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ENERGY BEYOND OIL

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Turning the World Upside Down

Could you live with the same amount of energy now available to those in the third world? A dramatic change such as this is likely within fifty years as present energy sources are used up. So future generations will have to manage with just a third of the energy we use now.

OIL IS A FINITE RESOURCE. MORE SIGNIFICANTLY, studies dating back to the mid-fifties show that production begins to drop off significantly as a field reaches about half its productive capacity. The 1970 peak in United States oil production, and its subsequent decline, were predicted in 1956. Likewise the peak in the North Sea foreseen some years ago, occurred in 2000 and 2001.

The application of these same techniques to global oil production has become controversial. Various studies put the peak in world production at between 1996 and 2035. However, most predict a date between 2008 and 2016. Recent price rises are, in part, a result of a decline in production relative to demand. This is the trend we would expect immediately before a peak in global pumping. However, whether or not we are experiencing 'peak oil' will not be clear for some time. It will take a number of years of production statistics to demonstrate this.

Oil makes up around 35 percent of global energy supply, and natural gas another 22 percent. Therefore, within one or two decades, one-third of the world's present energy supply will be in decline. In about three or four decades, after the peak in gas production, it will be one-half. Clearly, even if we did not face the hazards of climate change as a result of fossil fuel use, we have to find alternative energy sources to replace oil and gas in the next one or two decades.

The problem with replacing petroleum or gas is that they are very dense sources of energy. Fossil fuels represent tens of thousands of years of the sun's power captured in plants and animals. Consequently such fuels create a lot of energy per unit of volume, and are able to produce large heating or power loads cheaply with minimal engineering.

NUCLEAR

When thinking of alternatives, nuclear power is often promoted as the most reliable option. This is not so. Those opposed to nuclear power believe that it will never be successful because of its high cost, but the principal limitation to the use of nuclear power is the availability of uranium. The thermal nuclear reactors around the globe use one isotope of uranium that comprises just 0.7 percent of all uranium resources. Nuclear energy provides around 6.6 percent of the world's energy supply, and at this rate there is enough uranium to keep reactors running for a hundred years. However, if you significantly increase the amount of energy produced by such reactors the lifetime of the resource shrinks accordingly. For example, if nuclear were to provide over thirty percent of global energy, then uranium resources might only last two decades.

The only way to significantly extend the life of uranium reserves is to develop fast-breeder reactors. These are able to convert the unused uranium into plutonium, which can then produce energy by the same process as thermal reactors. The problem is that the design challenges of developing a fast breeder reactor mean that no safe and commercially-viable system has yet been developed.

Another option is nuclear fusion. This uses hydrogen isotopes extracted from water to produce energy, and creates only a fraction of the radioactive waste of conventional nuclear reactors. However, it may take four or five decades, perhaps more, to perfect a viable fusion system. Clearly, that's not fast enough to counteract the imminent shortfall in energy supply.

LOW CARBON

Low carbon energy technologies use waste or plant matter to produce energy with a lower level of greenhouse gas emissions than fossil fuel sources. The problem is that most of these processes seek to operate in a way that does not require change within society. For this reason the mismatch between the high level of energy use in industrialised society, and the low level of energy available from low carbon sources, does not make this a viable option in the long-term or at large scales of production.

Energy crops are the principle low carbon technology. They can be grown and burnt to produce heat and power, or processed to make liquid fuels or gases. The main drawback is that it takes a large amount of land to cultivate them. For example, one hectare of oilseed will produce enough biodiesel to keep a car running for one year. However, if we factor-in the level of petroleum consumption by all the vehicles and trains in an industrialised country the area of crops required may exceed such a country's

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entire land area.

One solution to the land-demand issue is for states with a large land area to grow and process energy crops for export. However, as a large part of the nitrate fertiliser used to grow these crops is derived from natural gas, and as climate change reduces the availability of agricultural land, this is not a practical option in the long-term as it might endanger food production.

HYDROGEN ECONOMY

Some states are investing in the development of hydrogen energy, in particular hydrogen powered cars. The problem is that hydrogen is not an energy source. It is a carrier of energy in the same manner as we utilise electricity. To get energy from hydrogen you must first put a larger amount of energy into its production.

Currently most of the world's hydrogen originates from the petrochemical industry, where it is produced as a by-product of refining. It can also be produced by other processes but this requires an even larger energy input. Thus the un-answered question in relation to the hydrogen economy is, where does the energy come from?

In reality hydrogen is not a dense source of energy. Natural gas contains more energy than a similar volume of hydrogen, and the transportation of hydrogen is problematic because it is explosive. One solution to transporting hydrogen is the production of fuels that can be processed to produce the gas at the point of use, such as methane or methanol. However, the effect of these precursor fuels is to further increase energy demand as they lower the efficiency of the system.

RENEWABLE ENERGY

Renewable energy can be extracted from the earth's natural systems. The principle form of renewable power across the globe is hydro-electricity – creating about 2.3 percent of the world's energy. However, the hydro-power sector is dominated by large-scale projects that can be damaging to the environment, and this limits the opportunity for growth.

Wind power is developing rapidly because large capacity turbines can be produced with little effort. The principal problem is its unpredictability. For about two thirds of the time the output from wind turbines must be backed up from other sources when their output falls. Most wind farms are supported by fossil fuel systems.

There are other significant renewable sources, such as tidal energy, wave power, and of course solar energy systems that provide hot water or electricity. However, these technologies are not receiving the same attention as wind power because they cannot easily be increased in scale to a level where they can compete with large fossil fuel or nuclear power plants.

MANAGING WITH LESS

Given the current trends in fossil fuel use, and the physical restrictions on the alternatives, global energy consumption must begin to fall before the middle of this century. Looking a hundred years ahead, it doesn't matter if we reduce fossil fuels and switch to renewables, or burn all the oil, gas, coal and uranium in the world to keep energy consumption growing at its current rate, global energy use will have to shrink by sixty to seventy percent. Whilst this may sound dramatic, in real terms it means that the populations of industrialised nations will have the same per capita energy consumption as those who live in developing states today.

The critical issue to resolve in the near future is how to manage with less energy. For most governments this is not palatable because it requires a level of change as fundamental as the Industrial Revolution. At present a large part of the globe's energy supply powers the movement of goods and people. After this the most significant energy use is the production of electrical power. Consequently, it is these two areas of the energy economy that will undergo the greatest change. However, this change need not be problematic. What we need to do over the next two or three decades is significantly reform our systems of energy use to make them smaller in scale and more efficient.

For example, if national power grids were dismantled and replaced with small plants serving large neighbourhoods, generation could switch to systems generating both heat and electricity. In a country such as Britain, this single change might save up to fifteen or twenty percent of the national energy supply, mainly through the increased efficiency of such systems.

The other benefit of smaller energy grids and combined heat and power is that they complement the small scale nature of most renewable technologies. More importantly, they allow small scale solar to satisfy a large part of the energy demand in individual buildings during the hot months. Then the local energy production system can be on the right scale to provide for the bulk of energy demand during the colder months when wind, hydro-power and energy crops are more readily available.

In many ways, a world using sixty percent less energy is a world turned upside down. Instead of global systems of economic production, more localised arrangements predominate. The production of foodstuffs and food commodities would have to be localised, as this uses less energy for transport. Overall commodities may be in short supply, but they would have to last longer and work more efficiently so that they were more energy and resource efficient.

The key feature of this upside down future is that the small-scale technologies it relies on are already available, in contrast to other technological futures which rely on systems yet to be perfected – such as nuclear fusion or nanotechnology. Given that the time scale for change is thirty to sixty years, society must decide when this transformation should begin: before the real energy shortages kick in, providing greater certainty but short-term disruption. Or after the shortages arrive, risking a longer period of disruption created by resource and energy shortages.