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Response to Energy Systems paper by Ian Lowe

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Ian Lowe has skilfully used the particular issue of choosing a sustainable source of energy for transport, and specifically the option of using hydrogen as the major transport fuel, to illustrate the main themes of sustainability and the relationships between them. I wish first to expand on one theme which he is able to touch only briefly, and then to make some observations about the sustainability of non-transport energy systems, where the mix of dimensions is somewhat different, and perhaps even more complex than for transport energy.

Local environmental effects of petroleum

Ian Lowe devotes one sentence to the local air pollution impacts of using petroleum fuels to provide the energy for transport, before turning his attention to greenhouse gas emissions. He does not point out that the "clean air" benefits of hydrogen could be one of the strongest factors favouring its early adoption as a transport fuel. Since it contains no carbon and no sulfur, the combustion of hydrogen does not result in emissions of soot and polyaromatic hydrocarbon particles, carbon monoxide, volatile hydrocarbons, or sulfur dioxide, which are responsible for most of the environmental and human health impacts of local air pollution in cities. It is true that progressively tighter regulations on the chemical composition of petrol and diesel, together with requirements to adopt the "technical fix" of tailpipe catalytic converters, have significantly reduced the level of emissions per vehicle. But a brief visit to Los Angeles, where such regulations are perhaps the strictest in the world, makes it easy to see that they are not sufficient to restore the air over the city to a level compatible with sustainably healthy life for humans, animals and plants. Adoption of hydrogen fuel would bring this dimension of sustainability much closer to realisation.

Our current heavy dependence on petroleum as a source of primary energy also affects local environments at various stages in the supply chain between oil well and vehicle fuel tank. The sheer volume (and mass) of petroleum moved round the world inevitably brings impacts such as oil spills and acoustic pollution of the sea. Technical improvements, such as mandatory double hulls for oil tankers, undoubtedly reduce the impact per ship or per tonne of crude oil cargo, but if the total volume shipped continues to grow, part of each gain in performance is absorbed in offsetting the increase in ships and voyages. Another legacy of our petroleum dependence, perhaps not so widely known by the public at large, is soil and groundwater contamination by petroleum products that have leaked from storage tanks. Worldwide, the cost of cleaning up such contaminated sites runs to many billions of dollars. At present they are mostly just left, and sometimes monitored. For example, in Canberra, petrol leaked from an underground storage tank at a now long-closed service station on the northern edge of the Civic area. A few years later a welder working in a nearby basement was killed when he ignited fumes escaping from the then unknown plume of pollution. Ever since, and probably for many years to come, local environmental authorities have the responsibility of monitoring the movement of this plume as it makes its way under the commercial centre of the national capital.

Meeting all sources of energy demand sustainably

Transport is of course only one source of the enormous demand for energy imposed by modern industrial societies. In Australia, transport of all kinds is responsible for nearly 27% of the total demand for primary fuels. Almost all of this is petroleum, with coal, used to generate the electricity that powers rail transport, accounting for about 0.4% and natural gas a negligible proportion. Apart from transport, the other sectors of the economy that rely heavily on petroleum are agriculture, mining and construction. All other sectors, including manufacturing, commercial buildings and the residential sector use predominantly natural gas, coal, and electricity, which is itself produced mainly from coal. Australia's mix of primary fuels is about 42% coal, 35% petroleum and 19% natural gas. Apart from the somewhat higher proportion of coal, this is roughly average for developed industrial countries, but in terms of primary energy consumption per capita (about 250 GJ) Australia is amongst the highest in the world.

The general term used to describe non-transport uses of energy is stationary energy. In Australia stationary energy accounts for about 65% of total primary energy. In most other countries stationary energy is at least as high a proportion of primary energy as in Australia, and in developing countries it is much higher. In general, the poorer a country, the lower the share of its total energy consumption committed to transport. It is important to remember that the very rapid growth in demand for petroleum transport fuels from China is coming off a very low base, and as a proportion of total primary energy is still far lower than in Western industrialised countries.

Two dimensions of sustainability, the social and the economic, are more important when assessing sustainability of stationary energy than they are for transport energy. The social dimension stems from the centrality of energy consumption for bare survival – for cooking food, providing light, keeping warm and keeping clean. The economic dimension stems from the fact that present energy systems do not bear the full cost of their resource and environmental unsustainability. If they are made to bear that cost, then energy, as an essential input to households, to industry and indeed to all economic activity will become more costly. Of course that is also true of hydrogen fuel, or any other more sustainable system for supplying transport energy. However, most countries tax petroleum fuels used to provide transport energy, in many cases very heavily. Consequently, a given increase in the underlying cost of energy has relatively less effect on the cost to the user of petroleum transport fuels than it does on the user of stationary energy.

Sensitivity to the cost of energy is most acute in the case of electricity supply. In Australia the generation of electricity accounts for about 44% of total primary energy consumption and a higher proportion, about 55%, of total energy related greenhouse emissions, because it is more coal intensive than energy consumption as a whole. Australia has some of the world's most abundant and easily mined resources of coal. The cost of electricity supplied to users is based on pricing coal at whatever it costs to mine it, supply it to a power station and make post-mining environmental restoration of the mine site, but takes no account of the long term environmental costs of the carbon dioxide emitted by burning coal. As a result, within present policy

frameworks, electricity supplied from new coal fired power stations in Australia is amongst the cheapest sources of incremental electricity supply anywhere in the world. Many parts of industry see continuing access to such low cost electricity as essential for Australia's economic wellbeing, a view shared by the Commonwealth government. The consequence of this policy choice is that Australia is unable to act decisively to reduce its greenhouse gas emissions, since to do so will mean supplying electricity by other technologies that are more costly in short run terms, that is if the long term cost of climate change is ignored. The alternative view is that a decisive change in the mix of Australia's electricity generation technologies, while it would clearly disadvantage some industries, such as aluminium smelting (but not alumina production to any extent and not coal mining, which is not particularly electricity intensive and is mainly – nearly 80% – dependent on export markets), would have no major impact on the overall level of economic activity.

Thus economic and industry policy considerations are another important, and intensely political, dimension to the assessment of energy sustainability. This covers not only the assessment of the technologies of supply and use, but also the social institutions through which the energy is supplied – competitive or regulated monopoly, publicly or privately owned. And these issues are no less prominent, indeed probably more prominent, in developing countries than in developed countries. They see the availability and cost of stationary energy supply, and especially electricity, as essential for economic development, modernisation and, it is hoped, helping the mass of the population escape from poverty.

Unfortunately, these social and economic issues tend to add further weight to short and medium term considerations and make it even more difficult for decision makers to give adequate weight to long term sustainability.