Energy in a Changing Climate

The future of sustainable energy

Much of our energy today comes from three high-energy resources - oil, coal and gas. These resources took millions of years to form. Over the last couple of centuries we've been avidly consuming them so it's reasonable to suppose that one day they will all be gone.

If at all possible, we should be building our future on more sustainable sources. Something that will continue to provide our descendents with the abundant energy that has helped transform the livelihood of human beings throughout the world.

Sustainable energy is one of those vague terms that can mean different things to different people. It is often used as a "green" catch-all for things like energy conservation, energy efficiency and renewable energy, all with a positive environmental overtone.

A more precise (and more useful) definition of sustainable energy is "sources of energy that provide our energy needs today without jeopardising the needs of future generations".

So how far in the future are we looking?

David MacKay in his book Sustainable Energy - without the hot air considers that 1000 years will about do it. If you consider how technology has changed since the 11th century, then worrying about what our descendants are using for energy in the 31st century is probably futile - as long as we haven't destroyed the planet in the meantime, of course.

Others such as the non-profit organisation invVEST consider that 100 years ought to be enough. Given that we are still using the energy sources that were used 100 years ago this might be too short a period. If these resources had been exhausted by our forebears by the early 20th century then we would be living in a very different world today. Some, of course, would wish that it were so.

The experts differ on how long coal, oil and gas will last and estimates vary from decades to a few centuries. But it is generally agreed that these fossil fuels will not meet MacKay's 1000-year test and may fail the 100-year test and so are not considered sustainable. The experts also differ on how long uranium can supply our current generation of nuclear rectors but we will deal with that below.

Renewable energy sources are often considered to be sustainable as they use resources such as water, wind and sunlight that are, to all intents and purposes, inexhaustible. Many will say that these are the only truly sustainable energy sources. As we shall see, that view ignores the 1000-year test as well as some serious technical deficiencies with some renewable energy sources.

First, not all so called renewable sources are themselves sustainable. For example, some biofuels such as ethanol made from food crops like corn are no longer considered sustainable because of the competing need for the land on which the feedstock grows. The Australian Greens consider some biomass such as wood waste from old-growth forests to be unsuitable feedstock because of the risk to the big carbon sinks of old-growth forests. Hydropower relying on water flow from a particular river may also not be sustainable - particularly in Australia. Climate change may dry up rivers or change their course and leave the hydro system stranded.

Second, some renewable sources such as wind and solar PV are too variable to meet our continuous power demands unless combined with conventional sources (fossil fuels and nuclear) to fill in the gaps. Others, like solar thermal with sufficient heat storage to produce continuous reliable power, are prohibitively expensive. So without further technology developments, such as huge cost effective, sustainable electricity storage systems, our energy system in Australia is not sustainable today with or without renewables. See Hasten slowly into renewable energy.

Geothermal energy is said to be promising but MacKay argues that a geothermal mine would be sustainable only if we are taking the energy out of the ground at the same rate as the earth is replacing it. So we might have to treat geothermal heat more like fossil fuels - a resource to be mined until it runs out.

MacKay also seriously questions whether Britain could ever generate enough energy from renewable resources to meet its energy needs even if technology was not an issue. Britain (and possibly Australia) may have to look at other options to find sustainable energy.

Are there any other sustainable energy sources on the horizon?

According to the World Nuclear Association, today's generation of nuclear reactors use an average of 175 tonnes a year of uranium per GW. These reactors are largely using the uranium in a "once-through" cycle where less than 1 per cent of the uranium is actually used to generate energy.

MacKay estimates that the total world recoverable uranium is about 27 million tonnes. This includes resources mineable at less than $130 per kg (the higher-grade resources of around five million tonnes) and lower-grade resources contained in phosphate deposits that will be more expensive to mine. According to the International Energy Agency, because nuclear reactors use relatively little fuel most of the cost in generating nuclear energy is in the planning, construction and decommissioning of the power station not in the fuel. This means that a significant increase in the price of uranium has a much lower impact on the price of electricity. So it is reasonable to suppose that as the cheaper higher-grade resources become depleted the industry will be able to turn to the lower-grade resources.

Using all this recoverable uranium, our current nuclear reactors could operate for 400 years so they would fail the 1000-year test but comfortable satisfy a 100-year test. But the WNA expects the world's reactor numbers to more than double over the next few years so our current once-through reactors using uranium may not be sustainable depending on your view of sustainability.

Thorium can be used as an alternative to uranium. It is three times as abundant in the earth's crust as uranium and is more evenly distributed around the world including Australia. Thorium has the added advantage that, unlike uranium, it can be completely burned up in simple reactors so it creates less long-lived radioactive waste. India already uses thorium in nuclear reactors so the technology is not new, but it will still not be sustainable using current generation reactors.

The newer generation fast breeder reactors burn up all the uranium so they can extract much more energy from uranium than traditional once-through reactors. MacKay estimates that fast breeder reactors obtain roughly 60 times as much energy from the same amount of uranium. They can also use all the discarded uranium from existing once-through reactors. This technology is not new either and several experimental reactors have been constructed over the last few decades but the promising Integral Fast Reactor technology might take several decades to become a commercial standard.

Fast breeder nuclear reactors could be the sustainable energy source we are looking for.

To the Greens this will all be bad news. First renewable sources will not deliver reliable, sustainable energy on their own - at least not in Australia. But worse news for the Greens is that the most likely source of sustainable energy will actually be nuclear power. James Lovelock knew this all along of course.

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