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# Renewable Energy: No Solution for Consumer Society

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Suddenly the energy and greenhouse problems have hit the headlines and everyone knows that significant steps have to be taken. What steps? Well, obviously just move to technologies that will get rid of the problems ...without threatening the economy of course.

It would be difficult to find a more taken for granted, unquestioned assumption than that it will be possible to substitute renewable energy sources for fossil fuels, while consumer-capitalist society continues on its merry pursuit of limitless affluence and growth. There is a strong case that this assumption is seriously mistaken. Following is a summary of the discussion in my forthcoming book *Renewable Energy Cannot Sustain Consumer Society*. [1]

The limits to renewable energy have been almost totally ignored as a topic of study, even (especially) within the renewable energy field. There are powerful ideological forces at work here. No one wants to even think about the possibility that these sources might not be able to underwrite ever-rising affluent living standards and limitless economic growth.

It is necessary to divide a discussion of renewable energy potential into two parts, one to do with electricity and the other to do with liquid fuels. Liquid fuels set the biggest problem.

## 1. Electricity

Many sources could contribute some renewable electricity, but the big three are wind, photovoltaic solar and solar thermal.

### *a) Wind*

An examination of wind maps indicates that the annual quantity of wind energy that is available could well be considerably greater than demand, but the important question is what fraction of this can be harvested in view of the *variability* problem; that is, sometimes there is little or no wind. In the past it was usually assumed that for this reason wind might be able to contribute up to 25% of demand. However, the Germans with far more wind mills than any other country, and the Danish with the world's highest ratio of wind output to electricity consumption, have run into problems "integrating" wind into the grid while wind is supplying only about 5% of demand[2]. (Denmark's output is equivalent to c.18% of demand but most of this is not used locally and is exported.)

A mill at a good site might run over time at 33% of its maximum or "peak" capacity, but this should not be taken as a performance likely from a whole wind system. Sharman reports that even in Denmark in 2003 the average output of the wind system was about 17% of its peak capacity and was down to around 5% for several months at a time. The E.On Netz report for Germany, the country with more wind mills than any other, also says that in 2003 system capacity was 16%, and around 5% for months. They stress that 2003 was a good wind year.

Another significant problem is that because the wind sometimes does not blow at all, in a system in which wind provided a large fraction of demand there might have to be almost as much back-up capacity from other sources as there is wind generating capacity. E.On Netz has emphasised this problem with respect to the

German experience. So if we built a lot of wind farms we might have to build almost as many coal, gas or nuclear power stations to turn to from time to time. This means that renewable sources tend to be *alternative* rather than *additive*. We might have to build two or even four separate systems (wind, PV, solar thermal and coal/nuclear) each capable of meeting much or all of the demand, with the equivalent of one to three sitting idle all the time. This would obviously be very expensive.

In addition, electricity distribution grids would have to be reinforced and extended, especially to cope with the new task of enabling large amounts of power to be sent from wherever the winds were high at that time. Centralised coal or nuclear generators do not have this problem. These costs must be added to get the full cost of renewable systems.

Davey and Coppin[3] carried out a valuable study of what the situation would be if an integrated wind system aggregated output from mills across 1,500 km of south east Australia. Coppin points out that this region has better wind resource than Europe in general. Linking mills in all parts of the region would reduce variability of electricity supply considerably, but it would remain large. Calms would affect the whole area for days at a time. My interpretation of their Figure 3 is that the aggregated system would be generating at under 26% of capacity about 30% of the time, and for 20% of the time it would be under 20% of capacity. Clearly a very large wind system would have to be backed up by some other large and highly reliable supply system, and that system would be called on to do a lot of generating (...and would exceed safe greenhouse emission limits).

*Electricity storage?*

These problems of variability and integration could be overcome if electricity could be stored in large quantities. This can't be done and satisfactory solutions are not foreseen. The best option is to use electricity to pump water up into dcams, then generate with this later. This works well, but the capacity is very limited. World hydro generating capacity is about 7 – 10% of electricity demand, so there would often be times when it could not come anywhere near topping up supply.

## *b) Photovoltaic solar electricity*

The big problem with PV is that it too is an intermittent source, and its possible contribution to a wholly renewable energy system is therefore quite limited without the capacity for very large scale storage. No matter how cheap it became, it can power nothing for some 16 hours a day, or over a run of cloudy days. It is fine (though costly) when it can feed surpluses from house roofs etc., into a grid running on coal, while drawing power from that grid at night. But this only works when a lot of coal or nuclear power plants are running all the time to act as a giant "battery" into which PV can send surpluses.

## *c) Solar Thermal Electricity*

After wind, Europe's best option for renewable electricity will probably be solar thermal plants located in the Sahara region. These will impose significant transmission losses but their big advantage is their capacity to store energy as heat to generate and transmit electricity when it is needed. However, the magnitude of the potential is uncertain, and especially doubtful in winter. Solar thermal trough systems do not work very well in lower solar incidence. Even in the best locations output in winter is about 20% of summer output. The winter incidence of solar energy in the Sahara is not that impressive, perhaps 6 kWh/m/d towards Libya and Egypt and a long way south of the Mediterranean.

Solar thermal dishes perform better than troughs in winter, but they cost more and their big disadvantage is that because each tracks the sun it is difficult to take heat via flexible couplings to a central generator or store. They are being developed with Stirling engine generators at each focal point, meaning that heat energy can't be stored to generate electricity when it is needed. Central receiver or tower systems can store, but like troughs they have reduced winter performance.

It is likely that solar thermal systems will be located only in the hottest regions, will have to supply major demand centres by long transmission lines, and will not be able to make a large contribution in winter.

*Plug the gaps with fossil fuels?*

Could the gaps left when there is little sun or wind be filled by use of coal without risking the greenhouse problem? Unfortunately the gaps are far too big. The IPCC emission scenarios[4] indicate that to keep the carbon concentration in the atmosphere to a safe level world per capita fossil fuel use should cut world carbon emissions to no more than 2 GT/y. For the expected 9 billion people this means average per capita carbon use would have to be about .11 tonnes p.a. This amount would generate about .03 kW … *which is about 3% of the rich world per capita electricity consumption rate.*

*Electricity conclusions?*

Renewables could provide a considerable fraction of electricity demand, probably in excess of 25% in some countries, but a) much of the generating capacity would have to be duplicated in the form of fossil or nuclear plant for use when there is little sun or wind, b) the amount of coal use still required would far exceed safe greenhouse gas emission limits.

*Hydrogen*

There are weighty reasons why we are not likely to have a hydrogen economy. If you make hydrogen from electricity you lose 30% of the energy that was in the electricity. If you then compress, pump, store and re-use the hydrogen the losses at each of these steps will result in something like only 25% of the energy generated being available for use, e.g., to drive the wheels of a fuel-cell powered car.

# 2. Liquid fuels

The limits to the hope of meeting liquid fuel demand via renewable energy sources are much clearer than those for meeting electrical demand. A very large scale supply would have to be via ethanol produced from woody biomass. The current view among the main researchers and agencies is that in the future it will be possible to produce about 7 GJ of ethanol (net of all production energy costs) from each tonne of biomass.[5]

People in rich countries such as Australia use about 128 GJ of liquids (oil plus gas) per year, so to provide this via ethanol would require 16.3 tonnes of biomass each year.

It is probable that for very large scale biomass production the yield will be 7 t/ha/y. This would mean each person would need 2.6 hectares of land growing biomass to provide for their liquid and gas consumption (in the form of ethanol net, not primary energy amount.) To provide the 9+ billion people we will probably have on earth by 2060 we would therefore need *24 billion hectares of biomass plantations*.

This is a slight problem here … because *the world's total land area is only 13 billion* hectares, and the total forest, cropland and pasture adds to only about 8 billion hectares, just about all heavily overused already. So vary the above assumptions as you wish (e.g., assume 15 t/ha/y for willows grown in Europe) and there is no possibility of explaining how all people could ever have something like the present rich world liquid fuel consumption from biomass.

# 3. The absurd growth commitment

All of the above references have been to the difficulty or impossibility of meeting *present* energy demand from renewables. That is not the focal problem for the evaluation of the energy viability of consumer-capitalist society. The crucial question is can renewables meet *the future* demand for energy in a society that is fiercely and blindly committed to limitless increases in "living standards" and economic output. The absurdity of this commitment is easily shown.

If 9 billion people were to rise to the "living standards" we in rich countries will have in 2070 given 3% p.a. economic growth, then total world economic output would be *60 times as great as it is now*!

What is not generally recognised is the magnitude of the present overshoot, the extent to which rich world ways are unsustainable. This is unambiguously evident via a number of lines of argument. The most powerful one, which is to do with greenhouse gas limits, has been sketched above. The "footprint" issue provides another. The area of productive land required to provide for one Australian is over 7 hectares per person. The US figure is closer to 12 hectares. However, the amount of productive land per person on the planet is about 1.3 hectares and by the time we reach 9 billion it will be close to .8 hectares. In other words we in Australia have a footprint about 10 times greater than all could share. The above greenhouse figures indicate a multiple of 30+.

Such multiples mean that the problems cannot be solved without enormous reductions in the volumes of industrial/commercial producing and consuming going on, perhaps to 10% of present levels. The numbers are so big that no plausible assumptions regarding technical advance, energy conservation, etc. could show that the problems can be solved without moving to a zero-growth economy on a fraction of present GDP.

In Chapter 10 *of Renewable Energy* I argue that there is no possibility of solving the many huge global problems confronting us unless the commitment to affluence and growth is abandoned. As the foregoing notes indicate, consumer-capitalist society is grossly unsustainable. It involves rates of resource use and environmental impact that are far beyond sustainable levels, and could never be extended to all the world's people.

Consumer-capitalist society is also grossly unjust, imposing a global market system which delivers most of the world's wealth to the corporations and consumers of the rich countries. A market economy inevitably gears the productive capacity of the Third World to the effective demand of the rich and cannot attend to the needs of people, society or future generations. Again it is obvious that Third World problems cannot be solved until the rich countries stop taking most of the world's resource wealth; as Gandhi said long ago, "The rich must live more simply so that the poor may simply live." That is not possible in a society committed to affluence and growth. Thus considerations of sustainability and of justice both lead to the conclusion that the problems cannot be solved without huge and radical systemic change.

In my view the core factor determining the trajectory of Western society in the past hundred years and in the near future is resource scarcity. Consumer society flared after 1945 on abundant cheap oil. We are now probably at the peak of oil availability and headed for rapid decline, which probably means catastrophic breakdown. Some believe 3 billion are likely to die off in coming decades. (See www.dieoff.com) About 480 million are fed by food irrigated by petrol engines.

Thus, thinking about alternative ways must focus on this scarcity factor. It has powerful implications for many classic sociological and philosophical debates. For instance, it means that a good society cannot be an affluent society. Marxists as much as free-marketers have been mistaken about this. It means that globalization is over. It means that industrialization is not the future (... indeed the dominant mode of production will probably be craft.) It means that viable settlements in an era of scarcity *must* be run on anarchist principles; they will not be able to meet their needs from local resources via systems they have to run for themselves unless they are highly participatory and equalitarian.

# 4. The answer?

The only way out of this alarming and rapidly deteriorating situation is to move to some kind of Simpler Way[6], which Chapter 11 of *Renewable Energy* discusses at length. This must involve non-affluent (but quite sufficient) material living standards, mostly small, highly self-sufficient local economies. Economic systems under social control and not driven by market forces or the profit motive and highly cooperative and participatory systems. Obviously, such radical systemic changes could not be made without profound change in values and world view, away from some of the most fundamental elements in Western culture, especially to do with competitive, acquisitive individualism.

There are good reasons for thinking that we have neither the wit nor the will to face up to changes of this order, especially given that they are not on the agenda of official or public discussion. A major factor that has kept them off the agenda has been the strength of the assumption all wish to believe, that renewable energy sources can substitute for fossil fuels and therefore can sustain consumer-capitalist society.

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[1] See Ted Trainer, *Renewable Energy Cannot Sustain Consumer Society,* (Springer, 2007).

[2] Sharman, H.: 2005, 'The dash for wind; West Denmark's experience and UK energy aspirations'. www.glebemountaingroup.org/Articles/DanishLessons.pdf, E.On Netz: 2005, *Wind Report 2005*, http://www.eon-netz.com

[3] Davy, R. and Coppin, P.: 2003*, South East Australian Wind Power Study*, Wind Energy Research Unit, CSIRO, Canberra, Australia.

[4] See for instance, Enting, I., Wigley, T., and Heimann, M., 1994, *Future emissions and concentrations of carbon dioxide; Key ocean/atmosphere/land analyses*, Technical Paper, CSIRO Division of Atmospheric Research, 31, Melbourne.

[5] Fulton, L.: 2004, *Biofuels For Transport; An International Perspective*, International Energy Agency.

[6] For more detailed information on these themes, especially the nature of The Simpler Way, see http://socialwork.arts.unsw.edu.au/tsw/