Environmental Damage

As fossil fuel supply gets harder to acquire, and prospectors search for new pockets of oil and have to drill longer and deeper to acquire it, there has been conflict between environmental groups and industry and between governments and both groups when local wildlife and environmentally sensitive areas are threatened. Here in the US, public consciousness and the need to protect our wildlife and natural landscapes means that many new developments are protested with concerns of environmental damage. Ongoing protests against fracking and new drilling in Europe and North America and recent examples. Though some renewables will have an environmental impact, many do not and when built, have no further impact - unlike ongoing drilling.

Public Health

Oil, gas and coal drilling and mining have high levels of pollution that are pumped into local environments and the wider atmosphere, so while protestors attempt to prevent the building of pipelines or new prospecting in virgin areas and wilderness, it is as much about public health as it is about conservation. We have known for decades about the knock on effect of industrial processes for public health. Few renewables are entirely emission-free, but their output is much lower than conventional fossil fuel acquisition and processing.

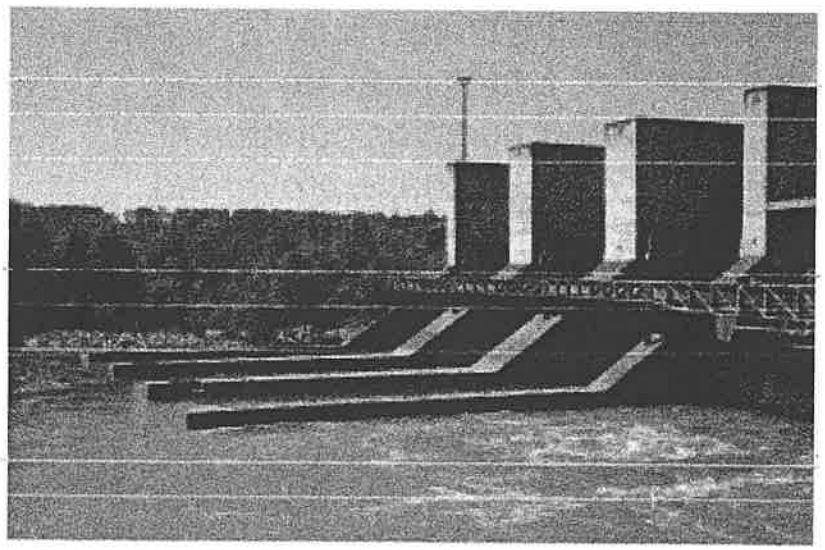
What are The Renewable Energy Types?

Renewables are by definition unlimited, but it is important to note that not all forms are environmentally friendly. Here, we look at some of the most common types of renewable energy and discuss their advantages and limitations.

Hydroelectricity

Using water's motion power to generate electricity is not a new concept; we have been doing so for around one hundred years and most countries have some form of water generated electricity source. There are two basic forms of using water for green energy needs. Hydroelectricity is produced by processing and controlling the flow of water through a dam. This is one of the most encouraging forms of renewable energy. Globally, it generates some 3,500 terawatts of power and has increased year on year since 2003. Hydroelectric power is likely to be one of our most common forms of energy production in the next few years and in the post oil world.

What are the Advantages of Hydroelectric Power?



The building of dams at key strategic places as decided by environmental engineers means that energy generation can be increased or decreased depending on the needs of the community that uses it. During times of low use output may be reduced, and increased during times of high output need **(23)**; these changes can be made quickly compared to oil production which has a delay due to the need to refine the raw product. The

speed with which output of hydroelectricity can be changed is a major advantage to our growing energy needs.

Hydroelectricity is one of the lowest cost forms of energy as it requires no fuel; this means no mining, no processing, and no transportation cost. It was estimated in 2010 that the average cost of a kilowatt-hour of energy produced by hydroelectricity was 3-5c.

It is one of the cleanest forms of energy. Though the construction process of building and maintaining a dam will mean carbon emissions, this is the only output - still a significant reduction over the burning of fossil fuels. The relative cheapness of construction and maintenance, and the low cost of generation means it is used increasingly in both the developed and the developing world.

Finally, dams do not exist purely for their energy generation; they have many uses today. Flooding and drought are a major cause for concern with many countries having suffered both in recent years, often one season after another. Dams regulate water supply during floods and maintain water supplies during a drought. Building Aswan Dam may very well have prevented drought in Egypt in the 1980s when countries around them (Sudan, Ethiopia) suffered horrific drought.

What are the Disadvantages of Hydroelectric Power?

Hydroelectricity and dam building does not come without cost and it's important that environmental engineers and decision makers keep this in mind when planning the siting of a new facility.

Building a dam destroys an area of landscape and changes the ecology downstream, this cannot be avoided, even where there is an extant river that is being modified. Dam building can and does destroy important cultural landscapes too. Using Aswan Dam as an example again, the river valley flooded to create the high water table that would sit behind the dam destroyed an important archaeological landscape. Although many relics were saved and

features recorded, and the international community came together to move Philae Temple block by block, the cultural landscape around the original site was lost forever.
In tropical areas, higher levels of methane output have been recorded from and around the reservoirs; this has been put down to the higher levels of anaerobic chemical processes. It's important to note that methane output is much lower in more temperate areas.
Finally, the potential for failure of a dam is catastrophic. Should it burst, any settlement in the valley below would be flooded, leading possibly to loss of human life, destroyed houses, disrupted power supply to all the homes affected and possibly flooding of the winder landscape beyond, more ecological damage, more loss of human life. Thankfully, burst dams are rare and when they do occur, usually cause minimal disruption.

Tidal Power

Tidal power is not yet common but it has been demonstrated that it is possible to generate electricity at sea by reacting to the ebb and flow of the oceans. This a common form of power generation across the Atlantic, in the eastern US states and Western Europe (with the UK being one of the early developers thanks to the high tidal ranges around the Orkney Islands). Its take up has not been wholesale elsewhere yet for a number of reasons. Tidal power generators come in four general types.

- **Stream generators** use the water flow to power a turbine which then generates electricity.
- **Tidal barrage** uses small dam like structures alongside natural features under water that seize the potential energy as the water flows in and converts it to mechanical energy as it flows out.
- **Tidal lagoons** are still in development, but they work in a similar fashion to the barrage but are completely artificial.

- **Dynamic tidal power** is still theoretical and has not been tried, but requires the building of dams that are tens of kilometers long to regulate water flow.

What are the Advantages of Tidal Power?

The first major advantage is that tidal power is more predictable than other well-known renewable systems such as wind and solar power thanks to the natural relationship between The Moon and the Earth. The pattern of the tides is predictable to a high degree of accuracy, a system on which we have been reliant for thousands of years of human existence. We have accurately measured these systems that people living in coastal areas where there is more than a minor variation, know the high and low tide times. This has always helped plan a number of maritime functions and now it is helping us begin to generate electricity.
The second advantage is that the volume of water on the planet is fairly constant and unlikely to run out, even without a significant temperature rise way beyond the 2-3^{0} predicted by climate scientists at present. Melting ice caps is not likely to affect these tidal ranges by a great degree, as the Moon is the only influencing factor on the fluctuations.
The third and most important is the low input to high output production. The density of water and its tidal motions means that we can, in theory, produce a lot of energy even from low wave activity. Choppy seas and stormy weather is not required to generate massive amounts of energy.

What are the Disadvantages of Tidal Power?

The technology has largely not been taken up due to high cost. It is mostly still in development stage so some authorities are reluctant to invest in the technology while there are still cheaper alternatives available.
As mentioned above, the technology is limited to those areas of the world with a wide variation in its tidal range to warrant harnessing the power of the sea - this includes the eastern

seaboard of North America and Western Europe but few other places. The overwhelming majority of coastal sites will not be suitable for this technology.
Underwater ecologies are just as delicate as land ecologies and any intrusion into the seabed or disruption to the natural marine landscape is going to affect the wildlife and alter it forever; what's worse is it seems that we don't know what (if any) long term effects are on the marine ecology.

Solar

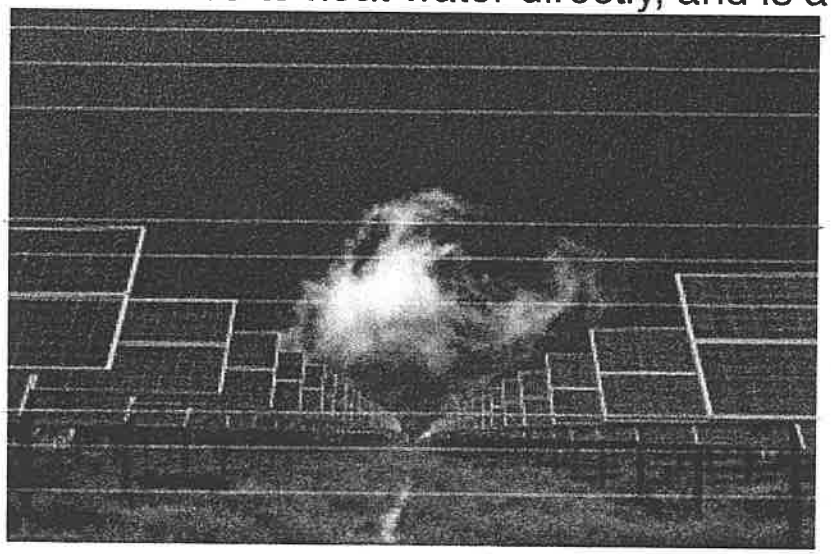
We can be pedantic and point out that the sun is not renewable, that it has a finite end - but the fact that it has some 4.5bn years of life left in it is not a major or immediate cause for worry. Solar power is arguably one of the best-known renewable energy sources and many argue that solar power should have been more common much earlier than it was. Interest began in the 19th century with the same people who understand that coal would eventually run out. Heavy investment in fossil fuels meant that it went undeveloped until the late 1970s when instability of oil supply began again (1973 Embargo and 1979 Crisis). Also, growing environmental awareness and the prominence of peak oil meant we once again need to look for cleaner energies. There are two basic types of solar energy:

- **Photovoltaic**: These are the most common form and have always been, but the new breed that have been in development since the year 2000-2005, and that which are now increasingly common on top of our homes, use the same basic technology as that used in the 1970s and 1980s. Each cell converts the light of the sun into electrical energy, which can then be used to power electrical devices.
- **Concentrated Solar Power (CSP)**: If you have ever seen a solar array using a large number of curved panels, it is most likely this type of technology. They may look similar to PV, but they work differently in that they draw in a concentrated

beam of sunlight, reflecting it through a system of mirrors. The resulting heat generated by the process activates a turbine that produces electricity through a conventional generator. Where PV produces energy from light, this produces energy from heat.

What are the Advantages of Solar Power?

The most obvious advantage is that it will last as long as the sun will last - which is billions of years against the maximum 70-80 years that we believe is the remaining life span of our oil supply, and against the several decades of gas and coal. It is a very flexible energy source and not only can it generate electricity, but can be used to heat water directly, and is a source of light.



The second is the cost saving of the system. Many people are concerned about the cost of the initial outlay, but they are far cheaper today than they were in the 1980s and far more efficient, representing long-term investment and saving. They are noise-free and work all the time too. Plus, if you use your solar panels in line with your local or national grid, you can save a lot of money using solar energy. In some cases, you may be able to feed that energy back to the supply, effectively selling it, and making money in the process. Once installed, they are low maintenance and with very little pollution compared to other forms of fuel.

As it will be an important form of our energy supply in years to come, it is constantly under development. Investment in better technologies is likely to lead to more efficient systems in future.

What are the Disadvantages of Solar Power?

There are three major disadvantages to solar. Firstly, their efficiency drops during cloudier days, during the winter when there is less sunlight generally, and during storms. Though the PV systems of today are far more efficient than they used to be, there is still a way to go. If you live in warmer and sunnier climes (such as California, Texas, Arizona and so on) you are likely to get more efficient use out of them than you would living in the northern states or places in the world where there is less sunshine.

The second disadvantage is that you need to consider careful placement. The rotation of the Earth doesn't need to be explained here beyond the understanding that the sun does not remain in the same place all day. It rises in the east and sets in the west. Unless you have an expensive system by which to rotate your panels, or panels on every slant of your roof to capture sunlight at every stage of the day (and most don't because both systems would be expensive) your PV paneling will be less efficient at certain times of the day.

The third is what to do with all that energy and power to get maximum efficient use of the energy that the PV panels capture. You may purchase batteries to stop all that energy going to waste, but these can be expensive even if it is energy efficient. What most people do though is use energy generated from solar sources during the day and use grid power at night - for the environmentally conscious person this could be counterproductive for what they are trying to achieve.

Wind Power

There are few countries in the world that do not use wind-generated energy. Often subject to campaigns to have them shut down or planning permission refused, to many they are a blot on

the landscape that ruins a perfectly attractive natural view. To others, they are a great way of harnessing an unlimited resource generated by the natural processes of the planet's weather systems. We have captured the wind for thousands of years - it drove our ships until relatively recently, and in many places still grinds our wheat into flour.

The same principle is behind the generation of electricity through the turbines of wind farms. At sea or on land, these giant spinning windmills capture the power of the air around it. Some countries have made a national industry of generating its power from wind. In 2015, Denmark broke its own world record by producing over 40% of its national power from wind energy. Wind power is far more popular in Europe than in North America, with nearly have of the global capacity produced across various European countries. Many of these are at sea where most of the wind power is produced.

What are the Advantages of Wind Power?

The advantages of wind power are well-documented. Firstly, wind is a constant as it is part of the planet's natural weather cycles. There is nowhere on Earth untouched by wind, not at sea or on land. There is greater levels of wind at sea as the topography does not act as wind breaks as it does on land, this means greater potential to harness energy and most wind farms are at sea. This is a potentially limitless source of energy if it can be properly harnessed.

Despite jokes about meteorologists always getting it wrong, the weather is predictable and certainly within a day or two. This means that turbines can be altered for maximum efficiency of use to generate as much energy as possible. Because it is efficient, it is also very low cost compared to most others - including other forms of renewable energy, arguably the cheapest form available. They can also be placed in rural areas on ranches, where they make minimal impact on the land.

What are the Disadvantages of Wind Power?

The optimum siting of wind farms is often counterintuitive to the needs of the people that will use the energy it generates. Wind sources are best out at sea where there are no cities, and on large, expansive plains (here in the US on large, expansive, flat ranches) which are far from the settlements that will need it. That means there needs to be great investment in an infrastructure to transport the energy from the place of generation to the place of consumption if we are to use wind power as a major power source.

Like solar power, wind energy generation is not constant and varies from season to season and even day to day, even though periods of low and high wind can be easily predicted. This means that warm, dry summers with very little wind means that other sources of energy generation will be needed to make up any potential shortfall.

Energy from wind generation is also geographically limited. As mentioned above, the best places are at sea and on vast plains. There are areas where they are completely unsuitable such as in mountain valleys and in urban sites where natural and artificial structures will shield any turbines from wind capture. On top of mountains may be a good place, but the wind must be strong enough to warrant placement. Poor placement could be a hindrance and not an advantage to power generation.

Geothermal

One of the most intriguing concepts of renewable energy, and one being used in the US today, is harnessing heat from under the surface of the planet produced as a result of geological processes such as natural heat loss, volcanic activity, or from perfectly normal and safe processes such as radioactive decay **(39)**. We have used the heat of the Earth for centuries; hot springs all over the world have been places of spiritual significance and centers of settlement. Indeed, one of the first examples of this form of

energy is in the Roman city of Bath in England. Not only were the hot springs a source of the famous public baths in the city, but they were used to warm local houses and to provide a constant supply of hot, clean water to the city's population.
We have come a long way since then, and today there are many geothermal power processing plants across the world providing clean energy to local areas. In the US, the most significant states that use geothermal power are Idaho, Hawaii, Alaska and Nevada mostly as a result of harnessing volcanic and tectonic processes.

What are the Advantages of Geothermal Power?

Geothermal energy is one of, if not the, cleanest form of energy production available. We are feeding off the heat generated by the natural motions of the Earth as it spins on its axis. The planet is a hotbed of geological activity that is constant and renewable. It only produces as much greenhouse gas as it would produce anyway, so there is no increase in the carbon footprint when harnessing this power source. Lower production cost also means lower maintenance costs and lower end cost to the consumer. Multiple studies have shown that geothermal energy is one of the cheapest forms presently available.
Many consider this a great answer to our growing energy needs. Though big power plants supply towns and cities, it is possible for houses to install their own simple geothermal power system that will only have minimal impact on the ground beneath the surface. These simple units available for the home vary in terms of usefulness and efficiency, but it is possible for every home in the US to have one, simply drawing off the heat from below ground.

What are the Disadvantages of Geothermal Power?

The major disadvantage of geothermal power is that for the most efficient use, they are geographically limited. The best use is from

areas close to tectonic plate boundaries and areas of high volcanic activity. Where these are present, they can produce a limitless supply of energy that will not deplete the more reliant we become on it, but in other areas it may not be particularly intensive, nor profitable. It may not be the best source of energy in parts of the world with little to no volcanic activity and in a temperate climate.

While the harnessing of such energy does not produce greenhouse gases in itself, we must remember that a large volume of carbon, methane and other harmful gases do exist beneath the surface. Locally, there is potential for major environmental disaster should these be released as a result of feeding off the geothermal energy; globally, we are trying to reduce the amount of GHG released into the atmosphere. Any increase would be unintentional, but counterproductive to a cleaner, greener world nonetheless.

There is a heavy upfront cost that could mean initially, that energy produced as a result of this process would be relatively expensive to the end consumer. Building large geothermal energy harnessing complexes can be expensive and intense, and maintenance costs may be high. That said, in the long run it will still be a cheaper alternative than dwindling fossil fuel sources.

Biofuel & Biomass

Biofuel is the production of the types of fuel we use in our vehicles (though normally and typically diesel) from plants or other organic matter rather than from the fossil fuels extracted from the ground. Biofuels are produced in one of two ways:

- Directly processing a raw plant material, such as extracting its natural oils, and processing it into a type of fuel
- Extraction of residues or decomposing matter as a result of natural anaerobic processes (such as broken down by bacteria or algae into an alcohol substance - bioethanol)

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Biomass is different from biofuel in that it is waste organic material such as wood and other plant matter, and not a derivative byproduct that results from processing. Biomass is chopped wood (logs and kindling), grasses, leaves, brush and scrub, and other raw organic material that may burn and produce energy, including manure and animal dung. In the past, and indeed in areas where there are few trees to burn as fuel (Arctic Circle) people may burn bone or as a source of fuel.

What are the Advantages of Biofuels and Biomass?

Whether burning the organic material itself or resulting substances that are processed from the breakdown of the raw organic material, as it is organic it is renewable. These are not a finite resource so long as we continue to plant vegetation to replace that which we harvest. Thankfully, there are now laws in many countries to ensure that deforestation does not happen on the sort of scale we used to see - even though in some places it is still very much an ongoing challenge to prevent further deforestation in environmentally sensitive areas (Brazil and Borneo for example).

Flexibility of source is a considerable advantage for biofuels and biomass, especially when producing liquid fuels such as ethanol. Different topographies are suitable for different types of crop, which means that most countries should be able to produce biofuels - it is not limited to one crop type. You can easily produce it in temperate areas of the US as you could in more tropical or arid locations. Also, anything organic will burn and produce energy as it request resource investment to grow - a food supply, water supply and sunshine to photosynthesize.

The other obvious advantage on a slightly related note, is localizing supply and not being dependent on international trade for fuel. Biofuel or biomass that is produced in a shorter radius will have a much lower carbon footprint for having eliminated the

transportation process of getting fuel from source to consumer, and of course increases energy security.

What are the Disadvantages of Biofuels and Biomass?

To many, biofuels are a stopgap at best until we can find something cleaner and greener than ethanol. The energy output of biofuels and biomass is much lower than conventional fossil fuels and much greater quantity is needed to produce the same energy output; this is counterproductive to the lower carbon emissions of the fuel type. As a knock-on effect, more areas of land will be required to produce biofuels and biomass, meaning that we will need more land on a planet that is a finite size.
On a related note and one of the major contentions of the use of biofuel and biomass is how we can justify turning over virgin land to agriculture to supply the world with fuel and energy while half the world's (estimated) population still starves. Aside from the ethics, more pressure on the land will mean less space to produce food and higher food prices, and more water use turned over to keep our energy needs supplied. By volume of land, biofuels and biomass production for the purpose of energy is simply not that efficient.

Renewables and the Economy

Any fundamental shift in technology is going to raise concerns about the economic impact of said technology. Typically, we hear questions similar to the following:

- How will people employed in existing technology sector going to be affected, will it cost jobs?
- Will this new technology require fewer jobs overall?
- How will we train the next generation to use / engineer this technology?
- What will be the economic impact on the local economy / the country / the world?