

RENEWABLE ENERGY

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 - **Nonrenewable energy**
 - **renewable energy**
 - Geothermal energy, Solar energy, Wind, Biomass from plants, Hydropower ,tidal ,wave power.

Energy

- Energy is the ability to do work
- Energy comes in different forms:
 - Heat (thermal)
 - Light (radiant)
 - Motion (kinetic)
 - Electrical
 - Chemical
 - Nuclear energy
 - Gravitational
-

Energy sources

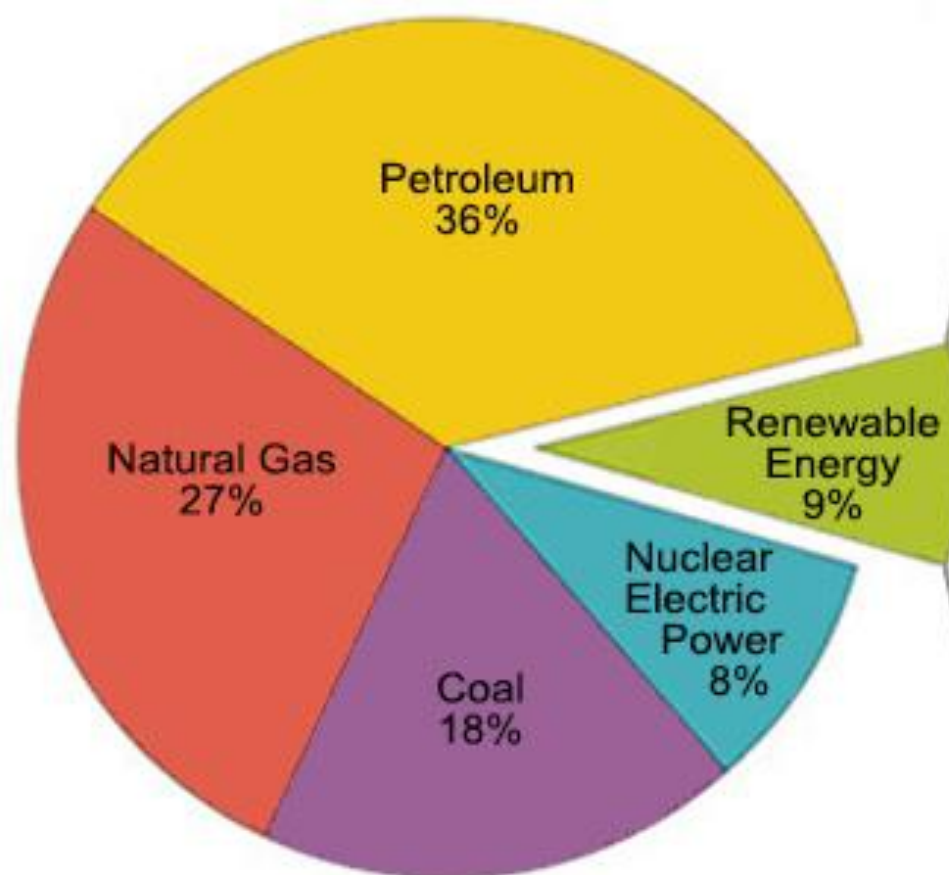
- Energy source can be categorized as:
 - **Nonrenewable** (an energy source that we are using up and cannot recreate).
 - **Renewable** (an energy source that can be easily replenished)

Nonrenewable energy

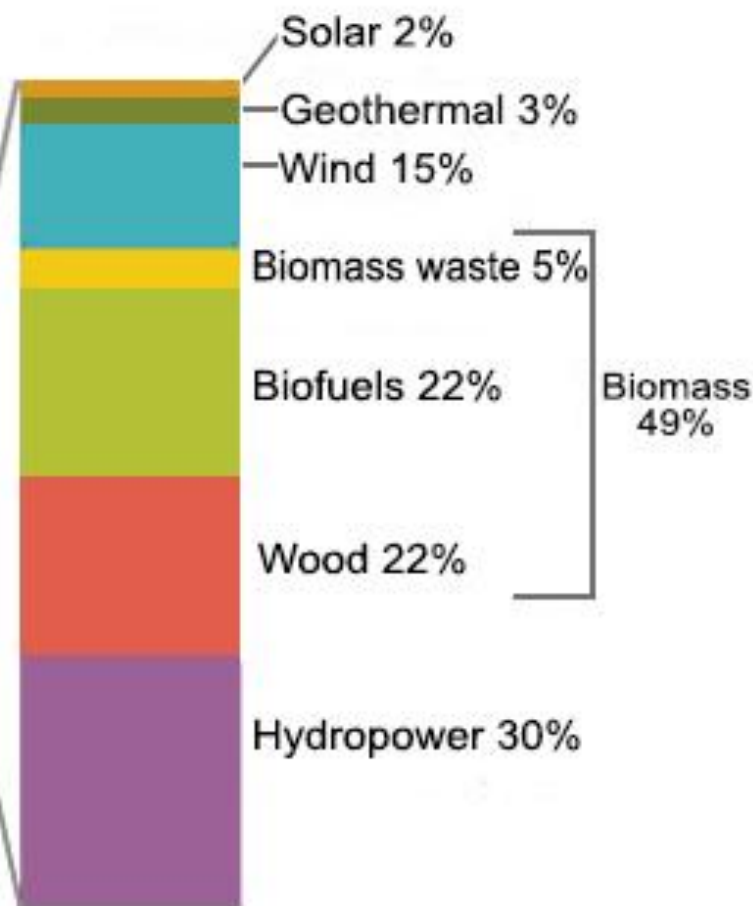
- **Coal, oil and gas** are called "***fossil fuels***" because they have been formed from the organic remains of prehistoric plants and animals.
 - By the **action of heat from the Earth's core** and **pressure from rock and soil** on the remains or "fossils" of dead plants and creatures like microscopic diatoms.
- Another nonrenewable energy source is the element uranium, whose atoms we split (through a process called nuclear fission) to create heat and ultimately electricity.

U.S. energy consumption by energy source, 2012

Total = 95 quadrillion Btu



Total = 9 quadrillion Btu



Note: Sum of components may not equal 100% due to independent rounding.

Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3 and 10.1 (April 2013), preliminary 2012 data.

Environmental impact of fossil fuels

- Damage the ecosystem
- Burning can cause air, soil ,and water pollution
- Waste disposal

Renewable energy - alternative energy

Renewable energy sources include:

1. **Solar energy** from the sun, which can be turned into electricity and heat.
2. **Wind energy**
3. **Tidal & Wave power**
4. **Hydroelectric power** from hydro turbines at a dam
5. **Geothermal energy** from heat inside the Earth.
6. **Biomass** from plants, which includes firewood from trees, ethanol from corn, and biodiesel from vegetable oil.

(1) Solar energy

- The Sun is amazingly powerful.
- Just the tiny fraction of the Sun's energy that hits the Earth (around a hundredth of a millionth of a percent) is enough to meet all our power needs many times over.
 - In fact, every **minute**, enough energy arrives at the Earth to meet our demands for a **whole year** - if only we could harness it properly.

How it works

Solar Cells

- They are called "**Photovoltaic**", "PV" or "**Photoelectric**" cells, that convert light directly into electricity.
- In a sunny climate, you can get enough power to run a 100W light bulb from just one square meter of solar panel.
- This was originally developed in order to provide electricity for satellites,
 - but these days many of us own calculators powered by solar cells.

Solar water heating:

- Where heat from the Sun is used to heat water in glass panels on building roofs.
- Water is pumped through pipes in the panel.
 - The pipes are painted black, so they get hotter when the Sun shines on them. The water is pumped in at the bottom so that convection helps the flow of hot water out of the top.

Solar Furnaces (Ovens)

- Use a huge array of **mirrors to concentrate** the Sun's energy into a small space and produce very high temperatures.
- There's one at Odeillo, in France, used for scientific experiments. It can achieve temperatures up to 3,000 degrees Celsius. →



Advantages

- Solar power is **renewable**
- Solar energy is **free** - **no fuel** it needs and produces **no waste or pollution**.
- In sunny countries, solar power can be used where there is no easy way to get electricity to a remote place.
- Handy for low-power uses such as solar powered garden lights and battery chargers, or for helping your home energy bills.

Disadvantages

- Doesn't work at night.
- Very expensive to build solar power stations, although the cost is coming down as technology improves.
 - In the meantime, solar cells cost a great deal compared to the amount of electricity they'll produce in their lifetime.
- Can be unreliable unless you're in a very sunny climate.
- you need a large area of solar panels to get a decent amount of power.
 - However, technology has now reached the point where it can make a big difference to your home fuel bills..

(2) Wind-Environmentally friendly

- We've used the wind as an energy source for a long time.
- The Babylonians and Chinese were using wind power to pump water for irrigating crops 4,000 years ago, and sailing boats were around long before that.
- Wind power was used in the Middle Ages, in Europe, to grind corn, which is where the term "windmill" comes from.



How it works:

- The wind energy can be used by building a tall tower, with a large propeller on the top.
- The wind blows the propeller round, which turns a generator to produce electricity.
- We tend to build many of these towers together, to make a "wind farm" and produce more electricity.
- The more towers, the more wind, and the larger the propellers, the more electricity we can make.
- It's only worth building wind farms in places that have strong, steady winds, although boats and caravans increasingly have small wind generators to help keep their batteries charged.



Wind-Energy harvesting

- The best places for wind farms are in
 - coastal areas,
 - at the tops of rounded hills,
 - open plains
 - gaps in mountains - places where the wind is strong and reliable.
- They need an average wind **speed of around 25 km/h.**
- The **propellers are large**, to extract energy from the largest possible volume of air.
- The **blades can be angled to "fine" or "coarse" pitch**, to cope with varying wind speeds,
 - The generator and propeller can turn to face the wind wherever it comes from. Some designs use vertical turbines, which don't need to be turned to face the wind.
- **The towers are tall**, to get the propellers as high as possible, up to where the wind is stronger.
 - This means that the land beneath can still be used for farming

Advantages

- Wind power **is renewable**.
- Wind is free, wind farms need no fuel.
- Produces no waste or greenhouse gases.
- The land beneath can usually still be used for farming.
- Wind farms can be tourist attractions.
- A good method of supplying energy to remote areas.

Disadvantages

- The wind is **not always predictable** - some days have no wind.
- Suitable areas for wind farms are often near the coast, where **land is expensive**.
- Some people feel that covering the landscape with these towers is **unsightly**.
- **Can kill birds** - migrating flocks tend to like strong winds.
 - However, this is rare, and we tend not to build wind farms on migratory routes anyway.
- Can be **noisy**. Wind generators have a reputation for making a constant, low, "swooshing" noise day and night.

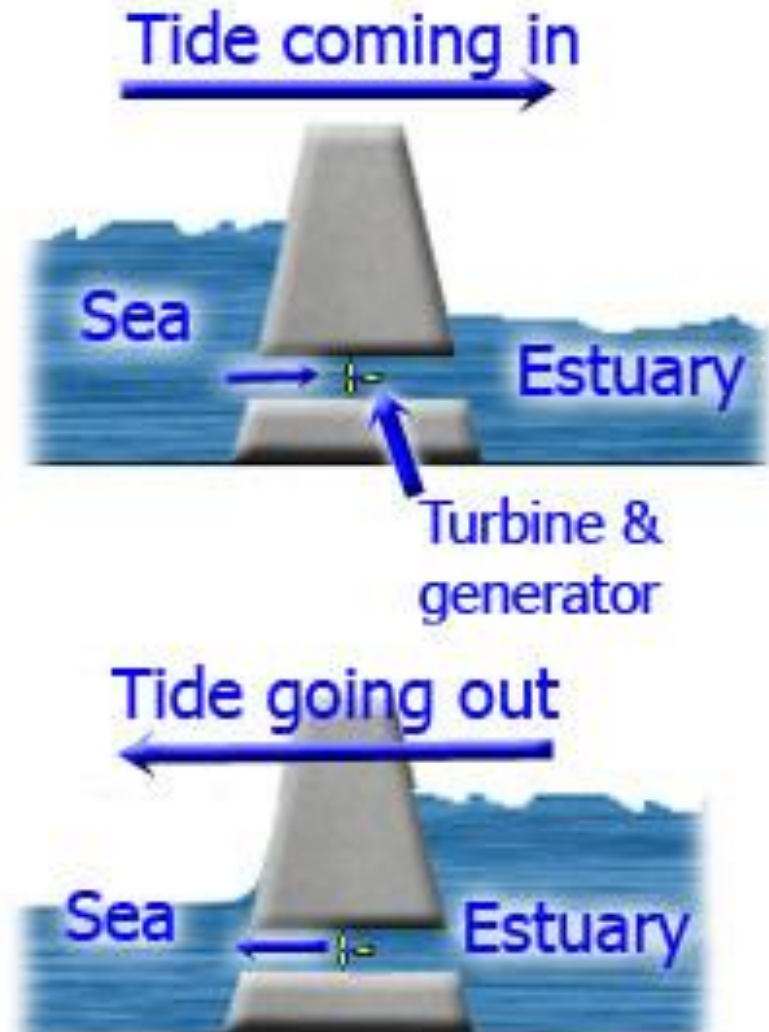
(3) Tidal & Wave Power

- The term **tide** means rise and fall of ocean and sea level due to gravitational strength from moon and rotation of earth.
- The tide moves a huge amount of water twice each day, and harnessing it could provide a great deal of energy
 - As example: around 20% of Britain's needs.
- Although the energy supply is reliable and plentiful, converting it into useful electrical power is not easy.
- A few years ago, "**tidal power**" meant "**tidal barrage**", but these days there are other options as well.

How it works: Tidal Barrages

- These work rather like a hydro-electric scheme, except that the dam is much bigger.
- A huge dam (called a "**barrage**") is built across a river estuary. When the tide goes in and out, the water flows through tunnels in the dam.
- The ebb and flow of the tides can be used to turn a turbine, or it can be used to push air through a pipe, which then turns a turbine.

- The Tidal barrages are designed to utilize the potential energy created due to the difference in the level (height) of the tidal waves.



Advantages

- Energy is renewable
 - Once you've built it, tidal power is free.
- It produces no greenhouse gases or other waste.
- It produces electricity reliably.
- Not expensive to maintain.
- Tides are totally predictable.

Disadvantages

- A barrage across an estuary is very **expensive** to build, and affects a very wide area - the environment is changed for many miles upstream and downstream.
- Fish can't migrate, unless "fish ladders" are installed.
- Only provides power for around 10 hours each day, when the tide is actually moving in or out.
- There are few suitable sites for tidal barrages

Wave power

- Ocean waves are caused by the wind as it blows across the sea.



World first wave and tidal energy projects for Scotland

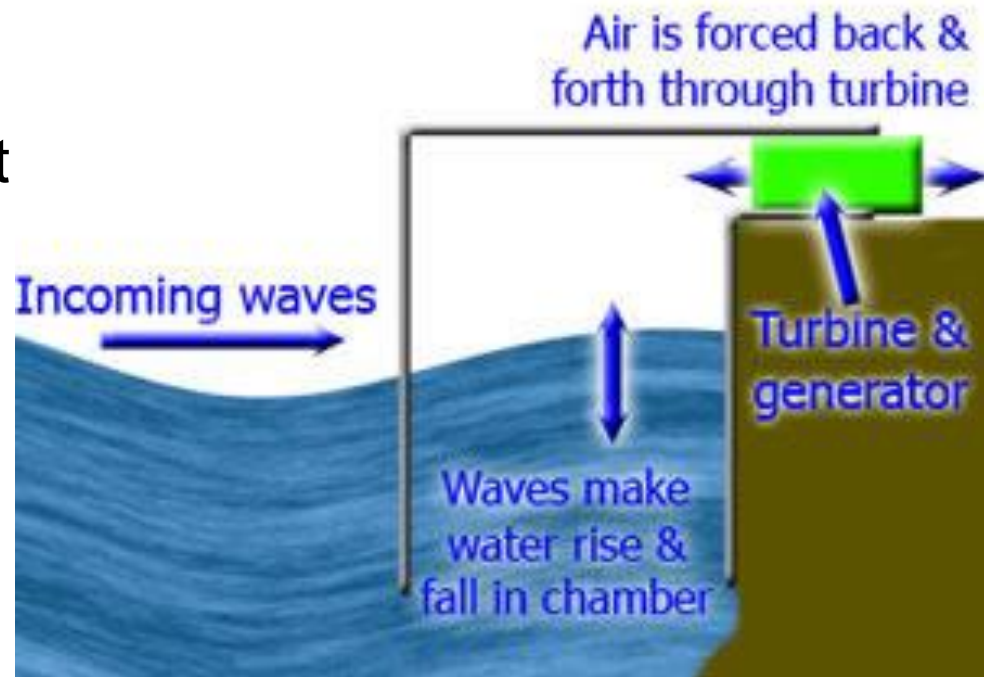
The world's first wave and tidal energy projects on a commercial scale are to be built off the Scottish coast, with developers claiming they have the potential to power 750,000 homes.

https://www.youtube.com/watch?feature=player_embedded&v=EAe4uRLVDjM



How it works

- At a wave power station, the waves arriving cause the water in the chamber to rise and fall, which means that **air is forced** in and out of the hole in the top of the chamber.
- A **turbine** is placed in this hole, which is turned by the air rushing in and out.
- The turbine turns a **generator**.



Advantages

- It is renewable
- The energy is free
- No waste produced.
- Not expensive to operate and maintain.

Disadvantages

- The problem is that it's not easy to harness this energy and convert it into electricity in large amounts.
 - Thus, wave power stations are rare.
- Depends on the waves - sometimes you'll get loads of energy, sometimes almost nothing.
- Needs a suitable site, where waves are consistently strong.
- Some designs are noisy.
 - A problem is that the rushing air can be very noisy, unless a silencer is fitted to the turbine.
- Must be able to withstand of very rough weather.

(4) Hydroelectric power

- Water is allowed to **flow through tunnels** in the dam, to turn turbines and thus drive generators.
- Hydro-electric power stations can produce a great deal of power very cheaply.



How it works:

- Because of the great height of the water, it will arrive at the turbines at high pressure, which means that we can extract a great deal of energy from it.
 - The water then flows away downriver as normal.

How it works:

- In mountainous countries such as Switzerland and New Zealand, hydro-electric power provides more than half of the country's energy needs.
- An alternative is to build the **station next to a fast-flowing river**.
 - However with this arrangement the flow of the water cannot be controlled, and water cannot be stored for later use

Advantages

- Once the dam is built, the energy is virtually free.
- No waste or pollution produced.
- Much more reliable than wind, solar or wave power.
- Water can be stored above the dam ready to cope with peaks in demand.
- Hydro-electric power stations can increase to full power very quickly, unlike other power stations.
- Electricity can be generated constantly.

Disadvantages

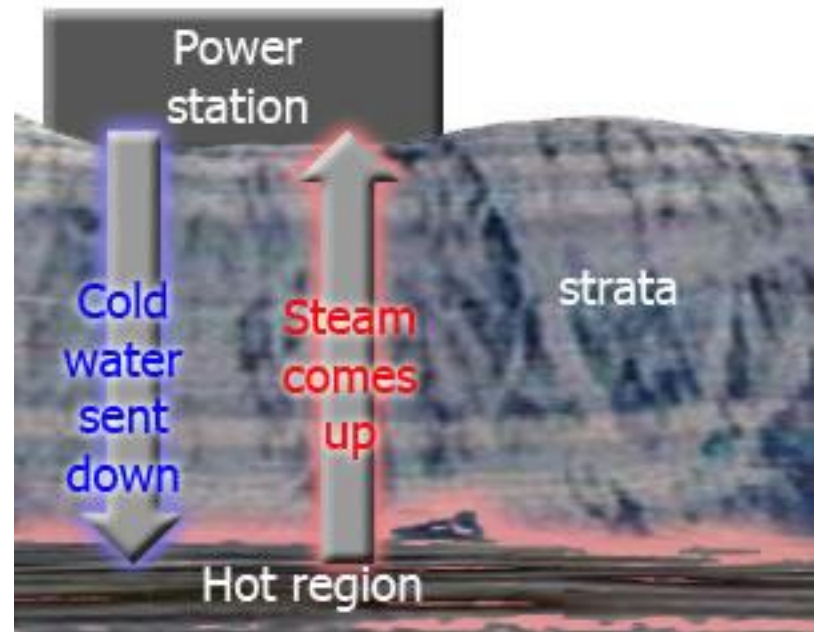
- The dams are very **expensive** to build.
- Building a large dam will **flood** a very large area upstream, causing problems for animals that used to live there.
- Finding a **suitable site can be difficult** - the impact on residents and the environment may be unacceptable.
- Water quality and quantity downstream can be affected, which can have an **impact on plant life**.

(5) Geothermal power

- The name "geothermal" comes from two Greek words: "geo" means "**Earth**" and "thermal" means "**heat**".
- The centre of the Earth is around 6000 degrees Celsius - easily hot enough to melt rock.
- Even a few kilometers down, the temperature can be over 250 degrees Celsius if the Earth's crust is thin.
 - In general, the temperature rises one degree Celsius for every 30 - 50 meters you go down, but this does vary depending on location
- In volcanic areas, molten rock can be very close to the surface. Sometimes we can use that heat.

How it works

- Hot rocks underground heat water to **produce steam**.
- We drill holes down to the hot region, steam comes up, is purified and **used to drive turbines**, which drive electric generators.
- There may be natural "groundwater" in the hot rocks anyway, or we may need to drill more holes and pump water down to them.
 - e.g In Iceland, geothermal heat is used to heat houses as well as for generating electricity.



- Geothermal energy is an important resource in volcanically active places.
- How useful it is depends on how hot the water gets.
 - This depends on how hot the rocks were to start with, and how much water we pump down to them.
- Water is pumped down an "**injection well**", filters through the cracks in the rocks in the hot region, and comes back up the "**recovery well**" under pressure.
 - It "flashes" into steam when it reaches the surface.
- The steam may be used to drive a turbogenerator, or passed through a heat exchanger to heat water to warm houses.
 - A town in Iceland is heated this way.
- The steam must be purified before it is used to drive a turbine,

Advantages

- Geothermal energy is renewable
- Geothermal energy does not produce any pollution, and does not contribute to the greenhouse effect.
- The power stations do not take up much room, so there is not much impact on the environment.
- Once you've built a geothermal power station, the energy is almost free.

It may need a little energy to run a pump, but this can be taken from the energy being generated.

Disadvantages

- The big problem is that **there are not many places** where you can build a geothermal power station.
 - You need hot rocks of a suitable type, at a depth where we can drill down to them.
 - The type of rock above is also important, it must be of a type that we can easily drill through.
- Sometimes a geothermal site may "**run out of steam**", perhaps for decades.
- **Hazardous gases and minerals** may come up from underground, and can be difficult to safely dispose of.

(6) Biomass from plants-Biofuels

- Biofuels (energy from organic matter)
- Divide in three type:
 - Firewood (Lignocellulosic)
 - Organic waste
 - Agricultural crops

How it works

- Lignocellulosic materials (cellulosics) includes plant debris, agricultural wastes and municipal waste cellulosics.
- A wide range of fungi are naturally capable of degrading cellulose through the concentrated action of several enzymes that collectively referred to as cellulase.
- In a number of microorganisms, cellulase activity is found as a part of a multiprotein complex that is called “**cellulosome**”.
- This complex lies on the external surface of the microbial cells.

How it works

- The anaerobic digestion of Corn Stover and mixtures of Stover with Swine Manure in the laboratory were used to produce **methane**.
- Anaerobic digestion involves two groups of microbial organisms:
 - those that convert cellulose to acetic acid (acid bacteria) and
 - those that use acetic acid to produce methane (**methanogenes**).
- Researchers can easily inhibit the methanogenes and use the acid bacteria to produce chemicals such as glycerol, lactic acid, ethanol and acetic acid.
- Researchers have used **metabolic inhibitors** that preferentially alter the pathway toward the desired product.

How it works

- Chemically, **transesterified** biodiesel comprises a mix of mono-alkyl esters of long chain fatty acids.
- The most common form, uses methanol to produce methyl esters as it is the cheapest alcohol available, though ethanol can be used to produce an **ethyl ester biodiesel** and higher alcohols such as **isopropanol** and **butanol** have also been used.
- Using alcohols of higher molecular weights improves the cold flow properties of the resulting ester, at the cost of a less efficient transesterification reaction.
- A byproduct of the transesterification process is the production of **glycerol**

Advantages

1. Biomass is a potential source of energy resources (methane and ethanol), commodity chemicals, animal feed, and specialty products (e.g., flavors, fragrances, pigments).
2. Biomass is an attractive alternative to petroleum - based sources because it is not only a low-cost substrate for production, but also it is renewable and improve the biodegradability of end products.
3. Cleaning the environment from waste materials.

Disadvantages

1. The main reasons that food price have rise rapidly in world wide.
 1. Agricultural crops is competes for water with all other use.
2. Use fertilizer and pesticides in these crop.
3. Biofuels reduce the production of green house gases but when natural vegetation is removed to grow biofuels crop the opposite case occurs.
4. Can pollute the air and degrade the land