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THE NORTH AMERICAN EXPERIENCE

The Charles River and the Boston skyscraper backdrop provided the setting for an important conference on energy and environmental problems. The Conference was held at Massachusetts Institute of Technology, Cambridge, Massachusetts, and attended by over 400 delegates from most industrialised nations and particularly North America.

The main aim of the three day conference was to analyse the increasingly complex relationships between the effects of energy supply and use and its impact on the environment. The conference highlighted achievements so far and defined new roles for technology and policy for the future. In a special report, Dr Michael Brett discusses the North American approach to energy questions.

In his keynote address, Senator Albert Gore, Democrat for Tennessee, placed energy and the environment in the context of recent world events. The political upheavals that have heralded the end of Communism have far-reaching implications for the world's pattern of energy use and accompanying environmental pollution. Senator Gore observed that, 'if the Federal government are out of step with energy issues, people certainly are not'. The evidence is clear to see — Chernobyl, Exxon Valdes, acid rain, polluted beaches, benzene fogs over large cities — people are beginning to ask, 'what are we doing to the environment?'

The scientific community has been warning of the effects of increasing energy use for many years; perhaps their words are getting through at last. Funding for energy related research has been reduced since the early days of the Carter administration. Fortunately energy issues are in vogue again and federal funding for energy and environment is increasing.

The environment is under greater threat now than at any other time. But there is strong disagreement about the extent and timing of this threat.

The majority of delegates at the conference perceived that this threat is real enough and called for increased efforts, to assess the extent of the problem and find ways and means to reduce energy use and combat environmental pollution.

Energy use in the USA

The efforts to counter rising energy demand in the US produced a gradual decrease in consumption from the oil crisis years (1973) until the mid 1980's, after which energy consumption began to increase again, Figure 1. There are two possible reasons for this: from the early 1980s public awareness faltered — fuel appeared to be plentiful and low in cost; and oil prices remained lower than anticipated throughout the decade.

This may be due to North Sea oil stocks which have helped to stabilise, and even deflate, oil prices and fuel prices in general. One American expert believes that OPEC has agreed to keep down the price of oil until North Sea stocks are exhausted — then we can expect a rapid price hike.

If this is so we should be using this opportunity to improve consumption profiles, switch to other fuels and practise more energy efficiency.

However, increasing energy consumption has not necessarily been accompanied by increasing pollution in the US. Federal laws on emission levels and the introduction of fuel efficient technologies have helped to offset some of the inevitable pollution caused by increasing energy use.

Continuing this trend towards less pollution, or even maintaining existing levels, is the challenge for the US and indeed for the rest of the world. Clearly the industrialised nations must take the lead.

The poorest countries are among the worst polluters and this trend is likely to escalate as these countries strive to raise their standards of living. Industrialised nations should ensure that only energy efficient technologies are transferred to developing countries: so far this has not always been the case.

What is being done?

So much for the scenario, but what is being done to improve the efficiency of buildings, to reduce energy levels and counter the threat of increased pollution and global warming? Energy use in buildings currently accounts for about one third of the total energy consumption in the US. In the UK this figure is nearer 50%, but North Americans use far more energy for their transport systems than any other country.

On a strategic level the US Department of Energy (DOE) in collaboration with the Environmental Protection Agency (EPA), have proposed seven measures for combating energy use and environmental effects.

Most of these measures are not new and some are even practised in certain states already. The measures proposed are:

the development of reliable test procedures to compare the effectiveness of energy technologies;

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energy labelling of buildings and appliances;

the introduction of more stringent building standards;

incentives for energy savers and disincentives for energy users;

taxation of imports which affect the price of energy and make energy efficient investment less attractive;

increasing support for information transfer and education; and

a gearing-up of research, development and demonstration schemes.

The DOE is considering directives which should accelerate commercialisation of new technologies, and the energy efficiency and solar programmes are to be co-ordinated into a single buildings programme.

The different regional patterns of energy use and environmental aspects, offer an opportunity for specific Federal support.

A case in point is the ingress of radon in buildings which is of considerable concern in some American states. Not surprisingly, indoor air quality is a major area for support and information transfer, enjoying considerable funding from the EPA.

Other technology areas are less well off. Taxation is certainly not popular — particularly for energy use. A carbon tax is seen as a last resort when all other initiatives fail.

Legislative measures, such as increased building standards, have to be introduced gradually. Otherwise the outlook for most of the USA's 90,000 builders could be bleak.

But what of US industry? Here the prospect is very encouraging. Firstly, the appliance manufacturers — some have certainly responded well. For example, since 1972 the efficiency of refrigerators has gradually improved by 100%, through the introduction of better designs, improved materials and production techniques.

Now this industry appears to have been penalised, for legislation on the labelling of appliances is calling for further improvements in efficiency within a timescale that is beyond current technical capability. Not surprisingly the refrigeration industry is sceptical about their future.

The prospect is better for the glazing industry. The demand for factory produced double and triple glazed units with low emissivity glass is growing, currently taking about 25% of the market. The use of thermal louvres (which regulate the heat entering or leaving a building) are quite common in commercial buildings, Figure 2. The second generation product — louvres between panes of glass — is now in production.

'Smart' glass changes its properties at the flick of a switch — either allowing total or partial transmission, or total reflection of light. This form of glass — similar to liquid crystal displays — is currently being developed. The timescale for introduction in buildings is probably about 5-10 years.

However, the automobile industry has adopted the idea and is likely to introduce a similar product far sooner, perhaps within 5 years. The US glazing industry is anxious of competition from other countries, particularly Japan and West Germany, and this may provide an impetus to their efforts.

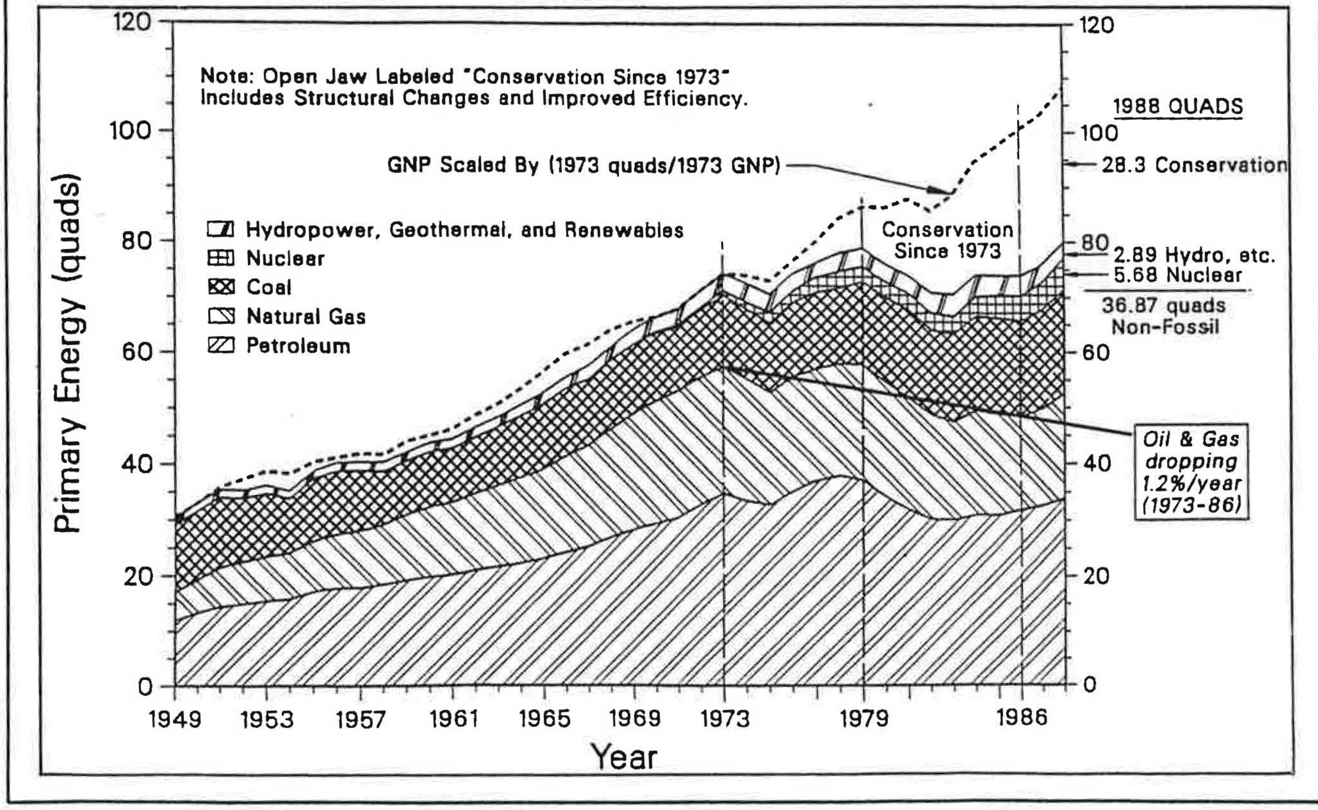
If the principle can be applied to glass, then why not to the fabric of buildings? This would help to reduce summer cooling and improve insulation properties sufficiently to reduce winter heating.

The idea re-defines the function of the building fabric, which instead of acting as an overcoat becomes a controllable membrane. This may be the technology for buildings of the future when applied as an external cladding to conventional construction.

The GE Corporation have traditionally manufactured plastic materials, particularly for insulation and packaging. In a partnership which has included the building design, construction and services industries, the company has developed and built the 'all plastic' house.

Unfortunately, the term does little justice to an otherwise spectacular initiative. The prototype looks for all ▶

Figure 1. **U.S. primary energy use — actual vs. predicted by GNP (1949-1988).** ***Note:*** **1 Quad = 1.054 Exajoules (10^{18} joules)**



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'The summer cooling load in American buildings is far greater than in Europe. In fact it is often greater than the winter space heating load in some states.'

intents and purposes like a house built with traditional materials. But every component of the building — walls, ceiling, interior fittings, windows, doors, services, plumbing, etc — is made of plastic or a plastic derivative.

Most of the building is factory built and then assembled on site, allowing high building tolerences without high construction over-costs. However, bearing in mind the conservatism of the industry, will these ideas ever catch on?

The summer cooling load in American buildings is far greater than in Europe. In fact the summer cooling load is often greater than the winter space heating load in some states.

Buildings that employ electric storage systems require electricity in winter for heating and in summer for cooling. The pattern of electricity generation varies throughout the day, peaking perhaps several times during the day as demand fluctuates, with no two days being alike.

A tariff structure, based on the hourly cost of electricity generation has been proposed. Under these circumstances it makes economic and social sense to take electricity at the most beneficial times of the day — when costs are at their lowest.

Computers, common in building management systems, can be programmed to optimise favourable electricity generating conditions. In such cases a building could draw electric charge at the most opportune time, reducing fuel bills and helping to smooth the demand pattern.

Furthermore, as daily heating, or cooling, largly depends on temperature — why not programme the computer with the following day's weather data as well? In the US this is a practical reality, weather data is digitally available at the end of a telephone line.

The use of weather forecasting and the choice of the most opportune times to draw load could reduce fuel bills and improve patterns of electricity generation. This is already a practical proposition — a pilot study, underway in three large buildings in New York State, is being monitored by MIT.

Systems such as this could be equally relevant to other countries for space heating, cooling, or both.

Conclusions

The last decade of this century is likely to see the developing nations emerge as the major energy users. As they improve their standard of living this is inevitable. The industrialised nations must take the lead in reducing their energy demand while maintaining the quality of life that is associated with high energy use. If the US is to maintain a major influence in world affairs it must put its own house in order first.

To bring about a significant change requires a major change in the way in which we use energy, not only in buildings but in all applications.

There is little evidence of this change, so far. In many ways we have only been 'tweeking' the controls. This has produced some improvement but there is still a long way to go.

It could be that Senator Gore is right when he says that people are beginning to demand consideration for the environment. As we move towards the 21st century, it is with some optimism that we look forwards to a challenging future.

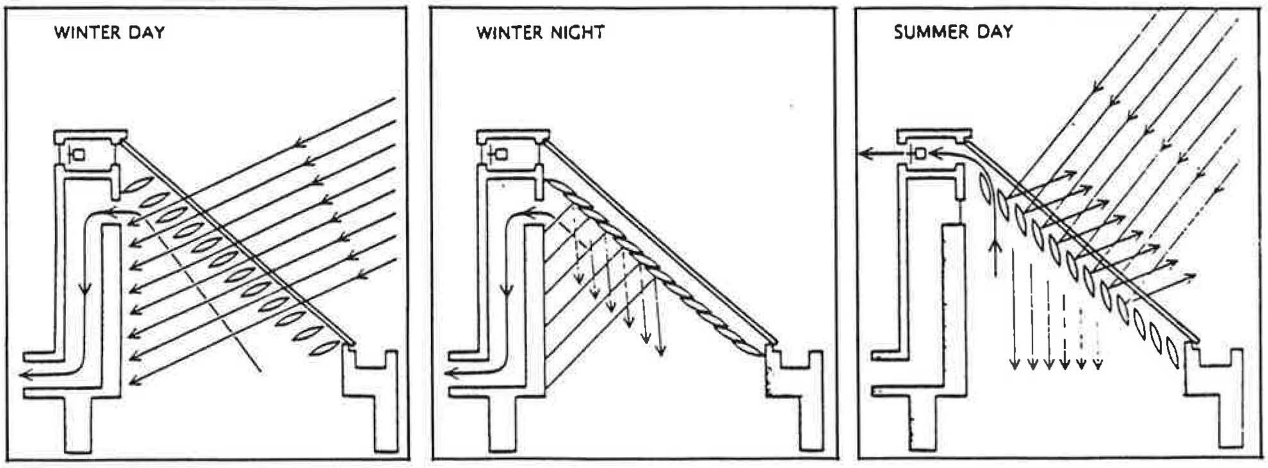

Figure 2. Computer controlled louvres, Albany County Airport, control sunlight entering through the skylight. On a bright winter's day sunlight heats the back wall drawing warm air into a space behind the wall. This air is then recirculated through the building. At night the insulated louvres are shut to trap heat. In summer the louvres reflect sunlight but admit diffuse light. Warm air collecting under the skylight is vented by exhaust fans.