

THE BLUE ENVIRONMENT PARTY

JOIN THE CLEAN TECHNOLOGY REVOLUTION

We will replace fossil fuels with something far better

There is no need to be anxious about having to give up your way of life. We will find faster, cheaper and more convenient ways to travel, live comfortably and enjoy our lives.

The abundance of energy on earth

There are five primary sources of energy on earth. We will have to find our energy supply from among these sources, but the good news is that they are many times more abundant than we require. One problem is that they tend to be most abundant far away from where we live, so we will have to find ways to transport the energy.

They are:

- (i) sunlight (produced by nuclear fusion in the sun);
- (ii) heat from the decay of the limited stock of radioisotopes present since the earth's formation (this generates most of the heat in the earth today, but is a declining source over time);
- (iii) some heat remaining from the original coalescence of earth (again declining with time);
- (iv) chemical energy obtained by reacting elements together (a rare possibility as most reactions have already taken place – an example would be organisms which react hydrogen sulphide with water to make sulphuric acid and release a little spare energy in the process); and
- (v) kinetic energy from a combination of the earth's spinning motion and the moon's orbit (again this declines with time). All other forms of energy, including fossil fuels, are by-products of one of these sources. Oil for example is made from dead organisms cooked up under heat and pressure over a long time to become an essence of distilled sunlight.

Some of the enabling technologies of the late 20th century, such as genetic engineering, nanotechnology and materials science, may have very important applications in the clean technology revolution.

12 technologies that can help us

The following technologies are some of our best hopes. Many are already working for us, some need improvement and others need strenuous development.

Fusion

The ultimate dream would be to make a fusion reactor on earth. The problem is that atoms always resist fusing and will do so only when forced into it by extreme pressure and/or temperature. Even at the centre of the sun, which is the only place we know where it happens naturally, fusion is a statistically rare event. On earth we have only been able to make fusion bombs, not controlled fusion reactions. This is done by using an atomic fission bomb as the detonator to create the high temperature and pressure.

With amazing ingenuity, we have been able to make occasional fusion reactions happen in a reactor, but we cannot yet make them self-sustaining, and we are

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uncertain if we ever really will. Even so, the prize of endless clean energy without the drawbacks of fission power is so great we must pursue it. We salute the scientists working in this field.

Fission

The next best thing would be to find a safe way to harness the energy of atomic fission, which happens naturally all the time. This is also the power source that heats the earth's mantle to make volcanoes and tectonics. We have been generating fission power quite successfully for 50 years, and are getting better at it slowly. Intriguing new small-scale, cheaper and safer designs are becoming available. We heartily recommend fission, as it really can solve our problems today. For a robust discussion on what to do about the waste, and other aspects of fission power, see the section on nuclear power in our Environmental Policies (downloadable from our website).

Solar electric

On average, some 1000 watts of solar radiation fall on every square metre of earth during the day. If we harnessed that power with 100% efficiency, that would be enough to light ten 100-watt bulbs. Solar panels may be a work of genius – Einstein did much of the work on understanding the photoelectric effect – but they are only about 15% efficient at best, and most far less. However, they are gradually becoming more efficient and cost effective. In certain areas where the sun shines strongly and local electricity prices are high they can now achieve grid parity. There is still plenty of scope for improvement, as the theoretical maximum is around 40% efficiency and there is scope to make them out of cheaper materials. Much work remains to be done.

Solar heat

Concentrating the sun's heat can be a simple, low-tech thing to do. Something as simple as a radiator painted black and mounted on the roof will produce hot water. There are more sophisticated ways too, using evacuated tubes (like a Thermos) and an evaporating/condensing cycle, as described in 'Heat Pumps', below. These can be effective ways of producing domestic hot water. This technology is already in use.

If it is electricity you are after, people are building power stations in deserts around the world using various methods of collecting and concentrating solar heat. Some use sun-tracking mirrors aimed at a central tower to heat water and drive a steam turbine. Others focus heat on a Stirling engine. Heat can even be stored effectively in salt ponds for power generation at night.

Wind, wave and tidal

The world's wind resource is only just beginning to be tapped. The best resources tend to be in remote places, e.g. offshore. The problems are its intermittency, and the vast numbers of turbines required. We need to improve turbines so they work more effectively in low and high winds. To balance wind, we will need cheap long-term power storage systems, such as pumped storage hydro-electric power (HEP). Wave power is a form of concentrated wind energy, which holds great potential but has so far proved hard to exploit. In certain places, tidal power may make a useful contribution, though we are not in favour of large barrage building schemes.

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Geothermal

Our planet emits heat through volcanoes and mid ocean ridges, and there are areas where radioactive elements are more concentrated in the Earth's crust, generating heat. All of these can be exploited provided we are careful to avoid accelerating the planet's natural rate of heat loss. Iceland produces about half of its electricity from geothermal (the rest from HEP). Many other countries have geothermal plants. Much more could be done, and new technologies are required.

Biofuels and use of waste biomass

Biofuels have been given a bad name. However we hold out high hopes for 3rd generation biofuels that do not displace rainforest or other habitat, or crop land, and do not require excessive water or other resources. Creating fuel from algae and certain other plants is looking promising, and work is being done on how to turn wood into liquid fuels. (It is worth noting that much of this research exploits genetic engineering techniques.) Advanced biofuels are the best hope for sustainable fuel for jet engines.

We should remember that until the industrial revolution our economy was powered by wood and other biofuels, and there is still scope to use our waste wood and other materials as a minor power source, unless we can do something better with them. Some of this biomass is now being co-fired in coal power stations to reduce the amount of coal needed.

Heat pumps

Heat pumps have great potential to revolutionise our heating systems, and in some cases energy collection and storage as well. Ground source and air source heat pumps are already being used to great effect across the world.

Heat pumps are familiar technology - your fridge is a form of heat pump. To understand how it works, think about why it is much quicker to steam something on the stove than to boil it. And then think of swimming. Why do you feel cold stepping out of a pool? The answer in both cases has to do with the change of state from liquid to vapour or vice versa. Basically when a vapour condenses, it dumps a large amount of heat very quickly into its surroundings. And vice versa, when a liquid vaporises, it suddenly soaks up a lot of heat from its surroundings, hence you feel cold getting out of the pool.

Now suppose you pump a liquid around a circuit and at one point in the circuit you release pressure so it vaporises, and at another point you constrict it so it condenses. Now you can see how, if you put those condensing/vaporising points in the places you wanted to heat or cool, you could pump heat as required.

The best thing about these machines is that they exploit latent heat from the environment and concentrate it where you need it. This is a very efficient way of using electricity, as for each unit of energy you use to pump the liquid/vapour round the circuit, you gain up to six units of energy from the surroundings. There is a refinement where you can even use heat itself to drive the pump. We used to have

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fridges powered by burning calor gas, which worked on this principle (basically the heat drives the evaporation part of the cycle, and this then makes the liquid flow round). This idea is so simple and yet so brilliant – and, again, it was Einstein who came up with it. He sold his patent to Electrolux.

Energy storage

Many things, such as cars and planes, require energy storage, i.e. fuel they can carry on board and burn en route. Fossil fuels happen to be excellent, dense energy storage systems, and we have not yet invented anything better. Much work is being done on batteries and capacitors and these are likely to improve in the next few years. The new Tesla roadster car shows what can be done with the lithium ion type batteries that power your computer.

We are interested in capacitors as they can be charged in an instant – theoretically you could drive over a charging-point in the road and receive a top up, and if there were charging-points all along the way, you could go anywhere.

Certain agents such as ammonia, peroxide and liquid hydrogen can store non-carbon fuel energy quite effectively, but each has its drawbacks.

Work is being done on storing electricity for the grid, to ensure that all energy generated is used and not wasted. One idea is giant batteries or flywheels, others include pumped storage and stand-by HEP schemes. If cars were to become electric, the transfer of energy to and from the batteries could balance the grid. An alternative way is when machines such as domestic appliances can be turned on and off automatically in response to the grid's requirements.

Advances have also been made in other ways to store heat, using change of state materials, salt ponds and aquifers.

Energy efficiency

This is the lowest of the low-hanging fruit, but we tend to forget about it because it is not as exciting as a shiny new eco machine. However, imagine a house here in Britain that does not need central heating, but only your body heat, sunlight and incidental sources such as your computer, or the family dog. Actually, it can be done – and demonstration houses have already been built.

Think of cars. Years ago it was common for a car to do around 20mpg. Without any worldwide massive effort to improve things other than the normal course of progress, you can now do around 80mpg. The message is that in the future you can enjoy the same or even a higher standard of living but only consume a fraction of what we consume today. If we really worked at it, we could probably do much better. The cheapest form of power is the 'negawatt' - i.e. the megawatt you save.

Long distance power transmission

This is a massively improved old technology. Using high voltage direct current you can send power for thousands of miles without losing too much of it down the wire. This opens up the possibility of bringing energy from those wild, extreme places such as deserts and stormy oceans, which are nature's power stations. The main drawback

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is the AC/DC conversion and stepping the voltage up and down, which is expensive in terms of kit, and uses up a bit of power. This aspect needs improvement.

Flight technology

The best way to travel to Australia would be in a machine slowly accelerated to huge velocity in an electromagnet tube and then carefully aimed and fired into space. It would only take a few minutes to get there, and you would not have had to burn a drop of fossil fuel. It would make a graceful descent and open its wings to land, like the space shuttle. Such machines have been contemplated for years.

While waiting for this or other technologies to emerge, an ordinary jet adapted to use biofuel may be the answer. Piston engine and turbo prop aircraft would be even easier to adapt. We may also see a new age of dirigibles, which would be useful for freight and passenger transport between city centres.

Things to watch

- We like the idea of thermoelectrics – things that produce electricity just because they get hot. At the moment they make relatively small amounts of power, but it is interesting. The ‘electricity from heat’ theme is the same reason we like the 19th century technology of Stirling engines.
- Fuel cells are machines for turning hydrogen into electricity. They hold some promise, if we could find a good, convenient source of hydrogen. Currently this is obtained from fossil fuels. The other drawback is they are expensive, heavy and delicate.
- Extracting and storing the CO₂ from fossil fuels has some attractions as a stopgap measure.

What about geo-engineering to cool the planet?

Many scientists have given up hope that politics will be able to deliver a solution to global warming. Last month there was a gathering in California to discuss the possibilities for geo-engineering – that is, a way for humans to influence the temperature on earth by technical means. The scientists are preparing for the worst, and they want to be ready with solutions when we the public eventually turn to them in desperation after failing to heed their warnings. Our party does not endorse any such ideas, but we should all be aware of the desperate measures scientists are considering.

Removing CO₂ from the atmosphere

Pure carbon is a very versatile and valuable substance. If we could find a cheap way of extracting it from the atmosphere, splitting the CO₂ molecule and turning it into carbon fibre cars, fishing rods, computers and so on, then people would no doubt mine it from the atmosphere and make their fortunes. Knowing the ways of men, they would probably do it to such excess that plants, which need a trace of CO₂ to survive, would no longer be able to breathe. But that is a long way from where we are today.

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The least controversial geo-engineering plan is to try to recapture some of the CO₂ now in the atmosphere. It does not matter where you do it, as CO₂ is fairly evenly distributed across the world. With current technology it is possible to build machines for the purpose, but they would be expensive, take up lots of space and, worst of all, require substantial amounts of energy. If you used fossil fuels to power them, you would probably end up emitting more CO₂ than you could capture; and if you used renewables you would be diverting energy that could be used for something else.

Options for enhancing nature's own processes:

- Plant fast-growing crops and trees, harvest them and dispose of them so that they are preserved for ever so that no CO₂ can leak back into the atmosphere. A good twist on this idea is to turn crop residues into charcoal (known as biochar). Once carbon has been stabilised in the form of charcoal, it can be used to improve the soil, and will remain there for a long time.
- Encourage algae to bloom in areas of the oceans that are currently less fertile, by fertilising them in some way. They will then take up CO₂, die and sink to the bottom. Fertilisers would be elements like iron and phosphorous spread from boats.
- Cold water has more nutrients than warm water. Use wave power pumps in warm water areas to draw up cold water from the depths. This will again encourage algal blooms.

Artificial trees

Apparently the plastic membranes used for osmosis desalination are quite cheap, and have a good capacity to absorb CO₂ and then release it when water is applied. Using them to make leaves on artificial trees might be a useful and relatively low-energy, low-cost technique.

Exploiting ocean chemistry

The box below explains how CO₂ is drawn into and stored in the oceans. If we can cause carbonate ions to precipitate out to form limestone, more CO₂ will be drawn down. We can do this by liming the oceans.

OCEAN CHEMISTRY

- CO₂ dissolves in water, just like oxygen and many other gases. The rate at which a gas dissolves depends on lots of things, e.g. the amount available in the air versus the amount already in solution (partial pressure), the temperature of the water (the cooler the water the more it holds), the ocean current system (which takes in gases at the poles and outgases it where there are upwellings) etc.
- Unlike other gases, dissolved CO₂ has an extra trick up its sleeve. It reacts with H₂O to form H₂CO₃ (carbonic acid). This reaction is in a reversible balance (i.e. equilibrium). The majority stays as dissolved CO₂.

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- H_2CO_3 in water tries to give away its hydrogens, and gradually converts itself into two different negatively charged salts: (1) bicarbonate (HCO_3^-) and (2) carbonate CO_3^{2-} .
- So there is a chain reaction, which is completely reversible depending on circumstances: $\text{CO}_2^{\text{air}} \leftrightarrow \text{CO}_2^{\text{aq}}$. Then $\text{CO}_2^{\text{aq}} + \text{H}_2\text{O} \leftrightarrow \text{H}_2\text{CO}_3 \leftrightarrow \text{HCO}_3^- + \text{H}^+ \leftrightarrow \text{CO}_3^{2-} + \text{H}^+$.
- The chain reaction means that if you take out or add stuff at any point, everything else will move along to compensate. So if carbonate ions are used up in the sea, more CO_2 will be drawn in from the atmosphere to make more carbonate ions, etc (providing all other conditions remain the same).
- Most carbon in the ocean is in the form of HCO_3^- . There is 50 times more carbon from CO_2 -derived products in the ocean than in the atmosphere. To date it has absorbed about 1/3 of man's CO_2 emissions. For a 10% increase in atmospheric CO_2 , ocean storage of CO_2 and its chain of sub products increases by about 1%.

The pH of the ocean is an important factor in determining how much CO_2 it can hold. Sea water naturally contains lots of ions, for example Na^+ , K^+ , Mg^{2+} , Ca^{2+} which are positively charged and Cl^- , SO_4^{2-} , Br^- which are negatively charged. There are more pluses than minuses in these ions, and since the overall charge must be neutral, this generates a demand for the creation of negative bicarbonate and carbonate ions. This in turn draws more CO_2 into the ocean.

Deflecting the Sun's Radiation

One simple idea is to block some of the radiation and reflect it back into space. This can be done in various ways:

- **Increase cloud cover to make a reflective white cloud layer**
One idea might be to spray salt and other cloud-forming nuclei into the atmosphere. One scheme being tested is to have unmanned wind-powered boats sail the oceans and spray a fine mist of sea water through nozzles up into the sky.
- **Launch glass mirrors into space**
We could develop a rocket system that would deploy huge numbers of space mirrors which would then sit in stationary orbit between us and the sun. The suggestion is to use a vehicle accelerated by electromagnets to deploy them.
- **Fire sulphur dioxide gas artillery into the stratosphere**
Sulphur dioxide reacts to form sulphate aerosols which are extremely reflective, and is often emitted by volcanoes. Once in the stratosphere the aerosols remains there for some time, and are distributed via jet streams etc.

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- **Nuclear spring**
A full scale nuclear war could trigger a “nuclear winter” as clouds of dust are sent into the stratosphere. A controlled version of this could be tried to lower temperatures a little.
- **More white houses**
Some people have seriously suggested painting roofs white in an effort to increase earth’s reflective albedo.

One thing we should be acutely aware of is that earth has natural mechanisms to cool itself, such as reflective ice sheets, cloud-forming jungles, cloud-forming ocean life, and so on, which we are unintentionally disabling one by one. It will require greater and greater efforts for humans to achieve anything like a similar cooling result by the artificial means described above.