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Into the 1990s

Vol.1

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Proceedings of the 1st World Renewable Energy Congress, Reading, UK, 23–28 September 1990

Edited by

A. A. M. SAYIGH
Department of Engineering, University of Reading, UK

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PREFACE

The World Renewable Energy Congress has been set up to evaluate and promote renewable energy and to identify the most promising areas for utilising renewable energy as well as pressing for more constructive research and development in these areas.

It has taken four years to consult, select and prepare the present meeting and hopefully, it will gain momentum with more congresses following up.

Approximately 1200 abstracts were received by the Congress organisers, out of which the following selection was made. The Proceedings are divided into five volumes.

Volume One consists of 9 plenary papers outlining the various important issues and possible commercial utilisation of different forms of renewable energy, and 90 papers in the field of photovoltaic technology. The papers review the present state of the technology, address the outstanding technical, financial, marketing and social problems and consider what the future holds for photovoltaics. World shipment of P.V. in 1989 was about 35 MWp, and the cost of installed power at present is $5/Wp from crystalline cells and $4/Wp from amorphous silicon. The average efficiency of crystalline cells reached 13%, while in the laboratory 21.7% was reached. Thin film efficiency a-si is about 7%, while 17% is reached in the laboratory. In reviewing these papers it became apparent that the combination of cell improvement and cost reduction is going to put P.V. in the forefront of the renewable energy sources for the next 5 - 10 years.

Volume Two consists of 121 papers on solar thermal technology. In this area the papers reflect the vast research and development programmes which have been carried out around the world. The overall system efficiency is about 21% and the cost of electricity generation is the same as that of oil or coal generation but it has the overriding advantages of being cleaner, safer and inexhaustible. The present installed capacity of power generation is about 300 MW, mostly in the USA.

Volume Three is divided into three parts: Part One deals with material science which consists of 26 papers. Rapid advances in materials science technologies now make available many novel forms of coating for energy efficient applications in solar radiation conversion. Insulating heat mirrors, selective absorbers, transparent insulation and fluorescent concentrators are examples of materials which are today commercially available. Radiative cooling, electrochromic windows and polymeric light pipes are areas which hold promise for future development. Chemical materials and papers concentrate upon new material advances as well as applications, costs, reliability, deposition technologies and industrial production, performance and characterisation.

Part Two deals with wind energy conversion. 46 papers dealing with success, utilisation and research and development programmes in this area. The installed capacity in the world is presently about 4000 MW and this is likely to increase rapidly during the present decade. The cost of electricity generation from wind is cheaper than that of conventional generation in areas where the wind regime is 5m/s or higher. The papers also cover large programmes in the USA and Europe.

Part Three deals with biomass technology and has 62 papers. This is probably the ultimate future energy of the world since biomass sources are the largest single provider of energy for developing countries and overall provide 14% of the world's energy - equivalent to 22 million barrels of oil a day. The increased undersupply of biomass is a serious environmental and socio-economic problem. There are, however, important opportunities in the biotechnology and agricultural/forestry management techniques to improve greatly the productivity of biomass plants and to improve the efficiency of conversion to easily usable fuels.

There is now considerable experience worldwide with the commercial use of biomass fuel and also the integration of agroforestry systems into the environment to meet local and natinal demands. How such experiences can be transferred to other communities and other entrepreneurial investments is important for the long term development of sustainable bioenergy systems.

The role of biomass vegetation (forests, trees, grasses, shrubs, crops, etc) in maintaining the world's climate and environment is being increasingly appreciated. The greenhouse/global warming effects can be ameliorated by increased aforestation and the halting of deforestation. Biomass fuels do not contribute to the CO_2 increase and have lower noxious gas and particled emissions than most fossil fuels.

Volume Four consists of 102 papers and is concerned with solar and low energy architecture. The papers focus on energy and environment issues facing designers in the forthcoming decade, examine the prospects and research issues in different climatic regions, recent architectural projects and the review of the development of computer aids for environmental design. Some papers also deal with educational issues.

Volume Five has 89 papers dealing with various issues. Solar radiation, which is the main source of all renewable energy, is covered in several papers; while wave energy, mini hydro, geothermal, tidal energy, hydrogen production, energy management, economic issues and other related topics are all covered in this volume.

All the papers collected in these volumes have been refereed. They represent a vast amount of intellectual and scientific commitment on the part of authors from every contintent and creed, working alone or in large commercial/national organisations, unified by the desire to promote a worldwide utilisation of renewable energy.

Finally, I would like to extend my warmest thanks to all my colleagues who have contributed to these volumes.

A A M Sayigh
<u>Editor</u>

11.6.90

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* unavailable for the proceedings

PASSIVE AND LOW ENERGY ARCHITECTURE
- FROM THE ENGINEERING VIEWPOINT

D S GILLINGHAM

President
The Chartered Institution of Building Services Engineers
Delta House, 222 Balham High Road, London SW12 9BS

ABSTRACT

The relevant achievements of engineers in the past are reviewed and the values of energy conservation measures are considered in relation to the costs of employment. Comparative powers of the components in building services are identified and approximate indications of their energy consumptions are given. The importance of efficient building design is emphasised and the possibilities for using non-depleting sources of energy in buildings are examined. Future developments in building services are discussed and the suggestion offered that architects of the future might care to assess the total amount of energy consumed by a building over its life, including the energy used in the manufacture, transport and site erection of the building materials, as well as the energy consumed by the services.

KEYWORDS

Efficient buildings, efficient services, energy sources, energy in building materials.

PAST RECORD OF ENERGY CONSERVATION IN BUILDING SERVICES

Professional engineers engaged in the design, installation and commissioning of building services have not entirely neglected energy conservation in the past. It is probably not generally known that combined heat and power systems were being designed and installed as early as 1900, waste steam from the engines driving the electrical generators being used to heat nearby buildings. In the twenties and thirties district heating was extensively developed with the intention of economy in the use of energy - although ideas on the effectiveness of this have changed somewhat in the meantime. It is to be noted that, in the fifties, an advanced design for Shell Centre, in London, used the natural cooling capacity of the water in the river Thames to cool the building for much of the year. For many years before the first oil crisis in 1973 it was common practice for engineers to estimate the running costs of the heating installations they were designing and to recommend methods that could be adopted to minimise such costs. The practice of using an intermittent regime of operation for heating systems was developed and used as early as 1950. In principle, the same method is used today, even though it has been refined by the use of computer technology. The heat pump was also used, in both commercial and industrial applications, for many years before the world became acutely conscious of the finite nature of energy resources. More recently, detailed attention has been paid to the recovery of thermal energy from the exhaust airstreams leaving buildings and here also the techniques pre-date 1973.

The engineer is not a novice in the conservation of energy in buildings. As witness of this the enterprise of the CIBSE in producing a code for the efficient design and operation of the services in new and existing buildings (CIBSE, 1977, 1979, 1981, 1982) is to be noted.

THE ECONOMICS OF ENERGY CONSERVATION IN BUILDINGS

The prime concern of the user of a building in the mechanical and electrical services is capital cost. Money received at some time in the future, as a result of taking measures that will conserve energy, are of much less interest. This is often so even if a good economic case can be made. The reason for such a view can be seen if the annual costs of the services are compared with almost any commercial activity that is related to the use of the building. Table I provides such a comparison.

Table I - Comparative Costs of Heating, Ventilation and Air Conditioning. (Expressed in £/m² referred to the treated floor area).

Service	Heating			Heating and Ventilation			Air Conditioning		
Capital Cost	£38/m²			£102/m²			£212/m²		
Interest rate	10%	15%	20%	10%	15%	20%	10%	15%	20%
Depreciation	4.5	6.1	7.8	12.0	16.3	21.0	24.9	33.9	43.5
Maintenance	9.7	9.7	9.7	12.1	12.1	12.1	14.8	14.8	14.8
Natural Gas	3.3	3.3	3.3	3.8	3.8	3.8	3.8	3.8	3.8
Electricity	-	-	-	0.5	0.5	0.5	5.1	5.1	5.1
Totals	17.5	19.1	20.8	28.4	32.7	37.4	48.6	57.6	67.2
As a % of :									
Salaries ;	1.0	1.1	1.2	1.7	2.0	2.2	2.9	3.6	4.2
Cost of Employment :	0.5	0.6	0.6	0.8	1.0	1.1	1.4	1.8	2.1

The above analysis is based on the following data and assumptions :

Capital costs: up-to-date statistical average figures for jobs actually costed.
Heating: cased finned tube using low temperature hot water.
Ventilation: 5.2 litre/s over each m² of treated floor area, filtered and

tempered, low velocity ducted supply and extract, with a recirculation facility.
Air Conditioning: four-pipe fan coil, with ducted auxiliary air.
Plant life: 20 years.
Maintenance costs: very approximate figures only (precise figures are not easy to obtain because of the considerable variation from job to job).
Natural gas: 40 p/therm.
Electricity costs: 6.1 p/kWh
Average staff salaries: £15,000 per annum.
Cost of employment: twice annual salary.

The electrical energy consumptions and costs are based on figures calculated for CIBSE Building Energy Code and relate to electrical energy consumed on site.

The figures suggest that, in terms of the value of possible annual savings, energy conservation may not always be readily accepted because the energy consumed (before conservation) represents only a small amount of money in comparison with the commercial or industrial activity. It follows that architects, structural engineers and building services engineers must engage in close co-operation. The design of buildings and their mechanical and electrical services must be developed in a way that promotes the conservation of energy without imposing penalties in capital costs. In this respect encouragement from central government through appropriate extensions to the Building Regulations, and perhaps in other respects, will be welcome.

REDUCING ENERGY CONSUMPTION IN BUILDING SERVICES

Efficient Building Design

This is a msot important first step: if the building is designed with energy conservation in mind then the duties of the mechanical and electrical services will be reduced and the energy consumed will be correspondingly smaller.

It is not enough to improve the insulating value of the envelope. This saves thermal energy but will increase the electrical energy used for artificial lighting if it involves an inadequate area of glazing. A proper balance should be struck between the benefit of natural lighting and the loss of heat through windows. Building services engineers can help by providing automatic control over electric lights to minimise unnecessary use, but the designer of the building can do more than this. Consideration must be given to the profile of the building, the location of the windows and the depth of the usable floor area in relation to the line of the windows, so that the utmost benefit can be obtained from natural lighting. Such steps will also help to give relief from overheating in warm summer weather by natural ventilation through open windows.

The building envelope must be tight, so that the leakage of unwanted air from outside can be eleminated. There are obvious adverse consequences if this preventa ventilation entirely: condensation is a risk and smells and other pollutants generated within a building must be diluted to an acceptable level by the admission of air from outside. Mechanical supply and extract ventilation, with heat recovery from the exhaust air, is then needed. A note of caution is necessary here. Mechanical ventilation alone is unable to prevent uncomfortably high temperatures within buildings, particularly if there are internal heat gains from lights and machines. Under such