Power failure

Energy Conservation and Renewable Energy

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An African proverb states “We did not inherit our environment from our parents, we are borrowing it from our children”. Traditional carbon-based energy resources are finite, within our lifetimes. Their combustion to produce energy increases carbon dioxide (CO_2) production which in Scotland amounts to around 60 million tonnes annually. The carbon-rich soils in Scotland contribute around 20% of this through agricultural land-use and this is not a readily mitigated effect. Emissions from combustion in the industrial and transport sectors contribute around 40% to this and are nearly as difficult to reduce due to the social and infrastructural dependence on carbon-based fuels. The electricity supply and chemical energy industries produce the remaining 40%.

Ambitious targets have been set to supply increasing proportions of national demand for electricity from renewable resources, and this has the potential to reduce carbon flows in the energy chain. The economic and environmental costs of renewable energy programmes are significant and bring with them the need for investment in electricity transmission networks and supplementary energy sources. Welcome investment in renewable energy supply is underway, although this only bears on the relatively smaller 28% contribution to CO_2 production made by electrical power generation. Electricity supplied from renewable energy or nuclear sources largely displaces that supplied from carbon-based fuels. The development of intermittent and remote renewable resources will rely to some extent on the presence of conventional carbon-based power generation. The delivery of renewable and all other forms of electricity incurs heat losses in the supply network. Ultimately, all energy that is converted to do work for mankind is lost as heat to atmosphere.

Substitution of low or zero-carbon energy sources at the beginning of the supply chain will certainly lead to reductions in CO_2 production and environmental consequence. Electricity generation and supply technologies are well-developed and asymptotic efficiency gains, while welcome, will only lead to marginal reductions in losses and associated CO_2 production. However, reduction of demand at the end of the supply chain removes absolutely the need to supply that energy and leads to relatively greater CO_2 and environmental savings. Last year’s Energy White Paper “Our energy future – creating a low carbon economy” stressed heavily the need for increased conservation and efficiency of end-use of energy. It forecasts that around half of the UK targets for CO_2 reductions could be met by demand-side energy reductions. The thermodynamic and environmental arguments are compelling but, despite this, research into and implementation of conservation and energy efficiency measures has not received due prominence in recent years. There are numerous explanations to consider and perhaps to explore as catalysts for change in this deceptively complex situation.

The need for affordable and secure energy supplies is fundamental to industrial and social prosperity. Market-led energy economies have driven down the price of energy (electricity and gas) to domestic and wholesale consumers at the end of the supply

chain to historically very low levels. Ironically, the markets do less to reduce the cost faced by energy generators at entry to the supply chain.

While the obvious drivers for pursuing energy efficiency are the environmental benefits that it can bring, its uptake will be determined by economic benefit to the investor in those energy reducing measures, assuming that all other influences are equal. The relatively low market-price of energy does little to promote conservation. Economic justification of efficiency or conservation measures is currently made difficult by the low value attached to delivered energy.

One of many ready examples of this is the take up of energy-efficient light bulbs. A typical incandescent 60W bulb costs around 40 pence and is designed to last 1000 hours. This accrues a lifetime cost of around £4. Alternatively, an 11W fluorescent bulb which offers the same luminance retails for around £6 and over the first 1000 hours of operation would accrue a lifetime cost of around £6.50. In the short term the inefficient alternative is cheaper. However, the fluorescent bulb is expected to last ten times longer and in its lifetime would see the incandescent replaced ten times. The lifetime cost of the fluorescent device is around £12.50, compared with £40 to replace and supply ten incandescent lamps over the same period. Substitution of say 15 incandescent lamps in an average house has a marginal capital cost of over £80, but offers a saving of over £400 in energy costs over the lifetime of the fluorescent lamps. Despite this many, consumers are put off by the initial cost and the fact that the saving is made over a few years.

Lighting is estimated to account for 16% of annual domestic electricity demand and tends to coincide with peak demand periods. Even on a flat-average basis this would require the operation of the equivalent of around 230 MW of generating plant to supply the domestic lighting load in the Scotland. Lighting technology substitution could reduce the net capacity required by around 200 MW. Depending on the renewable energy technology portfolio adopted, this could lead to between 500 and 600 MW less installed capacity of plant being needed.

Another consideration in the adoption of energy efficiency measures is aesthetic or other equivalence of the alternative in the eyes (literally - in the case of lamps!) of the users. Uptake can be hampered by the perceptible differences of the lower-energy alternative. Ongoing research in high-efficiency light emitting diode lamps seeks to colour the emitted light to at least equal or improve the light quality offered.

Despite the benefits, financially and environmentally, there are insufficient incentives for energy efficiency and energy conservation. A significant factor in this is that electricity markets promote energy supply, not conservation. To meet our goal of secure energy supplies whilst significantly reducing the carbon burden, there is a clear need for additional measures to incentivise energy conservation and efficiency. In most cases the technology is already available – what is still lacking is the political and economic initiative to achieve it.