com • (802) 777-6229			
Power Box 50	$435	7.5	50
Power Box	$250	4.7	20
Power Socket USB 1 AMP	$85	0.9	5
Pedal Power Generator • pedalpowergenerator.com • (480) 489-0111			
Emergency Power System	$1,499	34	500
Human Power Portable DC	$995	30	75
PowerHome • powerhome.com			
Portable Hand Crank Electric	$99	2	20
Hand Crank AC 110V/220V	$280	1.4	40
VEVOR® • vevor.com • (855) 385-1880			
Hand Power Generator 30W	$122	3	30
Zeus Dynamo • zeusdynamo.com			
Powerhouse 60 Kit	$329	9	60

3. Portable Lighting: Flashlights, Lanterns, and Headlamps

Courtesy Pixabay

Whatever Gets You Through the Night

Portable lighting products are essential tools in power-related emergencies and everyday life. Many can also charge other small electronic devices.

This section will discuss them in two categories: 1) products that can be autonomously charged (with solar and hand cranks); and 2) devices solely powered by batteries (built-in, disposable, or rechargeable). There is not a clear line here. Most autonomous charging devices can also be conventionally charged with a wall-plug; and rechargeable batteries can be charged with external solar devices such as solar-powered battery chargers and portable storage batteries. Still, self-powered products have a feel of more self-reliance.

When making purchasing decisions, there are fundamental things that distinguish well-suited and well-made portable-lighting products.

1. Light Quantity and Quality: The highest light output, measured in lumen brightness, is a key metric. Higher lumens also usually equate to a longer beam distance, allowing wearers to see farther into darkness.

Better flashlights and headlamps are usually engineered to ramp down from peak power when it is not needed to keep units from getting too hot and to conserve battery power. Better products almost all have high and low settings that operate manually as well. At the lowest "moonlight" setting, many products can stay on for days on a single charge.

Better quality flashlights and headlamps also allow users to toggle between flood and spot light settings, and some headlamps tilt the light at a certain angle.

2. Specialty Light Settings: Many products have strobe and SOS-blinker settings for emergencies and self-defense. These can be more useful if they are in a discrete setting apart from the normal toggle switch (of low/medium/high). If emergency settings are part of the main switch, they can become annoying if you have to cycle through them on the way to your desired lighting output.

Even more elaborate lamps have red lights, allowing people better night vision.

3. Water and Dust: Better products are rated by the IP (Ingress Protection) standard for their dust and water resistance.

Courtesy Pixabay

The highest dust prevention rating is 6 (complete prevention) and the highest water prevention rating is 8 (complete submersion deeper than 1 meter for 30 minutes without leakage). This rating is designated by IP and followed by the two rating numbers (e.g., IP68). Sometimes the rating

Dust/Water Resistance Rating Scale		
Protection from Solids		
Rating	**Protected Against**	**Example**
0	Not protected	N/A
1	Particulates >50mm	Large parts of the body such as the back of the hand, but will not protect deliberate contact with body parts
2	Particulates >12.5mm	Fingers and objects of similar size
3	Particulates >2.5mm	Tools and thick cables
4	Particulates >1mm	Most screws, wires, and small insects
5	Dust Protected	Some protection from dust; must not enter in sufficient quantity to interfere with the operation of the equipment
6	Dust Tight	Total protection from dust
Protection from Liquids		
Rating	**Protected Against**	**Test Time**
0	No protection	--
1	Dripping water; vertically falling when mounted in an upright position	10 minutes (water equivalent to 1mm of rainfall per min)
2	Dripping water; tilted at 15 degrees, all four positions tested	2.5 minutes per tilt (water equivalent to 3mm of rainfall per min)
3	Spraying water; up to 60 degrees from vertical	1 min per square meter (at least 5 minutes)
4	Water splash; from any direction	10 minutes
5	Water jets; from a nozzle of 6.3mm	1 min per square meter with 12.5 liters of water per min, including a pressure of 30kPa from 3 meters
6	Power water jets; from a nozzle of 12.5mm	1 min per square meter with 100 liters of water per min, including a pressure of 100kPa from 3 meters
7	Submersion of up to 1m depth	30 minutes
8	Submersion of the depth of 1m or more	Test depth should be specified by the manufacturer for 30 minutes or longer

will lack dust measurements (e.g., IPX8), though water-tight usually implies dust-tight.

Specific metrics for the IP scale are on this page.

4. Durability: Part of a flashlight's durability can be measured with an impact rating: how far the product can be dropped and still function. Impact ratings of better products range from 1 to 3 meters.

5. Portability: For lanterns and flashlights, consider how easy it is to carry the unit. How much does it weigh? Can it be placed in a pocket or backpack? Is there a "lock" that prevents the device from accidentally operating when stored in a pocket or backpack?

Low weight for headlamps is obviously a virtue, particularly with tasks that entail physical exercise. Most headlamps range from 2 ounces to almost a pound.

6. Batteries: This is a key metric of sustainability. Some of the preferred products listed in this article have built-in, rechargeable storage. While such equipment may last through many years and hundreds of charge cycles, the equipment will eventually need to be discarded when the batteries wear down, becoming landfill bait due to planned obsolescence. Environmentally preferable products use batteries that are rechargeable and replaceable.

Many rechargeable batteries are rated for 1,000 cycles, which means they can save hundreds of dollars over their lifespan compared to disposable batteries (assuming they are not lost).

7. Settings: Ease of operation is often essential for purchasers. Most people prefer toggle switches that are simple and intuitive (such as several increasing light levels in sequence on a single button). These buttons can include a "lumen memory" setting that allows the light at a preselected brightness rather than the highest brightness. Charge-level indicators allow easy monitoring of battery strength.

More sophisticated products feature reactive light, which throttles the light level up or down depending on how close a distance monitor determines the user is to physical barriers. (A headlamp does not need a beam distance of 200 feet if you are standing next to a wall 10 feet away.)

8. Cost and Quality: In life-dependent situations, do not choose low price over quality. As the saying goes, many readers are too poor to buy cheap tools. Some do not perform well or last as long.

3.1 Flashlights

There are likely more than a thousand flashlight models on the market. The best one can cast a beam over 2 miles away. The brightest one has over 100,000 lumens, 62 times brighter than a 100-watt equivalent LED (at 1,600). There are ultraviolet flashlights that can detect scorpions and counterfeit money. There are red-, blue-, and green-colored flashlights used for stealth hunting (animals and fish cannot detect them). A relatively recent advent in flashlights is the use of lasers to enable long beams with lower energy consumption. Products can range in price from less than $2 to more than $1,000.

The choices and specifications are dizzying.

The *Directory* has reviewed seven product analyses of flashlights to determine the best brands and products for general use. These analyses were conducted between 2023 and 2025, and included: *CNET*; *CNN*; *Field & Stream*; *Gear Junkie*; *Popular Mechanics*; *USA Today*; and *Wirecutter* (*New York Times*).

The brand most often mentioned as the leader was Fenix. Other respected brands included: Anker; Maglite; Olight; Streamlight; and ThruNite. Some of the better models and descriptions are on p. 28; prices are from January 2025.

3.2 Electric Lanterns – The Best Products

Arceli/Stock.Adobe.com

The *Directory* has reviewed seven product analyses of portable electric lanterns to determine the best brands and products. These analyses were conducted between 2023 and 2025, and included: *Field & Stream*; *the Miami Herald*; *Outdoor Gear Lab*; *REI*; *Travel + Leisure*; *Treehugger,* and *Wirecutter (New York Times)*.

The brand most often mentioned as the leader in quality and utility was Goal Zero. Other respected brands included: LuminAid®; MPOWERD (Biolite); Solight; and UST. Some of the better models and descriptions are listed on p. 29; prices are from January 2025.

3.3 Headlamps

ThomasLENNE/Stock.Adobe.com

Many people consider electric headlamps more convenient than flashlights since they operate hands-free. They are regularly used in outdoor activities such as jogging and camping, night-time physical and mechanical work, and emergency situations.

Their first use was in underground mining in about 1915, where they replaced more primitive headlamps fueled by oil and carbide gas. Electric headlamps were much safer than the more primitive flame lamps that could cause explosions if exposed to mine-shaft methane emissions.

Some headlamps feature reflective strips and "tail lights" to make it easier for drivers to spot joggers wearing them at night. Some are made with sweat wicking material for comfort. Many also allow flexible use, including wrapping them around hats and helmets.

Better products are also balanced to keep the light from "bouncing" during strenuous activity. Sometimes this is accomplished by removing the battery from the band itself; instead, a longer wire allows the power source to be inserted in a pocket.

The *Directory* has reviewed eight product analyses of headlamps to determine the best brands and products. These analyses were conducted between 2022 and 2025, and included: *Field & Stream*; *Gear Junkie*; *REI*; *Popular Mechanics*; *Popular Science*; *Travel + Leisure*; *USA Today*; and *Wirecutter* (*New York Times*).

The brand most often mentioned as the leader was Petzi. Other respected brands included: Biolite; Black Diamond; Coast®; and Ledlenser. Some of the better models and descriptions are listed on p. 30; prices are from January 2025.

4.0 Emergency Weather Radios and Lighting

Notice of severe weather events is paramount in a potential blackout situation. "Weather-Band" radios hone in on NOAA (National Oceanic and Atmospheric Administration) weather-alert stations in the local area to obtain urgent weather alerts and updated weather news.

Recommended Flashlights										
Model	**Charging Methods**	**Dimensions (inches) Dia X Length**	**Weight w/ batteries (Pounds)**	**Lumens**	**Cost (January 2025)**	**Run Hours**	**Impact Resistance (Meters)**	**Dust/Water Ratings**	**Beam Distance (Feet)**	**Other Features**
Anker • anker.com • (800) 988 7973										
Bolder LC40	1 Lithium 3350mAh built-in battery	1.3 X 5.04	0.27	400	$30	Up to 20 on Medium	1.5	IPX5	400	5 light settings; Reliable to 14˚F
Fenix Lighting • fenixlighting.com • (888) 775-9996										
PD36R V2.0	1 Lithium 5000 mAh replaceable battery; USB charging	1 X 5.5	0.37	1,700	$100	3.5 to 482	1	IP68	1,299	6 light settings
PD36R PRO	1 Lithium 5000 mAh replaceable battery; USB charging	1.04 X 5.74	0.38	2,800	$120	3 to 42	1	IP68	1,245	6 light settings
LR50R	1 Lithium 16000 mAh replaceable battery; USB charging	3.46 X 6.42	2.2	12,000	$320	1.8 to 58	1.2	IP68	3,117	Electronics charging; 7 light settings
MAGLITE • maglite.com • (909) 947-1006										
ML50L LED	2-C alkaline	2 X 8.2	0.8	466	$33	8 to 109	1	IPX4	955	4 light settings
Solitaire LED	1-AAA alkaline	0.5 X 3.2	>0.1	47	$14	1.75	2	IPX7	151	1 setting
Manker Light • mankerlight.com										
Manker E12	2-AA replaceable batteries	0.8 X 5.7	0.2	650	$40	2 to 300	2	IPX8	315	5 light settings
Olight® • olightstore.com • (888) 897-0966										
Olight® Baton 3 Pro	Lithium 3200mAh replaceable battery; USB charging	0.9 X 4	0.23	1,500	$70	3 to 2,880	2	IPX8	574	6 light settings
Olight® Warrior X 3	Lithium 5000mAh replaceable battery; USB charging	1.5 X 5.9	0.56	2,500	$117	2 to 8	3	IPX8	1,837	2 light settings
Streamlight • streamlight.com • (800) 523-7488										
Polytac X USB	Lithium 2600mAh replaceable battery; USB charging	1.35 X 5.46	0.3	600	$49	3.5 to 36	3	IPX7	673	4 light settings
MACROSTREAM	Lithium 800mAh replaceable battery; USB charging	0.83 X 4.5	0.14	500	$54	2 to 8	1	IPX4	295	2 light settings
THRUNIGHT • thrunite.com										
Archer 2A C	1 Lithium 1600 mAh battery or 2-AA replaceable batteries; USB charging	0.9 X 6.1	0.23	1,018	$40	2 to 648	1.5	IPX8	548	5 light settings
Archer 2A V3	2-AA replaceable batteries	0.87 X 6.1	0.23	500	$30	2 to 360	1	IPX8	305	5 light settings

Recommended Portable Electric Lanterns								
Model	**Charging Methods**	**Dimensions (inches) W x L x H**	**Weight (Pounds)**	**Lumens**	**Cost (January 2025)**	**Run Hours**	**Dust/Water Proof Rating**	**Other Features**
Goal Zero • goalzero.com • (801) 553-3654								
Lighthouse 600	Built-in lithium rechargeable 5200 mAh; external solar; hand crank	5 x 6.5 x 4.5	1.1	600	$70	2.5 to 320	NA	Electronics Charging; 4 light settings; provides ≈ 10 minutes of light per minute of cranking
Torch 500 Multi-Use Light	Built-in lithium rechargeable 5200 mAh w/ USB or built-in solar	2.2 x 1.4 x 8.8	0.8	500	$40	2 to 50	IP67	Electronics Charging; 8 light settings, including spot light and flood light
Biolite Energy • bioliteenergy.com • (844) 424-6548								
Base Light	Lithium rechargeable 4000 mAh w/ USB or built-in solar	6 Dia X 5.4 H	0.6	360	$36	5 to 110	IP67	Electronics Charging; 4 light settings; collapsible
Luci Outdoor 2.0 Pro	Lithium rechargeable 2000 mAh w/ USB or built-in solar	5 Dia X 5 H	0.4	150	$30	5 to 50	IP67	4 light settings; collapsible
LuminAID® • luminaid.com								
PackLite Titan 2-in-1 Lantern	Lithium rechargeable 4000 mAh w/ USB or built-in solar	6 x 6 x 6	0.8	300	$68	3 to 100	IP67	Electronics Charging; 6 light settings including red-light; collapsible
Solight • solight-design.com								
QWNN™ Solar Lantern	Built-in lithium rechargeable 4000 mAh from USB or solar	7 x 9.75 x 13.5	0.9	600	$83	48 to 150	IP67	Electronics charging; 5 light settings; collapsible
UST • ustgear.com • (877) 738-3738								
UST 60 Day Duro Lantern	6-D cell replaceable	4.8 x 5.1 x 9.5	3.1	1,200	$70	41 to 1,440	IPX4	4 light settings

If you already have a solar system or portable storage batteries, you will have power to receive local-area radio/TV broadcasts, which usually do an adequate job of covering hazardous weather events. However, for those who do not have these power backups, or for campers in outback settings, or drivers stranded in a rural area in their vehicle, emergency weather radios can literally be a lifesaver. They will also often deliver critical information when cell-phone service is offline.

There are many products with many different features. Here are some things to consider in purchasing decisions.

• Some products are designed to kick on immediately in the event of a weather alert, even if they are turned off. Others depend on the operator to tune in.

• Many products carry AM/FM stations for entertainment as well as weather news. Some even allow blue-tooth to play a request list.

• Almost all of these products have a flashlight and usually a reading light built in. Some even have motion sensors to automatically turn the lights on in the dark.

Recommended Headlamps									
Model	**Charging Methods**	**Weight (Pounds)**	**Maximum Lumens**	**Cost (January 2025)**	**Run Hours**	**Dust/Water Resistance Rating**	**Beam Distance Feet**	**Lamp Qualities**	**Other Features**
BioLite • bioliteenergy.com									
BioLite 800 Pro	1 Lithium 3000 mAh built-in battery w/USB	0.33	800	$100	7 to 150	IPX4	49 to 443	Spot; flood; tilt	4 light settings; red light; red tail light
BioLite 325	1 Lithium 700 mAh built-in battery w/USB	0.11	325	$50	3 to 40	IPX4	70 to 230	Spot; tilt	3 light settings; red light; dimmer
Black Diamond • blackdiamondequipment.com • (800) 775-5552									
Spot 400	Lithium 1500mAh replaceable battery w/ USB charging or 3-AA batteries	0.17	400	$50/$80 w/ battery charger	2.5 to 200	IPX8	39 to 328	Spot; flood; tilt	4 light settings; memory function for preset light level; night vision colors (red, blue, and green)
Sprinter 500	Lithium 1800mAh replaceable battery w/ USB charging or 3-AA batteries	0.23	500	$80/$110 w/ battery and charger	3 to 180	IPX4	20 to 164	Spot	3 light settings; memory function for preset light level; tail light strobe for safety
Coast® • coastportland.com • (800) 426-5858									
WPH34R	Lithium 4000mAh replaceable battery w/ USB charging or 3-AA batteries	0.5	2,075	$80/$100 w/ battery	6.25 to 36	IP54	118 to 639	Spot; flood; tilt	3 light settings
Ledlenser • ledlenserusa.com • (888) 245-2825									
H14R.2	Lithium 4400mAh replaceable battery w/ USB charging or AA batteries	0.75	1,000	$80	6 to 35	IPX4	230 to 984	Spot; flood; tilt	4 light settings, dimmable; rear safety light
PETZL America • petzl.com • (801) 926 1500									
Actik Core	Lithium 1250mAh replaceable battery w/ USB charging or 3-AA batteries	0.2	600	$85/$115 w/battery	2 to 100	IPX4	33 to 377	Spot; flood; tilt	4 light settings; red light; reflective headband
Tikkina	Lithium 1250mAh replaceable battery w/ USB charging or 3-AA batteries	0.2	300	$20/$55 w/ battery	2 to 120	IPX4	33 to 213	Flood; tilt	3 light settings
Tikka	Lithium 1250mAh replaceable battery w/ USB charging or 3-AA batteries	0.2	450	$35/$65 w/ battery	2 to 110	IPX4	33 to 246	Flood; tilt	4 light settings; red light

Most models have digital LCD displays.

• Some have emergency strobe lights and sirens to alert rescue teams. Some allow two-way communications. And some even have a "dog whistle" frequency that can send out high-pitched signals to rescue dogs. (Really!)

• They can often be powered several different ways: 1) rechargeable batteries from wall-plugs or solar-powered chargers; 2) non-rechargeable batteries; 3) attached hand

cranks that generate small amounts of electricity; and 4) built-in solar cells (though solar cells in some models are not that powerful).

• Some allow charging of cell phones. If this is a quality you seek, it is best to find a weather-band radio with a large battery capacity. Current cell phone batteries can be as large as 3000-4000 mAh, something few weather-band products can completely provide without extra batteries or redundant charging systems.

• Some are large enough to be difficult to carry when hiking. Others fit in the palm of your hand.

• Some are more durable than others, which is again important in hiking. This includes being drop- and water-resistent.

The Best Products – The *Directory* has reviewed seven product analyses of weather-band radios to determine the best brands and products. These analyses were conducted between 2021 and 2023, and included: *Gear Junkie*; *Gear Lab*; *Popular Mechanics*; *Travel + Leisure*; *Underscored (CNN)*; *Weather Station Advisor*; and *Wirecutter* (*New York Times*).

The brand most often mentioned as the leader in quality and utility is Midland®, a U.S. manufacturer. Other respected brands included Eton, FosPower, Kaito, and RunningSnail. Below are some of the better models and descriptions. Prices were taken in February 2025.

Fabbox/Stock.Adobe.com

Emergency Weather-Band Radios

Model	Charging Methods	Dimensions (inches) W x L x H	Weight (Pounds)	Cost (February 2025)	Other Features
Eton • etoncorp.com • (800) 872-2228					
Quest	Lithium Rechargeable 5200mAh; Hand Crank; Solar; 3-AA batteries	7.1 x 5.8 x 2.3	2.3	$130	Radio includes shortwave; Flashlight/Red Light; Emergency Beacon; USB Charging; Alarm Clock; Bluetooth; Headphone Jack
FosPower • fospower.com					
Solar Hand Crank D9	Lithium Built-in Rechargeabke 4000mAh; Hand Crank; Solar	3.2 x 5.2 x 2	0.8	$40	Flashlight; SOS Alarm/Compass; Bluetooth; USB Charging; IXP water rating; Ltd. Lifetime Warranty
Kaito Electronics • kaito.us/collections/kaito-radios • (909) 628-6088					
Kaito KA500 Voyager	Lithium Rechargeable 2000mAh; 3-AA; Hand Crank	2.5 x 8 x 5	1.8	$50	Flashlight; Lamp; USB Charging
Midland® • midlandusa.com • (816) 241-8500					
ER310	Lithium rechargeable 2600 mAh; 6-AA; Solar; Hand Crank	3.4 x 8 x 2.4	1	$70	Flashlight; SOS Beacon; Dog Whistle; USB charging; Headphone Jack; Clock; Up to 32 Hours Per Charge
ER210	Lithium Rechargeable 2600 mAh; Solar; Hand Crank	2.8 x 1.9 x 6.5	0.9	$50	Flashlight/SOS Beacon; USB charging; Headphone Jack; Clock; Up to 25 Hours Per Charge
WR120	AC Wallplug; 3-AA	5 x 1.5 x 6	1	$40	Siren; Clock & Alarm Clock
RunningSnail • runningsnailstore.com • daringsnail.com					
RunningSnail MD-090P	AC Wallplug; 4000 mAh Rechargeable Battery; Solar; Hand Crank	2.5 x 6.2 x 3.2	0.9	$29	3-Mode Lighting; Motion Sensor; SOS Siren; USB Charging
DaringSnail MD-091	Built-in 8000 mAh Rechargeable Battery; Solar; Hand Crank	3.1 x 3.9 x 9.6	1	$40	3-Mode Lighting; SOS Alarm; USB Charging; Earphone jack

5. Low-Impact Biomass Cooking

Courtesy Stovetec

Virtually all indoor residential cooking in the U.S. uses electricity, natural gas, or (to a limited degree) propane. Cooking with wood and charcoal (processed wood) is generally considered an outdoor recreational or camping activity. However, wood can be an essential backup for meal preparation and even emergency outdoor heating.

This is in stark contrast to more primitive conditions in much of the developing world. According to the World Health Organization, in 2022, about 2.4 billion people – a third of the global population – ate food prepared on inefficient open fires or primitive cook stoves burning solid or polluting fuel. These fuels include: biomass (wood, dung, crop waste); kerosene; and coal. This causes huge environmental, health, and safety problems.

Oft times, these indoor stoves do not even have chimneys, allowing soot and carbon monoxide to directly pollute indoor air. In addition to chronic illness, this pollution causes about 3.2 million premature deaths annually from stroke, heart disease, chronic pulmonary disease, and lung cancer. Women and children responsible for cooking and household chores bear the brunt of this.

The soot, a.k.a. "black carbon," is 330 to 2,240 times more potent as a greenhouse gas than typical carbon dioxide gas on a 100-year time scale. This is because the darkness of the soot retains more of the sun's heat inside the Earth's atmosphere.

Most wood cooking is also extraordinarily inefficient, yielding only about 15% of the primary energy in fuel. (It can be as low as 5% with poorly tended fires.) This increases fuel costs if it is purchased, or increases time to collect it if harvested, often further lowering what is already a poor standard of living.

Biomass Rocket Stoves				
Model	**Dimensions (Inches)**	**Weight (Pounds)**	**Thermal Efficiency**	**Cost (2025)**
Biolite Energy · bioliteenergy.com				
EcoZoom Versa	11 D X 12.5	14.5	38%	$150
Envirofit · evans-outdoorstore.com				
M-5000	12.6 D X 11	9.26	34%	$109
Econofire	14.2 X 16.2 X 10.6	6	34%	$59
Flat or Round Pot Skirts				$29
Smokehouse · smokehouseproducts.com · (877) 386-3811				
Mimi Moto	11.9 D X 14.4	9	>50%	$150
Stovetec · stovetecstore.net · (541) 649-4099				
Big Foot Deluxe	13 D X 15	17	25%	$109
Super Pot	13 D X 10	4	≈32% w/Big Foot stove	$69

Given the acute dangers, environmental effects, and budgetary impacts that fuel costs and cooking time have on low-income populations, considerable research has gone into developing wood stoves that are more energy efficient, clean burning, and safer to operate.

One of the innovations is the rocket stove. Unlike open cookfires, heat rises up a vertical tunnel, creating a fire-driven draft which does two things. First, this allows flammable volatile organic compounds released from wood (which escape from a camp fire and do not produce heat) to combust in an insulated enclosed vertical chamber along with the original biomass. Second, this draft circulates through the combusting wood, similar to a bellow, also contributing to more complete combustion. This air draft is audible, to a degree sounding like a rocket engine, hence the name.

Rocket stoves can increase thermal efficiency to 25-50%. Use of double-walled pots (which concentrates heat from the pot sides that is normally dissipated to the surrounding air) and skirted pots (which amplify heat transfer at the bottom) on these efficient stoves can increase efficiency even more.

While rocket stoves are more popular in developing countries, the chart on this page lists a few U.S. products and retailers to consider. Prices are from February 2025.

6. Space Blankets and Blizzard Blankets

Originally developed as a heat-reflective material by NASA for space travel in 1964 (hence its common name), space blankets are a relatively common and inexpensive emergency-survival tool. Aluminum deposited on a plastic sheet (Mylar) can reflect infrared body heat back towards its source, or alternatively, it can reflect external sunlight away.

Wilderness hikers will sometimes carry these on long-

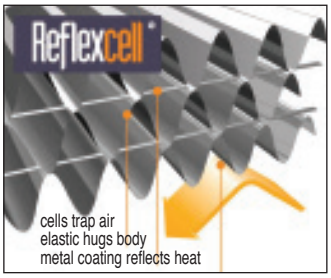
distance treks in case they are stranded in emergency situations. The opposite side of the space blanket is often a bright silver or orange color, which can be more easily spotted if rescuers are searching for them.

The material can be inserted into layers of winter clothing (as long as it is not the layer touching the skin), or wrapped around a person from the outside. Variations of the material can be closely pulled around a person's body with draw strings. It can also be employed in the form of small tents, or placed on an existing tent shell to retain or reflect heat.

Space blanket costs start at less than $2 a sheet plus tax. However, cheaper space blanket products can tear easily, and have been reported to conduct heat away from the body if they touch the skin. Many less-expensive products also have a limited shelf life (6 to 24 months) due to effects of oxidation and moisture, and given their thinness and fragility, it may not be possible to use them more than once.

While storing them in a cool and dark place may extend the life, a better option is to upgrade to a more reliable product. More durable space blanket products cost more, but can be used repeatedly. A few of these are listed below. In February 2025, prices typically range from $20 to $45 for the sizes listed on this page.

Blizzard Survival Blankets are a more recent variation on space blankets. They began to be popularized in the late 1990s. They combine a radiant barrier with thin "Reflexcell™" honeycombed plastic sheets that create insulative air pockets.



Originally invented to treat trauma patients, the medical form of this product is a body-length bag with drawstrings that close around the face.

However, product offerings have expanded to jackets and sleeping bags. The insulation greatly increases the warmth retention compared to a space blanket. Like space blankets, the outside is often bright orange to help with rescue operations.

People donning these blankets might be mistaken for a tall orange goose. Unlike warm winter coats, they do not confer agility for athletic sports – they are rather clumsy when worn. They are meant for emergency events.

However, they have measured effectiveness much greater than space blankets. A study printed in the *Emergency Medicine Journal* in 2016 evaluating medical technologies used to treat or prevent hypothermia showed that after an hour in ambient temperature, space blankets were 13°F (28%) warmer and blizzard blankets (with full body cover) were 17°F (37%) warmer than a control with no cover.

Blizzard Survival Blankets are also light, generally weighing a pound or less, and are sold in vacuum-packed bags to display a small and compact footprint until opened and expanded.

Blizzard Safeguard/Medical offers waist-length and full (ankle-length) jackets, blankets, sleeping bags, and medical bags (for treating hypothermia) in both two and three layers. The less expensive two-layered products have one sheet of reflective material (nearest the skin) and one outer layer to trap air.

The three-layered products, which are more expensive, have one sheet of reflective material and two layers to trap air. In February 2025, a two-layered waist-jacket, as well as a large three-layered jacket, could be found for about $48. These are also listed on this page.

Durable Emergency Blankets

	Dimensions (Feet)	Weight (Pounds)	Web site	Phone	Cost (2025)	Comments
Arcturus Survival Blanket	5 x 7	1.4	arcturusgear.com	(888) 604-7868	$22	4 Grommets; 4 Iron stakes; Carrying bag
Arcturus Survival Blanket (large)	8.5 x 12	4.4	arcturusgear.com	(888) 604-7868	$45	10 Grommets; 10 Iron stakes; Carrying bag
Bearhard Emergency Blanket 3.0	5 x 7	1	bearhard.top		$20	4 Grommets; 4 Iron stakes; Carrying bag
Bearhard Emergency Blanket 5.0	5 x 7	1	bearhard.top		$30	4 Grommets; 4 Iron stakes; Carrying bag
Go Time Gear Life Bivy Emergency Sleeping Bag	3 x 7	0.26	gotimegear.com		$23	Sleeping bag shape inside of carrying case
Blizzard Survival Blanket	6.6 x 7.5	0.8	blizzardsurvival.com	(855) 428-6074	$48	3 layers; Online retailers offer best prices
Blizzard Compact Trauma Blanket	4.9 x 7.5	0.6	blizzardsurvival.com	(855) 428-6074	$26	2 layers; Online retailers offer best prices
PerSys Medical Blizzard Survival Jacket	4 feet long	1.1	blizzardsurvival.com	(855) 428-6074	$48	2 layers; Online retailers offer best prices

7. Winter Clothing in a Blackout Don't Get Caught Dead Wearing This

From creatures that evolved with fur and feathers to humans that expropriate them, a protective outer layer is a prime and primary way animals protect themselves from the elements.

Clothing using natural fibers with such characteristics is widely available, but there are also various man-made "high-tech" fibers that imitate or enhance the comfort and protection that natural fibers can achieve.

7.1 Natural Materials

zhikun sun/Stock.Adobe.com

The best natural materials for winter clothing are harvested from animals: down and wool.

Down from geese and ducks is considered the best natural insulator for winter outerwear and apparel by trapping air inside its fibers. The quality of heat retention is rated as fill power, the volume (or loft) of down per unit of space and weight. With higher fill power, a garment requires less down to provide the same warmth.

Lower grade down has a fill power of 500; better quality will rate from 600 to 800. The highest quality natural products can rate 900 or even 1,000, though they come at an extra cost. And the warmth effect is linear: 1,000 fill power will be twice as warm as 500 fill power for the same weight. Of course, one can buy a thicker, heavier coat by using more lower-quality down than higher-end down products. But the point of using high quality products is lightness and maneuverability for activities such as winter labor, hiking, skiing, and mountain climbing.

The downside of down garments is moisture. When they are exposed to wet conditions (rain, snow, spray from water travel), the moisture fills its air pockets, reducing its insulative ability.

This is a main reason synthetic down was invented. While it is usually not as effective as natural down in dry conditions, it surpasses down performance in wet situations, retaining more of its insulation value and drying much more quickly.

One may wonder why geese and ducks are not adversely affected when wet. These birds have protective feathers that cover the down, which are coated with natural oil spread by preening. While humans don't preen themselves, down suppliers and clothing manufacturers have tried to adapt to deal with this situation.

These strategies include moisture-repelling garment shells, durable water repellent (DWR) treatments that render the down material hydrophobic, and mixing down with synthetic insulation to gain the best from both materials. However, hydrophobic down may not last as long as natural down.

Wool from sheep, alpaca, and goats is another material that traps air in its fibers, and is usually spun into yarn to weave clothing. The merino, alpaca, and cashmere varieties are soft as well as warm, making them a preferred but more expensive choice for consumers. Their insulative properties are much less vulnerable to water than down. Wool also has fire-retardant properties, making it particularly useful in bedding products.

7.2 Synthetic Insulation

Since the 1970s, garment manufacturers have attempted to imitate the insulative properties of natural down. As stated earlier, one of the reasons was to compensate for down's loss of insulative properties when wet, as well as the ability of synthetics to dry more quickly.

Regarding sustainability, virtually all synthetic down originates from petrochemicals – generally polyester. A number of manufacturers use recycled beverage bottles as a feedstock for the raw material.

While synthetic products provide a high degree of warmth, as a general rule: 1) they are not as efficient as high-loft down; 2) they are a better option when facing weather conditions that are wet and cold (as opposed to dry and cold); 3) they have a shorter life, as it tends to lose its loft with wear much more quickly than down. A few of the best synthetic insulation products are discussed here.

A. Polartec® Thermal Pro 200 and 300 – Polartec is the pioneer in commercialization of high-tech fibers.

Originally established in clothing manufacturing in the first part of the 20th century as Maiden Mills, the company developed and commercialized synthetic fleece, first retailed as "Synchilla" by Patagonia in 1979. While the company suffered financial setbacks in 2007 and came under new ownership, it maintained its expertise in designer fabrics. It currently makes about 400 different varieties that collectively offer a multitude of attributes including protection from rain, wind, extreme temperatures, and even fire.

Among the best for cold weather are its high-loft Thermal Pro 200 and 300 materials. Similar to several other

synthetic insulation products discussed here, the insulation comes in continuous sheets rather than as loose-fill fibers, and is breathable.

Continuous filament insulation can be woven into clothing as a solid, lightweight sheet. This minimizes heat loss both by preventing fiber migration, and eliminating the quilting seams found in a conventional down jacket where heat escapes.

In February 2025, there were 228 partners manufacturing products with Polartec® materials, including: Adidas; Apparel Solution; Arc'teryx; Banana Republic; Fila; Helly Hansen; Houdini; Nike; Patagonia; and Under Armour.

B. PrimaLoft® – PrimaLoft® manufactures synthetic down sheet insulation originally developed for the U.S. military in the early 1980s to retain downlike warmth even in wet conditions. It was first sold commercially in 1989.

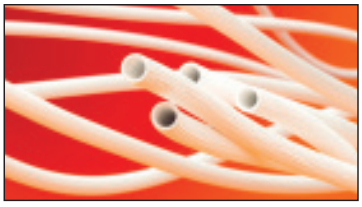
The company has four grades (listed here in increasing order of effectiveness): Primaloft® Black; Primaloft® Silver; Primaloft® Gold; and Primaloft® Gold with Cross Core, which combines synthetic down with aerogel (discussed elsewhere in this article) to enhance its insulative ability.

It is possible to create winter wear for extreme temperatures with the lower-rated Primaloft® grades. However, it will require more of the material to achieve the same effect as the higher-rated materials, meaning a bulkier, heavier garment with a lower "warmth to weight ratio." The lower grades are used in apparel designed for less extreme temperatures. The line also manufactures an insulation whose fibers biodegrade when they escape into the environment when a clothing article is washed.

Primaloft® Gold has a down-fill rating of about 500-625, similar to low-grade natural down. The aerogel-modified product has a fill power as high as 830, similar to high-grade down.

In February 2025, there were about 4 dozen major clothing manufacturers using the insulation, which included: Gap; Helly Hansen; Houdini; L.L. Bean; Nike, and Patagonia.

C. Lucra Thermolite® – Lycra is an established fabric company that began in 1958 when it introduced the stretch-fabric Spandex. It manufactures winter-fabric Thermolite®, a hollow polyester-based fiber that traps air to make light clothing more insulative and fast wicking.



Thermolite® has several adaptations, including sheet insulation for both coats and buildings. It is also used in cloth that embeds minerals to reflect infrared heat back to the body for extra warmth (discussed in more detail on page

Courtesy Pixabaycom

Ethical Considerations of Winter Clothing

People shopping for winter clothing, when not experiencing the desperation of a power outage, may pause when buying down or wool because of concerns about humane animal treatment. About 270,000 tons of down a year are produced as a by-product of raising about 2.5 billion ducks and geese a year in Asia, and to a small extent, Europe, for their meat. The majority of the world's down originates in China.

Cruel poultry-raising practices include live-plucking feathers, force-feeding of geese to create better taste, and denial of the "five freedoms" of animal welfare. These include freedom from: 1) hunger and thirst; 2) discomfort; 3) pain, injury, and disease; 4) constraints to natural behavior; and 5) fear. Third-party certification systems have been put into place by the Global Traceable Down Standard, the Responsible Down Standard, and Downpass.

Conventional sheep-raising practices can also be extraordinarily hard on livestock. Mulesing is a practice where the hide skins are removed to prevent insect infestations, causing acute pain and sometimes chronic conditions that can lead to death. Prohibiting this, as well as promoting the five freedom practices, are verified by third-party certification organizations such as the Responsible Wool Standard, the Organic Wool Standard, and the ZQ Merino Standard.

Some animal-rights activists question various standards as not being strict enough to prevent violations. It is, however, *more likely* that animals will be treated humanely under these inspections. More responsible retail products will carry these certifications.

One must also consider the alternatives. Synthetic garments may keep you comfortable without exploiting animals, but they are produced from petrochemicals, which carry a huge environmental footprint from air and water pollution, global warming, water consumption, and solid waste. A lifecycle analysis funded by the International Down and Feather Bureau claims polyester has a climate impact 18 times higher than down. While the funding came from a self-interested trade group, the results emphasize avoiding animal-based textiles is not a guilt-free alternative.

37), and to convey infrared heat from natural and artificial light into winter clothing during the day.

Companies that use these products include: 4F; Crest Clothing; Endura; H&M; OOSC Clothing; Ororos; REI; and Storm Creek.

D. Climashield® – This is a U.S. company that manufactures various insulation products that can be used for winter clothing, as well as designer fabric and material products that are used in the manufacture of bedding, tents, and fire-protective clothing. Its most effective APEX line for winter garments uses continuous filament batt insulation similar to Polartec® and PrimaLoft®, with closely-woven interlocking fibers that allow high effectiveness with extremely minimal weight and bulk.

In February 2025, there were at least 30 major companies manufacturing or retailing products using the company's materials, including: Arc'teryx; Direct Alpine; Eddie Bauer; Hyphen Sports; Mountain Equipment; and Tilak.

A Natural Comparison

To the degree possible, the chart below compares the warmth of natural down with two brands of synthetic insulation. The "clo" measurement is commonly used to benchmark clothing. It gauges the amount of insulation that allows a naked person at rest to maintain thermal equilibrium in an environment at 70°F in a normally ventilated room (0.1 m/s air movement). This chart estimates clo per ounce per square yard, with the higher ratings being warmer.

Comparison of Insulation (Dry Conditions)	
Material	**clo/oz/yd2**
Down Fill Power 550	0.70
ClimaShield® APEX	0.82
Down Fill Power 625	0.92
Prima-Loft® Gold	0.92
PrimaLoft® Gold Insulation/Down Blend	1.23
Prima-Loft® Gold With Cross Core	1.4
Down Fill Power 800	1.68

While this chart may benchmark the best products, it is important to remember three things.

- It is common to manufacture a warm coat with lower-value insulation. It will simply be heavier. Many coats made with high-warmth insulation weigh less than a pound. This lightness may be more comfortable, or more versatile for athletic activities, but not essential in most situations.

- A winter garment is about more than insulation. It is about ventilation, pockets and zippers, packability, and attractiveness.

- Manufacturers provided these clo values; they were not independently verified.

7.3 Aerogel

Courtesy Aspen Aerogels

Aerogel insulation prevents this flame from melting Kisses

Aerogel insulation, a high-tech material developed by NASA for space travel, has an R-value of about 10 or higher per inch, about 3 to 4 times the effectiveness of standard building insulation. It has been used in space suits.

It has been said that insulating a house with aerogel would allow a home's winter heating to be done with a candle. It is one of the lightest materials known on earth, often 99.8% air, with a solid base surrounding these insulative microscopic air pockets that can be made of various substances, including silica, plastic, and organic matter.

Aerogel has many unique qualities besides its superior insulation ability. It is hydrophobic, so it is resistant to mold, mildew, and decay. While it stops heat transfer, it also breathes, preventing condensation build-up. It is also resilient compared to other insulating materials that lose effectiveness with repeated compression. In addition to using aerogel as a primary insulator, there are synthetic insulation products (e.g., PrimaLoft® Gold with Cross Core™) that are hybrids enhanced with this material.

In February 2025, the following manufacturers were using pure aerogel insulation in cold-weather clothing.

Aerogel-Insulated Clothing		
	Web Site	**Clothing Articles**
Helly Hansen	hellyhansen.com	Jackets; Winter "suits"
L.L.Bean	llbean.com	Packaway jackets; Shoes
OROS	orosapparel.com	Beanies; Crew shirts; T-shirts; Gloves & mittens; Jackets & parkas; Vests
Outdoor Research	outdoorresearch.com	Booties
Shiver Shield	shivershield.com	Beanies; Blankets; Caps; Jackets: Hand warmers; Insoles; Mittens; Pants; Vests; Work clothes
SITKA Gear	sitkagear.com	Jackets; Pants
STELLAR	stellarequipment.com	Jackets; Vests; Pants

7.4 Bioceramic Clothing

Bioceramic fibers consist of yarn (often polyester) that is impregnated with micron-sized particles of minerals, primarily titanium dioxide or silicon dioxide. Clothing manufactured from these fibers has the ability to reflect far infrared radiation emitted from people's bodies back towards their bodies.

This not only provides garments, bedding, and even bandages the ability to provide more warmth , but proven medical benefits as well. Infrared radiation penetrates blood vessels, muscles, and tissue allowing more oxygen to flow. This often reduces pain, promotes healing, decreases recovery time after strenuous exercise, and increases strength, as documented in numerous scientific studies. These were summarized in a Harvard manuscript published in 2012.

• Ceramic Far Infrared Radiation (cFIR) emitters significantly quickened full thickness excisional skin wound healing in rats.

• Some findings suggest far infrared radiation could be used as an effective medical treatment for some cancer cells. It has also been found to be beneficial in fighting leukemia.

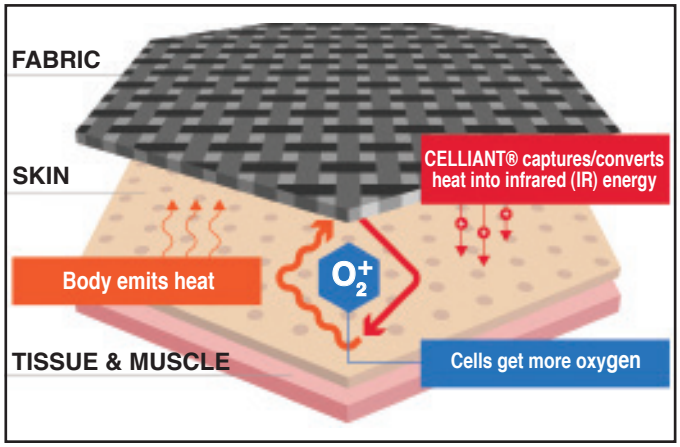
• Bioceramic-coated neoprene garments reduced cellulite fat in the legs of test subjects.

• Use of cFIR socks was shown to reduce chronic foot pain.

• At least two studies showed that use of ceramic belts reduced menstrual cramps.

• Rabbits that received injections to create inflammation similar to rheumatoid arthritis were placed in a cage surrounded by paper sheets impregnated with a thin layer of the ceramic powder, compared to a control group without the material. The results showed reduced inflammation when exposed to the ceramic.

• Another study reviewed the repair effect of cFIR in human breast epithelial cells after exposure to hydrogen peroxide and ionizing radiation from an X-ray source. Their results show that in both cases, the cFIR treated cells demonstrated significantly higher cell survival rates than the control groups. The researchers proposed that the protective ability of cFIR against ionizing radiation occurs predominantly through an antioxidant mechanism.



Courtesy CELLIANT®

Beneficial health effects of far infrared clothing

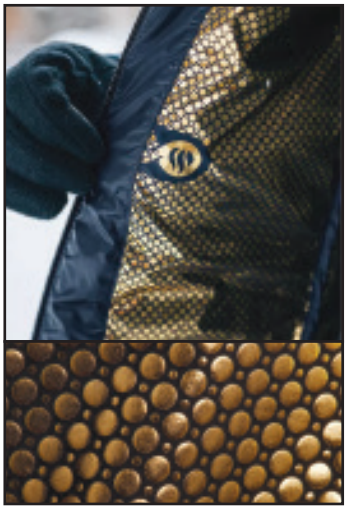
• Belts made out of these fabrics have been used for weight reduction. One study showed a reduction in body measurements after at least 30 days of use, which may have been a consequence of increased microcirculation and peripheral blood flow, which promoted improved general health.

One of the main manufacturers of this fabric is Hologenix, with its trade named CELLIANT® material. Its material is not sold to individuals, but to companies that make products using it. In February 2025, there were 40 partners manufacturing or retailing products with these materials, including: Allied Feather & Down; Decathlon; Medline; Tecnica; and Under Armour.

Taiwanese company Sportingtex® also manufactures this type of material. And European clothmakers Nanostitch and Schoeller Textile produce cFIR materials as well, though some of the clothing manufacturers that use their materials are not usually sold in the U.S..

7.5 Metalized Infrared-Reflective Clothing

Similar to bioceramic cloth discussed previously, clothing is now made with inserted metal to create reflectance that reradiates the body's infrared heat, or that actually attracts heat from the outside environment, to enhance warmth.



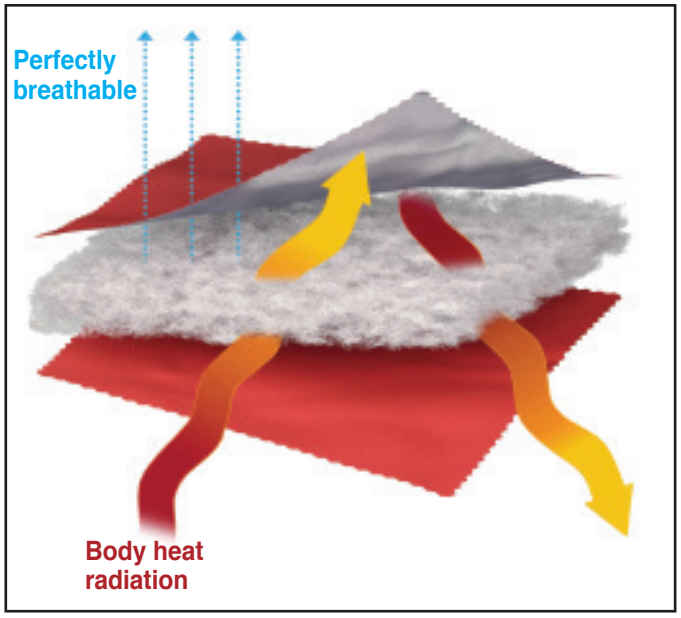
Omni-Heat Infinity

One of the main companies that has aggressively marketed this technology is Columbia Sportswear. In 2010, Columbia introduced its original Omni-Heat Reflective apparel liner, with silver-colored aluminum dots that cover about 35% of the interior to reradiate infrared heat back towards the body. The dots are irregularly placed to allow garments using it to breathe.

In 2018, the company began to add Omni-Heat 3D to its apparel. It embellished the same principle of reflectivity with a sort of vertical mesh that created insulative air pockets.

A more recent adaptation of the technology, introduced in 2022, is Omni-Heat Infinity. It uses a reflective, breathable weave of gold-colored aluminum dots to cover about 50-60% of a special interior liner to reradiate infrared heat back towards the body.

Xefco, a textile development company, is marketing a similar product manufactured with wearable jackets lined



XReflex

with XREFLEX®, which are sheets of breathable radiant-barrier fabric. It has three XREFLEX® products that achieve successive layers of warmth, with claims that the highest level will reduce required insulation by 50%.

In February 2025, retailers using this material in their products include: Mammut; Nespresso; Salomon; Stoney Creek; Zara; and Zhik.

The winter gear manufacturer Rab sells jackets and sleeping bags with Thermo Ionic Lining Technology (TILT), which deposits reflective layers of titanium or aluminum on the fabric. Combined with high-loft down, the products are incredibly warm and light.

Still another company, LifeLabs, makes winterwear with WARMLIFE® insulation coated with metallic nanoparticles to reflect infrared heat back towards the body.

7.6 Other Technologies

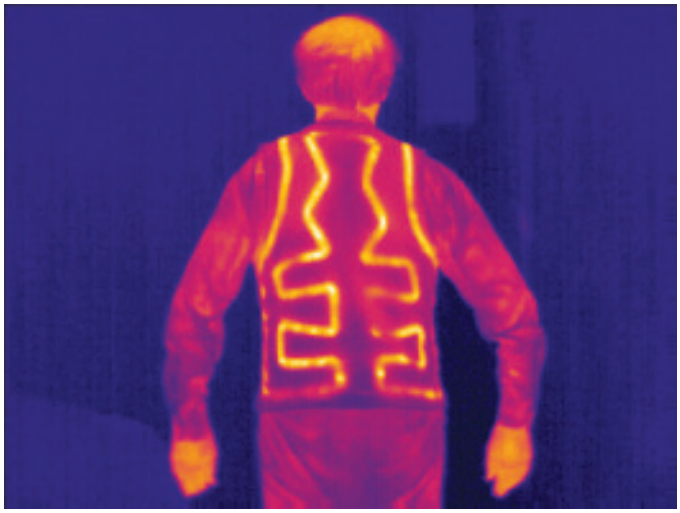
A. Uniqlo – This is a Japanese-based clothing/bedding company with its own unique brand that has retail stores throughout much of the world, including the U.S. Among its products are garments manufactured with HEATTECH. The cloth is a breathable hybrid of polyester, acrylic, rayon, Spandex, and sometimes cotton, that allows moisture to wick away while containing air pockets in the fibers to trap heat. The line is offered in three levels of increasing warmth.

In January 2025, there were only 5 Uniqlo stores in Texas, and none in Austin. However, its garments can be purchased online: uniqlo.com.

B. Heat Holders – This company markets clothing made of 100% polyester yarn that is an extra long looped cushion pile. The inner liners are thoroughly brushed to retain air inside the garments. Garments made with the material include socks, as well as blankets, gloves, hats, jackets, pants, robes, shirts, slippers, and tights. The clothing is offered with 3 levels of warmth: original; lite; and ultra lite The company claims its original level is 7 times warmer than cotton and almost 3 times warmer than ordinary thermal socks.

Products are sold on the company's Web site: heatholders.com

8. Technical Textiles – Battery-Heated Clothing



Shenzheneer/WikiCommons

Heated clothing is a growing niche market in winterwear. According to a 2025 report from Fortune Business Insights, heated clothing carried a 2023 value of $140 million in North America alone. Uses include: outdoor winter sportswear, workwear in cold climates: and motorcycle riding. They are also valued for health benefits, similar to clothing discussed in this article that reflects infrared heat back to the body.

Small battery-operated resistance heaters are embedded in clothing in strategic locations to distribute warmth. There can be five or more heating elements in a large heated jacket. Generally, batteries are attached and discretely hidden inside the clothing. Most of their power sources are lithium batteries, though some products employ AA (flashlight) batteries.

Types of heated clothing include vests, jackets, parkas, gloves, socks, shirts, pants, slippers, shoe insoles, scarves, hats, and thermal underwear. There is at least one company making heated scuba suits for cold-water diving.

Almost all heated clothing products operate at 3 settings (low/medium/high) which are triggered by a button, though high-end heated garments can also be directed by remotes. Though each company and garment is different, heat can range from a low of 100˚F to as high as 150˚F. The heat ramp-up can be felt quickly, often within 15 to 30 seconds of pressing the switch. Wearing heated clothes without a sufficient base-layer and monitoring has sometimes caused skin burns, so this clothing should not be worn directly on the skin.

The hotter the temperature, the higher the power drain. So at low settings, the batteries in jackets can provide as much as 10 to 12 hours of heat; the high end will be more like 2 to 4 hours. However, freshly-charged batteries can be used serially.

Many of the jackets and vests can also directly charge phones, tablets, and other portable electronics, or indirectly charge them with the same charger that powers the clothings' batteries. However, these other power uses compete with electricity, extending the charging time required by the garments.

Some heated coats and vests layer their active heat on to other warmth qualities built into the products, including down insulation and infrared heat reflection (previously discussed).

The following costs were observed for representative products reviewed in February 2025.

Heated vests generally ranged from $60 on sale up to $230, though most cost at least $100. *Heated jackets* generally ranged from $70 on sale up to $300, though most cost at least $140. One high-quality heated jacket hit $500. An extra battery (for frequent use or eventual replacement) ranged from $40 to $89.

Heated socks and sock liners using lithium batteries generally ranged between $50 and $200, with most costing $120 or more. Extra batteries (sold in pairs) ranged from $32 to $60. One brand of socks using AA batteries for energy cost between $20 and $50. (Unlike socks powered by lithium batteries, the AA batteries were not included.)

Heated gloves, glove liners, and mittens using lithium batteries ranged between $50 and $219, with most costing $120 or more. Extra rechargeable lithium batteries (sold in pairs) ranged from $20 to $60. There are also products of this kind powered by AA batteries.

Heated clothing can be laundered in a washing machine by taking certain precautions such as turning the wash cycle to the Gentle setting. However, they will not do well in a clothes dryer, and require air drying.

Some of the larger product lines of heated clothing are listed in the chart on this page.

Environmental Considerations of Heated Garments: Most indoor space heating systems condition indoor air in a space much larger than the individual being heated, which is then transferred by convection to skin to create comfort in cold weather. With battery-powered clothing, people are wearing their heating systems – the step to heat the surrounding air is eliminated.

This serves well in power-outage emergencies, where spare batteries or recharging with solar or crank devices can constantly restore the electricity supply.

Heated Clothing Distributors		
	Web site	Phone
ActionHeat	actionheat.com	(855) 336-0924
Bosch USA	boschtools.com	(877) 267-2499
Dewalt	dewalt.com	(800) 433-9258
Gerbing	gerbing.com	(800) 646-5916
DEWBU	dewbu.com	(844) 568-1666
Makita Tools	makitatools.com	(800) 462-5482
Milwaukee Tool	milwaukeetool.com	(800) 729-3878
ORORO	ororowear.com	(702) 751-7639
Venture Heat	ventureheat.com	(877) 261-9477
Venustas	venustasofficial.com	(888) 836-6460
Volt Resistance	voltheat.com	(888) 518.6871
Weston Heated Clothing	westonstore.com	(407) 801-3834

But it also serves as energy conservation. Though every person, situation, and garment is different, a heated jacket's consumption will often be limited to only 3 to 15 watts per hour. Compare this to a portable electric heater serving a single room that can use 600 watts of electricity an hour minimum.

Another environmental concern that few consider is the wiring insulation, which is often made of PVC, a material in widespread use that is extremely toxic to manufacture. PVC is, however, commonly used in a wide array of consumer goods, including house wiring, and even (non-electric) garment material. While it would be better if PVC was not used in heated garments, given the state of the industry, it should not be the deciding factor on whether to purchase these products.

9. Summer Clothing in a Blackout

eddtoro/Shutterstock.com

Summer fabrics have various attributes that work to keep people comfortable. Qualities of materials such as cotton, linen, and silk have been well known for thousands of years. Various types of rayon, a synthetic fabric largely made from natural materials, also have inherent cooling qualities.

Light-colored clothing reflects some of the sun's infrared heat away from people, and light-weight and loose-knit (airy) clothes allow more breathability to evaporate sweat.

However, going beyond historic natural fibers are a wide array of clothing and high-tech fabrics specially designed to meet or exceed their comfort.

There are newer, specially-designed fabrics that excel in moisture wicking. Many of these same fabrics then absorb and evenly distribute this moisture to the outside of the garment for fast drying.

Even more advanced fabrics are "cool to touch," as the material easily conducts heat away from the body.

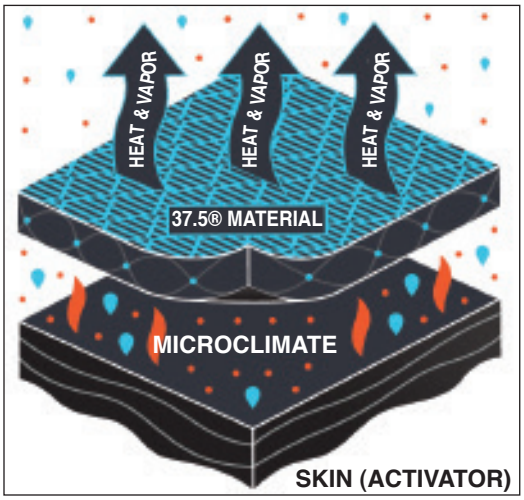
Some new materials embed small mineral particles to increase the surface area (which allows more evaporative cooling) or give the material a cooler feel.

And while it has not been commercialized yet, scientists are researching heat reflecting fabric that allows internal body heat to be converted by the clothing to mid-infrared heat, which is then radiated away.

In addition to cooler fabrics, there are various electrically-operated ventilated apparel and wearable devices using microchips that lower temperatures next to the skin.

Below is a discussion of some of the best cooling materials for clothing in extreme hot temperatures. Unfortunately, at this point there is not a widely-transparent *Consumer Reports* type of rating system that can compare these fabrics. Consumers will need to determine for themselves which ones work well for them.

A. 37.5® Technology – This company makes yarns embedded with volcanic minerals and carbon derived from coconut shells. This greatly expands the surface area to accelerate vapor attraction from the body before it ever turns into uncomfortable sweat. The minerals also make use of body heat to release the water-vapor molecules from the minerals. This allows increased comfort in both cold and warm temperatures.



37.5® Technology removes moisture in the vapor stage before liquid sweat forms

The yarns are used for clothing, insulation, foams, and laminates. While the yarns are manufactured out of recycled polyester or nylon, they can be blended with natural fibers such as cotton and wool.

The company claims that third-party tests showed denim clothing with its yarns had a lower combined temperature / humidity value of up to 5.3°F compared to a competing product, and up to 12.5°F when its yarn was used for both denim pants and briefs underneath.

Uses include clothing, mattresses and bedding, and shoes. There are about 100 brands manufacturing or retailing products with this technology, including: Abacus; Banana Republic; Calvin Klein; Costco; Duluth Trading; Mack Weldon; Merkel Gear; Pottery Barn; Trek; and vertx.

B. Arc-Chill® – This company has developed a technology that embeds particles of mica and jade in nylon yarn and other materials, rendering the clothing cool to touch. The fabric is also fast wicking and fast drying. Arc-Chill® claims a 4 to 7°F reduction in skin temperatures.

This technology has a scientifically measurable effect. A 2025 evaluation by *Consumer Reports* for a blanket using this fiber found it was 19% cooler than a cotton blanket compared as a control.

A number of companies make products with this technology, including blankets, sheets, T-shirts, and pillow cases. Most bedding is two-sided, using mica nylon on one side with jade particles embedded in the fabric. The other side is 100% cotton, bamboo, or polyester. In the case of blankets, the sides can be alternated depending on the season.

Retailers include Elegear (elegear.shop), Amazon, Walmart, and eBay. In February of 2025, costs of blankets and comforters ranged from about $18 to $94 depending on size, brand, and quality; sheets sets ranged from about $30 to $80, depending on size. T-shirts were $14 to $20.

C. ArcticCool™ – This company makes HydroFreeze X, fast-drying, fast wicking, evaporatively cooled light clothes made of polyester and Spandex. Moisture from the skin is evenly distributed at the fabric surface, which produces an instant cooling effect.

There is also another technology using the original fabric as the base. Vortex Vent™ uses micro-ventilated fabric construction to allow increased air circulation for a cooler experience. High heat areas in the garment contain additional micro-ventilated panels.

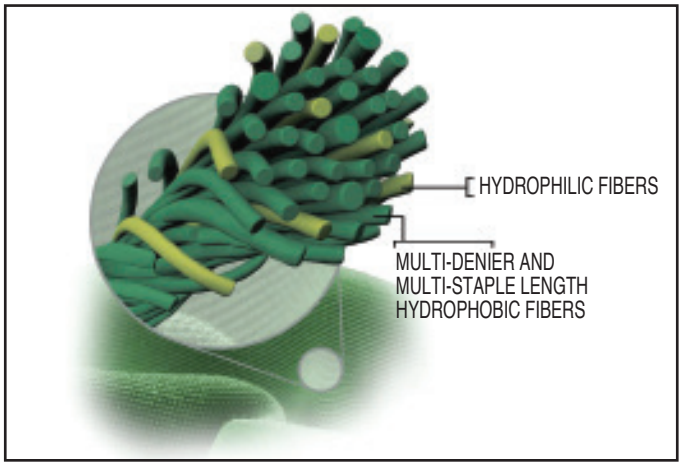
The company sells its products online: arcticcool.com. Items include: short- and long-sleeve shirts; tanks; under-

wear; and shorts. In February 2025, prices ranged from $20 to $70 per article.

D. Brrr° – Yes, this is really the company's name. It manufactures fabric that uses embedded minerals to render it cool to touch. Combined with quick wicking and fast drying, it claims to lower body temperature by several degrees Fahrenheit. Products include yarns and fabric blends made of denim, nylon, polyester, and rayon, as well as cotton.

There are dozens of major brands manufacturing or retailing products with this technology, including: women's apparel brand ADAY; Dillard's women's apparel line Alex Marie; Adidas; Tom Brady; outdoor brand FORLOH; and men's apparel brand GenTeal.

E. Drirelease® – This technology combines 85-90% (synthetic) hydrophobic fibers with 10-15% hydrophilic (synthetic or natural) mineral-infused fibers that wick away moisture for fast drying. The company claims that its fabrics keep skin up to 7°F cooler and up to 4 times dryer than cotton. It can be combined with any number of materials, including: cotton; denim; wool; linen; cashmere; and even pineapple.



***Drirelease®** combines hydrophobic and hydrophilic fibers for wicking*

In February 2025, there were 99 major brands manufacturing or retailing products with this technology, including: Cargo Crew; Dynafit; L.L. Bean; Nike; and Patagonia.

E. HEIQ – HeiQ has developed two technologies useful in summer cooling.

HeiQ Smart Temp is a dynamic evaporative cooling technology that can be used in any material. It allows heat vapor to escape when a person is hot, while adjusting when the body has cooled. The products can be used in mattresses and bedding as well as apparel. The company claims the fabric to be up to 4.5°F cooler than untreated fabric. In a dynamic evaporation test, at 35°C, the fabric evaporates at a 25% increased range compared to a control.

In February 2025, there were 20 brands using HeiQ Smart Temp technology, including: Eddie Bauer®; Burton; cep; Dickies; Hanes; and Timberland.

HEIQ Cool is another innovative fiber, cool to touch and with continuous evaporative cooling. The yarn is made of at least 50% biobased polymer. The company claims it has a fabric temperature 5.4°F below fabric without treatment.

In February 2025, the "running bare" line was using the fabric in tanks and tees.

F. Icebreaker – Icebreaker manufactures clothing with natural fibers. In 2023, 96% of its fibers were wool or plant based. Achieving this includes nylon derived from castor beans and elastic alternatives made with corn.

Most people associate merino wool with winter clothing, but using it in thin layers and plant blends allows it to be breathable and fast wicking.

Its Cool Lite™ fabric is a wicking and breathable blend of wool and TENCEL Lyocell wood fiber sourced from eucalyptus trees. The company claims the TENCEL allows garments to dry 3 times faster than wool alone. Clothing includes short- and long-sleeve shirts, shorts, leggings, underwear, and socks.

The line of clothing (including winter wear) can be purchased on the company's Web site: icebreaker.com.

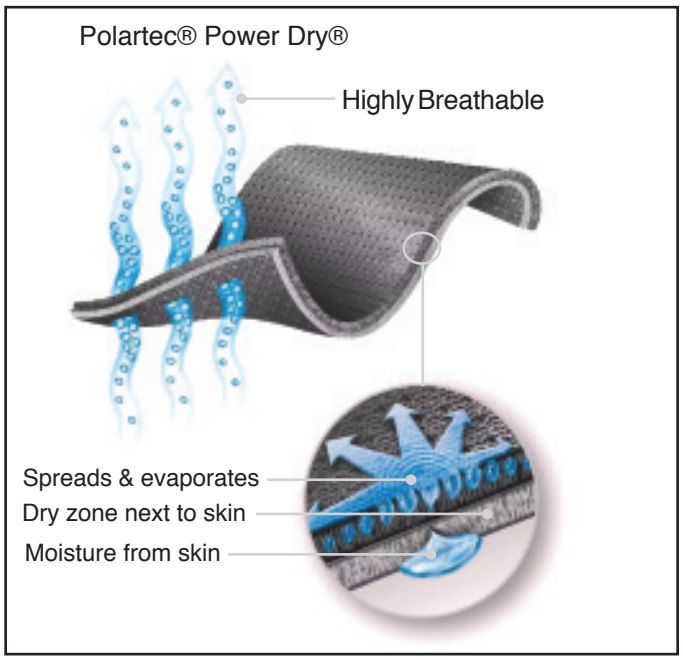
G. Lycra Coolmax® – Lycra, discussed earlier as a manufacturer of winter fabrics, also developed one of the earlier high-tech cooling fabrics, which began to be marketed in 1998. The material is a superbreathing, sweat-wicking polyester fabric whose manufacturers claim dries 5 times faster than cotton. Variations of it include EcoMade, based on recycled mill scrap, and ALL SEASON, which combines its classic sweat wicking material with hollow-fiber insulation for cold as well as hot weather.

It is used in many brands of clothing and bedding.

H. Nike – Nike is offering Dri-FIT technology, a polyester microfiber that moves sweat from the skin for quicker evaporation to help people stay dry and comfortable. In February 2025, almost 1,800 clothing products made with the materials were sold, including long- and short-sleeve shirts, shorts, socks, tanks, leggings, and tracksuits. Prices ranged from $12 for socks to $200 (and more) for professional sports jerseys and jackets. Products are sold on the company's Web site: nike.com.

I. Polartec® – Previously discussed in the Winter Clothing section, makes cooling fibers as well, typified by its Delta products.

Delta Power Dry® employs conventional wicking and fast drying to base layers for both hot and cold weather.



Delta™ Evaporative is a dynamic product that is breathable, fast-wicking, fast-drying, and cool to touch. It also uses a kind of evaporative cooling strategy where perspiration is moved to the front of the garment. Unlike a wet t-shirt, it does not cling to skin. But similar to a wet t-shirt, it allows the water (sweat) to cool the skin through the breathable fabric.

In February 2025, some of the retailers that sold product with Delta™ include: Backcountry.com; Competitive Cyclist; Foehn; Goldwin; Karpos Outdoor; and Kuhl Clothing.

J. Singtex – This Taiwanese clothing manufacturer produces S.Café® and S.Café® ICE-CAFÉ™. The yarns infuse nano coffee grounds with polyester, increasing surface area, which allows efficient sweat dispersion and evaporates moisture from the fabric. It is extremely breathable. Fabric made from the yarn from these materials is also cool to touch. The company claims the ICE materials lower skin temperature 2 to 4˚F compared to regular fabrics.

In February 2025, there were 54 partners manufacturing or retailing products with Singtex materials, including: L.L.Bean; Northland; Scania; and The Northface.

10. Active Wearable Cooling Devices

As the world gets hotter, a new class of products is taking off – active wearable cooling gear. These wearable products and garments provide ventilation, or cold temperatures, or both.

Bill Smith
Realtor®
Bill Smith
Cell (512) 656-2066
Landline (512) 444-7744
RealBillSmith@yahoo.com

10.1 Wearable Fan Jackets

Despite the seeming contradictions, various kinds of jackets and vests actually keep people cool. They use battery-powered fans on the back of coats and jackets to push drafts of cold air against the back, which provides ventilation while carrying away sweat.

At least two companies make jackets and vests with fan ventilation, and another makes a jacket cooled with both fans (that remove heat) and semiconductor cooling.

10.2 Wearable Neck Fans

Damir Khabirov / Stock.Adobe.com

While these products appear to be a recent phenomenon, the trend is growing fast. An analysis by Verified Market Reports estimated $113 million in neck-fan sales in North America in 2023.

Neck fans wrap around the neck, sending an artificial breeze upward to the neck and face. There are a number of similar looking products that place two protected fans on either side of U-shaped plastic. Many of the less expensive units have 3 speeds (low / medium / high). Depending on which speed is preferred, the fans can operate for 2 to 24 hours on a single charge. The batteries are often built-in, and are are recharged via a USB cord to the fan from a typical phone or electronics charger. In 2025, lower-cost neck fans often retailed for as little as $10 to $34.

Another adaptation of ventilation is the waist fan. It is enclosed in a small box that snaps on pant belts to force a breeze on a person's back or chest. It can, alternatively, be hung as a lanyard, to send wind upwards to the neck and face. In February 2025, lower-cost units started at around $25, graduating up to almost $100, with most of these more expensive units being better quality.

Like most of their neck-fan cousins, almost all of these devices operate at three speeds. There is a broad range of operating time, velocity (wind speed), and durability. The units range from about 3 to 12 hours at high-speed settings to 8 to 24 hours at low-speed settings.

Some units contain LED lighting and can also charge

electronic devices. All of these units emit noise to a greater or lesser extent.

Below are products for wearable ventilation. Note that there are over a thousand neck and waist fan products. You can find most of them through online retail sites. The ones in the chart on this page have been tested and recommended by *Consumer Reports*, *Popular Mechanics*, and *Wirecutter* (*New York Times*). The prices are from February 2025.

Important environmental concerns for these various fan devices include the durability of the product and sustainability of the power source. Landfills are littered with cheap, poorly built consumer products. Purchasing quality products increases the odds of both longevity and satisfactory performance. And buying products where batteries are replaceable and not built-in allows the products' continued use after the original battery expires.

10.3 Thermoelectric Neck Fans and Garments

Some portable cooling products use sophisticated Thermoelectric Cooling (TEC) semiconductors. While not as effective as refrigerant-based space cooling and resistance heating operated in buildings and vehicles, these alternatively move heat or cold from one side of the chip to the other, creating a localized comfort experience.

More sophisticated neck fans and garments with TEC chips alternatively chill or heat the body, often at the same time fan ventilation is occurring. Some products do not have fans at all. They fit on the back of people's necks, a sensitive point where temperature sensation is magnified.

Effectiveness of active cooling wearable devices has to be viewed by the challenge of human anatomy. Though science has not settled on an exact temperature, somewhere between 90˚ and 104˚F, hot summer air with low humidity blown on a human body actually causes the body to heat up, and is counterproductive to health. Seen in this way, TEC devices and garments are going to be more effective than fans alone.

In February 2025, products with TECs ran anywhere between $45 and $299, depending on the brand, features, and quality.

In 2023, when the *Directory* began to investigate these products, there were only a few made commercially. These are discussed here, along with another model recommended by *Wirecutter* (*New York Times*).

The *Egopp 1S Cool Down* model, at the lower end of costs, claims to lower temperature 30˚F in a second's time. Powered by a built-in battery, the 3-speed unit can last up to 1.1 to 1.4 hours in cooling/ventilation mode and 3 to 8 hours in ventilation mode.

There are other devices besides neck fans that employ thermoelectric cooling chips. These include fan vests with TEC chips next to the ventilation, and neck coolers without ventilation fans.

Peltier LLC employs up to 8 portable fans next to TEC chips in vests and shirts that can both cool and heat. Named for the Peltier effect of physics that allows TEC chips to work, these fans actually carry the heat emitted from the chips away from your body. The cooling and heating are distributed through conduction.

Wearable Ventilated Cooling

Makita Fan Jackets • makitatools.com • (800) 462-5482			
	2025 Cost (Battery not Included)	**Lowest Cost for Battery/Charger**	**Attributes**
DFJ214ZS 18V Cordless High Vis Fan Jacket	$151-357	$56/$31	Up to 11 hrs/charge; Phone charge port; 3-year warranty
DFJ304Z 18V LXT® Cotton Fan Jacket	$99-248	$56/$31	Up to 15 hrs/charge; Phone charge port; 3-year warranty
DFJ405ZS 18V LXT® Lithium-Ion Cordless UV Resistant Fan Jacket	$112-285	$56/$31	Up to 15 hrs/charge; Phone charge port; 3-year warranty
Alphacool Products • alphacoolproducts.com • (888) 406-1984			
	2925 Cost w/Battery	**Extra Battery**	**Attributes**
AlphaCool 5V Cooling Fan Jacket	$100	$50	Up to 10 hours/charge; 3-speed; 1-year warranty
AlphaCool 5V Cooling Fan Vest	$90	$50	Up to 10 hours/charge; 3-speed; 1-year warranty
Neck Fans			
	2025 Cost	**Battery**	**Attributes**
JISULIFE Portable Neck Fan	$34	Built-in	3 to 16 hrs/charge; 5 speeds; 1-year warranty
Gulaki Neck Fan	$24	Built-in	5 to 15 hrs/charge; 3 speed
Hotsales Neck Fan YP-06	$50	Built-in	4-16 hrs/charge; 4 speed

The manufacturer claims it can lower temperatures by 27 to 36˚F below the ambient outdoor temperature. The vests have 4 settings, and batteries can last from 3.5 to 5 hours on a charge. In February 2025, costs ranged from about $103 to $189, with extra batteries costing an additional $20.

Courtesy PolarSeal

The *Polarseal GEMM* is a neck cooler/heater. It is controlled by a device hanging on a lanyard meant to dangle on the upper part of a person's chest.

It has 3 settings, allowing its batteries to last between 3.5 to 7.5 hours per charge. In February 2025, the cost was $200. The device comes with a built-in battery. The company claims that at full power, it can lower temperatures by up to 36˚F (at 86˚F ambient temperature), while raising neck temperatures in winter by 32˚F.

The *Sony Reon Pocket 5* TEC neck cooler/heater was originally inspired from the company's development of cell phone temperature regulation. It adjusts to fit on the back of the neck with a thin silicon-coated wire tube. It has a fan on the back that exhausts heat during the cooling cycle, but does not run in the heating cycle.

The Pocket 5 model (released in 2024) has a built-in battery that operates with 5 settings to cool 4 to 17 hours per charge for as much as a 27˚F temperature fall. It operates with 4 settings to heat from 4 to 8 hours per charge for as much as a 46˚F rise in temperature.

It can either be controlled manually or by phone, and can be automatically set by phone for several types of timed cooling and heating cycles.

U.S. customers can buy the product on eBay. In February 2025, the lowest cost found was $174.

The *Torras Coolify* models are one of the more expensive and higher quality brands. The combination neck cooler/heater and neck fan models have built-in batteries. They operate at 3 fan-speeds and 3 temperature settings to cool or heat between 2 and 28 hours per charge depending on the model and settings. They can create a 30 to 36˚F temperature fall.

Below is a chart of these products and purchasing contacts. Consumers who want to shop the entire market are directed to eBay, Walmart, Amazon, and similar retailers.

10.4 Not Recommended: Wearable Ice Jackets

Despite the seeming contradictions, there are also cooling vests and jackets that allow packaged ice and phase-change materials (often benign frozen chemicals that solidify at around 59˚F) to be inserted within chest pockets in the garment.

This class of products is the only one in this article where vigorous cautions on effectiveness are advised. While these technically "work," there are several formidable challenges.

1. The largest problem is the cooling effect is very temporary. In hot summer weather, the cold materials can melt in as little as an hour. The cold packs then have to be replenished, which would require a freezer (or ice chest) to be located nearby.

2. In emergency situations that cause long power outages, sustainable supplies of cold packs would be unlikely. Even if a building had an alternative source of power for refrigeration, the priority for most people would be food preservation, not cold packs.

3. In the case of ice packs, there would likely be condensation, which might cause discomfort, and the water would drip on to damageable surfaces if worn indoors. Packs of reusable phase change materials above 59˚F can be purchased instead of using ice that avoid this problem. But they will not hold as much cold temperature.

In many situations, these products are impractical, and other alternatives should be considered.

Wearable/Portable Thermoelectric Cooling

Company	Type	2025 Cost	Battery	Contact	Attributes
Egopp 1S Cool Down	Neck Fan	$60	Built-in	Web retailers	1.1-8.3 hrs/charge; 3 settings @ for fan and cooling
Peltier	Vests and Shirt	$103-189	$20/extra battery	peltiernyc.com	3.5-5 hrs/charge; 27 to 36˚F fall cooling
Polarseal Gemm	Neck Cooler	$199	Built-in	polarseal.me/gemm.html	3.5-7.5 hrs/charge; 3 settings; 36˚F fall cooling; 32˚F rise heating
Sony Reon Pocket 5	Neck Cooler	$174 up	Built-in	sony.com.hk/reonpocket/en/	Cooling: 4-17 hrs/charge; 5 settings, 27˚F fall. Heating: 4-8 hrs; 4 settings 46˚F rise.
Torras Coolify	Neck Fan	$149-$299	Built-in	torraslife.com	2 to 28 hrs/charge depending on model; 3 fan-speeds and 3 temp settings for both cold and heat; 30 to 36˚F fall