



# *Montana Fish, Wildlife & Parks*

## **Deterring Bears with Electrified Fencing: A starter's guide to constructing a front country electric fence**



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## Introduction

A properly constructed electric fence is safe for people and pets and has proven to be effective at deterring bears from apiaries (beehives), fruit trees, gardens, livestock pens, rabbit hutches, garbage containers, dog kennels, chicken coops, compost piles, storage sheds, along with numerous other attractants. There are an abundant variety of applications and fencing designs for deterring bears. Design, construction and proper maintenance will determine the effectiveness of your electric fence.

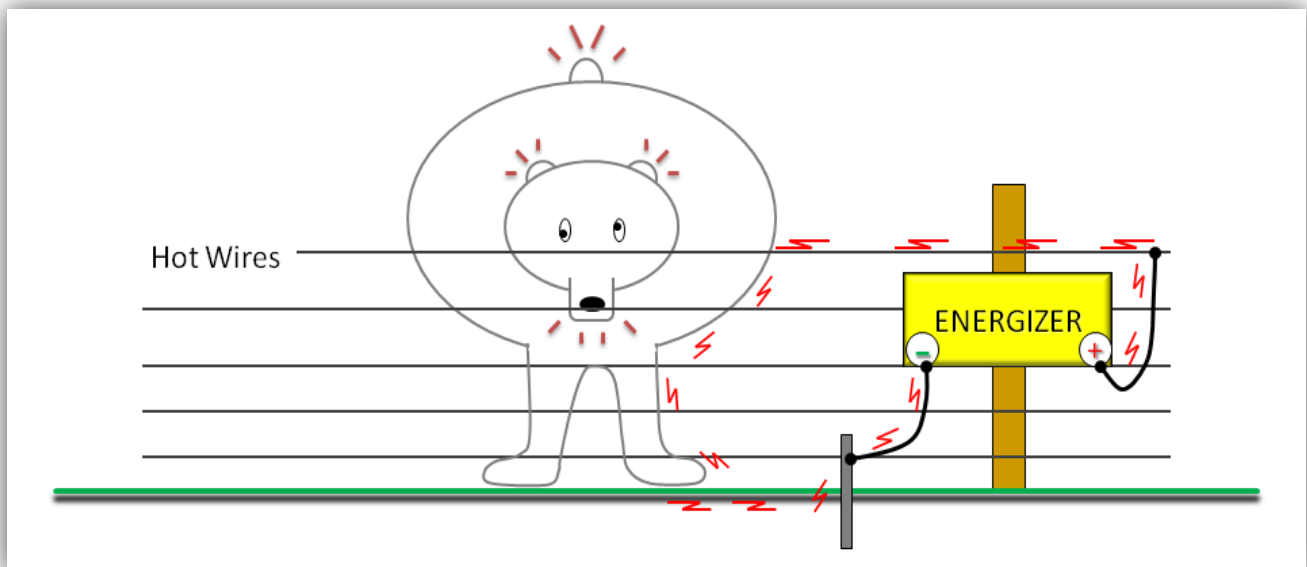
The purpose of this guide is to provide basic information on how to create an electrified fence. It is designed for people that may have limited experience with electrified fencing but are interested in understanding the basics before designing a fence of their own. This guide does not provide detailed information on designing electrified fences for exclusively keeping in livestock. For more detailed information on fence design options, and other ideas, please see the *Additional Resources* section on page 13 of this guide.

Safety is always a concern when using electrified equipment. Modern electric fence energizers have been shown to be safe for humans, animals and vegetation. The pulse rate of a modern energizer is so quick that it cannot generate enough heat to start vegetation on fire. While touching an electrified fence is unpleasant, modern energizers are safe to use around pets and children. However, it is always advisable to use common caution around electric fencing:

- Do not touch an electrified wire or fence with any part of your head, neck or spine
- Do not attempt to step over or climb through a fence that is electrified
- Wear appropriate footwear when approaching an electrified fence
- Never electrify barbed wire
- Hang warning signs in locations that will warn children, untrained adults and visitors that your fence is electrified
- Make your electrified fence as visible as possible
- Never encourage anyone to touch an electrified fence
- Never touch the positive and negative terminals of an energizer at the same time with anything other than an appropriate voltage meter
- Use an energizer that is appropriate to the length of fence being electrified

## How Electrified Fencing Works

When an animal touches an electrified wire and the ground simultaneously, the electricity passes through the animal, into the soil, to the ground rod and back to the energizer. The electrical circuit is then completed and the animal receives a full shock (Fig 1.). However, if the soil is too dry or the grounding rod is inadequately placed, the electricity will be unable to find a path back to the energizer and the animal will receive little or no shock.



**Figure 1. A bear touches an electrified wire, completing the electrical circuit, and receives a shock**

To effectively deter bears, they require an electric fence design that they cannot climb through, over or under without receiving a shock. This generally requires constructing a fence that has 1) multiple electrified wires, 2) a combination of electrified wires and an existing fencing, 3) a combination of electrified wires and rigid wire panels, or 4) a pre-fabricated electrified net fence.

## Getting Started

A few things to consider before buying materials and building your fence:

### Will your electric fence ever need to be moved or taken down?

There are many pre-fabricated electrified “net” fences that are quick to install and easy to move. A fence constructed of Polywire and step-in-the-ground plastic posts can be used as a seasonal or semi-permanent electrified fence. Although easier to construct than permanent fences, these temporary fencing designs typically require more maintenance than permanent fencing to keep them running at optimal performance.

### Are dry periods common?

Electric fences rely upon soil moisture to properly deliver an effective electrical shock to an animal. If the soil in your area becomes dry during certain months of the year, or if your fence will be placed in dry, rocky soil, you will need to design a ground-return system (see Figure 3).

### Will you need to leave the electric fence in place during months of snow and ice?

Some electric fencing materials handle snow and ice better than others. Check with your electric fencing retailer for information on appropriate products. Be prepared to do spring maintenance on an electric fence that has been partially buried under snow and ice.

### Will your electrified fence need to secure hooved livestock as well as exclude bears?

Check with your local fencing retailer or agriculture extension agent on electrified fencing designs appropriate to your livestock, and for how to train your livestock to respect an electrified fence.

## Components

The five primary components of electric fences are:

1. Energizer
2. Grounding System
3. Wire
4. Posts
5. Voltage Meter

There are other components that may be necessary, or convenient, for designing your particular fence, such as gate handles, drive through gates, or on/off throw switches. These can be added as needed.

### 1. Energizers

Energizers (sometimes called chargers or controllers) are the power source for your electrified fence. Energizers come in a wide variety of makes and models, but all of them store energy and deliver very short pulses of electricity (about one pulse per second) through the electrified wires. To effectively exclude bears, you will need an energizer that pulses approximately 45-60 times per minute, or once every 1.0-1.5 seconds.

An energizer's stored energy is measured in joules, which is a measure of the volume of electrical energy; similar to a pint or gallon measurement for water. **For excluding bears around residences and in the front country, your energizer will require a joule rating of at least 0.7.** This type of energizer should be able to produce an output of at least 7,000 volts of energy throughout your fence, as long as there is minimal weed and grass contact with energized wires.

Low cost, low pulse rate, low joule-rated energizers are abundantly available and are adequate for many livestock applications. However, these energizers are not suitable for deterring bears or other wildlife. Along the same lines, very old farm energizers were not designed with the safety measures that are in place today and may be unsafe to use. On the other end, big and expensive energizers are not necessarily appropriate either. For those designing a fence to exclude bears from attractants such as chicken coops, fruiting trees or beehives, a joule rating between 0.7-1.0 should be adequate. Unless you are energizing several miles of fencing, and have a high weed/grass load, a joule rating higher than 1.0 might be unnecessary.

### ***Plug-in, Battery or Solar?***

There are 3 basic types of energizers to choose from:

**AC:** A plug-in energizer directly connects into a 110-volt outlet (standard household current). AC energizers are the least costly type of energizer to purchase and operate. They have a standard pulse rate of 50-60 pulses per minute, receive a consistent power and require less maintenance than battery or solar operated units. Wherever possible, AC plug-in energizers are recommended for electric fencing.

**DC:** Battery operated energizers receive their power from 6 or 12-volt DC deep-cycle or marine batteries. Battery operated energizers are just as effective as plug-in units and are more versatile for location placement. However, because the batteries themselves are an added expense, their overall cost is higher than AC energizers. Some DC energizers will have a lower pulse rate than AC energizers, so remember that bears require 45-60 pulses per minute to be effectively deterred. DC energizers will require more maintenance than an AC unit, as the battery must be regularly recharged for your fence to remain at optimal performance.

**Solar:** Solar units consist of a solar panel directly attached to both battery and DC style energizer. Some solar energizers come as a single unit, with both the battery and energizer enclosed in a case or other type of housing. Solar-panels can also be purchased separately and added to a DC operated energizer. If purchased and added separately, the solar array must be powerful enough to charge the deep-cycle battery(s) used. The location of your solar energizer must receive enough sunlight to ensure that it will provide a sustainable charge for the battery.

## **2. Grounding System**

**Adequate grounding is an important component in the design of all electrical fencing.** Without adequate grounding, an electrified fence will be unable to deliver an appropriate shock to an animal.

*You will need 3 to 6-feet of grounding rod per 1-joule of energy from your energizer.* Grounding rods should be ½" -3/4" in diameter and made of galvanized steel. Non-galvanized metal rusts and will

cause resistance, reducing the effectiveness of the grounding rod. Painted metal, t-posts or rusted metal should not be used, as the paint and rust will act as a barrier for conducting electricity. A grounding rod clamp should be used to attach the wire running from grounding rod to the energizer's ground (-) terminal.

Grounding rods should be driven in the soil near the energizer to a depth of 3-6 feet. It is necessary to drive grounding rods as deep as possible so that the rod is in contact with the greatest amount of surface area, which will facilitate the flow of electrical current back to the energizer.

In dry soils, or in locations where it is difficult to drive a grounding rod to a 6-foot depth, you can use multiple grounding rods, which should be placed in a series 5-10 feet apart. Dry soils will make it harder for the electricity to travel through the soil, to the grounding rod and back to the energizer; this will reduce the effectiveness of your electrified fence.

There are 2 types of grounding systems for electrified fencing:

### A) All-Hot Fences

In an all-hot fencing design, all of the fence wires are electrified (hot or +). **All the electrified wires are connected to each other** and then to the positive (+) terminal on the energizer. The negative (-), or ground, terminal is only connected to the grounding rod. The animal stands directly on the ground, touches one of the electrified wires, and receives a shock (Fig 2.).

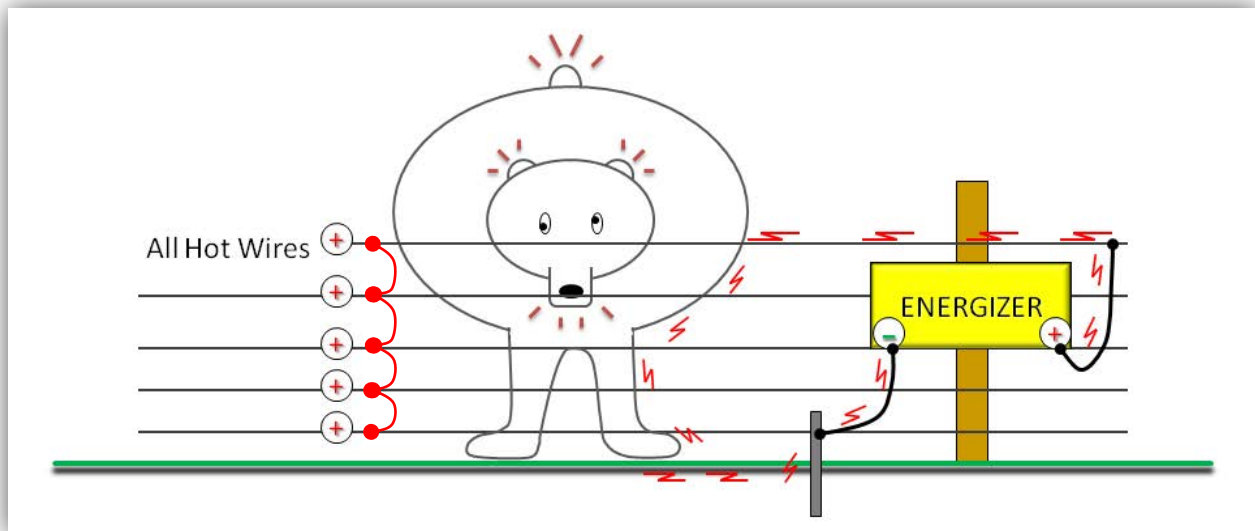


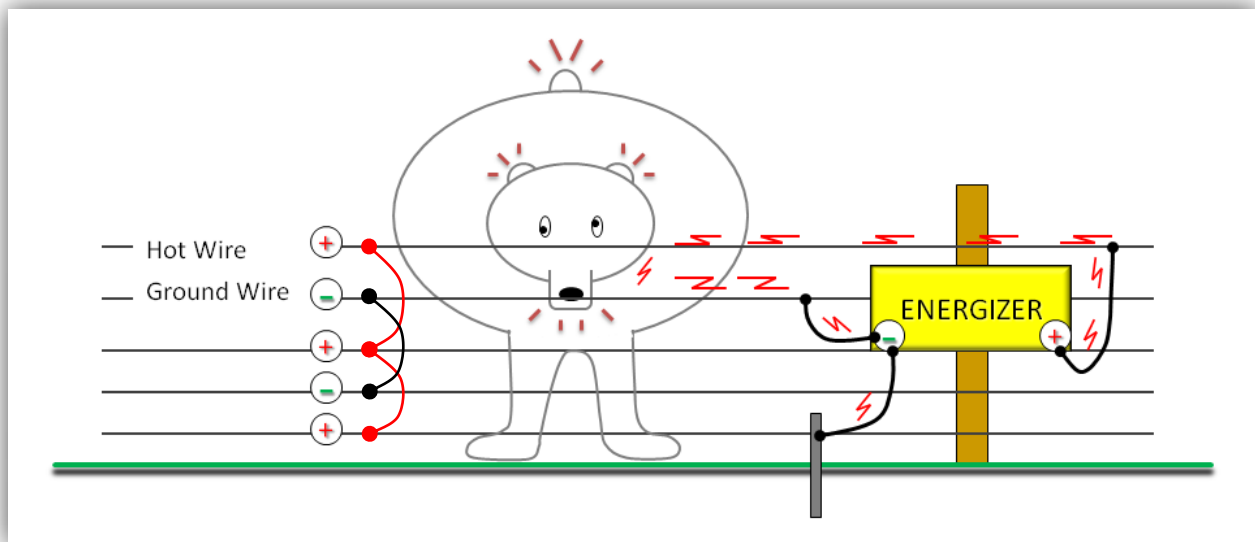
Figure 2. An all-hot electric fence design. All wires are connected to each other and to the positive terminal on the energizer

At least 5 electrified wires are recommended, placing the lines close enough together so an animal cannot pass between them without receiving a shock. The wire closest to the ground should be low enough so that an animal cannot easily go under it without also receiving a shock, usually 8-10" high. For a fence designed to only exclude bears, the overall height typically needs to be 40-54" high.

An all-hot fence design is only good in areas with damp or moist soil year round. Areas that are frequently watered, such as gardens or fruit orchards, are suitable for an all-hot design. If necessary, you can increase the moistness of the soil surrounding the grounding rod(s) by placing a 5-gallon water bucket, with a small hole drilled in the bottom, next to the rod(s). The water will slowly drain from the bucket and increase the moisture of the soil surrounding the grounding rod. Refill the water in the bucket as needed.

### B) Ground-Return Fences

A ground-return design consists of alternating hot (+) and ground (-) wires (Fig 3.). All hot wires are connected to each other and to the positive (+) terminal on the energizer. All ground wires are connected to each other and to the negative (-) terminal on the energizer. The energizers negative terminal must also be connected to the grounding rod. Rather than solely relying on the soil to complete the electrical circuit, this design directly returns the current to the energizer through the ground (-) wires. The animal must touch both a hot and a ground wire simultaneously to receive a full shock. This fence design should be used in dry or rocky soils and in locations where there are poor grounding rod conditions.



**Figure 3. A ground-return electric fence design. All hot wires are connected to each other and to the positive terminal on the energizer. All ground wires are connected to each other and to the negative terminal of the energizer.**

At least 5 electrified wires are necessary, placing the lines close enough together so an animal cannot pass between them without receiving a shock. The wire closest to the ground should be low enough so that an animal cannot easily go under it without also receiving a shock, usually 8-10" high. For a fence designed to only exclude bears, the overall height typically needs to be 40-54" high. The bottommost and topmost wires should always be hot (+), therefore you will always need an odd number of wires in a ground-return design.

*There are many fence designs that can be created based on these two different wiring systems. Just remember, no matter which wiring system or fencing design you chose, you must always connect the energizer to a sufficient grounding rod for the fence to work properly.*

### **3. Wire and Panels**

All metal wire should be used for permanent electrified fencing and can be found in galvanized smooth-steel or aluminum. Smooth-steel wire is strong and durable, but it is difficult to work with and typically only used in high-tensile fencing designs. Aluminum wire is lightweight and easy to use, but it will break with constant or repeated bending. Permanent electrified wire should be 12-14 gauge in size. Electrified wire or panels should be hung on the outside of your fence posts.

For temporary, seasonal or portable electric fencing, you may consider using a type of polyethylene wire (Fig 4). “Polywire” consists of multi-stranded aluminum or stainless-steel wire braided within polyethylene. Polywire is flexible, strong and can be unrolled and re-rolled multiple times without breaking. It is recommended that your Polywire has at least 9 strands of wire imbedded within the polyethylene. Polytape, which is flat, is less effective for bear exclusion and is not recommended.



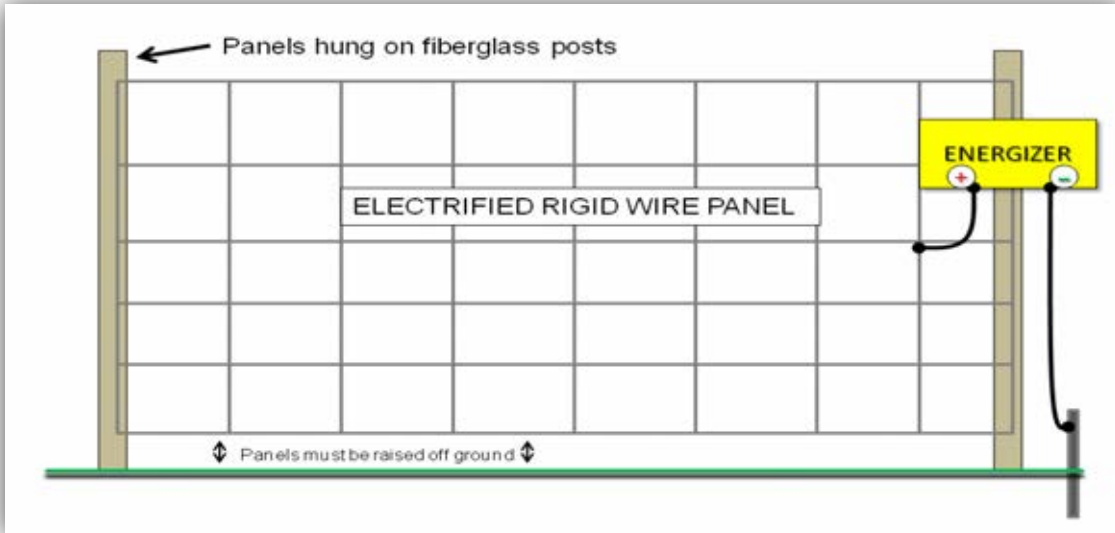
**Figure 4. Two styles of electric fencing Polywires.**

Heavy gauge insulated wire, specifically designed for electrified fencing, will be needed to connect the energizer to an electrified wire, to connect electrified wires in a series, and to connect two sections of fence together, such as at a gate opening. This type of insulated electric fence wire can be buried underground (i.e. under gate openings), fixed to posts or buildings, and be used in locations where using un-insulated wire might cause an electrified wire to ground out.

#### ***Using rigid wire panels***

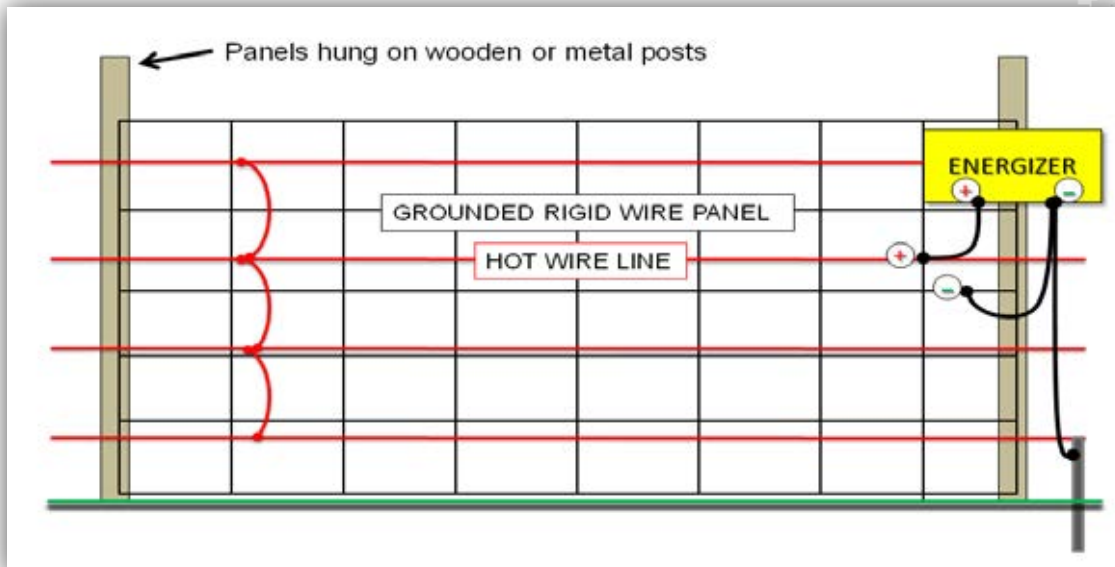
Depending on the size of the fence and application, rigid wire (cattle or hog) panels can be used in addition to, or even instead of, traditional electric fencing wire. For example, metal rigid wire panels can be raised off the ground, by attaching them to fiberglass posts, and then electrified. The panels are attached to each other and to the positive terminal of the energizer. The fiberglass posts will insulate the panels to ensure that they remain electrified (Fig 5).





**Figure 5. Electrified rigid wire panel.** The wire panel is electrified by connecting it directly to the positive terminal on the energizer. The panel must be insulated by hanging it off the ground onto fiberglass posts.

Or, panels can also be used as the grounded wire in a ground-return fencing system (Fig. 6). This design can also be used to upgrade an existing fence by adding electrified wires to the outside of your field, or rigid wire, fence.



**Figure 6. Rigid wire panel, or existing field fence, with 4 electrified wires on the outside.** The rigid wire panel, or field fence, is directly connected to the negative terminal on the energizer to create a ground-return system.

## 4. Posts

The primary difference between permanent and temporary fencing is the choice of fence posts and the extent to which they are installed. For low maintenance, permanent fencing, treated wooden posts are the best choice. Less permanent fencing is sometimes constructed using fiberglass or metal T-posts. And seasonal or portable fences are usually constructed from step-in-the-ground plastic posts or fiberglass posts. Wooden posts and metal t-posts are more expensive and require the added expense of insulators; however, they are permanent and more durable than plastic and fiberglass posts and require less overall maintenance.

Insulators must be used to secure electrified wires to wooden and metal posts to prevent the wire from touching metal, wood or the ground. There are many different styles of wire insulators to choose from. Look for insulators that will hold the electrified wires 4-6 inches away from posts, existing fencing or wire panels. Plastic step-in-the-ground posts are designed with multiple slots in which the wire is held in place. Wire can be held in place on fiberglass posts with metal clips, or holes can be drilled through fiberglass posts and electrified wire can be fed directly through each post. In ground-return fence designs, the ground (-) wires may be directly attached to any type of post as these wires do not need insulation from grounding.

## 5. Voltage Meters

The most important part of electric fence maintenance is the use of a voltage meter, sometimes referred to as an electric fence tester. This small device not only tells you if your energizer and grounding system are working properly, it tells you the amount of current passing through your electrical wires. This is not the same as a voltage reader, which only tells you *if* electric current is passing through the wire, not *how much*...and to effectively deter bears, it is the *how much* that matters. Bears require a minimum of 7,000 volts. Electric fence voltage meters should be used to test if your fence is functioning effectively immediately after setup, and then periodically thereafter as part of regular fence maintenance.

## Electrified Net Fencing

Prefabricated electrified net fencing creates a quick and easy temporary fence that is frequently used to keep out wildlife and keep in small domestic livestock. Electrified netting is a combination of horizontal and vertical poly-wires attached to step-in-the-ground posts (Fig. 7). They are pre-manufactured in 50 to 164-foot lengths.

Electrified net fencing is fully portable and requires no special tools to install. Once an energizer and grounding rod are attached, it becomes a fully functioning electrified fence that can be used to temporarily secure fruiting trees, chicken coops and yards, sheds, or in any location where bears need to be excluded from. Electrified net fencing does not need to connect back onto itself, or create a full circle, in order to function. Multiple sections of netting can be connected together to design a fence of any length or size.

Electrified net fences come in all-hot and ground-return (pos/neg) designs. For excluding bears, ground-return (pos/neg) designs are recommended. There are many manufacturers of electrified net

fencing. Please see a local or online fencing retailer for more detailed information regarding electrified net fences.



**Figure 7. A pre-manufactured ground-return (pos/neg) electrified net fence. The orange horizontal wires are electrified (+) and the green horizontal wires are grounded (-). The vertical black lines secure the horizontal wires in place.**

Once you have a basic understanding of how an electrified fence functions, you can create just about any type of design with these basic concepts in mind. For example, you can create an electrified mat that lies flat on the ground at gates or driveway entrances. This design allows people wearing rubber soled shoes to walk over the mat, or vehicles to drive over, without being shocked. Or you can electrify a bird feeder, a doorway or even a harvested game with these same electric fence concepts. *For more information on how to create these, and other, unique electric fence designs, go to the **Living With Wildlife Foundation** website [www.lwwf.org](http://www.lwwf.org) and download the **Living with Predators Resource Guides**.*

# Electric Fence Specifications for Deterring Bears

Minimum Joule Requirement:	0.7
Minimum Voltage Requirement:	7,000
Minimum Fence Height:	4 feet
Minimum # wires (for a stand-alone electrified fence):	5

## What Can Electrified Fences be Used For?

Fruiting Trees	Garbage Containers	Songbird Feeders
Chicken Coops	Poultry Pens	Porches
Chicken Feed	Small Livestock Pens	Sheds
Livestock Feed	Beehives	Yurts
Outdoor Dog Pens	Dumpsters	Gardens
Compost	Barbeque Grills	Refrigerators/Freezers
Harvested Game	Outbuildings	Summer Cabins

## Tips and Trouble Shooting

- ***Remember that grounding is the most important component in the design of an electric fence system. If your energizer is not properly grounded then it will not deliver an appropriate shock and will be ineffective.***
- If using a solar or battery operated energizer, check the charge on your battery often. Check battery terminals for corrosion and that they are still appropriately connected.
- Check that electrified wires are not touching heavy vegetation, fallen branches, broken insulators, non-electrified wires, wooden posts or metal posts.
- Check for poor connections in spots where electrified wires have been spliced together.
- Check voltage on every electrified wire with a voltage meter weekly, and as part of routine fence maintenance.
- Place electric fencing signs on the perimeter of your fence to improve visibility and warn people the fence is electrified.
- When protecting a structure (chicken coop, shed, rabbit hutch, etc.) the fence should be placed 3-5 feet away instead of directly on the structure, whenever possible. This way the bear encounters the fence before reaching the structure.
- When protecting fruit trees, place your electric fence so that all fruit will fall inside the fence boundary instead of outside it.

## ADDITIONAL RESOURCES

### **Montana Fish, Wildlife & Parks**

<http://fwp.mt.gov> For information specific to bears, click on the “Fish & Wildlife” tab and then the “Living with Wildlife” tab.

**To contact a Montana Fish, Wildlife & Parks bear manager near you:**

<b>Region 1:</b>	Libby	Grizzly/Black Bears	Kim Annis:	406-293-4161
	Kalispell	Grizzly Bears	Tim Manley:	406-751-4585
	Kalispell	Black Bears/Mtn Lions	Erik Wenum:	406-751-4588
<b>Region 2:</b>	Missoula	Grizzly/Black Bears	Jamie Jonkel:	406-542-5508
<b>Region 3:</b>	Bozeman	Grizzly/Black Bears	Kevin Frey:	406-994-3553
<b>Region 4:</b>	Choteau	Grizzly/Black Bears	Mike Madel:	406-466-5100

### **Living With Wildlife Foundation**

<http://www.lwwf.org>

Look for the “Living with Predators Resource Guides”

### **Interagency Grizzly Bear Committee (IGBC)**

<http://www.igbconline.org>

**Information on electric fences, 'How To' guides, and instruction videos can be found by doing an internet search for “Electric Fencing How To Guide”.**