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THERMO—FLUIDS ENGINEERING RESEARCH CENTRE

FATS FOR FUEL

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ABSTRACT

High, and increasing energy consumption, is a characteristic of modern industrialised society. Unfortunately, the bulk of this energy is being derived from fossil sources incapable of renewal. Liquid fuels are shown to be an important form of energy distribution and use — and are likely to remain a desirable form for a considerable time in the future. in the interests of extending the useful life of natural fossil resources and to promote national self—sufficiency in energy requirements, it is suggested that animal/vegetable oils can, in appropriate circumstances, provide an acceptable energy source.

INTRODUCTION

The concept of using fats as fuels, i.e., as a source of energy, is not at all novel. Oils, fats and waxes, along with vegetable products, have been used for centuries to provide primitive forms of heat and light. However, before considering potential applications and uses in todays world, it is helpful to look at an overview of energy uses, current trends and some projections for the future.

A BRIEF HISTORICAL PERSPECTIVE

Man’s use of energy through the centuries have evolved from what might be termed local low—technological forms to bulk production and supply from the exploitation of coal, oil and nuclear sources.

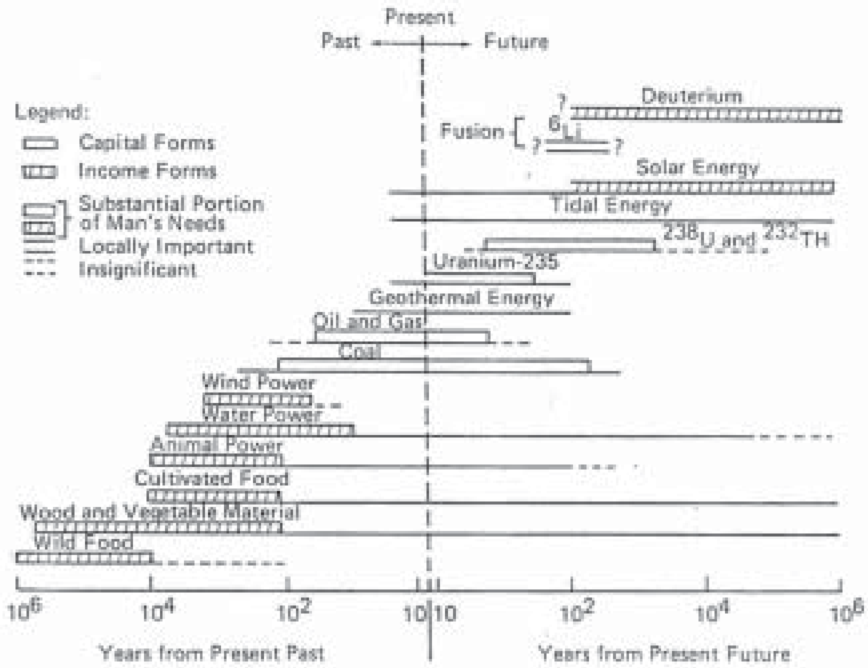

Figure 1. Man's principal energy sources down the centuries.

As illustrated in Figure 1., from Cook(1), not only have we moved away, at least in industrialised society, from low—tech forms of energy, we have also moved away from renewable, i.e., income, forms of energy. The present period is characterised by man's use of capital energy sources(2) which will become increasingly expensive to extract and process.

Oil and gas reserves are projected as being exhausted sooner than coal, with nuclear power in its various forms taking over ultimately as the predominant, and again renewable, source. Other renewable resources capable of exploitation include geothermal, solar and tidal.

Not only have the sources of energy changed, but so too has the rate at which it is used and the form in which it is made available for use.

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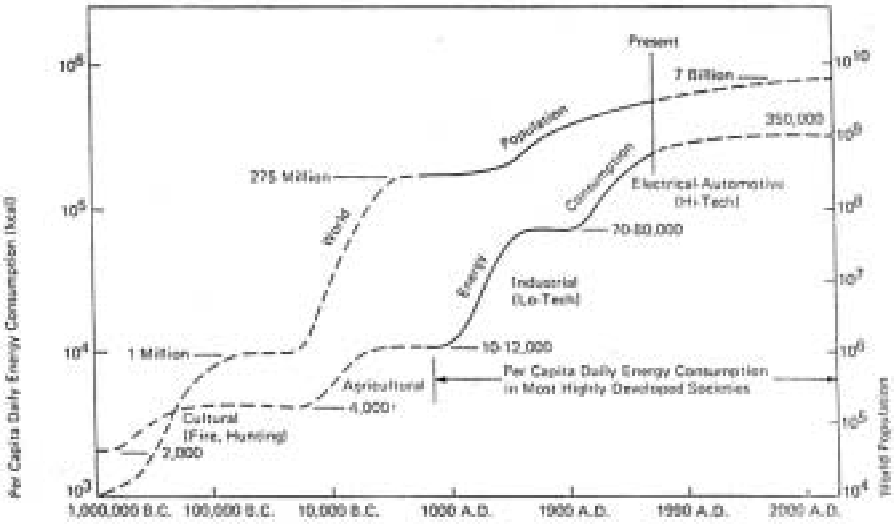

Figure 2. World population and per capita energy consumption from 1,000,000 BC to 2,000 AD - see ref. 1

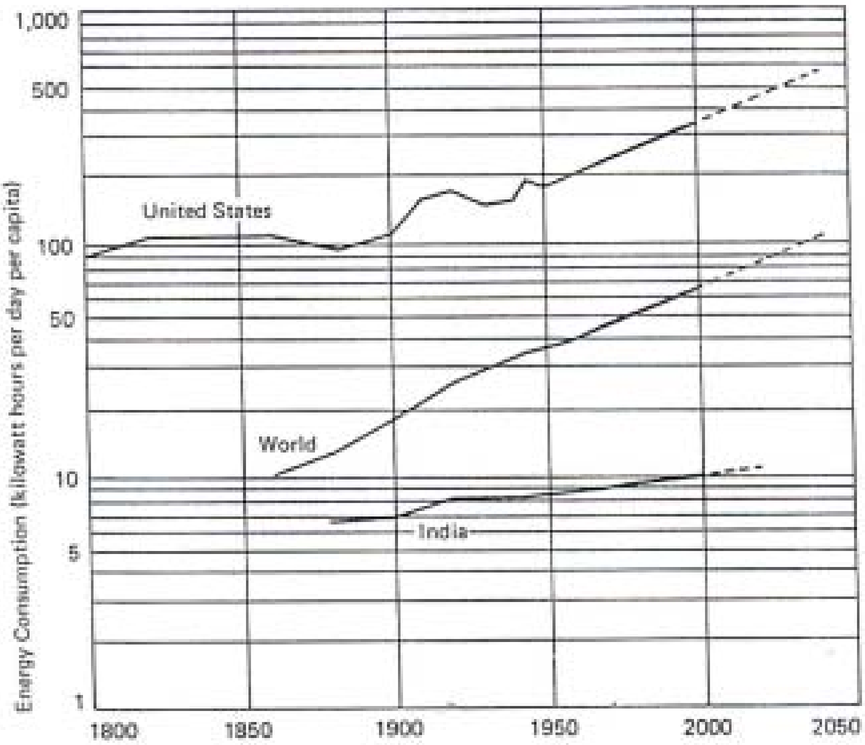

Figure 3. Recent growth in energy consumption for a developed and developing country.

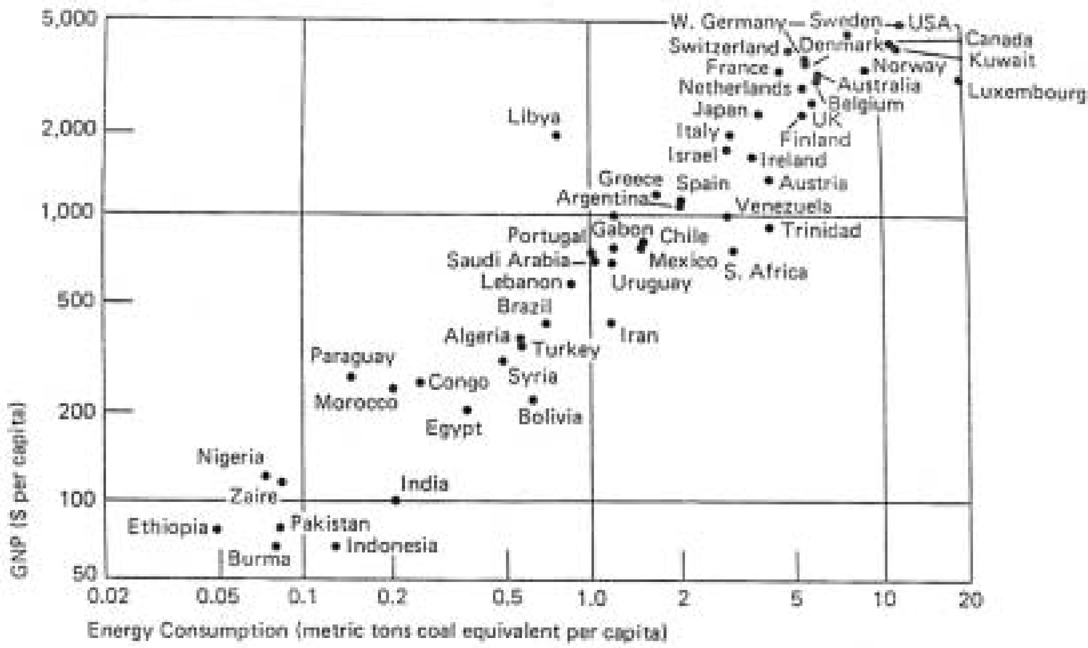

Figure 4. Correlation between Gross National Product (GNP) and per capita energy consumption for 52 countries.

The global rate of use is loosely related to world population, but tends to vary with culture and degree of industrialisation. Considering more recent times this is illustrated in Figures 3 from Starr(2) and 4 from Linden(3).

Generally speaking, the countries with the higher degree of industrialisation, indicated by the Gross National Product (GNP) also have higher rates of energy consumption. There are some variations, which can be seen, for example, in the upper right of Figure 4, and the interested reader may pursue discussions of them elsewhere (4, 5). Of more immediate interest is the form in which energy is used — the evolution of which is shown in Figure 5 from Cook(6).

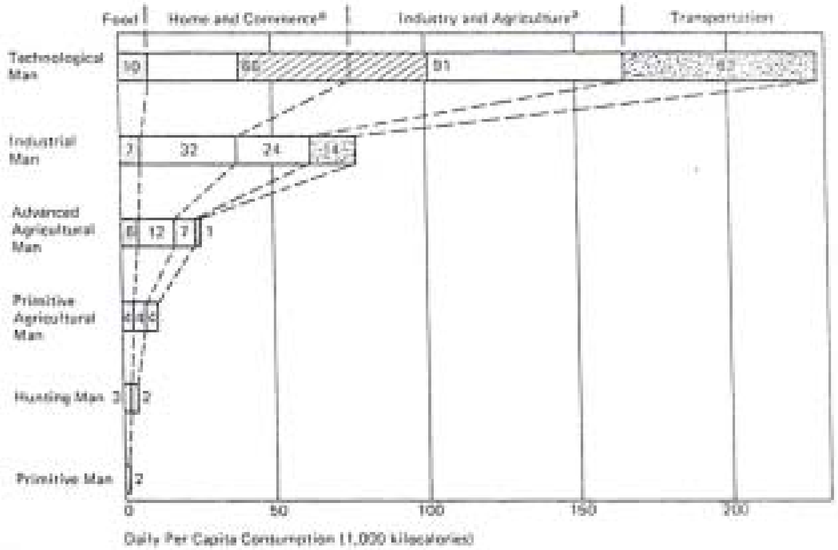

Figure 5. Daily energy consumption, per head, for six stages in human development.
a: the hatched area indicates the portion of energy needs fulfilled by electricity.

Among the features to note here are the importance of transportation, industry, and home and commerce. Although electricity contributes a significant porportion of the energy requirements, large contributions to the three major categories come from either solid or liquid fuels. Of particular relevance is the use of liquid fuels and the reliability of their continued supply at acceptable costs.

LIQUID FUELS

Among the applications of liquid fuels are:

heating oils in furnaces for domestic, commercial and industrial space heating, crop drying, etc.

fuel oils for engines, including gas turbines, for transportation (cars, trucks, railways, etc.) stationary engines for power plant, water supply, irrigation, etc.

The primary sources of these liquid fuels are natural crude oils, with some contribution from coal liquefaction. Both of these, in the long term are capital sources which will become increasingly expensive to recover. It is therefore highly desirable that alternative sources of liquid fuels be investigated with a view to extending the life of current resources as well as developing economical substitutes for when they become really essential.

To add a political dimension, it is worth noting that the European Economic Community is a net importer of liquid fuel oils, requiring several hundred million gallons per annum. The United States also imports some 40 percent of its requirements(8), and many other countries import even more. Consequently, there is both an economic and strategic need to review the uses to which fats, derived from animal and vegetable sources, can be put as fuels. Clearly they will not replace conventional sources, but they could have a useful role, either as fuel extenders or as substitute fuels for specific applications. To be successful they need to satisfy economic and performance criteria.

FATS FOR ENGINES

To be readily accepted as an engine fuel, fats would have to meet the same criteria as the more normal fuels whether used on their own or as an extender. They would, for example, need to meet national and international standards concerning exhaust emissions, and be acceptable to engine manufacturers to ensure warranties are not rendered void.

To meet the latter criterion, several aspects need to be considered. The fuel (or modified fuel) must be stable, i.e., not display property changes with time or temperature fluctuations, be compatible with the various materials encountered in a fuel system, from the storage tank to the combustion chamber and once in the combustion chamber, burn cleanly and release energy at a rate and temperature consistent with the engine design.

Although these criteria may be judged rather stringent, recent tests(9) have shown that it is possible to meet them with a fuel extender. Among the animal/vegetable oils used are tall oil, a by—product of paper manufacture and butter oil. In the latter case, a modified diesel fuel containing virtually 20 percent of butter oil was tested in a Ricardo E6 fuel research engine. Operating performance with the modified fuel and normal diesel fuel oil was essentially the same, with some indication of a lower smoke generation with the butter mix. More extended tests are planned to investigate effects, if any, on long term performance and reliability. Other studies are in hand with tallows.

Present supplies of tallow and surplus butter are not likely, however, to provide a suitable source of alternative liquid fuel oils. The most productive way forward, and it is now very possible, is to capitalise on current international developments in genetic engineering applied to the design of plants and animals, especially the former. Soya, rape and sunflower represent the most likely candidates for exploitation — rape especially in Northern Europe.

FATS FOR FURNACES

The criteria for furnace oils are perhaps slightly less severe than for engine fuels. Smokeless combustion is essential and if used as a direct substitute for normal fuel the furnace temperature and size and shape of the flame should be similar.

On the other hand, if a long term and secure supply of the animal/vegetable oil is available at an economic price, replacement burners and other modifications to the combustion equipment may be warranted.

As with engine fuels, even when technically feasible, the ultimate justification for using fats either on their own or as extenders is in cost benefits. These consist not only of the net fuel cost, i.e., cost per mile or per hour, but include the effect on equipment life, down time, service and maintenance.

Liquid fuels are an essential component of the energy needs of modern society not only in Europe and North America, but also in the developing countries. At present, such fuels are derived from natural oil reserves and to some extent, coal liquefaction.

Although both coal and oil reserves are not yet on the verge of exhaustion, they are being depleted and will be more expensive to recover in the future.

In the interests of extending the useful life of fossil reserves and in strengthening the self—sufficiency of countries and continents with respect to their future energy requirements, there is a strong case for promoting the development and use of fats as fuels. The most promising lines of development would seem to be the use of genetic engineering tools, allied to the use of modern processing techniques, to produce vegetable oils that are suitable for use in internal combustion engines and furnaces for space heating and crop drying.

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