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EXTRACT FROM A UK GOVERNMENT/CIVIL SERVICE REPORT 1988

PROSPECTS FOR THE USE OF HYDROGEN IN THE UK

There ere three broad headings under -which hydrogen might be considered: .
(i) as a chemical feedstock;
(ii) as a general energy vector;
(iii) as an energy store for special purposes.

CHEMICAL FEEDSTOCK

Hydrogen is already used on an industrial scale, principally for the manufacture of ammonia for fertiliser and fcr use in oil refineries for upgrading refined products. For both purposes the hydrogen is presently manufactured from natural gas or oil at a cost of about one-third of that of producing it by electrolysis of water. Should gas or oil supplies eventually become too expensive, a suitable alternative would be coal. The manufacture of hydrogen from coal used to be practised in the past until simpler oil/gas-based processes were developed. There would be no basic difficulty in up-dating the technology to use coal again if the need should arise.

GENERAL ENERGY VECTOR

Since hydrogen can be produced only by the use of energy, it is strictly an energy vector not an energy source. Its potential therefore needs to be seen alongside that of alternative vectors such; as electricity and substitute natural gas (SNG) , In looking forward to the time when fossil fuels -would be in short supply, the original proponents
of the "Hydrogen Economy" cited as its main advantages the avoidance of

pollution and the low cost of production from nuclear reactors.

The pollution advantage applies clearly at the point of use but not necessarily at the point of production. Many of the arguments favouring hydrogen could be applied equally to the other clean energy vectors. Hopes for the manufacture of cheap hydrogen rested originally on the prospects of using thermochemical cycles powered by a high temperature nuclear reactor. It was claimed that the efficiency of this method would be considerably greater than that obtainable from electricity generation. Some work on .thermochemical techniques for hydrogen manufacture is currently being sponsored by the Governments of the USA and Japan. In Europe, the work is centred at the Joint Research Centre of the EEC at Ispra, where the world's first complete production circuit has been operated. However, the prospects of discovering a sequence of chemical reactions which result in high efficiency are now much diminished and the costs are expected to be high. The best that can now be expected is that manufacture of hydrogen on a 500 KW scale will cost no more than manufacture from electrolysis.

Electrolysis, therefore, remains the only viable process for manufacturing hydrogen for use as a large scale energy vector. Because of the additional capital costs involved and the loss in efficiency, hydrogen produced in this manner will

always .be more expensive than the electricity from which it is derived. Its prospects for large scale manufacture and distribution (by, say, existing gas distribution systems) are not encouraging. In the UK, where we have large reserves of coal, it seems much more likely that v/hen oil and gas are no longer adequately available, energy will be distributed as electricity and SNG.

The use of hydrogen as a fuel does not pose any particularly difficult problems. In fact, before the advent of natural gas, the town gas in general use consisted of 50% hydrogen.
There would be detailed problems of adaptation of appliances end burners and of ensuring the integrity and safety of the distribution system, but none of these need require long term research.

ENERGY STORAGE FOR SPECIAL' PURPOSES

The most promising use for hydrogen is as a means of utilising off-peak electricity from nuclear reactors. The hydrogen might be used near the point of production as a fuel or feedstock, but more likely it could be stored and used to generate electricity on-peak, by either conventional gas turbine/steam plant or by fuel

cells. This option would compete with alternative means of central storage of energy such as pumped water, compressed air or heat.

This option, can be realised only when the proportion of nuclear plant is greater than that needed for the base load on the electricity system. On present plans, it is not expected that this situation will be reached in the UK before the turn of the century. In countries with small energy resources which are opting for a large increase in nuclear power, a surplus of off-peak nuclear capacity will arise much sooner than in the UK. This accounts .for the greater interest in hydrogen production in countries such as France and Belgium.

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In the exploitation of some renewable energy sources, hydrogen may provide a viable method of collecting and storing energy from low density or variable sources. It might possibly be produced from some biological processes under the action of sunlight without a separate stage of electrolysis. Such applications may compete with more orthodox solutions which generate electricity. Research into these aspects is being carried out, both as a part of the Department's R & D

programmes on alternative sources of energy and independently , in the universities. The scope for the application of this work is, however, limited since the contribution which renewable sources are expected to make to the UK energy supply in 2000 is 2% at most and sone of this would certainly be in the form of heat or electricity.'

For use in vehicles, [Editors Note and *in aircraft*] liquid hydrocarbons offer many advantages over alternatives such as hydrogen. When hydrocarbon supplies diminish, it seems most likely that substitutes will be synthesised from coal or that alcohol derived from renewable sources will be used. Technically, hydrogen can be a suitable fuel for internal combustion engines but its storage on vehicles is however difficult and expensive if vehicles of reasonable range are to be produced. The problems are similar in some ways to electricity storage in batteries and the battery vehicle provides an alternative solution to the replacement of hydrocarbons for transport purposes.

CONCLUSION

Although technical possibilities exist for the use of hydrogen as a fuel or energy store, there are alternative options. The circumstances under which it will be economic to utilise hydrogen seem rather limited and will arise in the UK later

than in countries less well-endowed with fossil fuels.

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Irrigation water management: Course summary

1 Summary : Why do farmers irrigate? : to obtain a crop or to obtain higher crop yield; to obtain improved crop quality. Crop yield improvements from:
providing water, when there is insufficient soil water/ rainfall for growth, especially germination;
providing water to help make soils workable viz rice;
preventing weed competition viz rice;
controlling soil temperature in spring for rice and mountain agriculture;
providing frost protection to fruit crops, by coating blossom with ice to provide heat and prevent heat loss;