FORGET WIND AND SUN FOR THE PRESENT[1]

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If the fossil fuel reserves of the world are looked on as energy capital, the only true energy income our planet has is represented by solar energy, tidal power, wind energy and wave power. Geothermal energy is sometimes included but this is not strictly a renewable source.

Some energy sources can quickly be dismissed (in the context of the commercial glasshouse situation). Three of these are:

Wave power. This is thought by many to offer the greatest potential for our country and being studied at various centres. Ideas such as Salter's Duck, the Cockerell Raft, Russell's Rectifier are fascinating, but of no direct use to growers. More than one-third ($14.4 million) of the Department of Energy funding of R & D programmes on renewable sources is allocated to wave power.

Tidal power. A lot of thought has been given to building a tidal power station in the Severn estuary. Energy from such a source is predictable and calculable and it lends itself to energy storage. So why doesn't somebody do something about it? Whatever the attractions of the technology, the accountant comes on the scene sooner or later. On the basis of normal criteria for pay-back period, and with the cost of the proposed Severn barrage estimated at over $8 billion, the power produced would be much more expensive than that resulting from investment in conventional power stations.

Geothermal energy. This, like sunshine, is not uniformly available. In our country, the southwest shows most potential and trial drillings have been made. The output would be in the form of medium temperature hot water, thus it would be more suitable for heating purposes than for generating electricity. However, its quality and availability are uncertain, cost of drilling is high, the water is usually highly corrosive and there are often quantities of pollutant gases present.

Wind Power

Wind power is nothing new, it has been used for centuries. More recently small electricity generating windmills have been used successfully for remote rural houses. Larger units (say 200 kW) are being investigated in many countries. Although this research usually aims to produce mechanical or electrical power, the energy extracted from the wind can, just as effectively, be in the form of heat.

Unfortunately, not all power available in the wind can be extracted by a windmill. At low wind speeds the rotor is ineffective and at high wind speeds the blades have to be "feathered" to avoid damage. The windmill designer has many factors which interact, and which should be optimised.

The meteorological records for a particular area enable an estimate of the average wind energy potential to be made. Local topography and obstructions to wind flow will obviously modify this potential. There are some meteorological stations where wind speed is recorded every hour and one such place, where there are 17 years of records, is Thorney Island on the south coast. Because this meteorological information has been analysed in such a way that the average total number of hours yearly in steps of windspeed are available, the likely output can be estimated (see the Table below).

The example in the Table is a 60ft diameter windmill from which energy appears as heat. The rotor produces power between the manufacturer's stated design start-up speed of 8mph, and the feathering (maximum) speed of 30mph. No windmill can be 100% efficient, as only by stopping the moving column of air can all the power be extracted from it. This efficiency is taken into account in the table.

Energy potential of a 60ft diameter windmill

mile/hour	Yearly hours	Energy kWh	Energy MJ
Calm	447	-	-
1-3	2172	378*	1362*
4-7	1761	3896*	14025*
8-12	2199	24509	88233
13-18	1691	63609	228992
19-24	350	31208	112349
25-31	79)		
32-38	9)	15325	55170
Total	8760	134651	484744

Note: The SI (Systeme International) unit of energy is the Joule. One Megajoule (1 MJ) = 948 Btu.
*Energy contribution excluded

If the annual average amount of energy captured is expressed as a fossil fuel equivalent, then about 4000gal of oil burnt at 75% efficiency would provide this total for the year. However the windmill might be producing heat when it was not needed, and presenting the data on a yearly basis takes no account of the month-by-month variation which needs to be balanced against the monthly heat demand of the glasshouse.

[1]*Reprinted from The Grower, August 23, 1979. Dollar figures are conversions from british pounds.*

Repeating the calculations for a more windy area (Fleetwood in Lancashire) would double the potential energy. The grower needs to make his own calculation of the amount of money he could find profitable to invest in a windmill to capitalise this amount of fossil fuel substitution.

Solar Energy

The variable climate of the British Isles makes it difficult to think of solar energy as a very large energy source. An interesting (but not very useful) fact is that the total solar energy received during a single June day by the mainland area of England, Scotland and Wales is about 4×10^{18} J (four million million million Joules), about the same as the yearly UK petroleum energy consumption!

The total solar energy intercepted by a greenhouse is greater than that needed as fossil fuel over the whole of a typical year. The main problem is the wide variation of solar energy supply between summer and winter and between the maximum and minimum values which averages don't show. Whilst average values may tend to confuse the issue, they can be used to make comparisons. Comparing London with Los Angeles illustrates the effect of northerly latitude and the overcast sky of a British winter.

	London	Los Angeles
Annual sunshine hours	1650	3284
Daily sunshine hours, June	7	10
Daily sunshine hours, December	1	7
Annual total radiation MJ per sq m	3337	7056

Predicting the average amount of solar energy which can be captured is fairly easy; 1 sq m of horizontal surface at Kew on a typical June day will have 17.3 MJ of direct and diffuse solar radiation falling on it but in December it will be only 1.66 MJ. The ratio of summer to winter energy receipt is thus 10:1 for UK, but better than 5:1 for the south of France. In the USA, Japan and Israel it is better than 3:1 and in Australia and India less than 2:1. This puts in quantitive terms what we all know - the British Isles have a particularly poor record of winter sunshine.

Energy Storage

The ideal of storing the excess of summer sunshine for free winter heating is not capable of achievement in the present state of knowledge, certainly not in a cheap and practical manner. Perhaps some lesser goal is feasible? Energy storage for a shorter period should be investigated. Economic reasons dictate that the store should be of minimum size while prudence and technical requirements demand the largest possible store. The meteorological records have to be examined further; for example, the number of consecutive days with low or high values of solar radiation must influence the design of solar heat storage systems.

In a similar way, the evidence for the likely glasshouse heat demand has to be considered. But the most appropriate combination of the two sets of data is a matter of opinion. Should the heat store be given the capacity to cope with a period of high demand because the glasshouse is suffering a few days of bitterly cold weather and high winds? Suppose such conditions followed several days of overcast skies with no input to the store. There is no easy answer to some of the problems.

Thus it is possible to conclude that the heat requirements of large commercial galsshouses of 1970s design in UK are not going to be provided by the wind or the sun. But energy problems are not unique to the grower of protected crops, and in research centres all over the world ideas are being developed which are relevant. Although it is difficult to picture a traditional glasshouse block heated only by solar energy, a solar-assisted greenhouse designed with a markedly lower heat loss coefficient, coupled with limited thermal storage, could be feasible and is worthy of study. Aspects of this are being investigated at NIAE.

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