

Energy Use in Scotland: The Future?

James Fenton, 14 January 2015

info@james-hc-fenton.eu

Energy, we all need energy. Ever since we raised ourselves above the animal kingdom by discovering we could control fire, we have been reliant on energy above that gained from food. For most of our existence as a species it was wood for fuel, then, following the Industrial Revolution, coal, and now oil and gas. For our use of energy has been increasing inexorably, particularly since we discovered the stores in the ground laid down by millions of years of plant growth. Indeed, the Industrial Revolution may never have happened if coal had not been available to power the emerging industries: to produce one ton of iron you need the charcoal produced from 24 acres of forest. Hence to build even a few miles of iron railway would have taken the woodland resources of a whole county. But the same could be achieved from only five tons of coal – less than a lorry load and quickly dug out of the ground.

Our modern society could not cope without a continuous supply of energy because as well as heating, lighting and transport we use it to power all our machinery whether household or industrial, our telecommunication systems, our water-pumping stations, our food storage systems and all our electrical gadgets. We all know how difficult it is to cope with a long-power cut and we have all experienced an increased tension, almost panic, when our petrol or diesel supplies are threatened through industrial action.

When the most recent report from the Intergovernmental Panel on Climate Change said that the whole world must stop using fossil fuels by the end of the century we carry on as normal, because we hope the energy experts have the situation in hand, while, at the back of our minds we may well dismiss all the doom and gloom about global warming as the normal doom-mongering by environmental groups.

But if we take global warming seriously, as we must, how do we become fossil-fuel free? Fossil fuels will always be used as a feedstock for the chemical industry, in the manufacture of plastic, for example, but as an energy-source they will become a no-no. The Scottish Government's target of all Scotland's electricity coming from renewable energy is a start, and this includes the full range of energy sources: wind, tides, waves, rivers, sun, wood, biogas, biofuel.

The advantage of fossil fuels, whether coal, oil or gas, is that they are concentrated, easily transportable energy. Renewable energy in contrast is more diffuse so a huge amount of land is needed to produce enough to power a modern society. For example, biofuel made from plants can be used to run cars but it has been estimated that if all the arable in land in the UK were turned into fuel this would only produce 22% of the current requirement for road transport. This is because plants, through photosynthesis, are relatively inefficient in converting sunlight to biomass, with even the most efficient, sugar cane, only reaching a conversion efficiency of eight percent. And if all the arable land were used for growing fuel crops, where will we grow our food?

The low efficiency of photosynthetic energy conversion applies also to wood as a fuel: there is not nearly enough land in Britain to grow trees to power the whole country, although wood has its place to power small rural communities and some individual households.

For all forms of renewable energy we need to cover a lot of ground or sea with the energy gathering devices, whether wind turbines, hydro-schemes, plants or sunlight-collecting device. This means smothering a large proportion of Scotland, or even more of England which is less-windy and has ten times as many people, with infrastructure. But do we really want to live in a Scotland where every last kilowatt of energy is extracted from the natural flows? Every hill and moor with its wind-turbines, every burn dammed and piped for hydro-schemes, every coastal view marred by wave-collecting machinery or massive windmills? Are we willing to lose all wild land to sate our energy needs, every square inch of the planet industrialised? For do not get me wrong, this could happen. If such cherished wild areas as Torridon or the Ardessie Burn below An Teallach are not immune from hydro-schemes, is anywhere sacrosanct?

Already about half of the Highland river catchments are managed for hydro-electricity dating from the great schemes of the nineteen fifties and sixties. Most of the easily dammed catchments are now in use, so that, in spite of the wet climate, there is not a huge potential for further hydro schemes in Scotland: only small-scale ones that may help local communities but do little to mitigate global warming. Pumped storage schemes, where water is pumped up hill into storage reservoirs, are often mooted to temporarily store surplus electricity from wind-farms, but again these are designed to produce electricity at peak times for only about five hours. Do we really want to sacrifice some of our remaining undeveloped mountain corries for the sake of five hours of electricity? Likewise, how much of our remaining wild mountains do we want to cover with wind-turbines and their associated tracks, and how much of the sea do wish to industrialise?

And what of the waves and tides, I hear you ask, there is surely some potential here? Yes, they might help us out: the Pentland Firth has an estimated 2,000 megawatts of extractable electricity which must be seen in the light of Scotland's current electricity demand of the order of 15,000 megawatts. Tidal barrages are often suggested, with the Solway Firth, or better still the Bristol Channel, having huge potential. But these are massive engineering projects, resulting in major impact on the ecology and environment of these areas, and adding to the industrialisation of the whole landscape. The technology of extracting energy from waves is still in its infancy, but again this energy is relatively diffuse and will need a huge area of the sea to be covered in machinery to extract significant amounts.

And of course if we rely on wind-power the wind does not blow all the time so to make up for this we need a reliable base-load capacity, which is currently provided by coal, gas and nuclear. We do not yet have the technology to store all the electricity we generate on windy days for use on calm days. It has been estimated that in Scotland windfarms will not be operating significantly for 20% of the time – or for the UK as a whole, 10% of the time: the greater the geographical extent of linked renewable energy production, the greater the probability of energy production somewhere. But where will Scotland's future base-load come from as our power stations age and shut down? The way things are going, we will be dependent on importing gas, coal and nuclear-power from England: in other words, we are selfishly handing over the problems associated with these base-load stations to another country. However, contrarily, there is probably no way that England, with ten times the population of Scotland and less renewable resources, can survive only on its own renewable energy. If Scotland does become a renewable energy factory for England, then this shows a willingness to sacrifice our own landscape for the sake of others. Are we willing to do this?

There has been talk of a European-wide super-grid, so that when the wind is not blowing in Scotland, we can import hydro-power from Norway or photovoltaic from the Sahara, but this is still a long way off and will not get away from the problem of the large areas of land needed to harvest renewable energy, which will be of concern to the people living in these areas. And all European countries will be fighting over who has access to, for example, Norway's hydro-power because it does not possess enough to power all of Europe on calm, cloudy and cold days. One problem is that building power stations is an expensive business and power station operators cannot nowadays make enough money for reinvestment because much of the time the market is flooded with renewable energy from other suppliers. Hence new power stations do not get built, building up base-load issues for the future, which I find worrying.

The problem is actually worse than this if we want to wean ourselves off fossil fuels completely because electricity comprises only 20% of our energy use: we will also have to give up oil and gas in our transport, heating and manufacturing. If this energy came instead from renewables, then we will need to multiply the number of wind-farms, tidal schemes, biomass boilers, etc. by a factor of five: five times the current area of wind-farms, for example. For transport there will be a need to electrify all our railways and replace all urban buses by trams or trolley-busses. Road transport is more difficult because vehicles are harder to electrify, at least if we want to continue long journeys for cars or lorries: technologies of the future include better battery storage or the use of hydrogen as a fuel, with hydrogen generated from water using electricity. But again, these means are all dependent on electricity, and where is this to come from?

The vast majority of our imported goods get here by sea. Hence there is a possibility that sea transport could revert to wind power, but in that case we would have to be more patient with the delivery of goods, and the 'just-in-time' manufacturing approach would have to be reappraised. It is hard to see how air-transport becomes fossil-fuel free unless the concept of airships is revived. As discussed above, the amount of land needed to grow bio-fuels for aircraft would take away too much land from agriculture. There may be possibilities of making hydrocarbons using electricity as the energy source, but again this is long into the future.

In terms of our current base-load supplies, gas, the energy source of choice in Britain, may result in less output of carbon to the air than coal, but it is still a fossil fuel and will not really mitigate global warming. Coal is the worst possible fuel source in terms of contribution to climate change, and hence it is surprising that Germany, once seen as the power-house of green energy, is now burning more coal, including the worst polluter of all, brown coal or lignite. This is because a tsunami in Japan frightened the Germans into closing down their nuclear power plants – even those inland. And we thought the Germans were logical people!

There is talk of 'carbon sequestration', i.e. removing carbon from the exhausts of fossil-fuelled power stations, but this reduces the efficiency of power stations, can never remove all the carbon and the extracted carbon has to be put somewhere. If buried underground it must be in places where it cannot leak back to the surface: carbon dioxide is perhaps more lethal than nuclear waste in this regard. This was demonstrated when a natural eruption of carbon dioxide killed many people living Lake Nyos in Cameroon a few years ago: a silent and invisible killer.

If gas and coal are ruled out for base-load, this only leaves the option of nuclear power. Arguments here tend to be based on emotion rather than science. Nuclear waste is easy enough to get rid of

safely if buried deeply enough in sites with no ground water such as salt mines. The problem is political: no community wants such a store in the area where they live. However nuclear power is probably the only energy source that can provide continuous base-load electricity without the significant use of fossil fuels. Unfortunately nuclear power originated from a nuclear-weapon background: if power stations were designed from scratch to produce power only, then a design based on thorium rather than uranium might well be better, particularly as thorium is more abundant on the planet. There is currently research into this, which perhaps indicates the future, but we are not there yet. In the interim there will be a need to build more uranium-based reactors, albeit with modern safety standards. Interestingly more people have probably been killed by uranium released by the burning of coal rather than from nuclear power stations. However we are more averse to dramatic, high-profile disasters than insidious, chronic problems.

I personally would prefer to live in a Scotland with two or three modern, safe nuclear power stations covering a few hectares than in a Scotland where energy generation infrastructure is found wherever you go, even in the wildest corner. For then we humans really will have taken over the planet.

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