

**Can-U-Read**

**Clean Energy**

Humans need energy. We use energy to do basic things like cook our food and heat our homes. We use it for conveniences like driving to work or watching the news. We even use it for silly and fun things like making and watching cartoons.

We need energy. We don't have enough. And the energy we have is dirty. How can we fix this?



What do we mean by “dirty” energy?

Energy is dirty if it is made or delivered in a way that adds to the pollution of the planet. For instance, I can heat my home with a coal fire. Coal is dirty to get, dirty to deliver, and dirty to use. Coal is a very dirty energy.

Why would we use dirty energy if it is so bad?



First, what kinds of energy are there?

Energy comes in lots of forms depending on whether it is *stored* or *expended*.

Energy can be stored in a chemical, potential, magnetic, or nuclear form.

Energy can be expended in a mechanical, kinetic, electric or nuclear form.

All energy eventually turns to thermal.

Mechanical



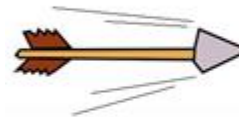
Chemical



Potential



Kinetic



Thermal



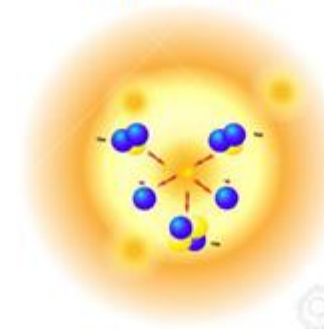
Electric



Magnetic



Nuclear





It's also important to know that energy can be moved from one form to another.

I can eat an apple to get the chemical energy. Then I use that energy to do mechanical work. In the process I can power a light bulb.

The transfer of energy from one form to another is how we make it do **work**.



Each stage in this process loses a little bit of energy. Any process that transfers energy is rated by its *efficiency*.

Efficiency is the percentage of energy that transfers. The rest usually is lost as heat.

This motor takes in electrical energy, transfers it through magnetic energy into mechanical energy to run a washing machine. It's not very efficient. Maybe only 10%.

$\epsilon$  = efficiency



So which of these energies is best?

Humans have learned to use electricity best. We can turn electricity into anything. Because of motors like this one we can use electricity to make things go.

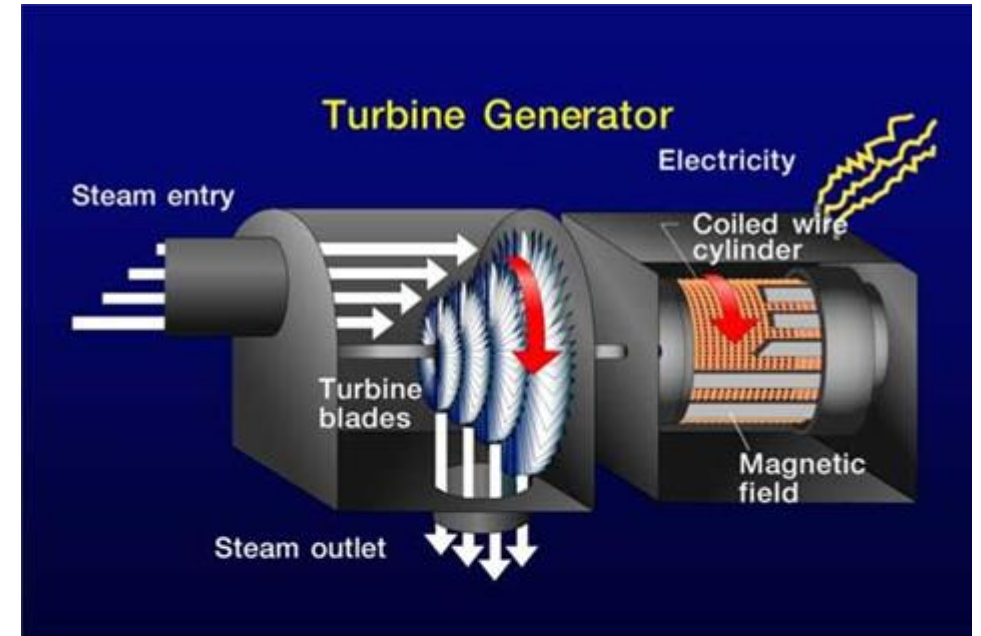
We can also create heat and even shoot guns with electricity. It is our friend.



Making electricity really hasn't changed much in a hundred years.

We make hot steam go through a fan. That fan, called a *turbine*, creates mechanical motion of a magnet. As the magnet spins it creates electricity in a surrounding wire.

This process is entirely clean. In fact, we can do it with water or wind.





The problem is how we make the steam to spin the turbine.

Most electricity is created from coal. Coal is really dirty, so even if the electricity is clean, the coal is just disgusting.

The electricity has to go a long distance over wires, but it doesn't lose much energy. The only real problem is the coal.



We can also make steam with nuclear power. Nuclear generators create a lot of heat and lots of steam with no smoke at all. Very clean. Very pretty.

But the leftovers, *nuclear waste*, are a real problem. They are lots of atoms that will poison anything alive. You don't want them anywhere near your home. Wherever you put them they will poison the land around them.

Maybe not all that clean after all.



So what are some clean ways to make electricity?

Well, we can use wind. These big tall turbines are pretty well known. There are also many other turbine styles. Some even use wing shapes to work better in the wind.

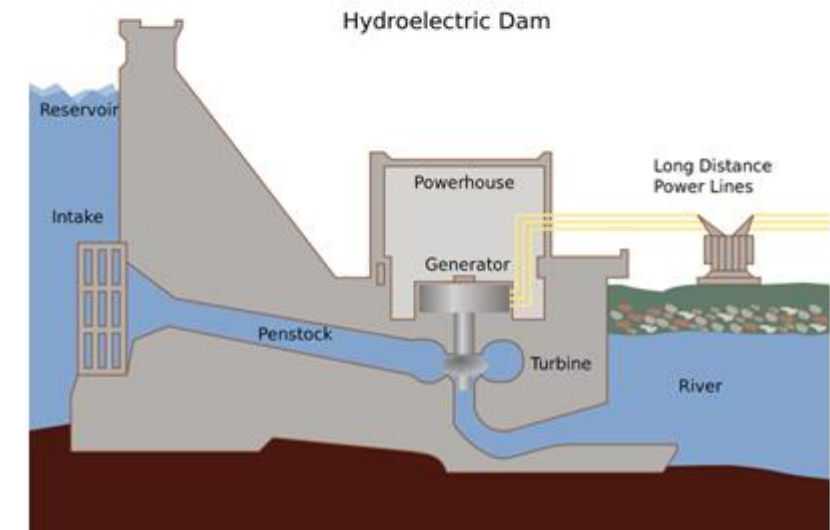
The problem is the cost of making the turbines. Often these turbines take more energy to make than they will ever get back. That is very bad.





Water can also be used to generate electricity. *Hydroelectric* generators can be built into dams on any river. Even small ones can power a house. Big ones can power whole cities.

Hydroelectric power is entirely clean. Once built they last for years and pay back way more energy. But there is still a problem. Rivers aren't everywhere. You can't do this in a desert or even in most places with lakes.

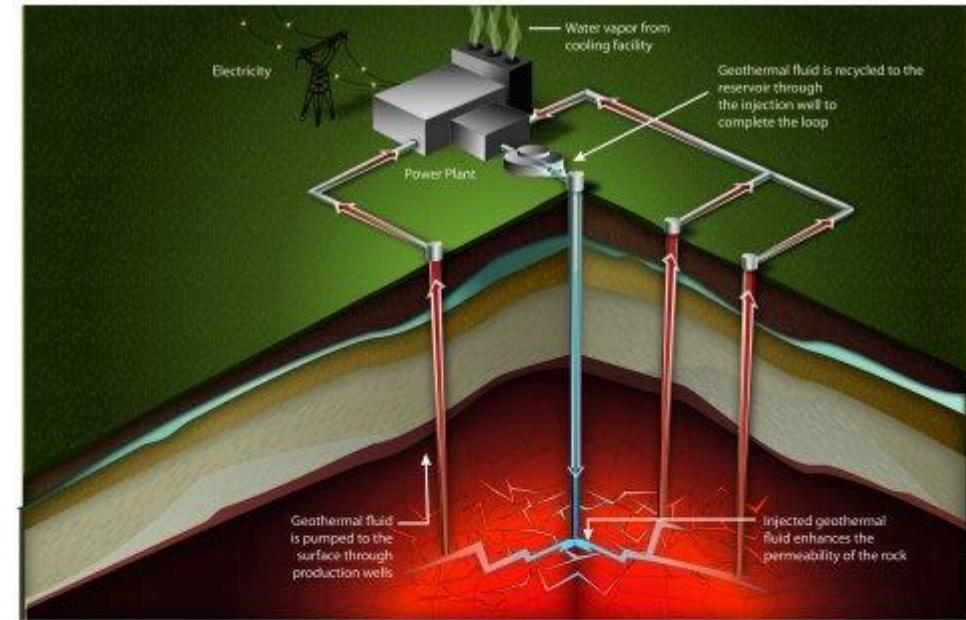




We can also get heat from the earth itself. ***Geothermal*** generators use heat from the earth to warm water and create steam. The earth does this naturally with geysers like Old Faithful.

Of course geothermal energy is buried pretty deep in the earth. Only some places where volcanoes are pretty peaceful can get this kind of energy.

Iceland is a little country with all free energy. Of course, they live on top of a huge volcano, but every home has its problems.

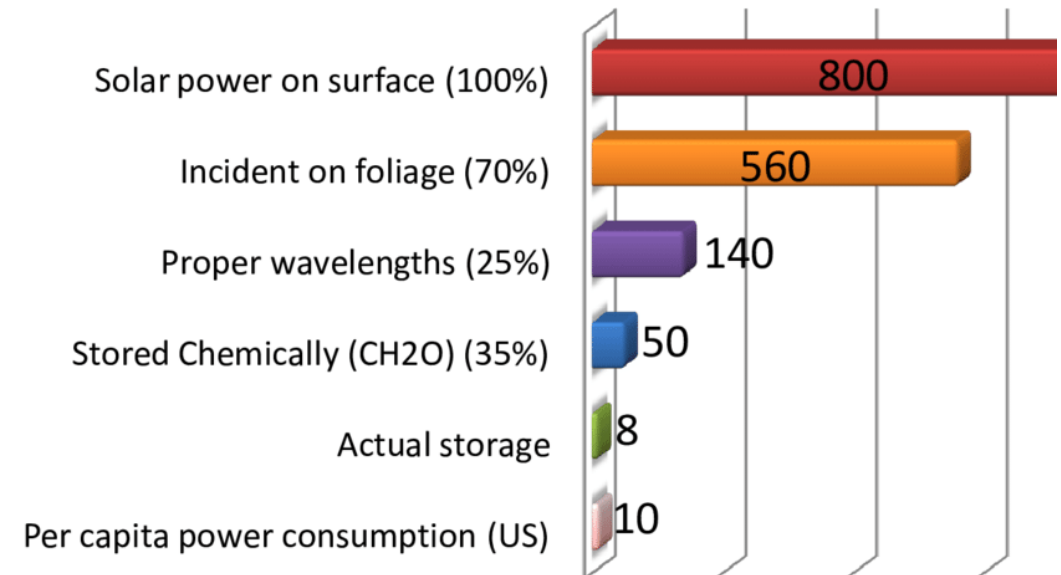


Some people want to use plants and bacteria to make our energy. After all, they already do such a great job. It turns out that plants aren't really that efficient.

Some of the light doesn't fall on leaves. Only 25% of that light can be used. Even then, just 35% of that light is stored chemically. Only 8% of the that energy is harvested by mitochondria.

Just 1% of all that light energy is used. That doesn't sound like much.

**Solar power in kW per acre captured from plants  
(energy averaged over 1 year)**

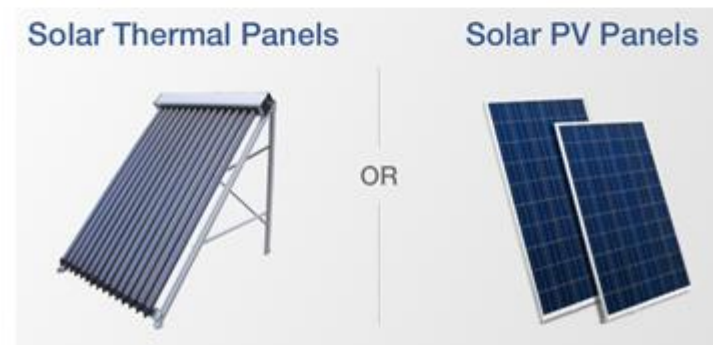




Right now, solar power looks like the best answer. It comes from the sun and it can be captured either as heat or electricity. It is everywhere on the planet.

In the deserts of California there is a tower that stands in the middle of many reflecting mirrors. The sunlight bounces off the mirrors and up to the tower where it is made into electricity.

Solar panels can be put on your roof or your yard and power your house.



The problem with solar is efficiency. Most solar panels are only about 20% efficient. Most of the sunlight is wasted as heat.

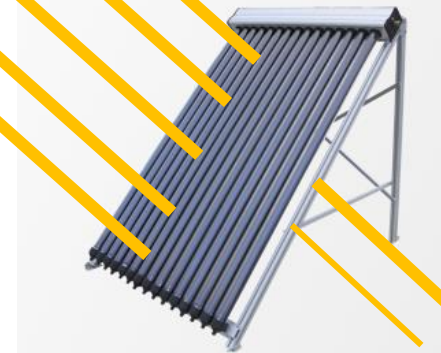
Solar thermal turns 90% of the energy into heat, but it can't store that heat. The energy has to be changed to electricity. In the end it's only about 35% efficient.

While solar is really clean and available everywhere, it's not that efficient.

Solar PV Panels



Solar Thermal Panels





For right now we still don't have enough energy. We have to keep using oil, gas, and coal.

Doing that is emptying our earth of precious energy and filling the sky with dirty stuff. One day soon that will have to change.

Until then we need to work really hard to find a new way to get energy. Something that will free our planet from the confines of limited energy.

