



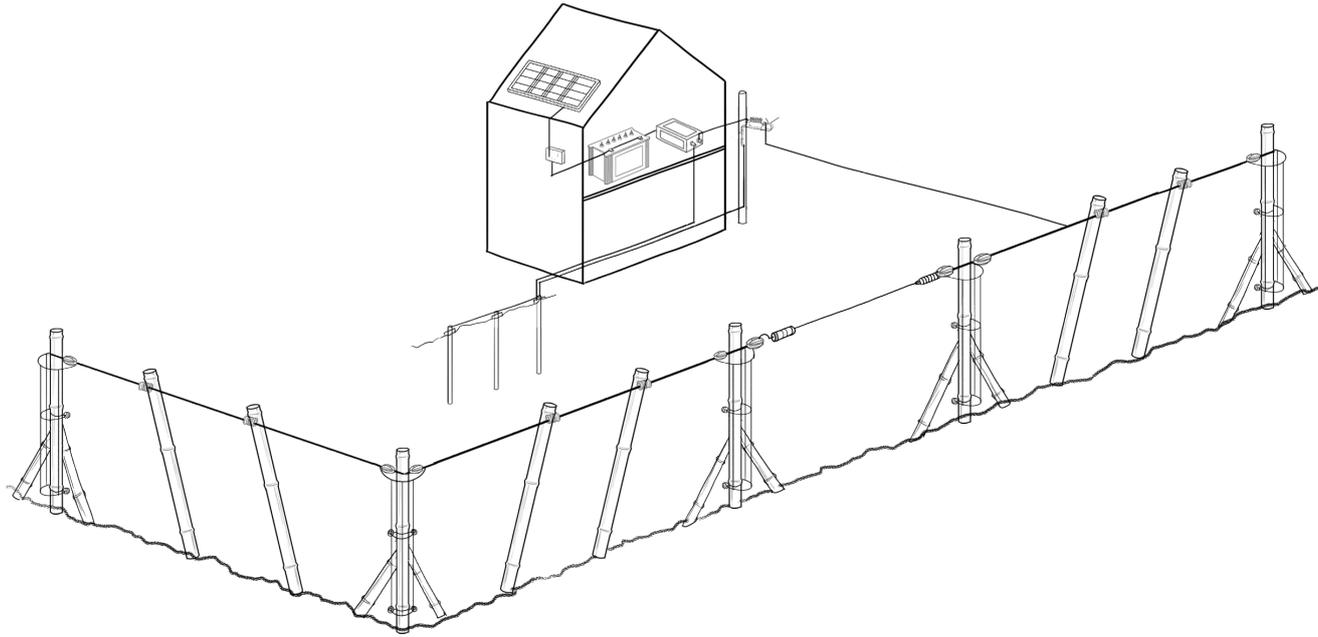
Working together
to reduce negative
human-elephant
interaction in
Assam.



Pernod Ricard India
FOUNDATION

The Ele-fence Manual

Installation of low-cost solar-powered fences to manage human-elephant conflict



WWF-India thanks the Assam State Forest Department and Assam Civil Administration for their support. We also appreciate the contributions of local community anti-depredation squads, power fence management committees, tea garden workers, and tea garden management.

WWF-India offers special thanks to Pernod Ricard India Foundation. Their gracious support made this manual possible.

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Introduction

Non-lethal solar-powered fences can be very effective at preventing elephants from entering villages or agricultural lands. However, if not set up properly, these fences can either be ineffective at keeping elephants out or become lethal to both elephants and humans.

This manual contains step-by-step instructions on how to install and maintain a low-cost solar-powered fence. The manual is intended to help officials, conservation NGOs, and communities safely install non-lethal solar-powered fences to help prevent losses of crops and property to elephants. It contains four sections.

This **introduction** section summarizes how a solar-powered fence works.

The **pre-installation** section explains how to prepare for the installation of a solar-powered fence.

The **installation** section contains detailed instructions on how to install a solar-powered fence.

The **post-installation** section describes how to maintain the fence after installation.

This manual is based on the expert experience of WWF India conservation practitioners, but WWF India does not bear responsibility for any accidents that occur while trying to construct these fences.

About the ele-fence

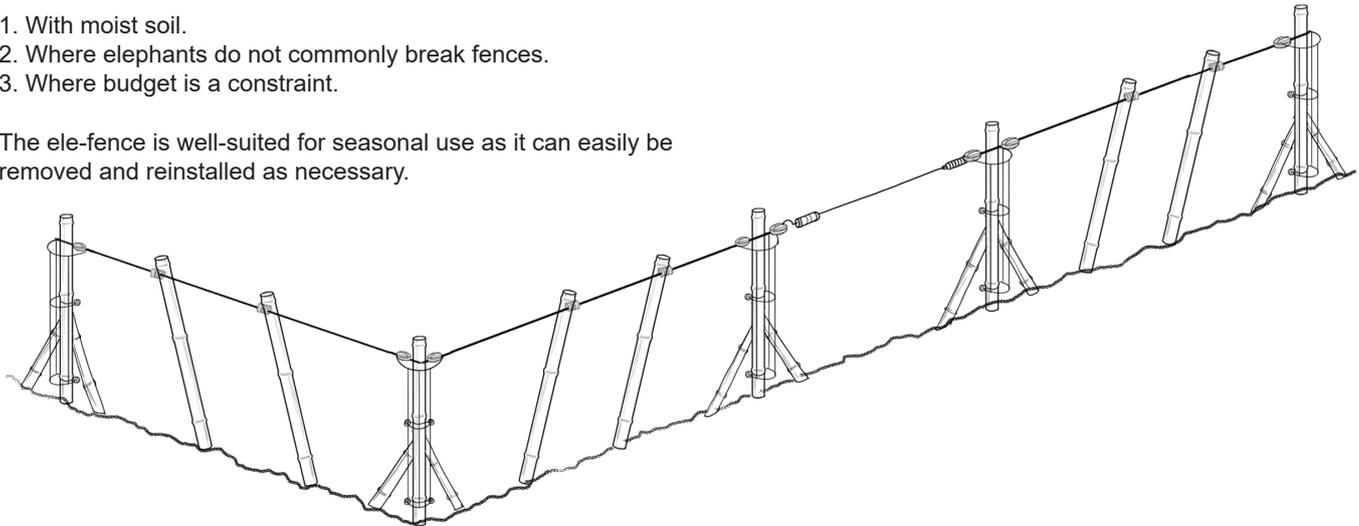
The ele-fence is a low-cost, single-strand, solar-powered fence with bamboo/wooden posts designed to protect human life, property and crops from wild elephants.

Elephants (and other animals) receive a non-lethal shock when they stand on the ground and touch the fence.

Ele-fences work best in areas...

1. With moist soil.
2. Where elephants do not commonly break fences.
3. Where budget is a constraint.

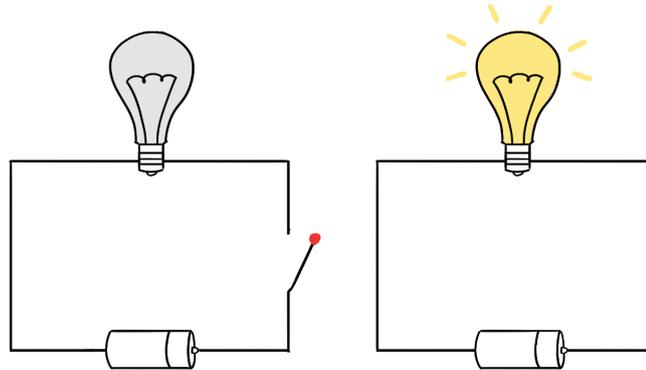
The ele-fence is well-suited for seasonal use as it can easily be removed and reinstalled as necessary.



How a power fence works

Electricity needs to travel in a complete loop for a circuit to work. In an incomplete circuit, the flow of electricity will stop.

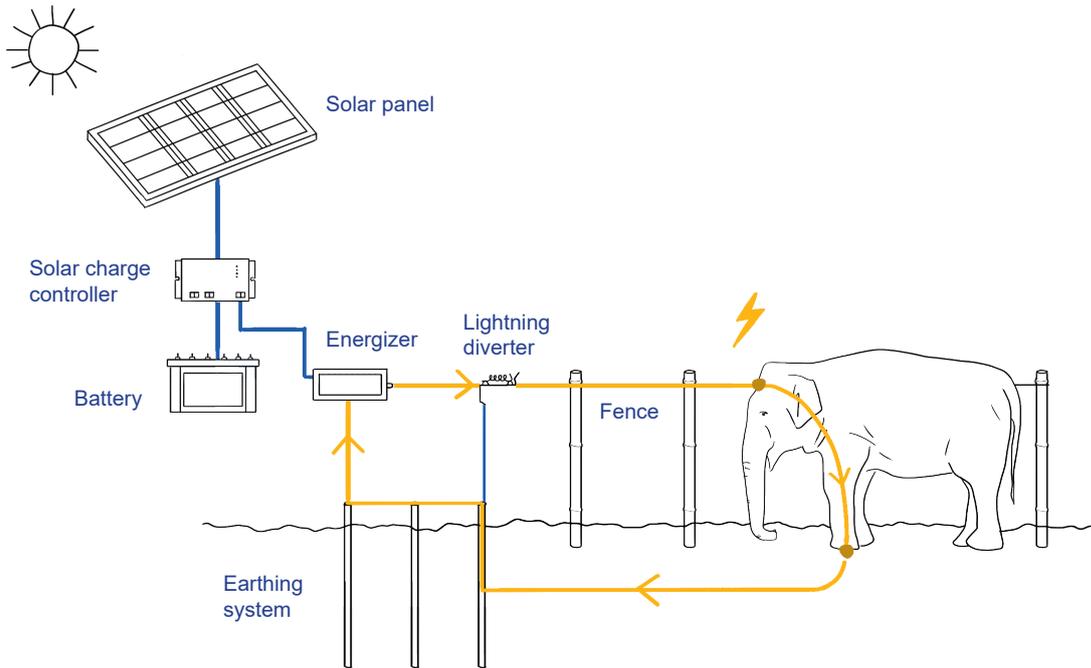
For example,
The bulb does not light up when the circuit is open.
The bulb lights up when the circuit is closed.



Open circuit

Closed circuit

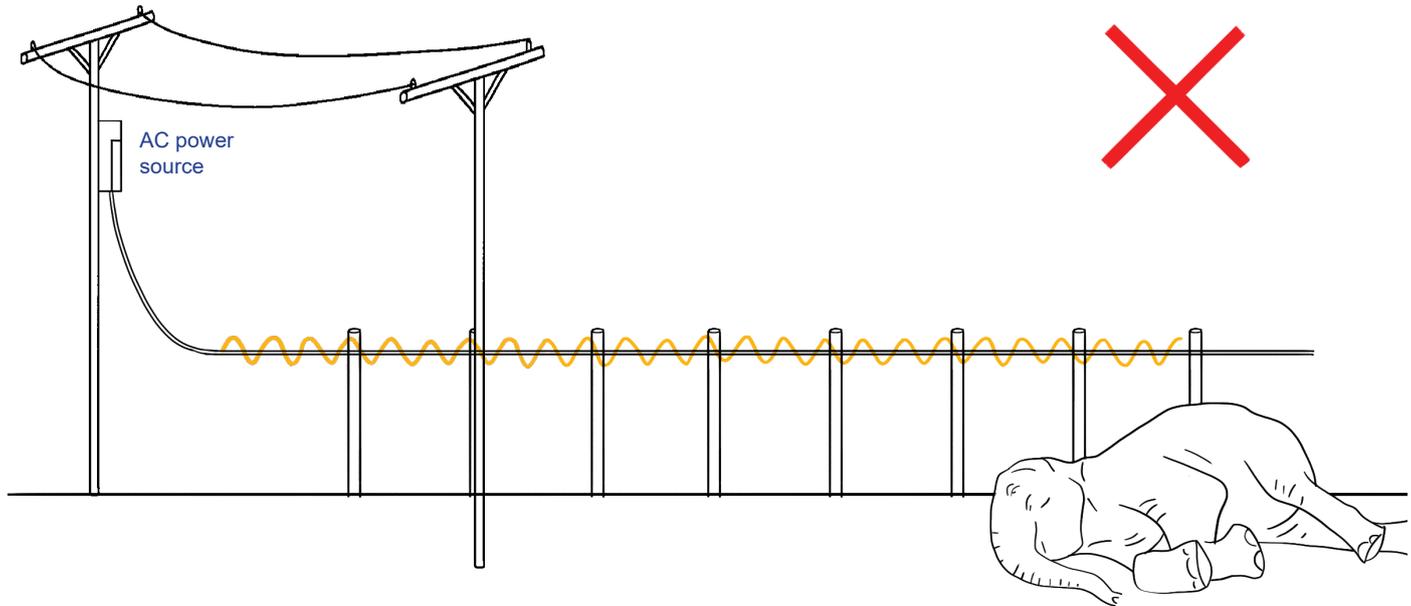
Similarly, in a single-strand fence, an electric shock will be received only when the circuit is complete. When an elephant touches the live wire, the current can flow from the fence, through the body of the elephant, into the ground, and back to the energizer, completing the circuit and giving a non-lethal shock to the elephant.



Lethal power fences (illegal!)

If the fence is connected directly to an AC power source, the shock given by the fence is harmful and may be lethal to elephants and humans.

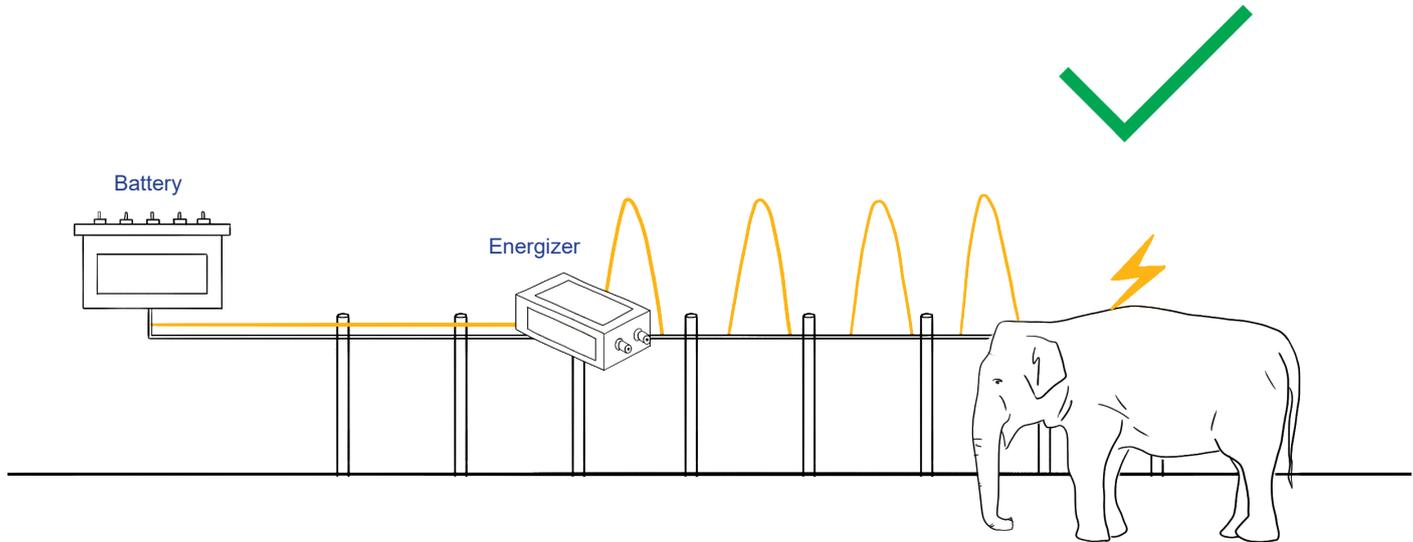
A fence **should not** be connected directly to an AC power source, inverter, or DC to AC converter. Installing a lethal power fence is **punishable by law**.



Non-lethal power fences

When the fence is connected to a battery and a proper energizer, the current comes in pulses. The shock is non-lethal and will not result in the death of humans or animals.

A fence must **always** be connected to a battery and an energizer.



Pre-installation

Committee formation

Conduct a meeting with as many people as possible from the village where the fence is being installed. If possible, at least one person from every household that will be protected by the barrier should be present. The village headman or leader should be present. Discuss the purpose of the fence, how it works, safety precautions, and how it must be maintained. It is critical to discuss the design of the fence, especially where the fence will be located and the number and location of gates.

In this meeting, a fence maintenance committee should be formed (responsibilities detailed below).

Who should be part of the committee?

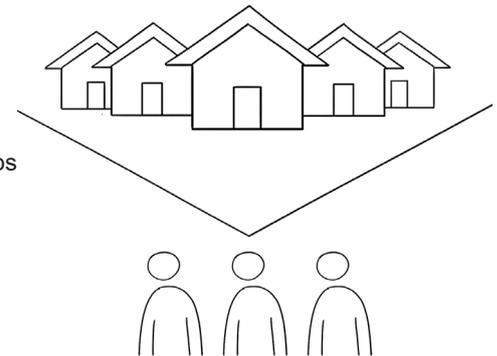
The committee should have at least 10-15 people from the community installing the fence. Wherever practical, every household affected by the fence should be represented on this committee. Include, where possible, an elected member of the Panchayat to be a member of the fence committee.

Appoint one president and one secretary to be in charge of the committee.

Ensure that the committee reflects the diversity of ethnicities, genders, and age groups present in the village. The committee should include both men and women.

What are the responsibilities of the committee?

1. Designing the fence and selection of materials to use for the fence.
2. Ensuring proper installation and maintenance of the fence.
3. Collection of regular contributions from the community for maintenance and repair of the fence.
4. Ensuring the fence remains both functional and safe for people and animals (e.g. that the fence is not connected to an AC power source).



Joint survey and site selection

The fence maintenance committee, other villagers affected by the fence, Forest Department, and interested wildlife NGOs or community-based organizations (wherever applicable) should conduct a joint survey to determine:

1. What area villagers wish to protect with the fence.
2. Where the community wishes to build the fence.
3. The location and number of gates required by villagers.

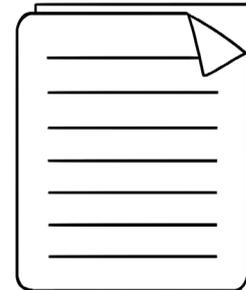
During the joint survey, participants must **ensure that the proposed fence will not prevent elephants from moving between habitat patches**. If this is a risk, the fence should be redesigned so elephants can go around the community.

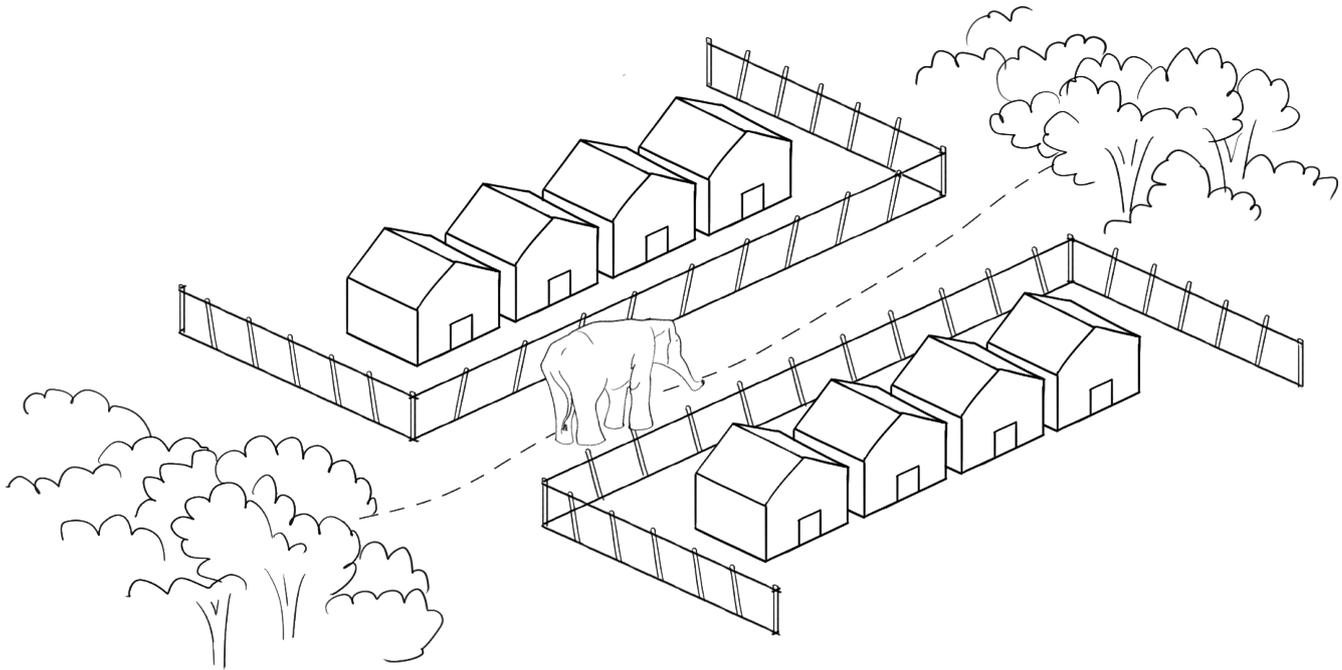
Ideally, fences should be less than 2.5km long as that eases maintenance. Fences longer than 5km should be split up into smaller fences with separate power units.

Official permissions

Two documents are required before installing a fence at a specific site:

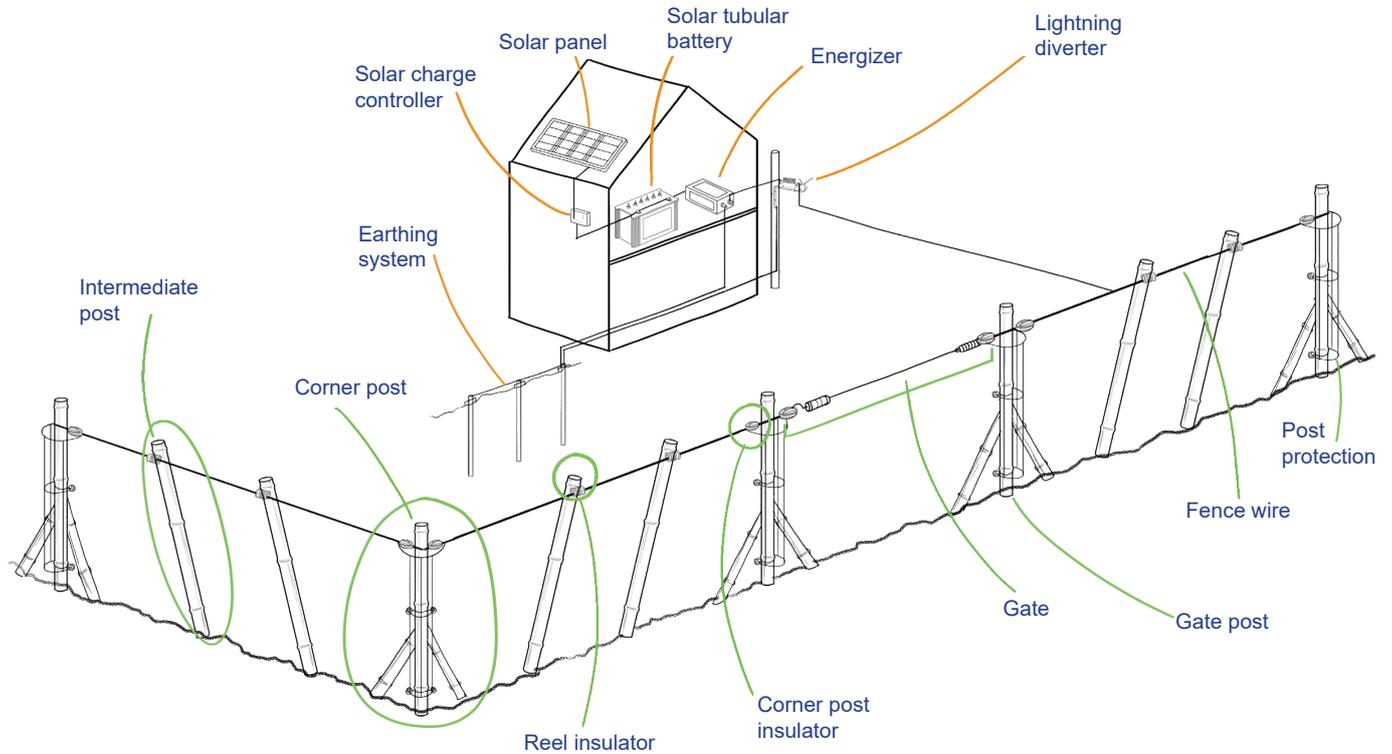
1. An official letter from the village committee given to the Forest Department requesting permission to build a non-lethal electric fence. It should contain the details of the fence, especially the location of the fence, area protected by the fence, and the length of the fence.
2. A no-objection letter from the Forest Department granting permission to install the fence.



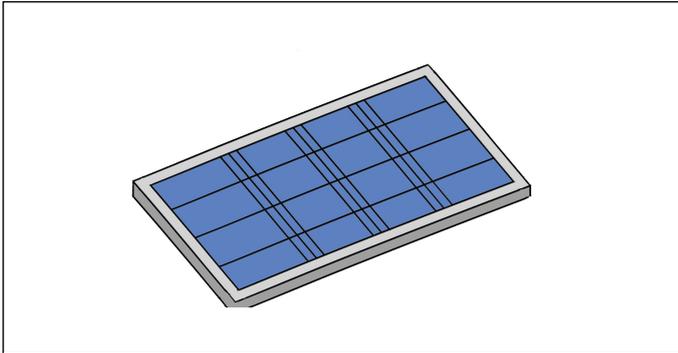


Fences must allow elephants to move between habitat patches.

Parts of a single-strand fence



Components and tools

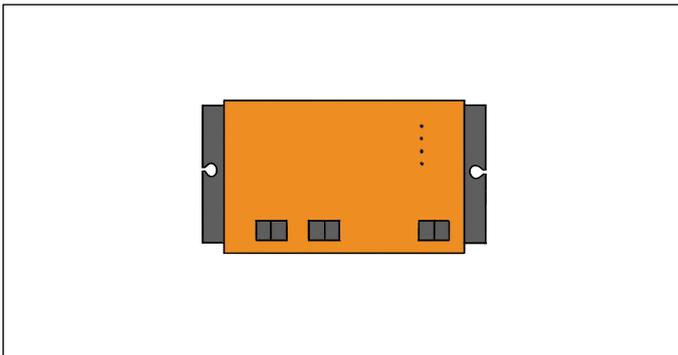


Solar panel

Purpose:
To charge the solar tubular battery.

Specifications:
80-100 Watts

Quantity:
1 per fence

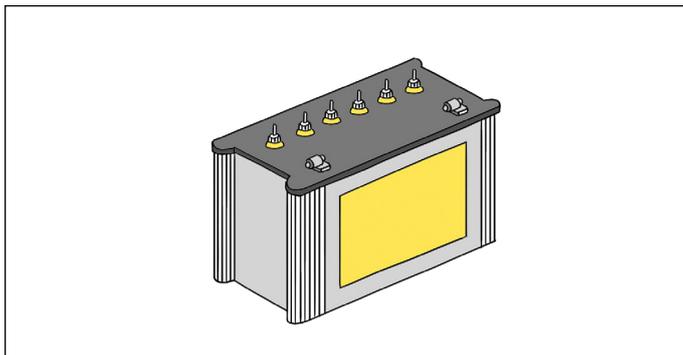


Solar charge controller

Purpose:
To prevent the battery from over-charging or over-discharging.
The solar charge controller is connected to the solar panel, energizer, and the battery.

Specifications:
10 amps

Quantity:
1 per fence



Solar tubular battery

Purpose:

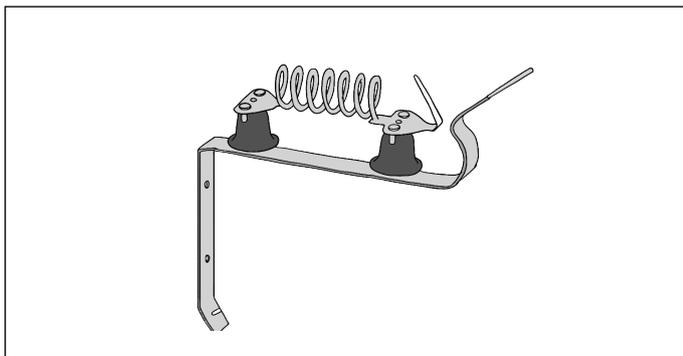
To power the fence. It is charged by the solar panel.

Specifications:

12 V and 100-120Ah

Quantity:

1 per fence



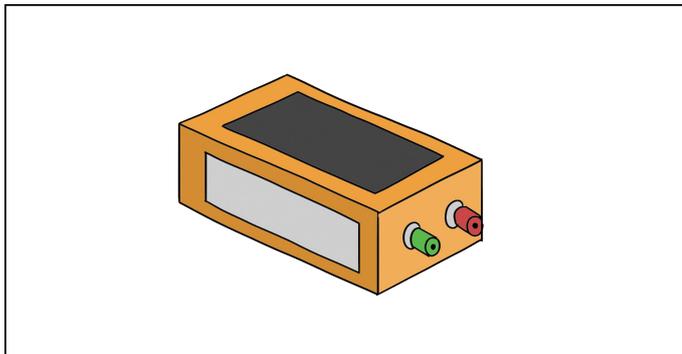
Lightning diverter

Purpose:

To protect the power unit from lightning strikes. It should be bolted to a post between the energizer and the fence.

Quantity:

1 per fence



Energizer

Purpose:

To convert battery power into a non-lethal, high voltage, low amperage, DC pulse.

Specifications:

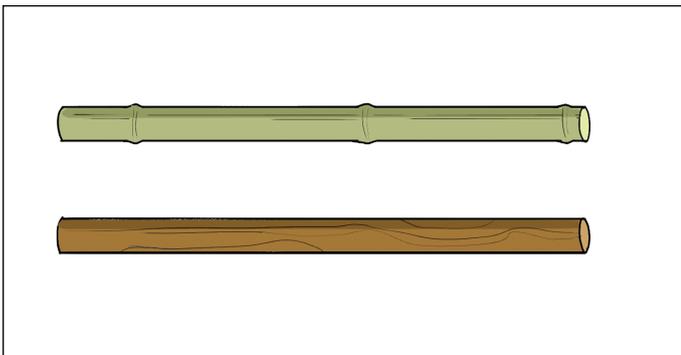
- Should be certified by the Bureau of Indian Standards (BIS).
- Should produce a pulse lasting 0.003 seconds with a gap of 1.2 seconds between each pulse.
- Should produce a voltage between 6000 and 9000 volts (V).

Specifications depending upon length of fence:

Length of fence	Recommended energizer strength
<3km	1J
<4km	2J
<5km	4J

Quantity:

1 per fence



Fence posts

Purpose:

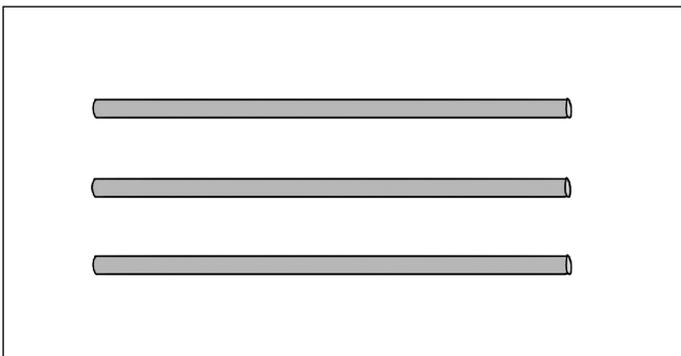
Vertical structures that hold up the current-carrying wires.

Specifications:

- May be made of wood or bamboo.
- Each post should be 2.3m (7.5ft) in length.
- Each post should be at least 6 cm in diameter.

Quantity:

1 post every 8m of fence length.



Earthing rods

Purpose:

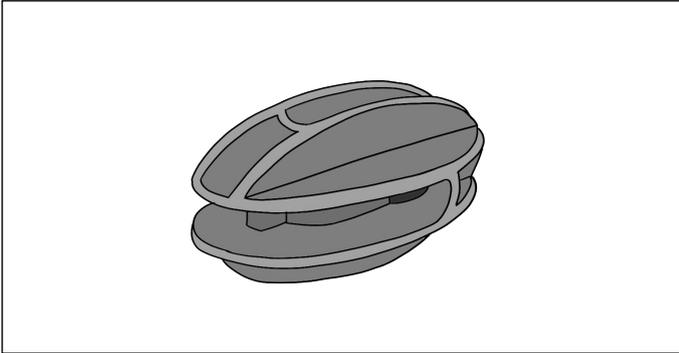
To ensure good earthing which ensures an elephant will receive a shock when it touches the live fence.

Specifications:

Stainless steel rods/galvanised iron pipes that are 1.5m in length and 2.5-4cm thick.

Quantity:

At least 3 for every fence (see page 75).



Corner post insulators

Purpose:

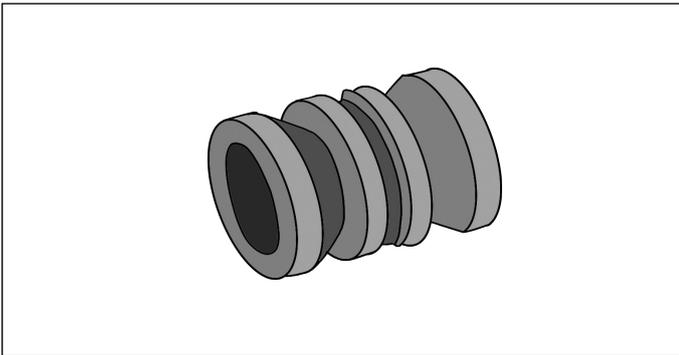
To limit leakage of current through corner posts.

Specifications:

Insulators should be made of polycarbonate.

Quantity:

2 x number of corner and gate posts.



Reel insulators

Purpose:

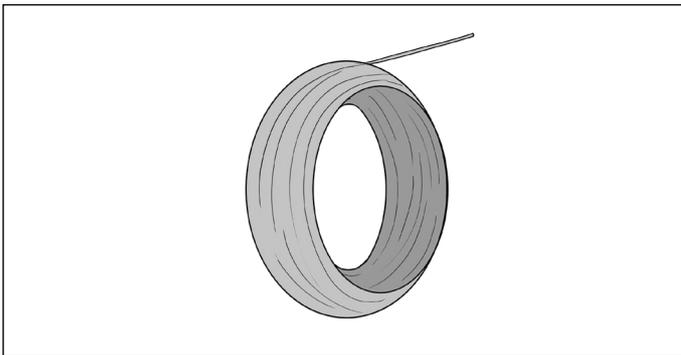
To limit leakage of current through intermediate posts.

Specifications:

Insulators should be made of polycarbonate or other plastic.

Quantity:

(1 per intermediate post) + (4 per corner and gate post).



Galvanized iron (GI) wire (2.5mm)

Purpose:

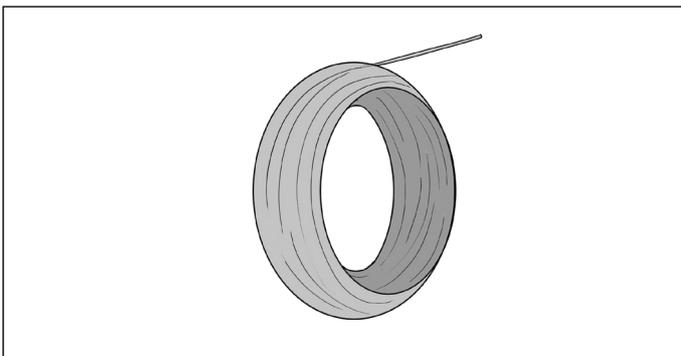
To carry current along the fence.

Specifications:

2.5mm hot-dipped galvanized wire.

Quantity:

45kg x length of fence in km.



Galvanized iron (GI) wire (2mm)

Purpose:

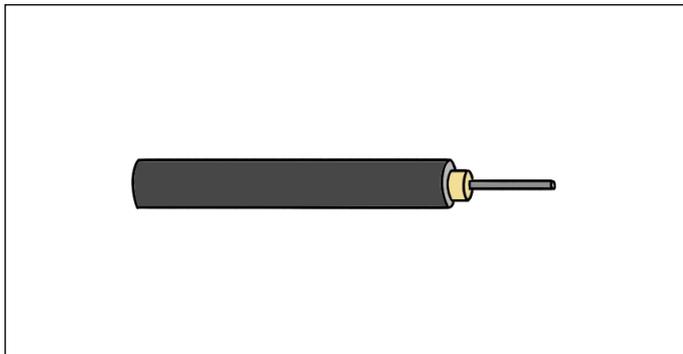
To tie insulators to fence posts.

Specifications:

2mm hot-dipped galvanized wire.

Quantity:

5kg x length of fence in km.



Double-insulated (DI) wire

Purpose:

To connect key electrical components and for other underground connections. These include:

- Energizer to lightning diverter and earthing system
- Lightning diverter to fence and earthing system
- Gates
- Underground connections

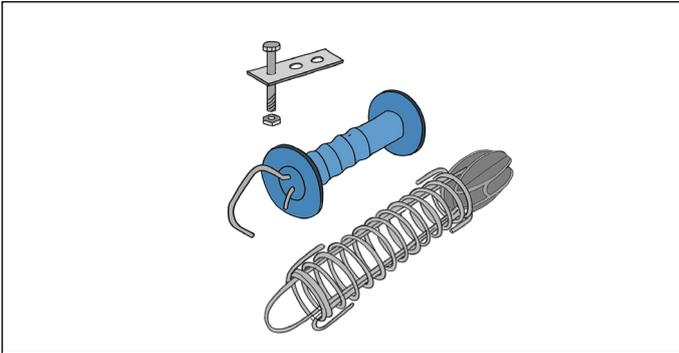
Specifications:

2.5mm

Quantity:

Varies based on fence design.

Approximately 20m + (5m x number of gates).



Gate kit

Purpose:

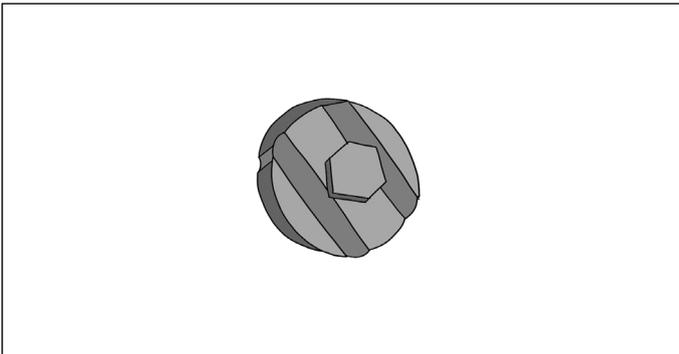
To install a gate for easy movement of people across the power fence.

Specifications:

Gate kit must contain a gate clamp, gate handle, and gate spring (pre-attached to a corner post insulator).

Quantity:

One for each gate in the fence.



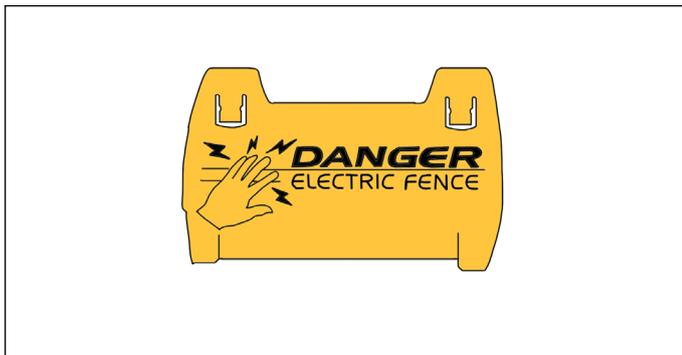
Toupee clamp

Purpose:

To connect two wires to each other.

Quantity:

2 x number of gates.



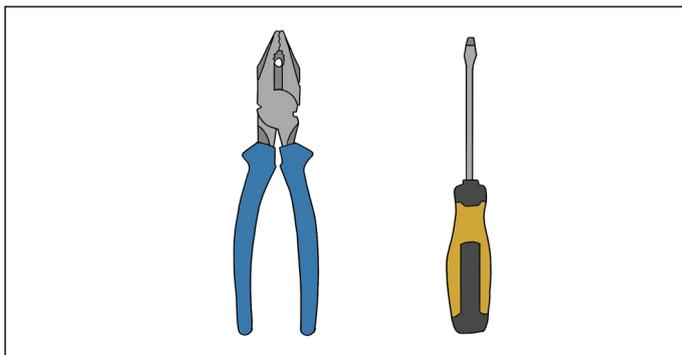
Warning signs

Purpose:

To warn people of the current flowing through the wire.

Quantity:

One for every 250m of the length of the fence.



Pliers and screwdrivers

Purpose:

Necessary for basic installation.

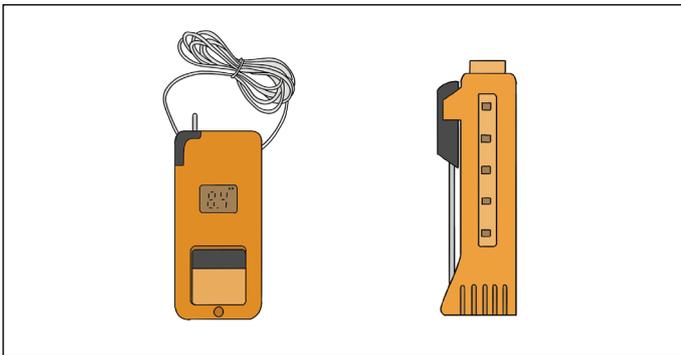
Specifications:

8-inch cutting plier

8-inch flathead screwdriver

Quantity:

At least one of each per fence.



Power fence voltmeter or neon tester

Purpose:

To check the voltage of the fence.

Specifications:

Digital fence voltmeter is preferred. If this cannot be afforded, a 5-light neon tester may be used.

Quantity:

1 per fence.



Digital multimeter

Purpose:

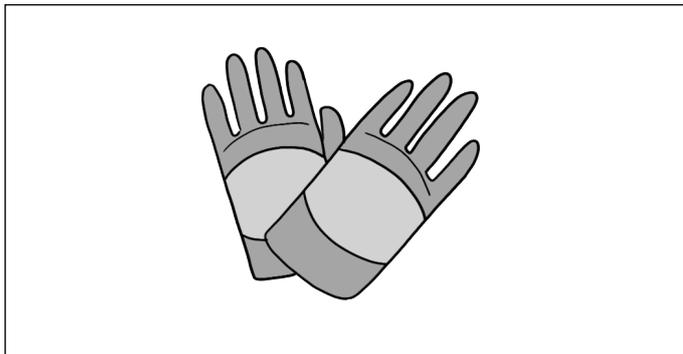
To check battery voltage.

Specifications:

Should be able to provide measurements from 0 to 20 volts (DC). This should not be used to measure the fence's voltage (as it is too high).

Quantity:

1 per fence.



Electrical safety gloves

Purpose:

To protect users from electric shocks.

Specifications:

Gloves should be rubber-insulated and allow for proper gripping of materials.

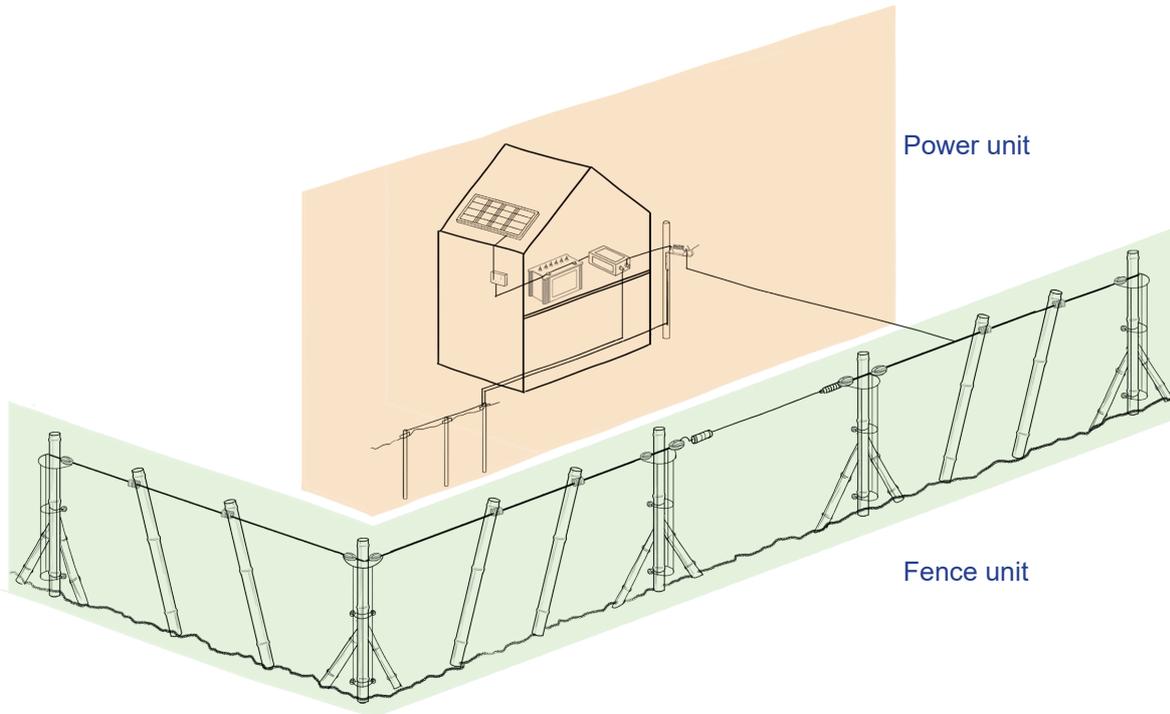
Quantity:

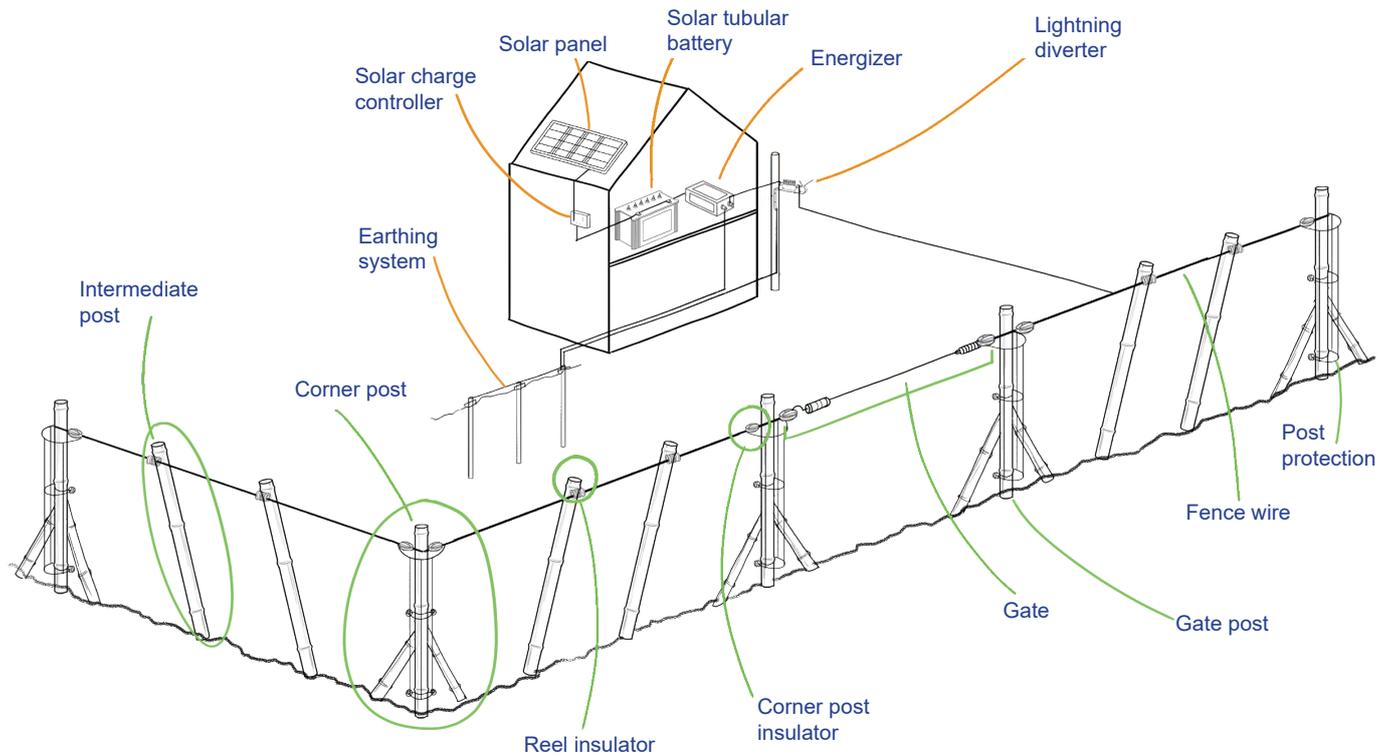
At least one pair per fence.

Installation

Parts of a single-strand fence

A single-strand fence is divided into two units: the power unit and the fence unit.

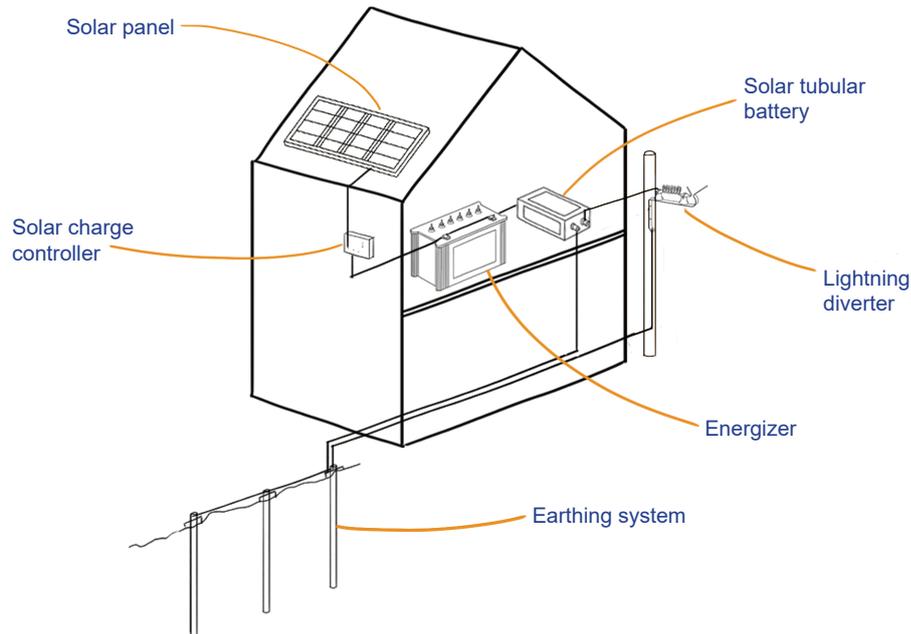




Power unit

The power unit consists of the solar panel, solar charge controller, battery, energizer, earthing system, and lightning diverter. Where possible, the power unit should be placed approximately at the centre of the length of the fence.

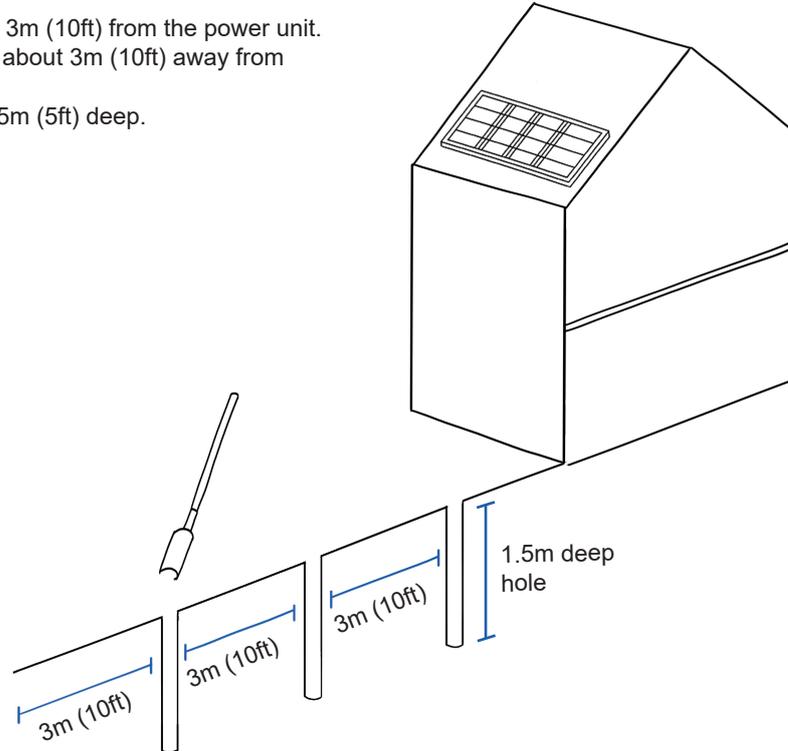
For safety reasons, the power unit should be installed in an area away from any living quarters. The space for housing the power unit should be at least 1.5m x 1.5m.



Earthing system

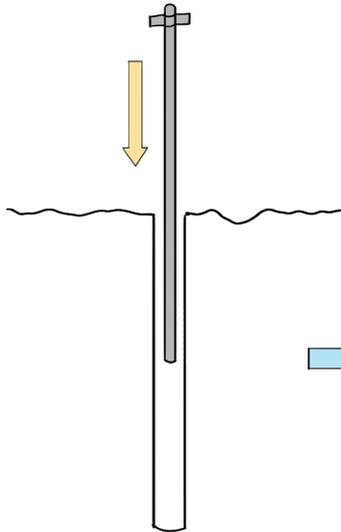
STEP 1

- Dig three holes at a distance of 3m (10ft) from the power unit.
- The three holes should also be about 3m (10ft) away from each other.
- Each hole should be at least 1.5m (5ft) deep.

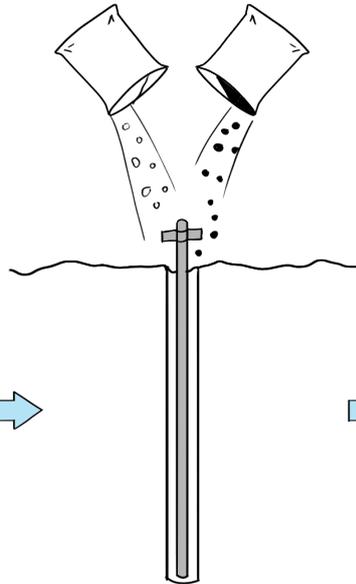


STEP 2

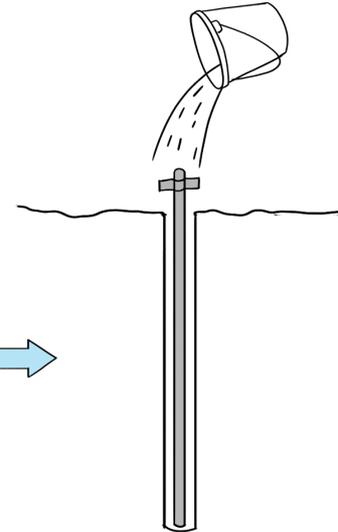
Insert a stainless steel rod in each of the holes.

**STEP 3**

Fill the hole completely by adding a mixture of equal amounts of salt and coal around the rod.

**STEP 4**

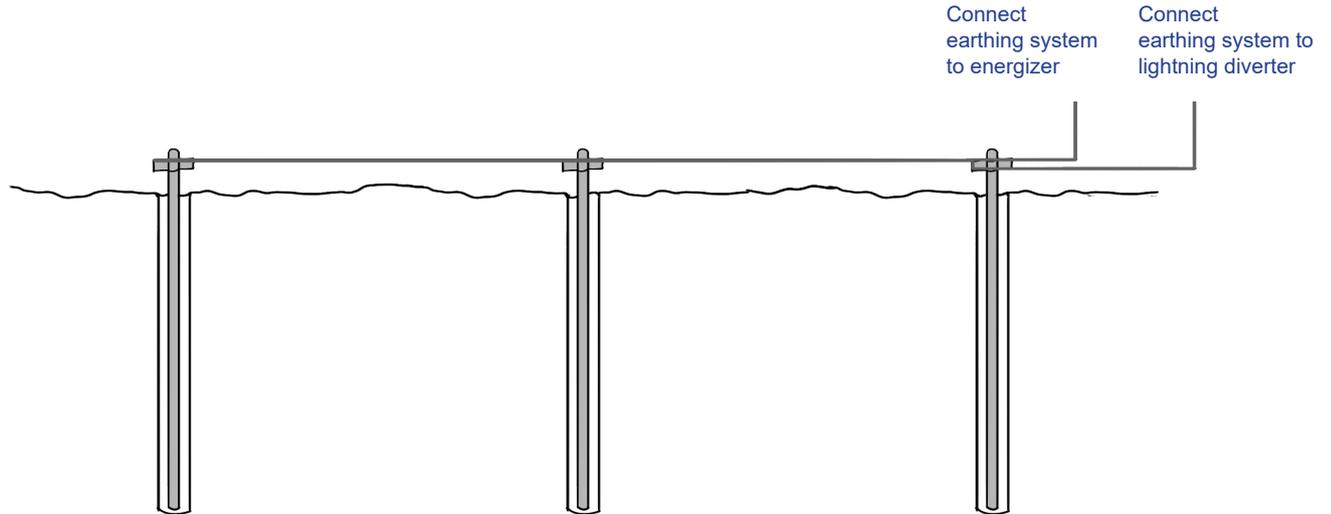
Pour water until the mixture around the rod is completely wet.



STEP 5

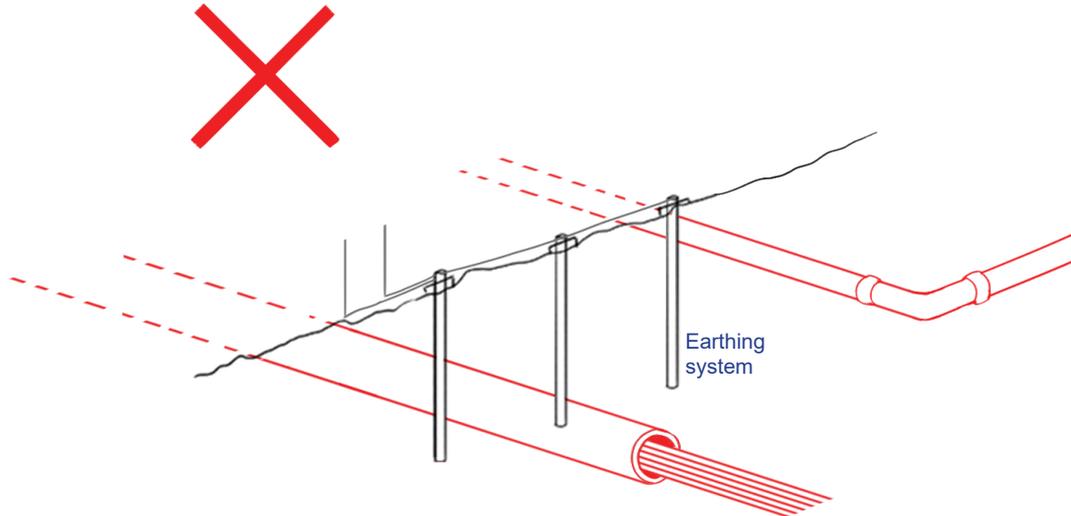
Join the 3 rods with 2.5mm GI wire. Wire can be clamped or tied onto the earthing rods.

The last rod of the earthing system will be connected to both the energizer and the lightning diverter using DI wire.



Warning! Avoiding hazards

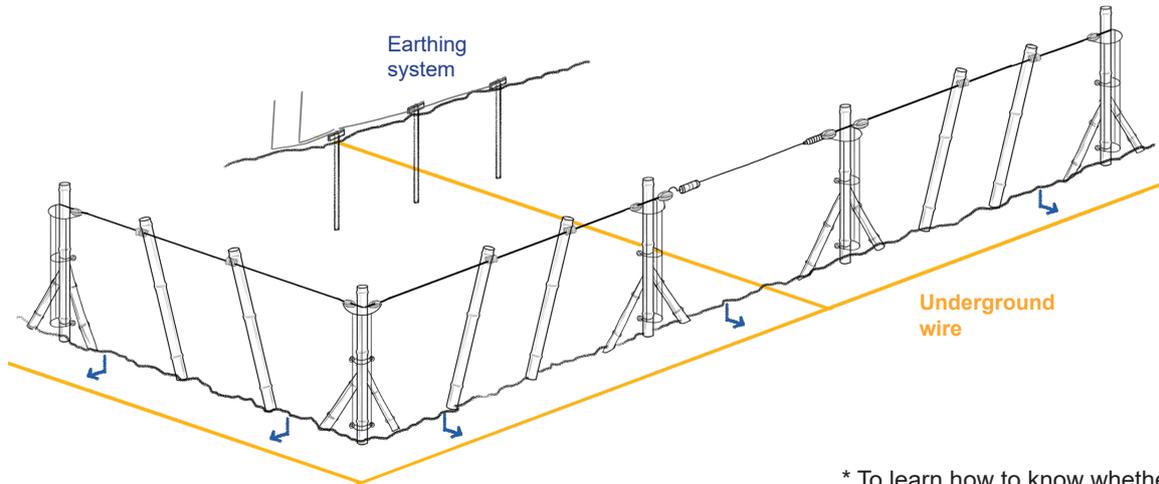
Do not install the earthing system near underground pipelines or cables. The fence's earthing system **should** be at least 10m away from any other earthing systems (e.g., a house's earthing system).



Alternatives: Dry areas

In areas where the soil is dry and earthing is not sufficient*, pass a wire underground along the length of the fence and connect it to the earthing system.

The underground wire should ideally be a little bit outside the fence, directly below where an elephant might stand.

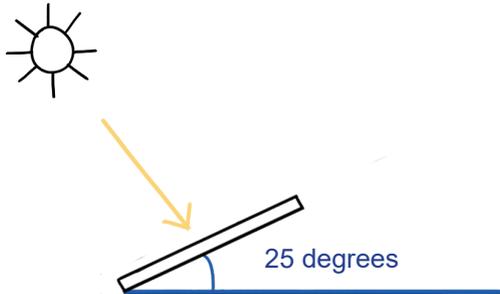


* To learn how to know whether the earthing is sufficient for your fence, please see pg.75.

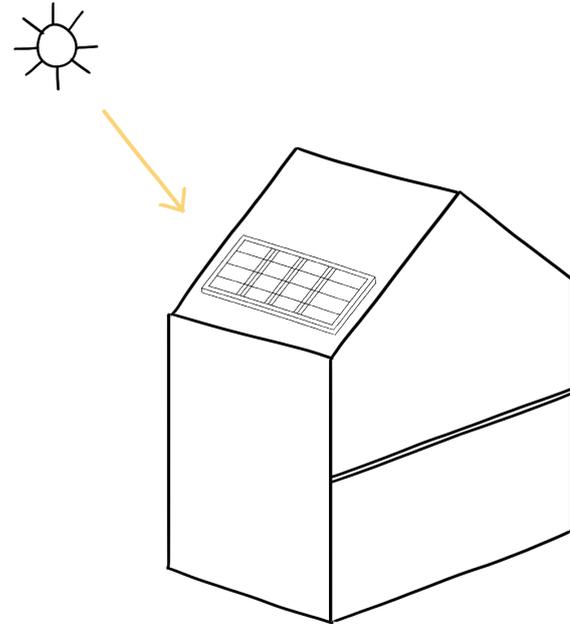
Solar panel

The solar panel should be angled to the south at an angle approximately equivalent to the latitude of the location. In central India, this might be about 20 degrees. In northeast India, this might be about 25 degrees.

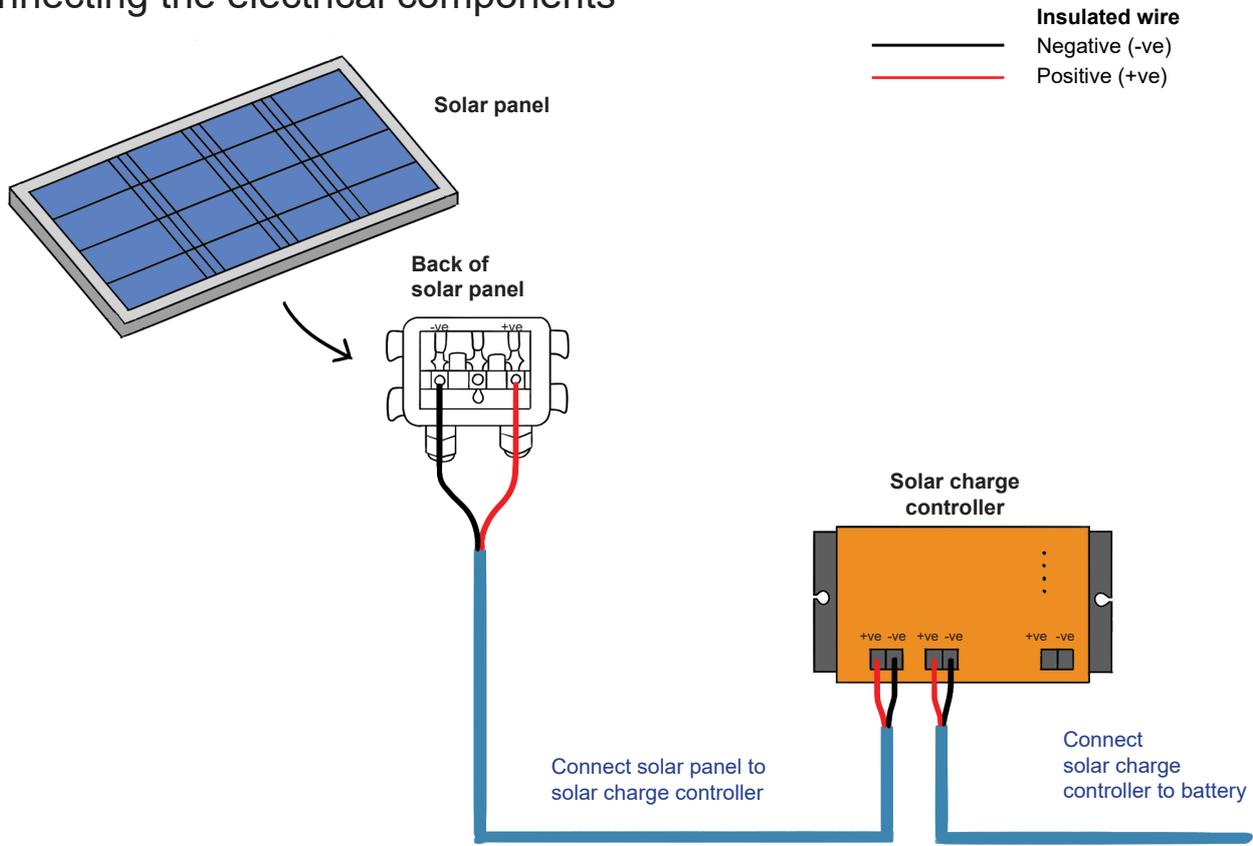
It should be installed in a spot that receives maximum sunlight with no obstruction.

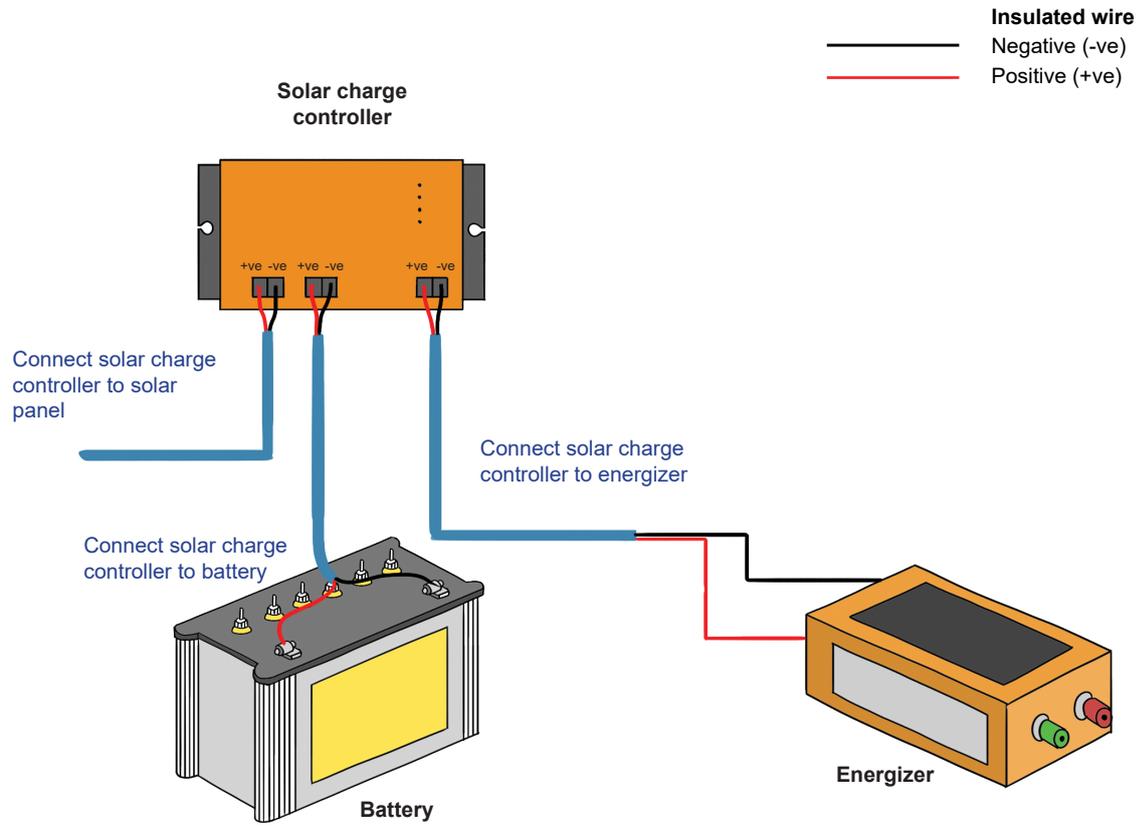


The solar panel should be angled to match the latitude of the location.



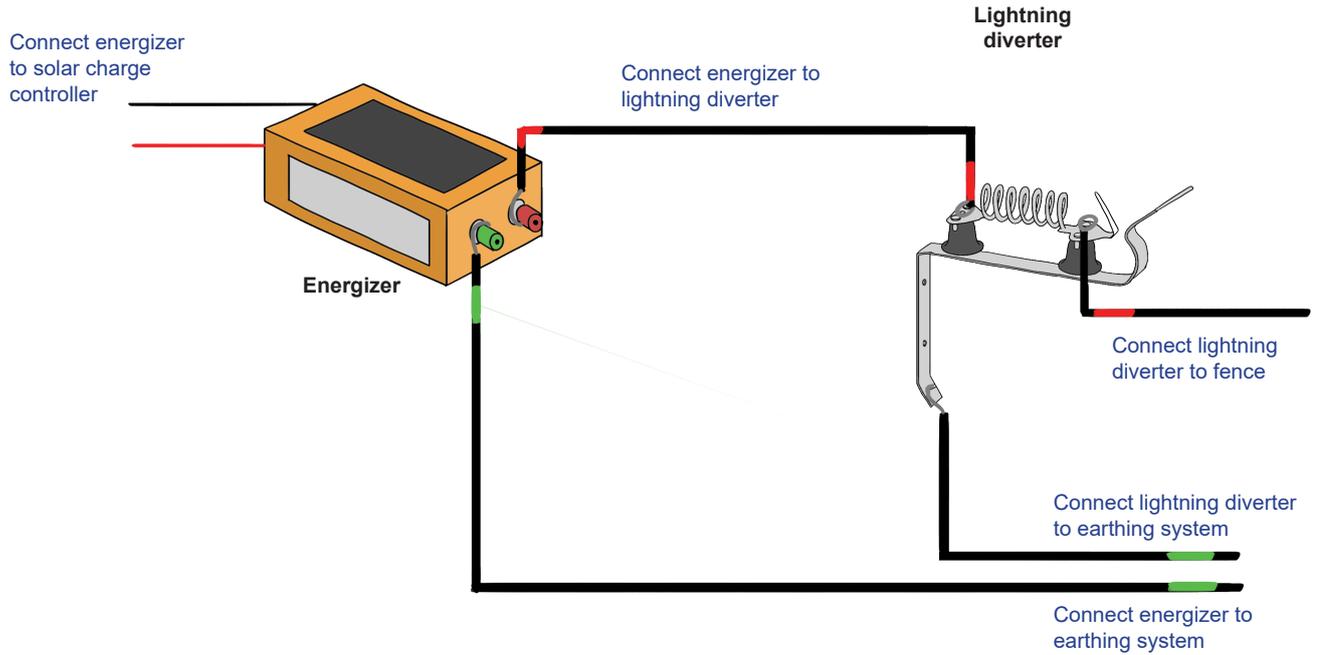
Connecting the electrical components



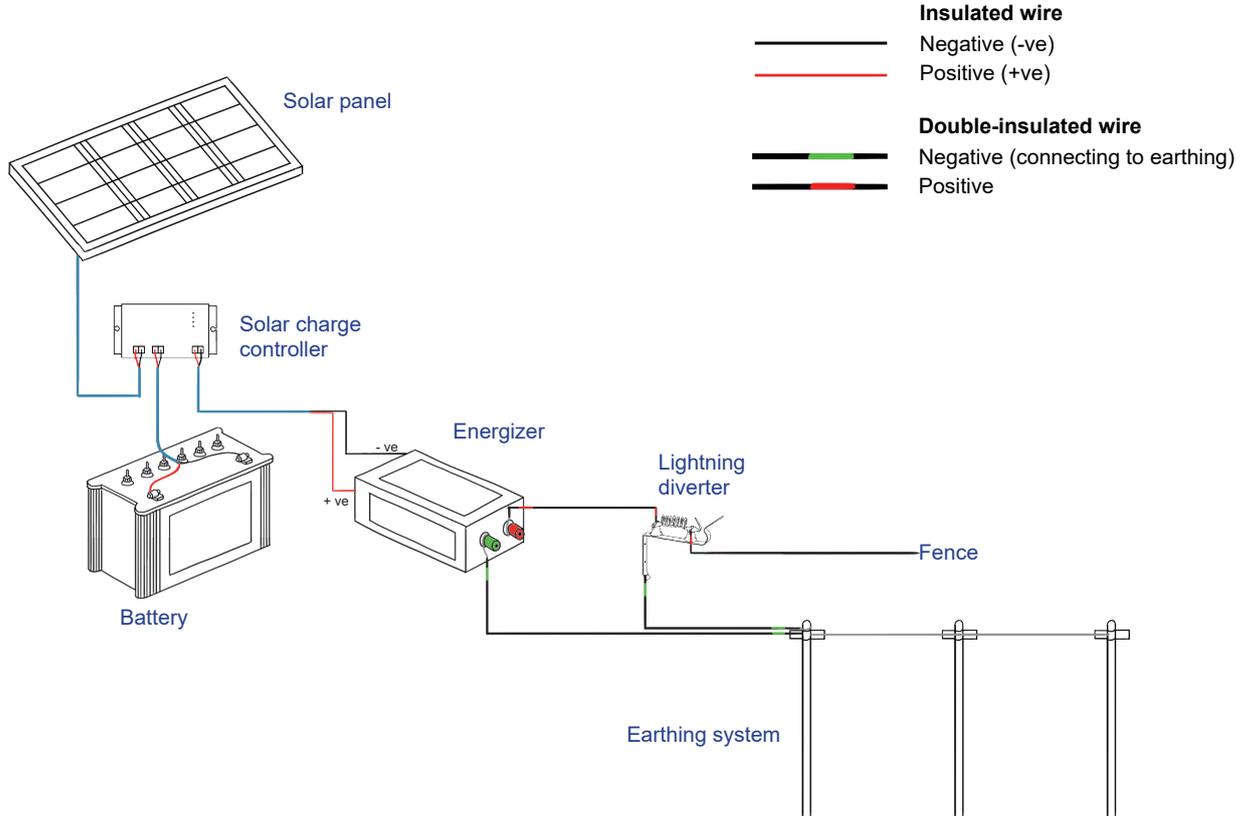


Insulated wire
Negative (-ve)
Positive (+ve)

Double-insulated wire
Negative (connecting to earthing)
Positive



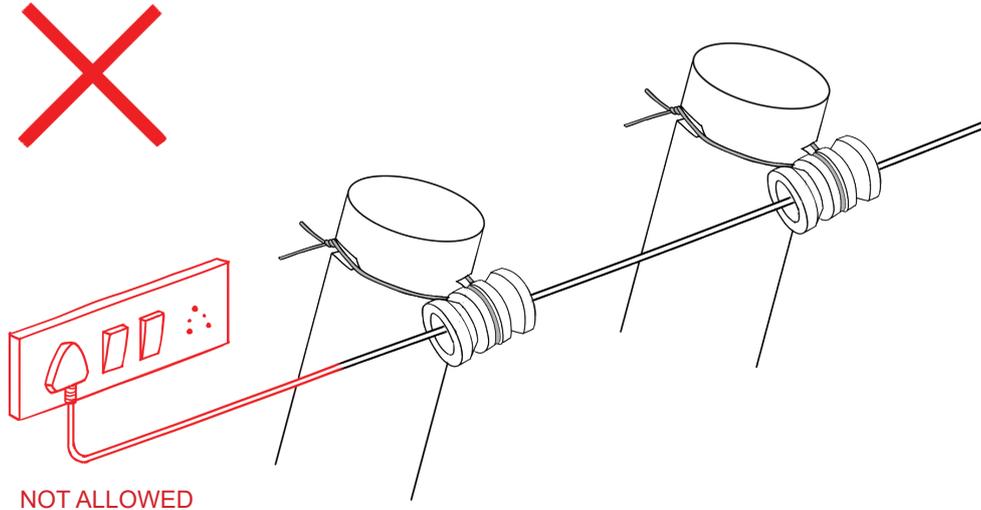
Full circuit



Warning! Lethal power sources

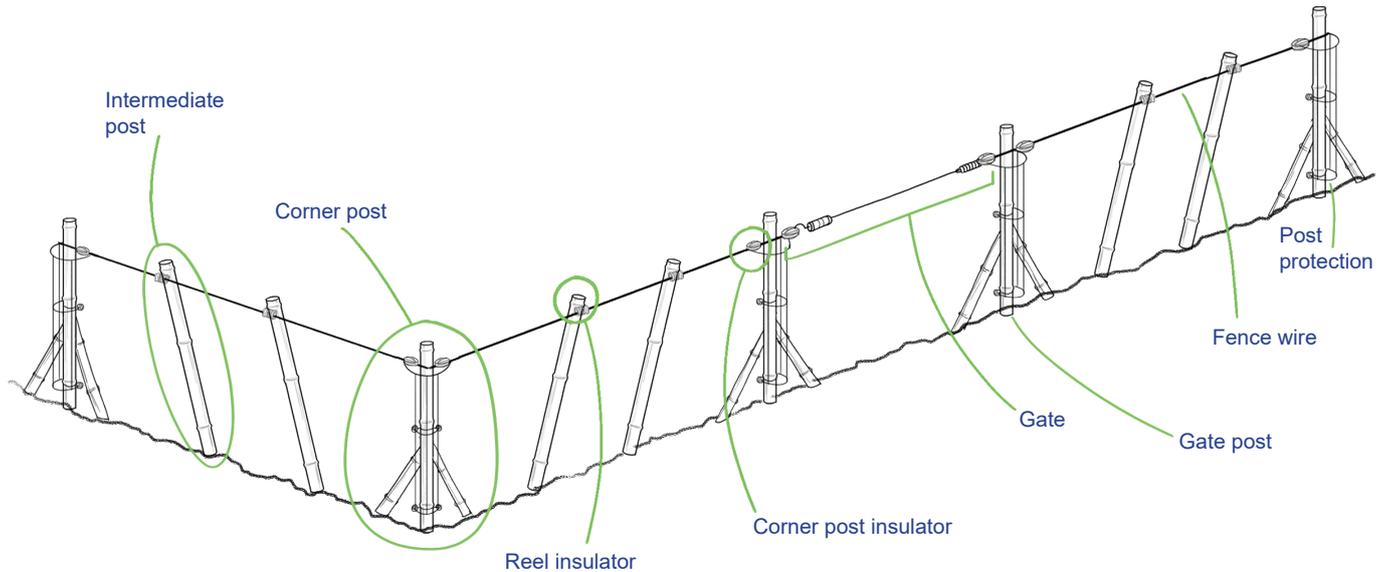
Do not connect the fence directly to an AC power source or inverter.

This may lead to death of humans or animals and is punishable by law.



Fence unit

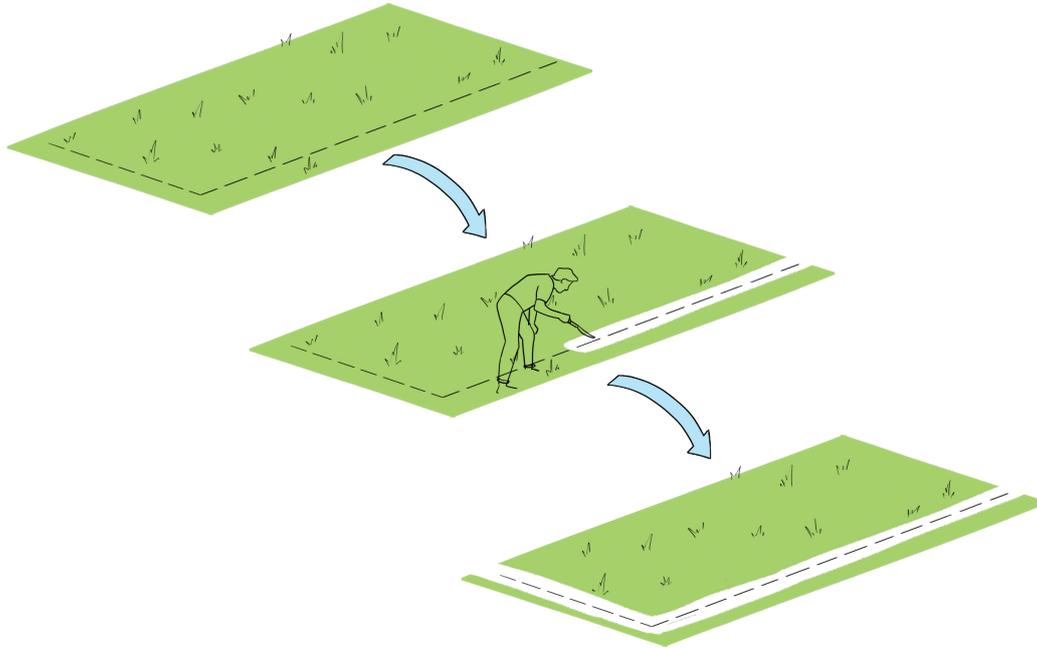
The fence unit consists of the posts, insulators, wires and gates.



Prepare the fence site

Clear the undergrowth 1m on either side of the path along which the fence will be installed.

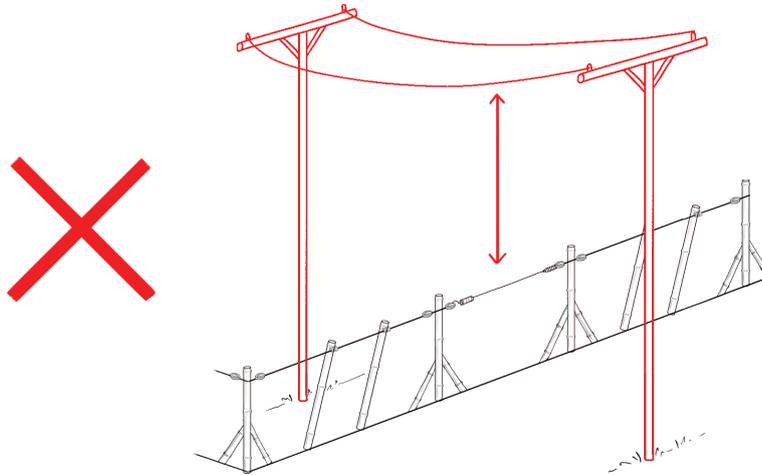
If plants touch the wire of the fence, it will cause a leak in the current.



Warning! Avoiding hazards

Do not install a fence close to an electric line.

If the electric line accidentally touches the fence wire, the fence will likely become a fire hazard, damage the power unit equipment, and give lethal shocks when touched.



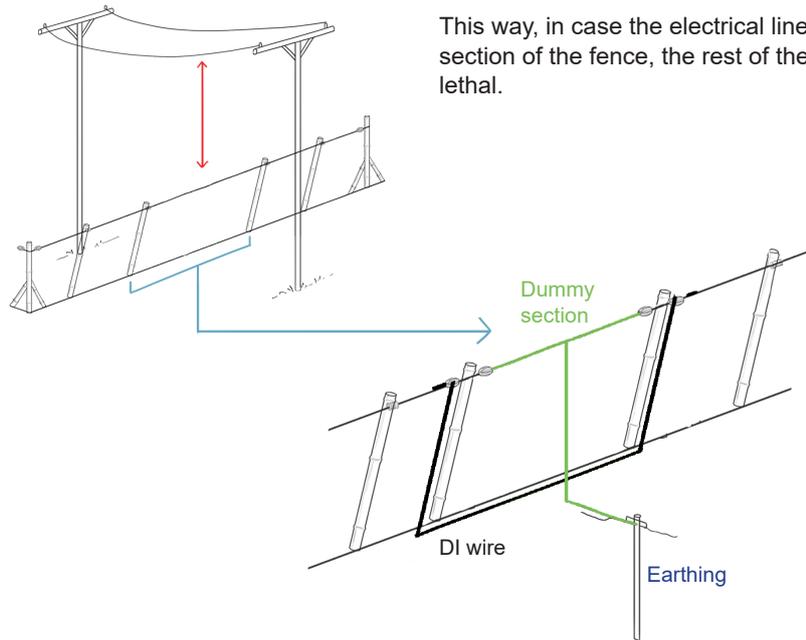
Alternatives: Fence under electrical line

If passing the fence under an electrical line is unavoidable, separate the section of the fence passing under the electrical line, creating a dummy section that is not electrified.

Connect this dummy section to the earth.

Connect the active wires on either side of the dummy section to each other with an underground DI wire.

This way, in case the electrical line falls on the dummy section of the fence, the rest of the fence will not become lethal.

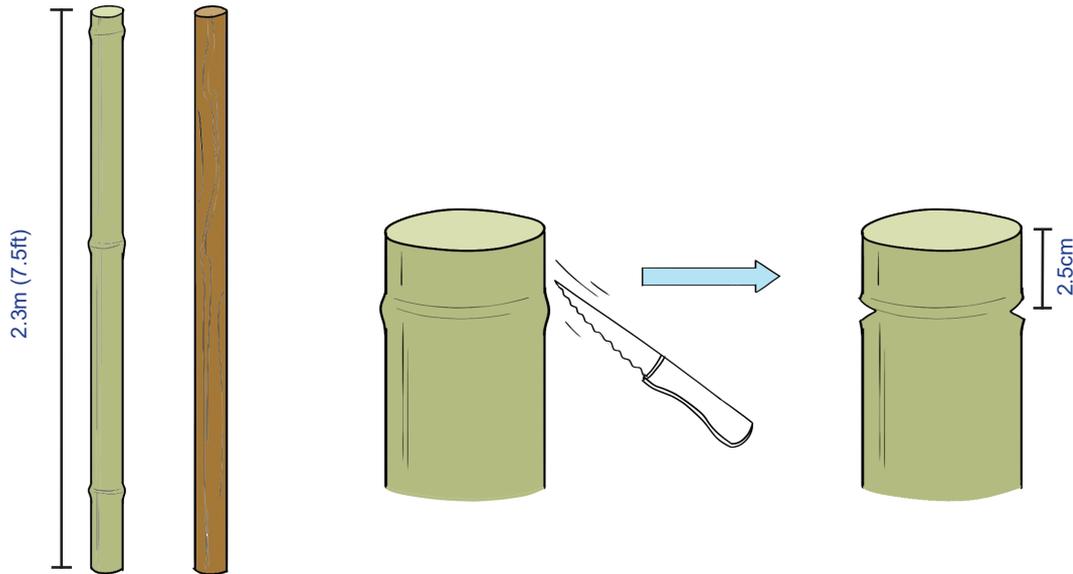


Installing fence posts

Preparing fence posts

Make grooves on both sides of the posts at a height of 2.5cm from the top.

These grooves will stop the insulators from slipping down after they are tied to the posts.



Posts can be bamboo or wood.

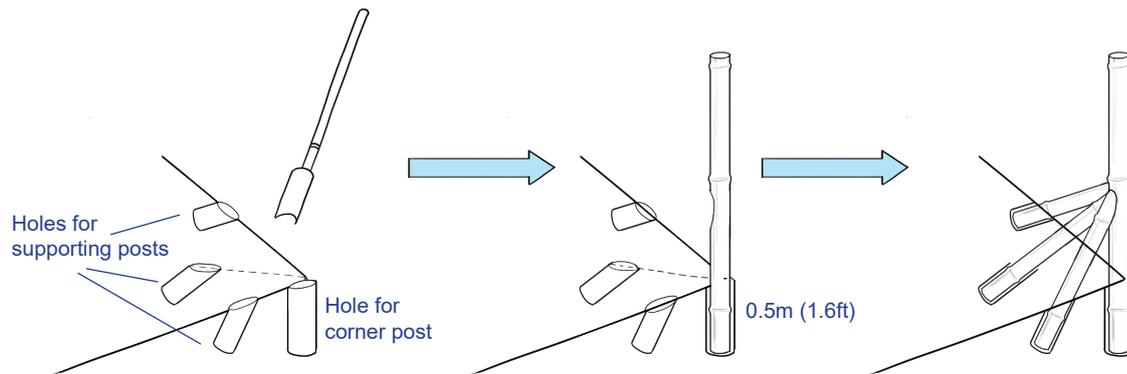
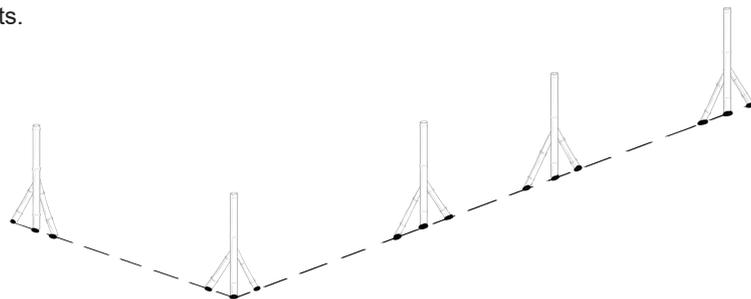
Dig holes and insert corner and gate posts

At the corners of the fence, dig vertical holes for corner posts.

Holes should be 0.5m (1.6ft) deep.

Add supporting posts on three sides of the vertical posts.

The same should be done for gate posts.



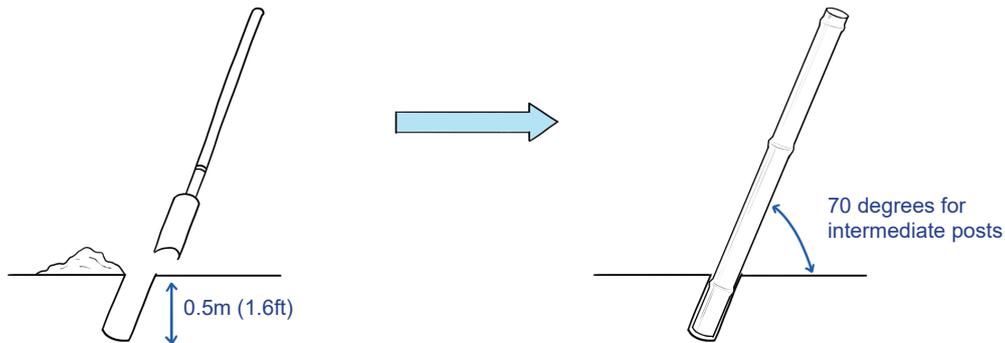
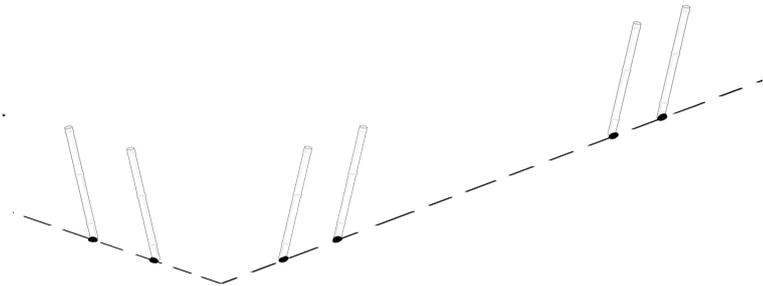
Dig holes and insert intermediate posts

Dig holes for the posts every 8m.

Every hole should be 0.5m (1.6ft) deep.

Holes for intermediate posts should be at a 70-degree angle.

Posts should point outward so that elephants will be unable to knock them down with their feet.



Installing insulators

Tie wire to corner post insulators

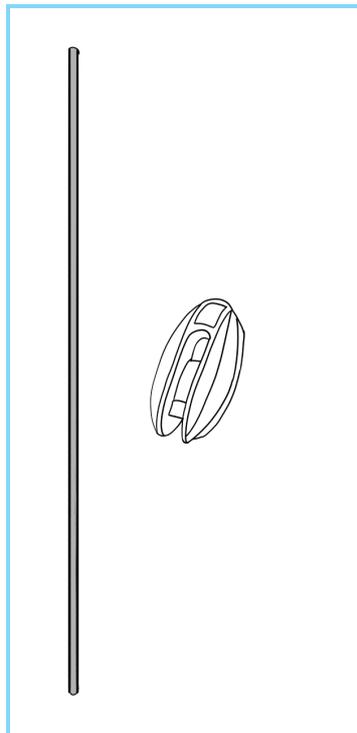
What do you need?

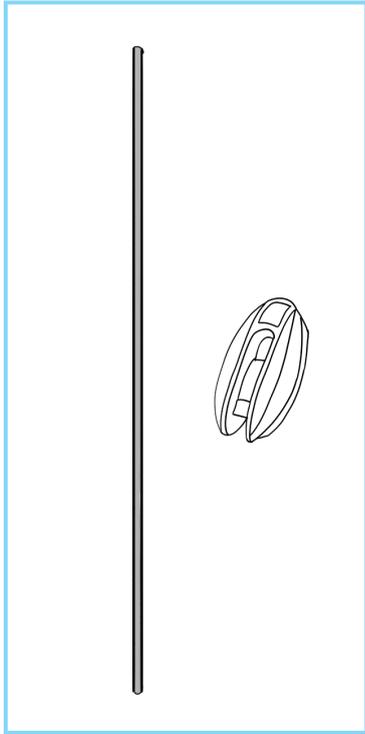
- 2 corner post insulators for every corner post and gate post.
- 70 cm of 2mm GI wire for every corner post insulator.

Why?

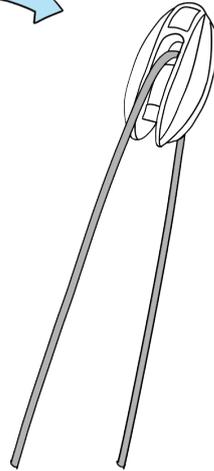
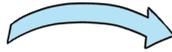
Each corner post and gate post will need two corner post insulators tied to it.

First, a wire is tied around each corner post insulator.
Then this wire is wrapped around a corner post or gate post.

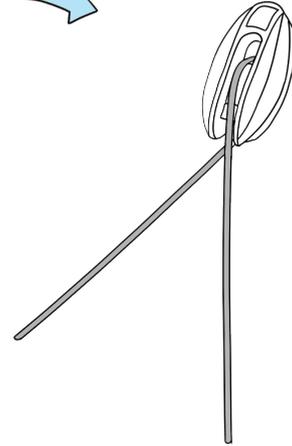




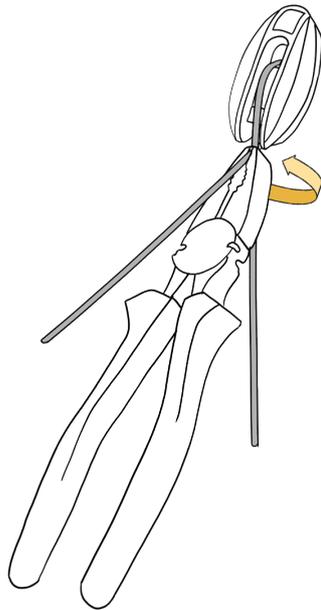
STEP 1



STEP 2

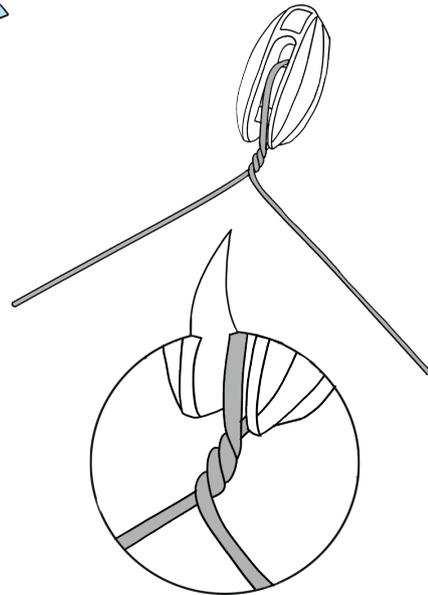


STEP 3



STEP 4

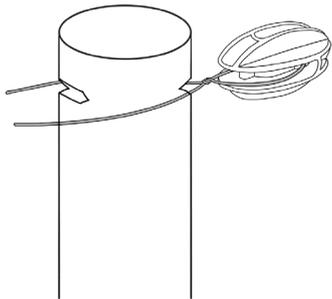
Twist 3 times



Tie corner post insulators to corner posts and gate posts

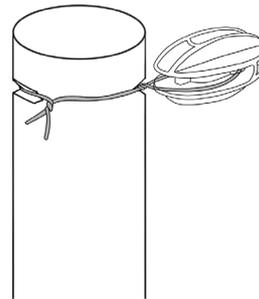
STEP 1

Hold the insulator wire around the groove at the corner post or gate post.



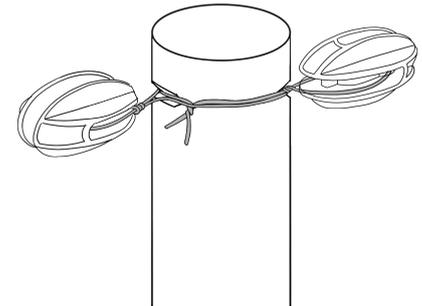
STEP 2

Twist the wire tightly around the post.



STEP 3

Tie the second corner post insulator on the opposite side of the corner post or gate post.



Tie wire to reel insulators

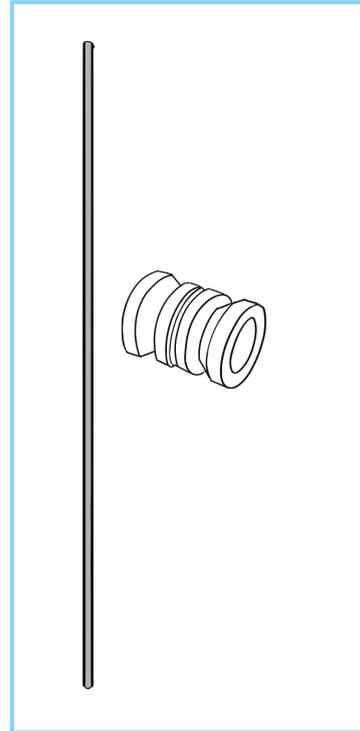
What do you need?

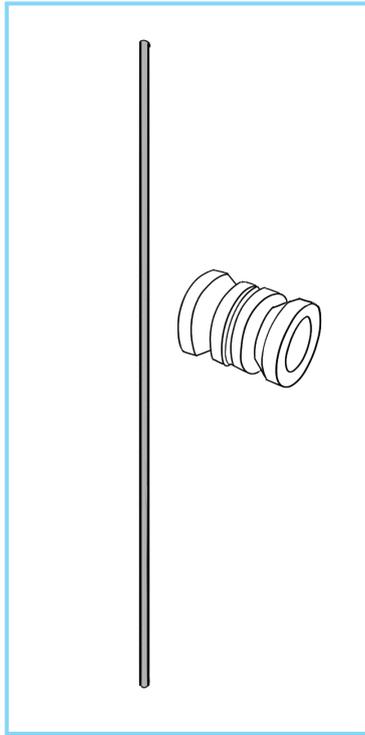
- 1 reel insulator for every intermediate post in the fence.
- 40 cm of 2mm GI wire for every reel insulator.

Why?

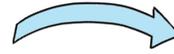
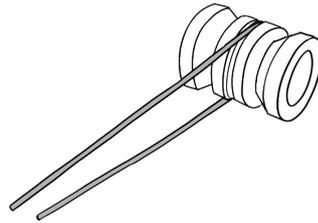
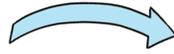
Each intermediate post will need one reel insulator to be tied to it.

First a piece of wire is tied to each reel insulator. Then this wire is tied to the intermediate post.

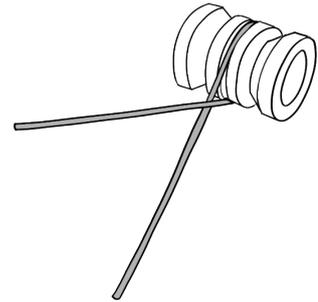




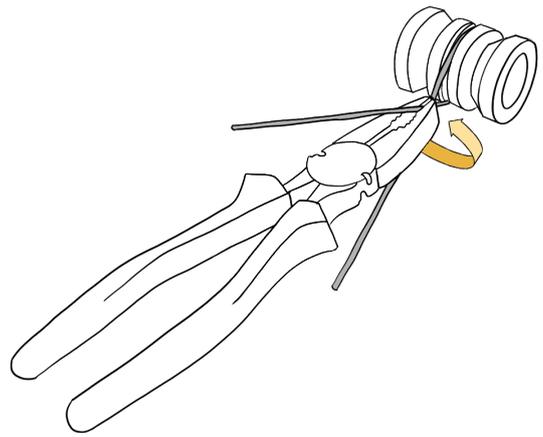
STEP 1



STEP 2

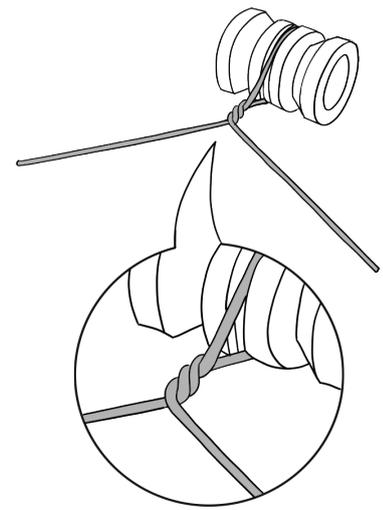


STEP 3



STEP 4

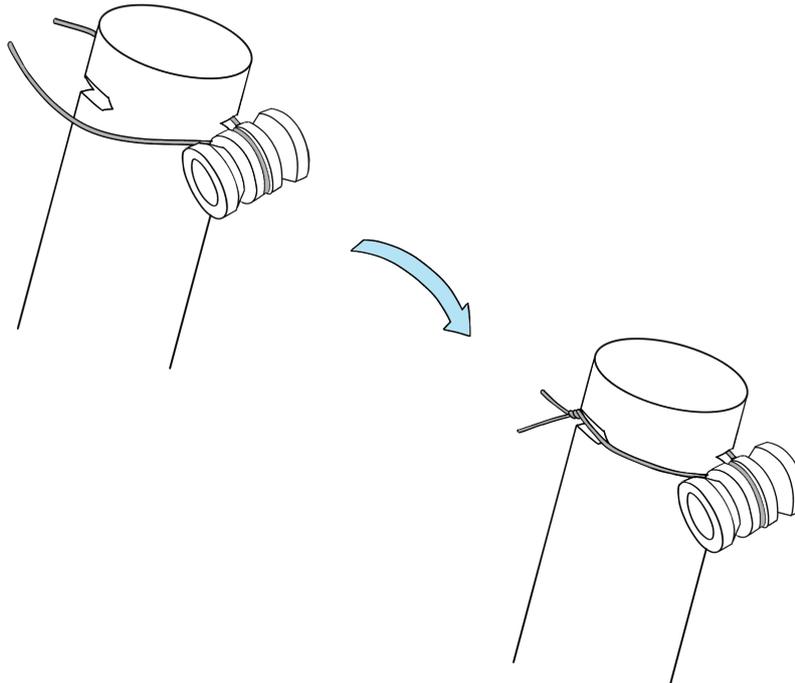
Twist 3 times.



Tie reel insulators to intermediate posts

Tie the insulator wire around each intermediate post.

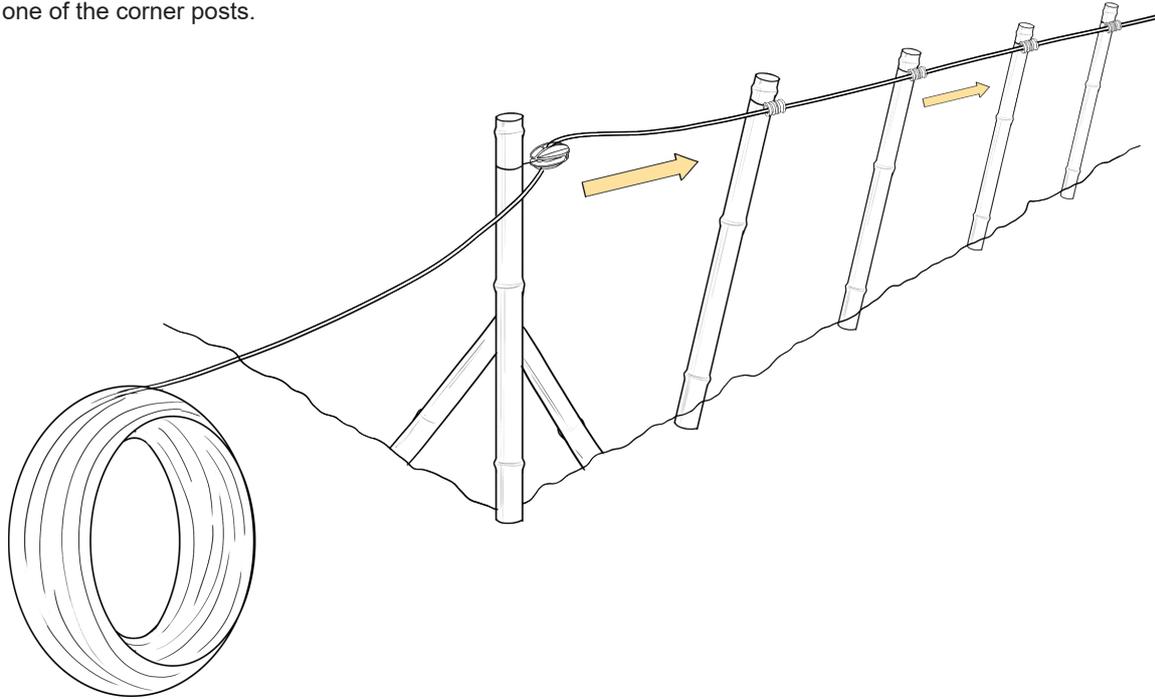
The insulators should be on the outside of the fence.

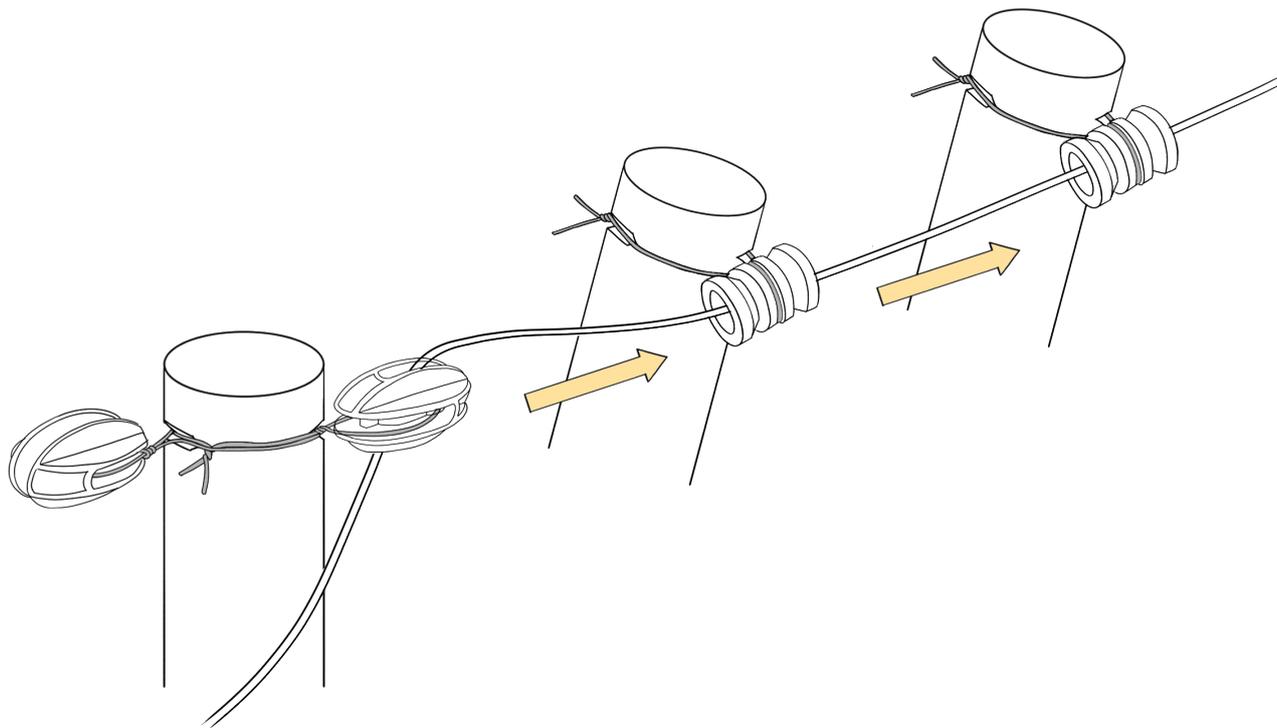


Inserting wire

Put wire through posts

Unwind the 2.5mm GI wire and insert it through the insulators starting at one of the corner posts.

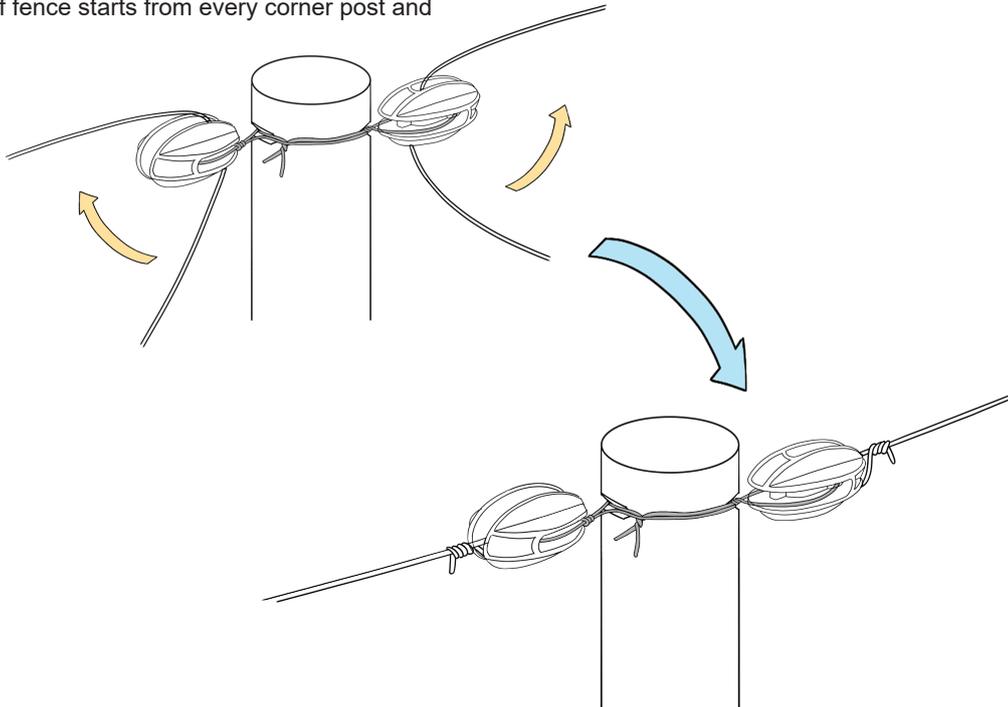




Tie wire at corner posts

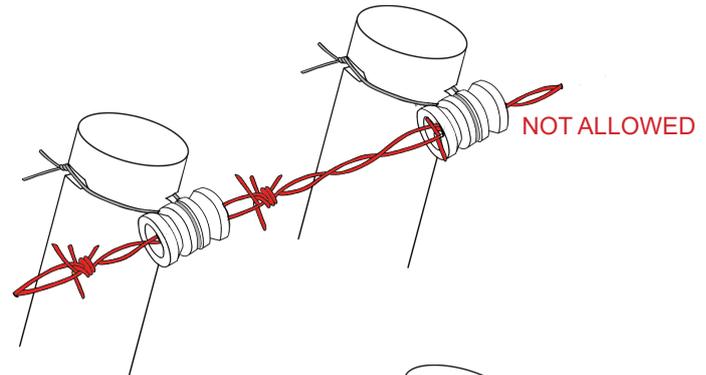
Tie the wire off at every corner post or gate post.

A separate section of fence starts from every corner post and gate post.

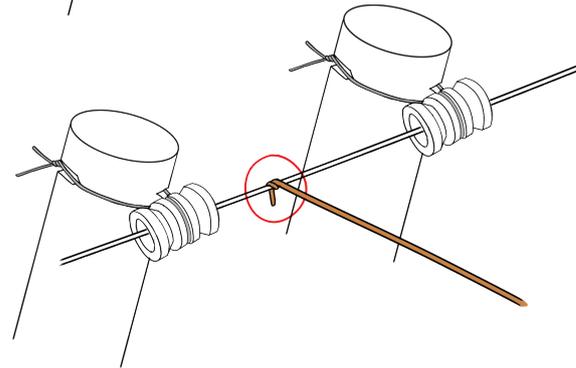


Warning! No barbed wire!

Do not use barbed wire on a power fence. This may cause an animal or person to get stuck to the fence and receive continuous electric shocks, resulting in injury or death.



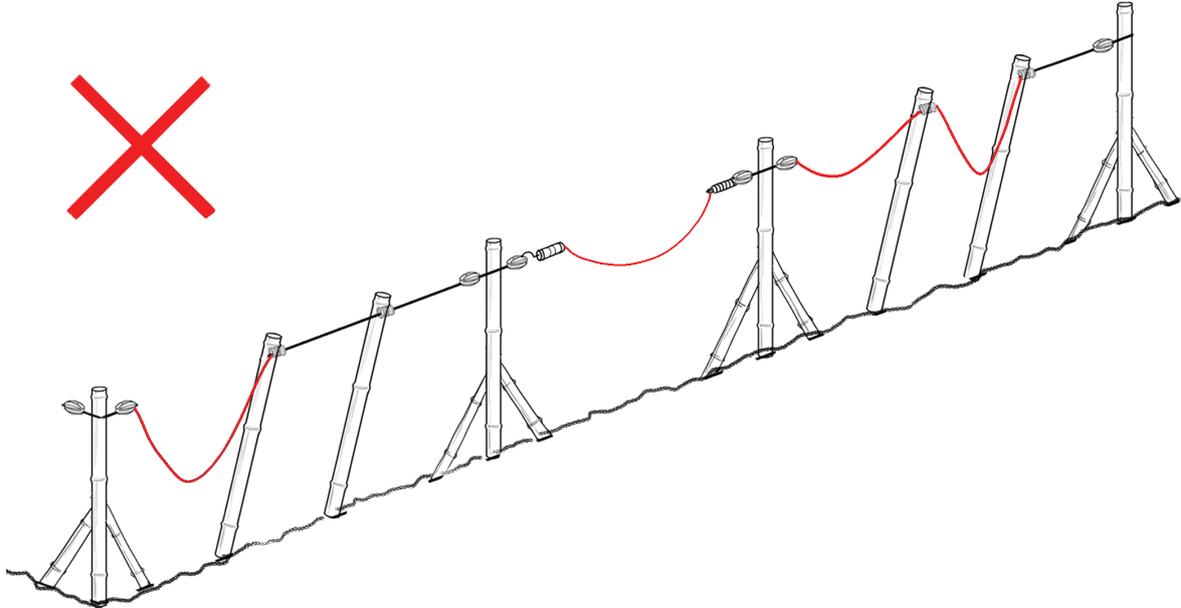
Do not use multiple types of metal wire together (for example, copper and steel). This causes the metal wire to corrode making it weak.



Warning! No sagging wires!

Do not let the wire sag.

Sagging wire may touch undergrowth causing current to leak.
It may also make it easier for animals to pass.

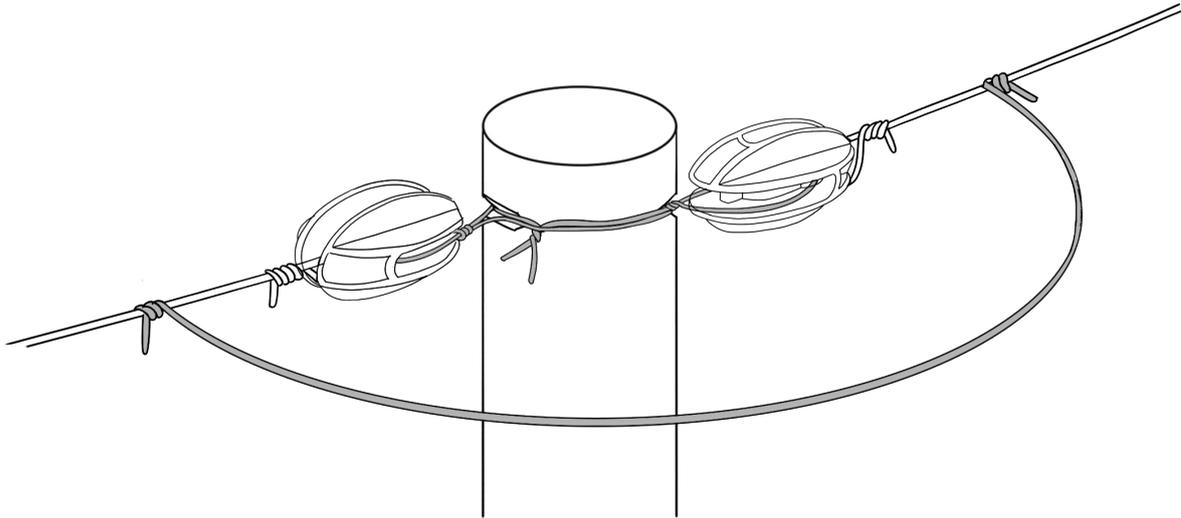


Joining sections at corner posts

A jumper is a 2.5mm GI wire that is 40cm long.

Use a jumper to join 2 sections of the fence at corner posts and gate posts.

Do not let this wire touch the post.



Installing gates

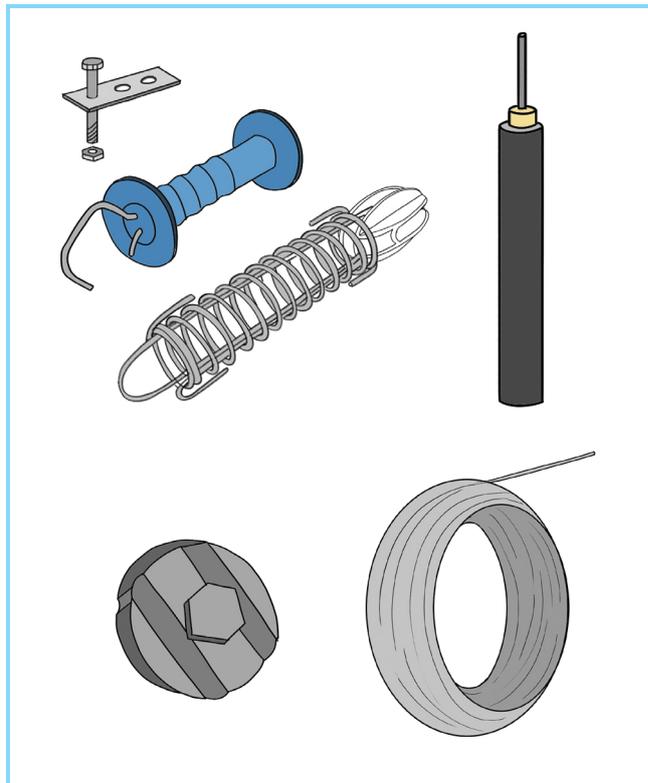
What do you need?

For each gate, you need:

- Gate kit
- 5m double-insulated wire
- 2 toupee clamps
- 5m 2.5mm GI wire

Why?

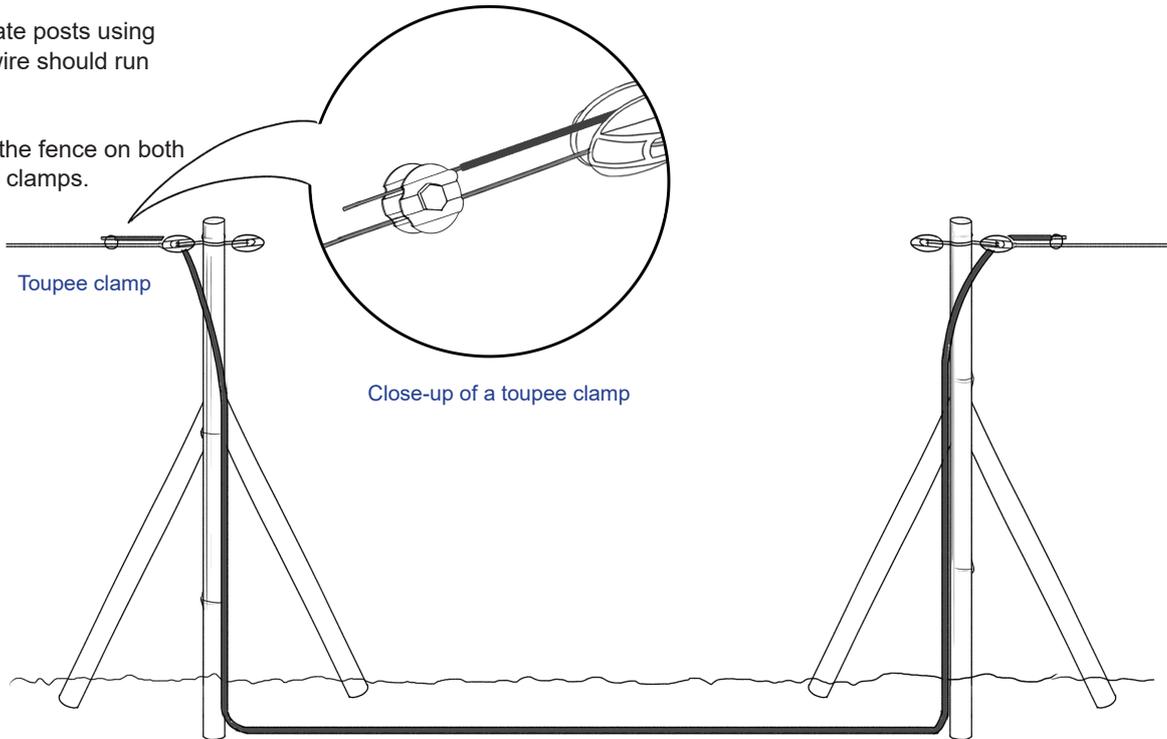
At gates, current should run both through the wire above ground and through an underground DI wire so that the fence continues to function even if the gate is left open.



STEP 1

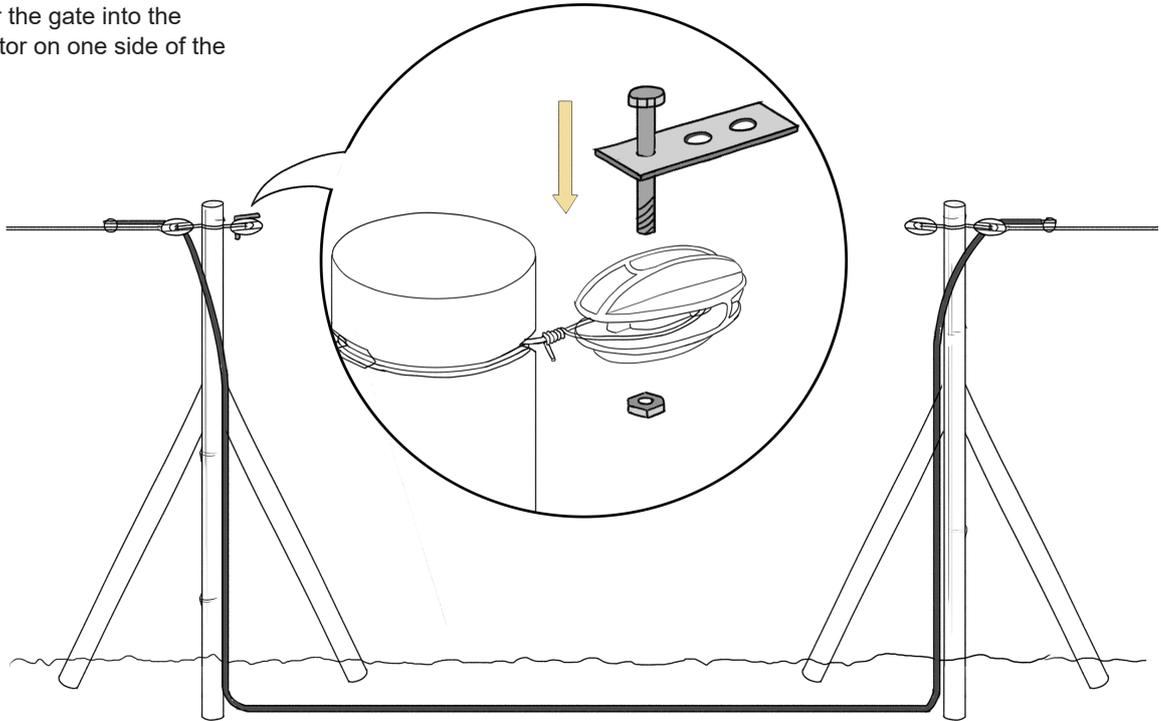
Connect the two gate posts using a DI wire. The DI wire should run underground.

Join the DI wire to the fence on both sides using toupee clamps.



STEP 2

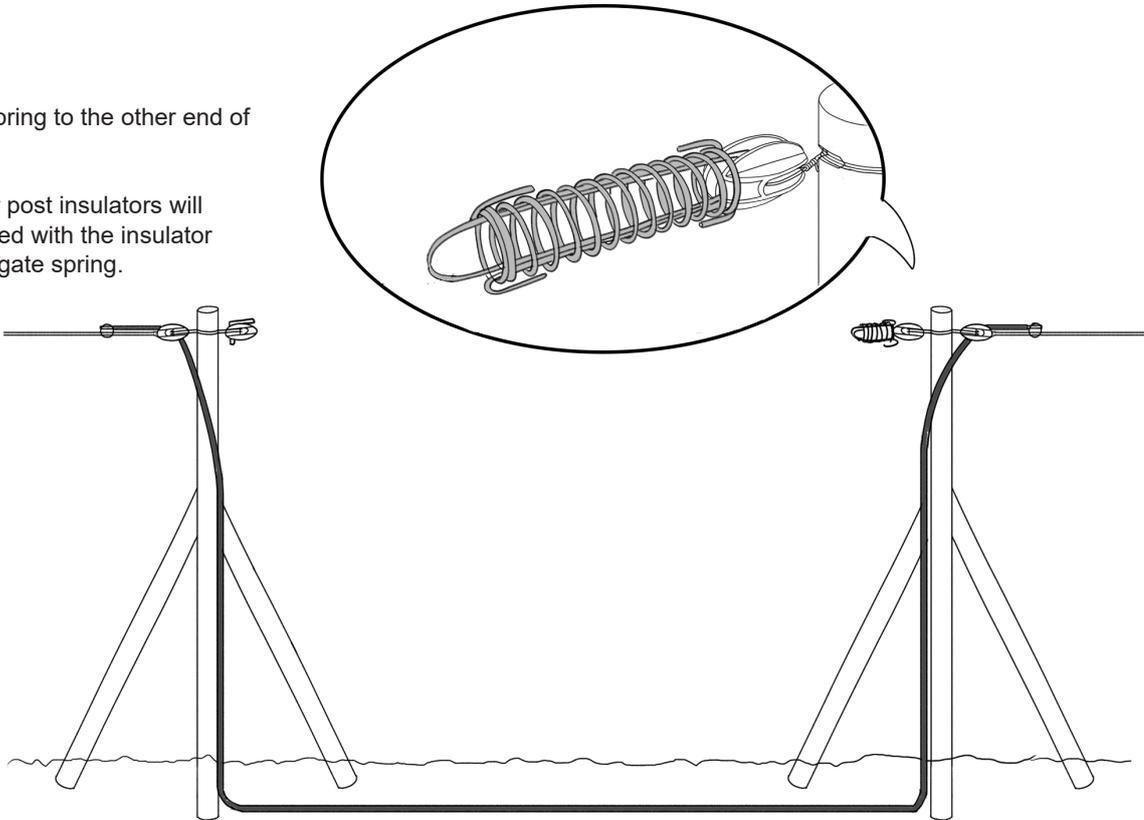
Insert the latch for the gate into the corner post insulator on one side of the gate.



STEP 3

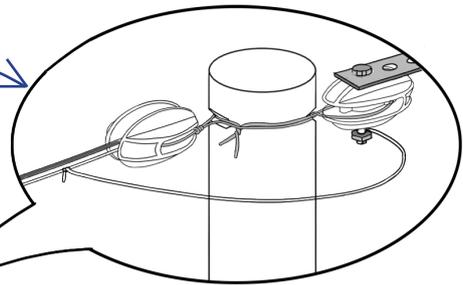
Attach the gate spring to the other end of the gate.

One of the corner post insulators will have to be replaced with the insulator connected to the gate spring.



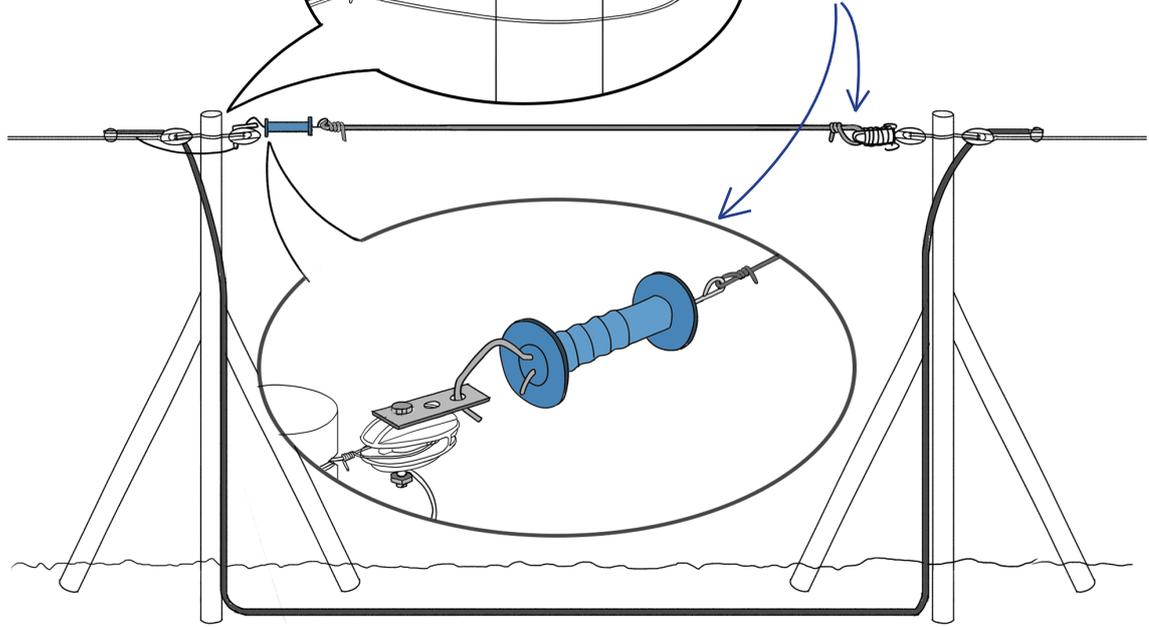
STEP 4

Tie a jumper to connect the fence wire with the screw in the gate latch.



STEP 5

Tie 2.5mm GI wire to connect the gate handle and connect the other end of the wire to the gate spring.



Protecting fence posts (from elephants)

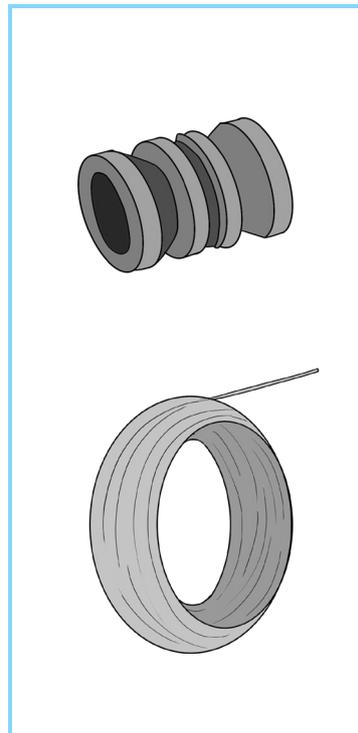
What do you need?

For every corner post and gate post in the fence:

- 4 reel insulators
- 3 jumpers of 40 cm each (made of 2.5mm GI wire)
- 6m of 2.5mm galvanised iron wire

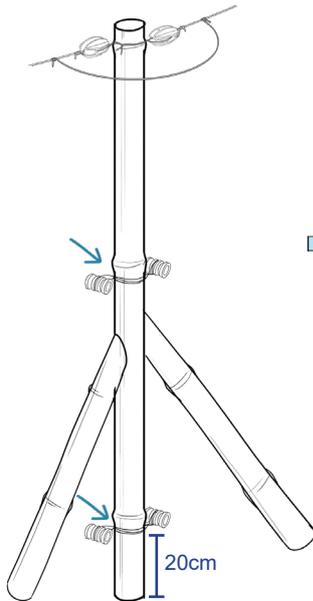
Why?

Since the corner and gate posts stand straight, there is a risk that elephants could knock them over with their feet and cross the fence. It is thus good to protect them.



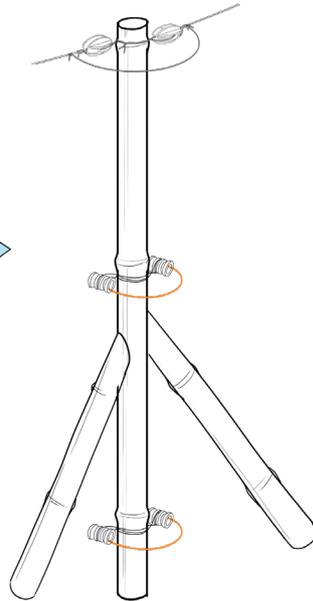
STEP 1

On each corner post and gate post, tie two reel insulators in the middle of the post and two insulators at a height of 20cm from the bottom of the post (see pg. 53-55).



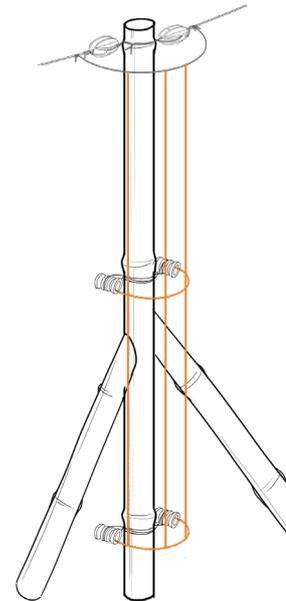
STEP 2

Connect the two reel insulators at each height with each other using jumpers made of 2.5mm GI wire.



STEP 3

Connect the 3 jumpers with each other using three strands of 2.5mm GI wire.



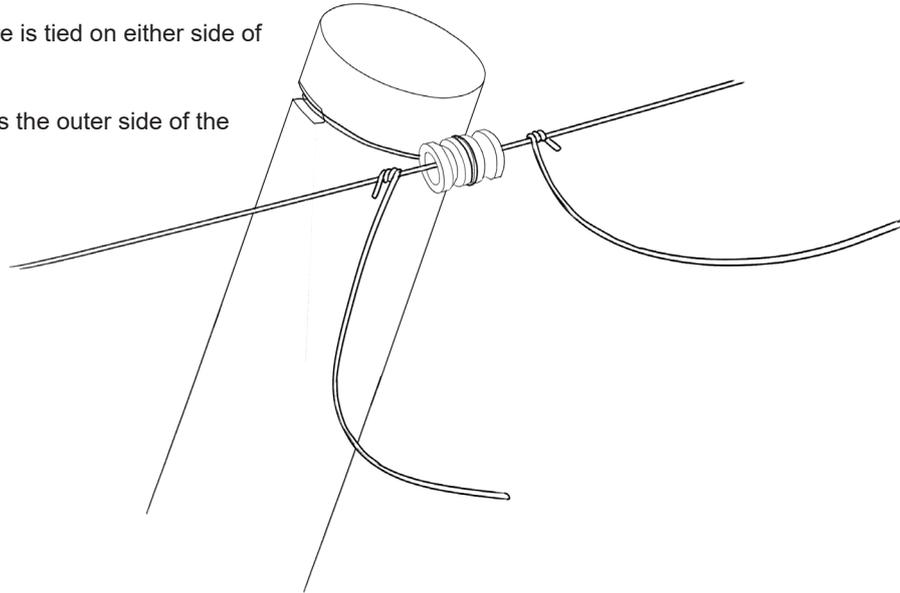
Alternatives: Protecting fence posts

Add “tentacles” of wire on intermediate or corner posts that are vulnerable to damage by elephants.

These tentacles will make it difficult for elephants to grab the posts without getting a shock.

A 50cm-long strand of 2.5mm GI wire is tied on either side of the insulator to form tentacles.

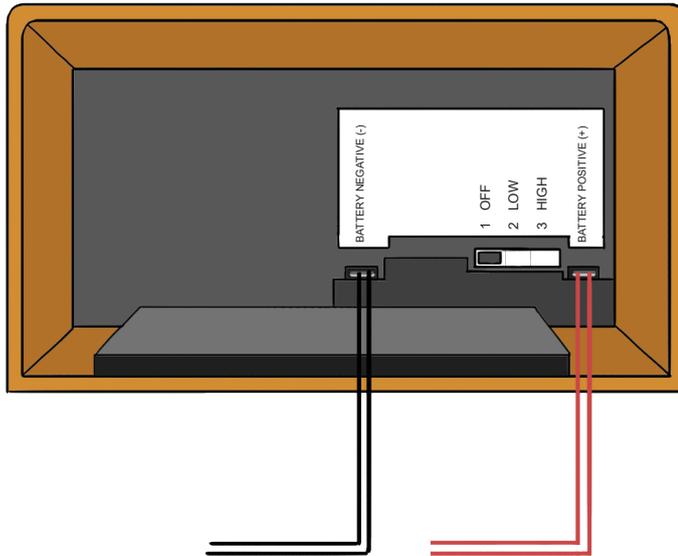
Each tentacle is then curved towards the outer side of the fence.



Turning the power fence on and off

Once the power unit and fence unit have been installed, the power fence can be turned on and off with a switch at the back of the energizer.

Back of energizer

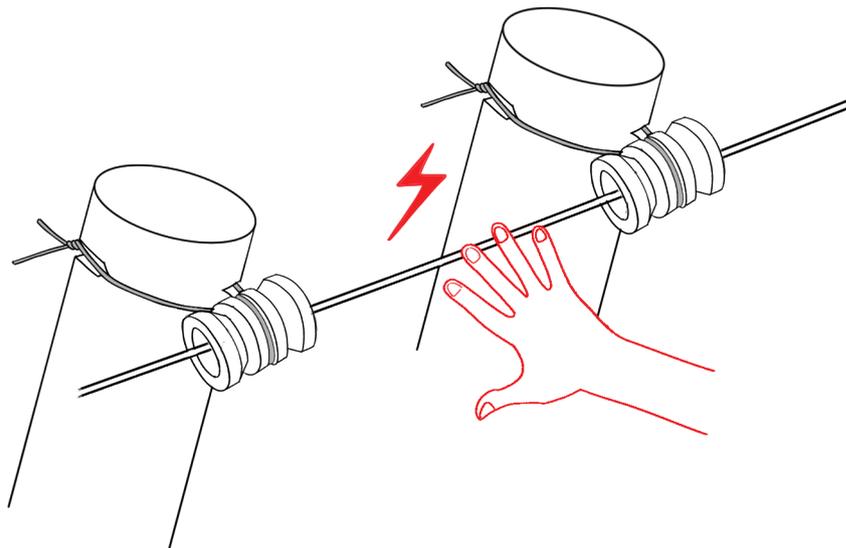


The switch on the back of the energizer has three positions:

- 1 OFF - the power fence is off.
- 2 LOW - the power fence is on (to be used during wet seasons).
- 3 HIGH - the power fence is on (to be used during dry seasons).

Warning! Do not touch!

Beware! **Do not** touch power fence once on!



Post-installation

How to measure battery voltage

Set multimeter to 20V DC

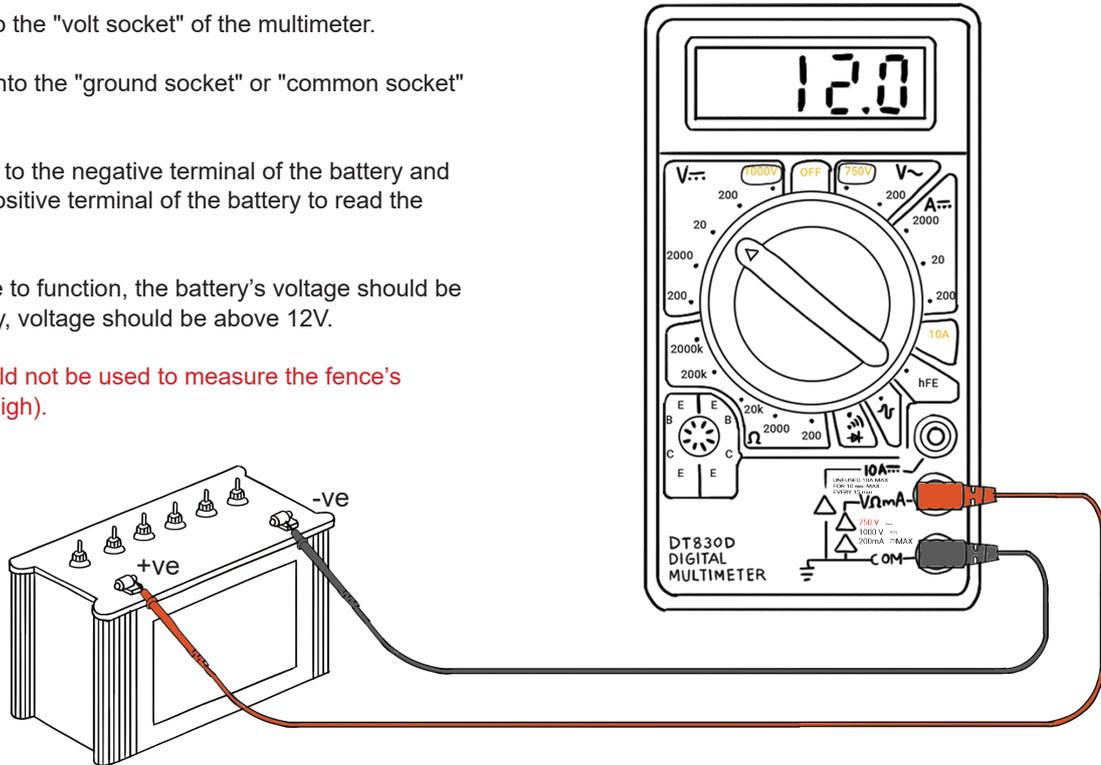
Plug the red wire into the "volt socket" of the multimeter.

Plug the black wire into the "ground socket" or "common socket" of the multimeter.

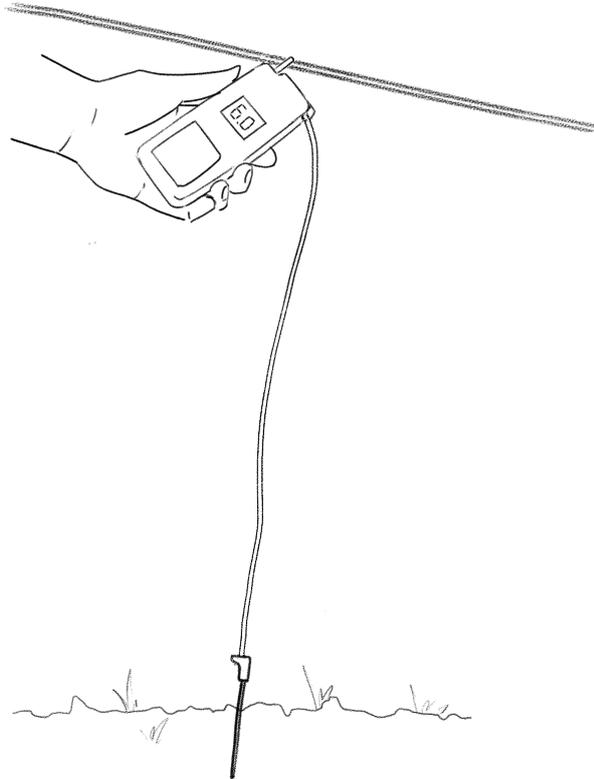
Touch the black wire to the negative terminal of the battery and the red wire to the positive terminal of the battery to read the voltage.

In order for the fence to function, the battery's voltage should be at least 11.5V. Ideally, voltage should be above 12V.

The multimeter should not be used to measure the fence's voltage (as it is too high).



How to measure voltage of fence

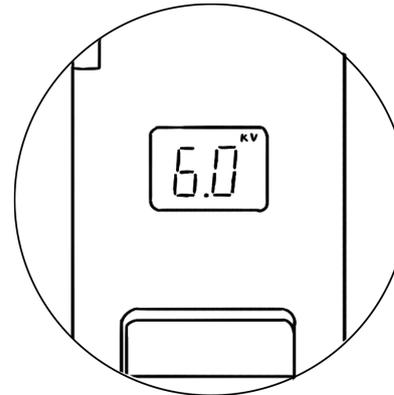


To measure the voltage of a power fence, **first** insert the long black lead into the ground. **Then**, touch the voltmeter to the fence wire.

If the fence voltage is between 6000 and 9000 V (or 6-9 kV), the fence is working properly.

If the voltage is less than 6000V, please check:
(i) the battery voltage (pg. 73)
(ii) for breaks or leaks in the fence (pg. 76)
(iii) for proper earthing (pg. 75).

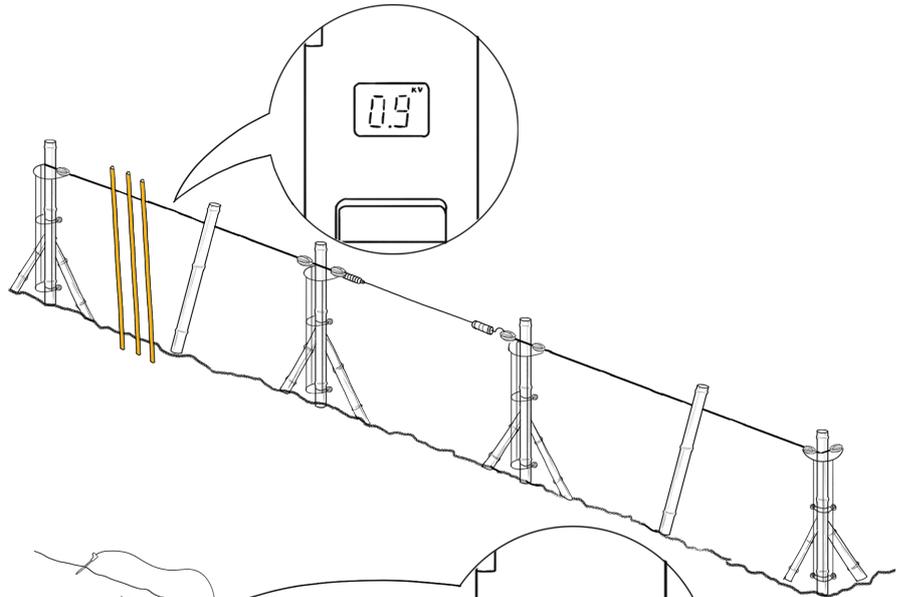
You may also consult an expert.



How to check earthing

STEP 1

After turning the energizer off, place metal rods such that they lean on the fence. Turn on the fence and check the voltage. Repeat this process, adding more rods until the fence voltage drops below 1000 V (1 kV).

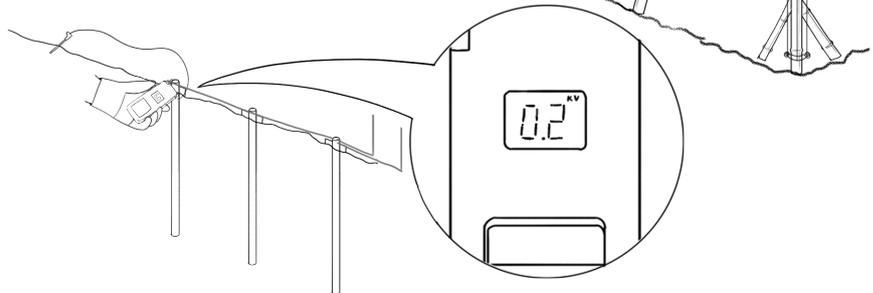


STEP 2

Measure the voltage at the earthing rods by placing the voltmeter on an earthing rod and inserting the long black lead into the ground.

If the voltage is less than 300 V (0.3 kV): Earthing is good. Switch off the energizer and take iron rods off the fence.

If the voltage is more than 300 V (0.3 kV): Add more earthing rods until voltage is less than 300 V.

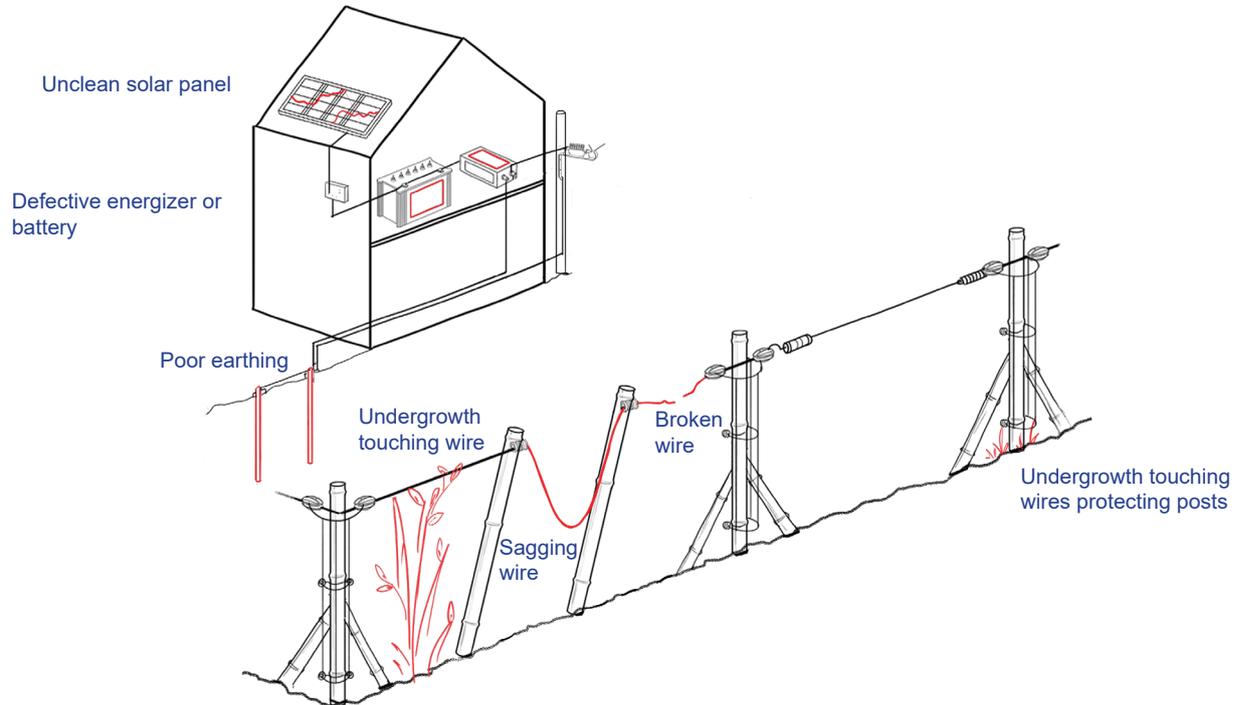


Earthing system

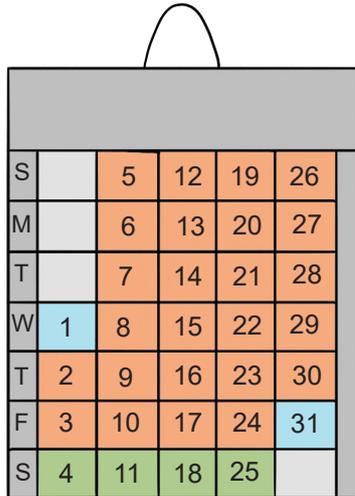
Common defects in power fences

These common defects lead to malfunction or leakage of current from the fence.

To avoid such defects, regular maintenance is necessary.



Maintenance schedule



S		5	12	19	26
M		6	13	20	27
T		7	14	21	28
W	1	8	15	22	29
T	2	9	16	23	30
F	3	10	17	24	31
S	4	11	18	25	

- Daily
 - Check battery voltage (see pg. 73)
 - Check fence voltage (see pg. 74)
 - Look for visible physical damage (see pg. 76)
- Weekly
 - Check all power unit connections (see pg. 36-39)
 - Check battery water level
 - Remove undergrowth near corner and gate posts (see pg. 42)
- Monthly
 - Clean solar panel
 - Remove undergrowth around full fence (see pg. 42)
 - Check earthing system (see pg. 75)

