Other Pergamon Titles of Interest

BACH
Renewable Energy Prospects

DE MONTBRIAL
Energy: the Countdown

DE WINTER
Sun: Mankind's Future Source of Energy

DIXON & LESLIE
Solar Energy Conversion

EGGERS LURA
Solar Energy for Domestic Heating and Cooling

EGGERS LURA
Solar Energy in Developing Countries

GARDEL
Energy: Economy and Prospective

GOODMAN & LOVE
Small Hydroelectric Projects for Rural Development

GRENON
The Nuclear Apple and the Solar Orange

HOWELL
Your Solar Energy Home

JACKSON
Human Settlements and Energy

McVEIGH
Sun Power, 2nd Edition

ROSS
Energy from the Waves, 2nd Edition

SIMON
Energy Resources

Pergamon Related Journals
Free specimen copies gladly sent on request

ENERGY, THE INTERNATIONAL JOURNAL
ENERGY CONVERSION AND MANAGEMENT
GEOTHERMICS
INTERNATIONAL JOURNAL OF HYDROGEN ENERGY
JOURNAL OF HEAT RECOVERY SYSTEMS
SOLAR ENERGY
SUN AT WORK IN BRITAIN
SUN WORLD
<table>
<thead>
<tr>
<th>Country</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.K.</td>
<td>Pergamon Press Ltd., Headington Hill Hall, Oxford OX3 0BW, England</td>
</tr>
<tr>
<td>CANADA</td>
<td>Pergamon Press Canada Ltd., Suite 104, 150 Consumers Rd., Willowdale, Ontario M2J 1P9, Canada</td>
</tr>
<tr>
<td>AUSTRALIA</td>
<td>Pergamon Press (Aust.) Pty. Ltd., P.O. Box 544, Potts Point, N.S.W. 2011, Australia</td>
</tr>
<tr>
<td>FRANCE</td>
<td>Pergamon Press SARL, 24 rue des Ecoles, 75240 Paris, Cedex 05, France</td>
</tr>
<tr>
<td>FEDERAL REPUBLIC OF GERMANY</td>
<td>Pergamon Press GmbH, 6242 Kronberg-Taunus, Hammerweg 6, Federal Republic of Germany</td>
</tr>
</tbody>
</table>

Copyright © 1981 Pergamon Press Ltd.
All Rights Reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means: electronic, electrostatic, magnetic tape, mechanical, photocopying, recording or otherwise, without permission in writing from the publishers.

First edition 1981

British Library Cataloguing in Publication Data
Energy for rural and island communities.
1. Power resources - Congresses
1. Twidell, John
333.79'11'091732 HD9502.A2 80-41995
ISBN 0-08-027290-8

In order to make this volume available as economically and as rapidly as possible the authors’ typescripts have been reproduced in their original forms. This method unfortunately has its typographical limitations but it is hoped that they in no way distract the reader.

Printed and bound in Great Britain by
William Clowes (Becles) Limited, Becles and London
'Need' and 'opportunity' are the key words to describe energy supplies for island and rural communities in the 1980s. The need is to cater for the continuation and expansion of supplies at a time when costs from centralised sources are rising above inflation. The opportunity is to be the first to benefit from the modern development of renewable energy sources, which must first take place on a small scale at sites favouring these sources. Likewise where costs are rising steeply, there is the strong desire to improve the efficient use of energy with the opportunity to utilize modern developments in building and energy conservation.

The conference was planned from the Energy Studies Unit and Department of Applied Physics at Strathclyde University because the Highlands and Islands of Scotland were believed to show both the need and the opportunity. Our original ideas were for a small working seminar to consider a few local problems, but interest increased rapidly to warrant activity on a larger scale. It became apparent that whilst a single island or rural community might be treated as an oddity of no significance within a nation, there were so many thousands of similar communities on a world scale that the need of one becomes the need of many.

The distinctive nature of the conference was to value small scale development and to stress realistic application. Self sufficiency and self reliance became frequent themes. We wished to create a down-to-earth approach, and were pleased at the mix of participants from industry, business, regional administration, research institutes, universities and the general public. A small exhibition of wind, hydro and wood-burning devices, and energy efficiency applications helped to stress practical application.

By the conclusion of the conference it was apparent we had made a start along the road of rural and island energy development. The complexity of the opportunities for new energy sources was seen as support for self sufficiency and local development, which certainly included many ideas for business and increased employment. Both technical and economic difficulties were fully realised, and there was unanimous agreement about the poverty of resources being allocated to solve these difficulties. Nevertheless the opportunities are so great, that there was a general mood of optimism.

The mix of subjects covered was not fully comprehensive, yet papers ranged from the biological to engineering, from financing a small business to environmental impact. Energy supplies could certainly not be considered in isolation from each other, and an optimum mix of supplies and resources could lead to robust, stable
and sustainable communities in contrast to the uncertainties of recent times. Interest was also shown by those favoring large scale development of renewable resources, since small communities provided the opportunity to begin realistic development. This is obvious for instance regarding the introduction of wind generators in the U.K., that the Scottish islands provide excellent sites both for wind potential and local need. It is probable that a similar opportunity exists for the development of relatively small scale wave power systems.

The conference is to be repeated in 1981 on an extended scale, and will again be organised from the Energy Studies Unit of Strathclyde University. Eden Court Theatre makes an excellent site for the conference with the facilities for exhibiting equipment within and outside the building. Our policy is to include meals taken in the Theatre dining room as part of the conference programme, and to arrange accommodation in the hotels and boarding houses along the River Ness, within walking distance of the Theatre. A policy of moderate and interrelated energy supply should be advocated by a conference displaying similar aims in itself, and the environment of Inverness allows this without hardship and indeed with much benefit. Our thanks are due to the management of Eden Court Theatre, and to all the participants and speakers who so enthusiastically supported the conference.

John Twidell
Energy Studies Unit and Department of Applied Physics, University of Strathclyde, Glasgow.
Energy for Rural and Island Communities—An Introduction

John Twidell

Department of Applied Physics and Energy Studies Unit,
University of Strathclyde, UK

ABSTRACT

Rural and island communities form the major proportion of World population, yet receive little attention for energy development. Only the harnessing of the dispersed low-intensity renewable forms of energy, in small scale local application, will provide energy for these communities. Development is complex, but must be based on ecological principles. Modern science and technology has much to offer in harnessing renewable supplies, but the associated affects of local development and employment must be considered. Examples are given from the conference programme to reinforce the appreciation of these principles.

KEYWORDS

Renewable; energy; rural; technology; planning; development.

INTRODUCTION

Energy Needs

The rural population of the world forms 60% of the total 4,400 million population. The fraction is decreasing as people in the Third World are drawn to cities for employment, social services, economic markets and energy supplies. This urban drift is seen as a major difficulty in development for universal prosperity, and all countries have agencies to reinforce rural life. In Scotland all this has been seen before, so that now the Highlands and Islands area with 17% of Britain's land area has but 0.6% of the population. The number of people economically maintained in the area is moreover much less than the whole due to retirement and unemployment. We may compare this with 200 years ago when the same area maintained six times the proportion of Britain's population. The reasons for the changes are complex and often beyond control, yet energy supply clearly plays some part. At this conference we shall concentrate on energy supply as a poorly understood and even less developed aspect of rural and island life.
We must adopt a down-to-earth practical approach to the problem. There are too many academic conferences and publications on national large-scale energy strategy that have little relevance for rural and island communities. We are told there are no energy difficulties now, and the main need is to consider insurance for the future rather than tangible developments for immediate use. This is however poor advice, and such statements are too easily made by national authorities working in urban administrations out of touch with rural and island life. In Britain, such policies stem mainly from South East England.

**A Lesson from Fiji**

Recently I had the privilege of working in the Fiji Islands of the South Pacific. Within the programme of rural electrification, islanders were given diesel generators for cooperative village grid networks on the condition they maintained the supply themselves. Their difficulty however was how to pay for the fuel and services even if the capital payments were donated. Oil price was like a rising meniscus that was steadily submerging development and threatening established livelihood. At the time it appeared to me that this meniscus was rising through the less developed world, and that it would be many years before it engulfed the developed countries. I was wrong. On returning to the U.K. I find the identical problem is being faced by certain Scottish islands. The only difference is that the islands in Scotland are being treated as minor oddities with little national impact, whereas the Fiji islands are credited with national importance representing a problem being faced by 60% of the World's population. The common link is the extraordinary power of small islands to act as microcosms for the analysis and solution of problems that have immense complexity on a national scale.

There is a further aspect of these island electric energy supplies that is of major importance. The difficulties appear to be economic, but are fundamentally technical. Present energy efficiencies range between 10% and 30%. This is far too low, since it is quite feasible for efficiencies to rise close to and beyond 100% by controlling all aspects of the energy and using heat pumps. Moreover fuel costs can become zero if renewable sources are used. In practice therefore energy development and application is 'device limited' and not 'cost limited'.

**Energy for Whom?**

We are considering energy for rural and island communities. We are not considering the extraction or release of energy from rural sites to be transmitted to urban complexes. This is an important difference and we must be clear about the distinction. It is this aspect that distinguishes our conference from many others, and with which we must hope to produce real and immediate benefits for rural people. I believe the distinction will lead us to realise that small scale renewable sources of energy offer by far the best opportunities for improvements, especially when local industry and employment opportunities are included in the equation. It is people that matter, not things. It is pointless to send energy to a rural area if the population has evaporated. Energy developments demand large resource allocations, but all too frequently the money for capital and maintenance appears as benefit outside the rural area of concern and does not reach the local community. We know it is the local education and employment of young people that give vigour to a community, and unless a full range of job skills can be exercised the community will decline. Thus I am sure we shall be keeping an eagle eye on energy developments that lead to increasing local employment and manufacture in our rural and island communities. This is more likely to happen by harnessing the dispersed renewable forms of energy and using these at low
intensity in the vicinity, rather than bringing in supplies from centralised sources or concentrating the renewable supplies for export to urban complexes. Several of the papers at our conference will be describing commercial and planning activities stemming from energy developments, and I hope such subjects will feature strongly in discussion.

ENERGY REQUIREMENTS

Rural and island areas of the world are now critically dependent on oil for commercial energy supplies. The extent of this dependence is still not fully appreciated at the local level, and it is urgent that we quantify these energy flows. The way we use energy now relates to the life we wish to preserve, and we must reinforce this life before considering new developments. We have one conference paper describing a complete energy survey of an island community in Orkney, which will remind us how we use energy. Perhaps this will convince every local administration to conduct energy surveys as preparation for energy developments.

Energy requirement may be likened to a multilayer cake that becomes sweeter and more decorative to the top, but relies on hidden foundations below which must not crack. For most of the world the main foundation is firewood for cooking and space heat. This is usually a non-commercial energy flow of extreme importance. In Scotland this relates to peat and the yet unquantified supplies of waste wood from forestry, and falls within the study of biomass production and the use of waste products. We shall be having several papers within this general area, at both a strategic and local industrial level.

Heat

In cold and temperate regions a basic requirement for energy is space heat, and in all agricultural and manufacturing industry there is need for process heat. On the islands of Northern Scotland domestic heating is continuous through the year and forms about 50% of total energy demand. Architectural design must allow for this, and we have several papers relating to building construction. These show that in Scotland it is surprisingly important to design for passive solar heat gain and essential to regulate ventilation. When considering alternative supplies of energy, the need for space and process heat usually dominates over the need for controlled electricity. Thus it becomes sensible to consider direct energy conversion to heat from wind and hydro sources.

Transport

Haulage and transport are dominant energy requirements in rural and island areas. Again it is necessary to quantify the needs and consider local effects. Any fuel system based on large-scale oil refining or synthetic petroleum production from coal will prove expensive for these areas. Located at the outer circumference of any centralised energy supply, the communities will bear the greatest distribution costs, will appear of minor market importance, and will not benefit from the cash flow and employment opportunities of centralised production. For instance in Northern Scotland there is stark contrast between the difficulties of rural and island energy supplies and the energy bounty of the off-shore installations feeding centralised refineries.
There is but one strategy to lessen the problems of transport to rural and island areas - the strategy of local self sufficiency for goods and of modern telecommunications for information. The former must certainly include food, and the latter can today include two-way video and facsimile telecommunication. Within the communities, alternative forms of transport such as electric and hydrogen powered vehicles are exceptionally well suited for local use. The requirements for short predictable range, back to base operation, low speed, robust construction, and local maintenance expertise are all met in agricultural and island use. In addition there is ample opportunity for local wind or hydro sources to charge the energy store provided as part of the vehicle. We may further note that these vehicles may be 'fueled' at night and so provide a load to balance daytime electrical use.

Electricity

Heat and transport dominate as energy requirements in the rural areas of temperate and cold latitudes. If we include the provision of frozen food from refrigeration as an aspect of heat, then we can safely say that heat and transport are dominant requirements throughout the world. What is the importance of electricity therefore as an energy supply? The answer is that electricity is of prime importance as a supply of high quality power for high quality living. We all expect to have as a public service, electricity for lighting, refrigeration, washing machines, power tools and entertainment. Nevertheless there are important qualifications to make.

(a) Electrical services form an icing on the energy cake - they are attractive, useful and acceptable only so long as the foundation supplies of heat and transport are maintained at prices that can be afforded.

(b) Grid electricity supply from centralised intensive sources is by no means the only way to supply electricity.

(c) Electrical supply can be integrated with other forms of energy supply and storage to improve overall economics, as in combined heat and power installations and wind power integration into established networks.

(d) Very often electricity supply can ride 'piggyback' on dominant supplies such as space and process heat. The cost of the electricity is then a marginal cost on another installation, and so the unit costs of electricity can be much reduced. For example lighting from batteries becomes attractive in association with wind machines built for heat production.

(e) 'Electricity' must not be used as a synonym for 'energy'. Thus quite misleading policies can result from using the term 'nuclear energy' for 'nuclear grid electricity', and island communities mislead themselves if they consider all energy needs are satisfied by a submarine cable connection to a mainland grid.

We shall be having several papers that touch on these themes, but it is to be regretted that opportunities for integrated energy supplies are so handicapped by the present policy of separated services. This not only limits supply, but limits initiative and incentive.

ENERGY COMPLEXITIES

Energy is not a subject for study by itself. We have to ask what energy does for us and how it does it. We find that a correct flow of energy leads to a satisfactory and sustainable quality of life through mechanisms of great complexity.
How are we to know what is correct however? Do we have any examples or principles to guide us? Fortunately there are both examples and principles.

Natural systems are maintained by the flow of dispersed low-intensity solar energy that continuously cycles organic material. The systems are complex, have long term stability, and are sustainable. Man can interact with these systems and adjust them for his advantage, but only within certain limits. We are more wise to cooperate with nature therefore than to fight against it. Our greatest experience is in agriculture where sound ecological principles are respected and used. It would be folly indeed for rural and island communities to forget the importance of agriculture, and it is important for technological development to respect these ecological principles and adapt to them. Technology must learn to harmonise and not be discordant with nature.

**Examples**

Consider the example of a combined heat and power generator fueled by methane from a biological waste digestor. The machine may be classed as a 'final stage parasitic decomposer' in a trophic system driven by solar energy. Classification of this sort describes the full worth of the device, and is far better than merely acknowledging the machine in money saving terms. An advertising agency might disagree however.

There are other complexities of which the relationship of employment to energy supply is most important. It is urgent that local authorities consider this question with all seriousness since the answers are not obvious. Consider some examples from the Highlands and Islands of Scotland.

(a) Colonsay now has a local cooperative electricity supply from small diesel sets not connected to the national grid. There is part employment for a skilled crofter as a half time engineer, for a merchant who handles the fuel, and for the ferry. The system also leads to local initiative and challenge for social cooperation. However for various understandable reasons costs per unit of electricity produced are high and the system must change as we shall be hearing in a paper at this conference. There are but two strategies for improvement: either (i) the system must head for a complex self-sufficient operation involving such aspects as combined heat and power, automatic load control for optimum operation, the inclusion of transport and the incorporation of wind and other renewable sources of power, or (ii) electricity should be supplied by submarine cable from the national grid and no thought taken for integrated energy planning. The best answer to the choice is not obvious, but I find it disappointing that the decision with regard to electricity was not openly debated in these terms.

(b) The Highlands and Islands are famous for a biological product - whisky. For fundamental reasons of processing and marketing the distilleries will always be based in rural and island environments, but in a modern distillery the number of employees has been reduced to a minimum. Even so this employment is vital to the localities and intricately bound to the biological process. If however the distillery is seen as part of an ecological system using biological materials efficiently and avoiding any waste of energy, then much development is possible. There is the obvious possibility of linking horticulture to the distilling activities. One important result is the resultant increase in local employment at the skilled and semi-skilled level. We shall be having an example of such a distillery described to us.
The widespread use of hydro power in Scotland seems an obvious advantage to us now, but was not so obvious in the 1940's when Mr. Tom Johnston, the Secretary of State during the Second World War, had the vision to establish the North of Scotland Hydro Electric Board. We will appreciate the importance of hydro power when I remind you of the generating costs of public power in Scotland last year, as taken from the official reports. The figures are pence per kilowatt hour for 1979/80

<table>
<thead>
<tr>
<th>Power Source</th>
<th>North of Scotland</th>
<th>South of Scotland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydro</td>
<td>0.70</td>
<td>0.26</td>
</tr>
<tr>
<td>Steam (coal, oil), [Gas turbine, Interchange]</td>
<td>2.00</td>
<td>1.72</td>
</tr>
<tr>
<td>Diesel</td>
<td>3.66</td>
<td>-</td>
</tr>
<tr>
<td>Nuclear</td>
<td>-</td>
<td>1.75</td>
</tr>
</tbody>
</table>

Whilst some of the hydro plants are not the most beautiful buildings, there is general public satisfaction with the environmental aspects of the systems, and there is confidence in the associated employment for hundreds of years to come.

Not all hydro power is arranged by the Public Boards. Private generation is well established, with great potential for many thousands of small scale installations. We shall be hearing details of one such installation that has become associated with developments for local industry, and other papers will detail various device possibilities. There are also clear indications here of small firms manufacturing the generating equipment in the hydro areas - an example that should surely be followed by manufacturers of small scale wind power equipment.

Energy Agrarians

Recently a name has been suggested for people who recommend that commercial energy supplies should follow natural processes - 'energy agrarians'. This is a reasonable name, but it fails to describe the engineering challenge of most of the devices and systems. It is quite misleading to suggest that any ideas in alternative energy are so easy that homesteaders can knock up the required gadgetry using back yard scrap. The task of extracting reliable supplies of energy from a wild and fluctuating environment is a daunting task. The supply moreover must fit the loading and dynamic characteristics of a modern society wishing to live independently of their environment. This is a new challenge for modern engineers requiring new science and new ideas. It is not a return to old fashioned engineering since so much more is known today about materials and control systems. Modern microelectronics for instance allows a completely new range of systems to be designed to increase the efficient use of energy. This could not have been contemplated in the 1930's.

Modern Science and Technology

Thus the most modern scientific techniques are needed to consider and develop energy for rural and island communities. This will not happen unless resources are allocated in the same way as any other development of national importance, and unless the very special challenges of the rural environment are appreciated. For instance there have been enormous national and international resources put into the development of nuclear electricity. It is entirely reasonable to
Energy for Rural and Island Communities — an Introduction

expect corresponding resource allocations to renewable energy and energy efficiency. However allocation of money is not sufficient by itself; the institutions and industries that the money encourages must be established in the correct places. Consider wind energy. This is a complex subject ranging from meteorological measurement, through structural engineering, to the incorporation of the supplies into community use. There is a strong case for the UK, which is one of the world's windiest countries, to have a National Wind Energy Research and Development Authority. This should be placed in a region where the wind is available, the technology welcomed and the supplies needed. Mainland Orkney is such a place, but South East England is not. Yet I doubt whether such a development will occur in a rural or island environment unless the local population press the case. It is all too easy for the pressure of national administrative convenience to place such institutions near urban cities, notably London. One can be quite sure that energy will not be available for rural and island communities unless the appropriate planning authorities press for development in their own localities. Neither the centralised UK Department of Energy in London nor the Energy Technology Support Unit, placed within Atomic Energy Authority at Harwell, have the stimulus or vision to tackle what they see as a minor problem. This requirement for local planning authorities to be drawn into the energy debate adds yet another complexity to an already scientifically complex subject. Yet there is no alternative, and for this reason we plan to conclude our conference with presentations and discussion on alternative energy and local development.

CONCLUSION

It is easy to dream dreams, but action following dreams requires more care. My dream is for a world of self sufficient rural and island communities more prosperous than their urban counterparts. Communities where traditional values are respected, and the young remain to enrich and encourage new development. Can the dream be realised? If so, one requirement is undoubtedly the need to harness local renewable sources of energy and use these efficiently and carefully. The energy is there in abundance within the complexities of the natural environment, but neither science nor local industry has developed sufficiently to produce reliable supplies.

Our task at this conference is not unlike that of a ship's captain. The energy ship has been steering on a course set some time ago, and is now heading for the rocks. We have to make two types of decision, firstly to set a new long range direction perhaps completely different from that previously, and secondly to manoeuvre round individual rocks in the short range so as to come about into the new direction. It is folly to avoid immediate rocks (such as diesel oil surcharge) if there is no long term strategy (such as developing wind energy), and it is equally folly to look only to the long range direction (such as the UK wave energy programme) without avoiding errors near at hand (such as lack of ceiling insulation). The ship can sail through, but the best of science and technology must be used by a crew sensitive to the needs of the passengers.
Energy for Remote Communities—
The Strategy

Malcolm Slesser

Director, Energy Studies Unit, University of Strathclyde, 100 Montrose Street, Glasgow G4 0LZ, UK

ABSTRACT

Energy is an indispensable element of running a modern economy. The more centralisation, whether of Government or industry, the more the periphery is rendered dependant on the decisions, whims or needs of the heavily populated centre. The basic strategy for the peripheral communities is to adopt life-styles, methods of work, energy provision and energy-use systems that render them increasingly independant of the centre. Renewable energy has just such a potential. Rural communities can capitalise on their greater land availability per capita. However it will need positive government help, both with capital for systems and modified legislation to allow a greater degree of adaptation to local circumstances.

KEYWORDS: Energy; strategy; independent; government.

The poet Donne said "No man is an island". We might paraphrase that to say that no physical island is an economic island. That is every community, isolated or otherwise, draws some succour and inputs from outwith its system. The problem arises when the external system imposes on the internal. The fact is, of course, that the evolution of a highly centralised economy in the UK with its vigorous and vigorously enforced rules of safety, with an all-embracing social security system and with unionisation of labour permeating to the furthest corners of the kingdom, what are norms, feasible and even desirable in the urban/industrial zones can become burdensome to remote communities and reduce their viability. Part of the strategy must be to allow the people in remote communities more freedom to adapt to their circumstances rather than forcing them to conform to urban norms. After all, it was these genetically evolved powers of adaptation and will to survive that led to those personal qualities we all so much admire, and which must inevitably be sapped undermined by legislation adapted for the urban hinterland. I make these points because I believe we cannot, either technologically or economically, solve the problems of remote communities without also relieving them of some of the burden of over-weaning centralisation of thought and action.

Let me now move to the wider system, the world beyond the UK's shores. Where lies the world's energy future? You will find many opinions expressed, and little guidance as to which are credible. Moreover, the economics profession is in confusion over the significance of energy prices on other costs, and this confusion
makes it impossible to interpret a forecast, even if one believed it. Rather than
give you a distillation of the views of others, I give you my own analysis, based
on many years experience in this field, and a very quantitative approach to the
analysis of the data.

There is no impending energy crisis in the sense of running out of energy. The
world's energy stocks are simply enormous. However they are getting harder and
harder to get at, and as time passes each additional barrel of oil, each addi­
tional kilowatt of electricity will require behind it so much more capital, and
just so much more primary energy input for each unit of useful energy output. You
might look upon it as an energy inflation within the energy system dictated by the
laws of thermodynamics. The situation at the present time is worse than it need
have been because of the failure of those in power (or, shall we say, their
advisors) to invest in the new energy systems before the existing one's like
readily available oil from the middle east became expensive. This failure to
appreciate what was happening arose out of the fact that economic theory has no
paradigm for dealing with energy as one of the worlds two non-renewable resources
(the other is time). It was therefore left to those who saw energy resources
through the second law of thermodynamics to offer a word of warning, but it went
unheeded to a great extent, and still does today.

We are in for a period when, in order to secure our energy supplies quite enormous
investments in the energy sector are going to be necessary. Already these run,
globally speaking, at over 25% of total world capitalisation, and by the end of
the century, will be running at about 45%. What we spend on securing our energy
supplies will, inevitably, reduce what we can spend on hospitals, schools,
universities or industrial expansion. It will prove a very hard time for govern­
ments, for people have been conditioned over the last few years to expectations
which cannot be fulfilled any longer for reasons largely beyond the immediate
control of government.

The present price of energy is absurd and had steps been taken using other energy
sources to prevent oil becoming a market leader, it could have been avoided. In
1970, when there were almost as many energy options open to us as now (since
then solar energy has made big strides, nuclear has not), investments on alter­
native systems were deferred because they were ten, fifty or a hundred percent
more expensive. Now we are finding oil 1500% more expensive and little control
over its price. It is worth noting that the UK government chose an expensive
energy policy.

In my view, on the long haul, oil will rise on average about 30% a year till such
a time as OPEC oil is no longer a market leader. It will drag with it an inflation
rate almost as high, mitigated by our skills at learning to use energy better.
For the third world and for island and remote communities this is a sombre fore­
cast. The direct energy costs of supporting island communities are substantial,
higher than those of supporting an urban community. If these communities are
obliged by the nature of government and the economic system to import the means of
their survival from the economic heartland, then they are doomed. Island and
remote communities will be refuges for the rich only.

But the very fact of rising fossil and fissile energy prices, and the trend of
energy conversion technology towards larger and larger units, offers to open a
price window for decentralised energy systems. Before embarking on this theme,
let me first ventilate two schools of thought that exists here, which in turn draw
their conclusions from differing views of how energy prices affect producing
costs. The first view is that since energy represents but a mere 6% or so of
manufacturing and producing costs, the impact of a big rise in energy prices,
though undesirable, are not grave. For example a doubling simply makes the 6%
Energy for Remote Communities - the Strategy

into : \[
\frac{2 \times 6}{106} = 11.3\%
\]

This view ignores any gearing effect as energy prices move through the economy. The other view, which takes this into account, argues that in the absence of a fall in labour's buying power and without a move towards better use of energy, a doubling in energy prices will double costs, but with a time lag of some five years. This view seems more consistent with observed facts, but it is too early to be sure. I shall not argue the case further, but simply point out that it has important repercussions on investment decision making. If the first view is correct, then capital intensive energy technologies such as nuclear or solar have only to bide their time, and they will become viable. Yet though energy has increased 1500% in price since 1973, it is hard to find any which have become more viable. If the second view is correct, (or more nearly correct, because labour has lost buying power and there is a small move towards better energy use), alternative energy systems become viable only when their technology has improved. Nevertheless, there is a time window after an energy price increase, when existing capital equipment is cheaper than it will be in the future - hence there are opportunities for investment which would not exist in a stable price environment.

What energy does.

We cannot work out our strategy until we have a clear idea of what it is energy does for our lifestyle and standard of living. Man utilises two quite distinct qualities of energy. The familiar one is for heat - warming homes and offices. The second is for doing work. It may not be generally appreciated that the reason we enjoy a materially, more affluent lifestyle than our forefathers is because we have many slaves to work for us. In the UK, each citizen has about fifty slaves at his behest. They are in the form of machines which do work, and need energy to operate them. Just imagine how many people would be needed to row a MacBraynes steamer from Uig to Stornoway, or a sleeping car from Edinburgh to Inverness - it would be late even more often! Associated with every use, there is a capital structure and an energy source. It may be readily shown that economy of energy goes hand in hand with greater investment, provided the investment takes into account natural limitations. An example of a poor, indeed stupid misguided investment has been the development of evermore powerful fishing trawlers, so that the energy use per unit of fish caught has soared to the point of economic disaster. This is the direct result of unfettered competition for a finite resource. A sensible approach is to restrict the catch or the catches and adjust the method to the right combination of capital and energy use. Figure 1 shows this event in terms of the Scottish herring fleet before and after the last war.

The scope for energy conservation in buildings is enormous. It would be safe to say that practically every house built since the brick and metal era commenced uses three or four times as much energy as an efficiently designed (but more expensive) home. It may be readily shown that, within a very short time, investment in conservation pays off. Such conservation in island communities reduces imports. Government subsidy should be for conservation rather than freight subsidies to imported fuel for there is then less to freight.

The next step is to use the natural advantages of the remote communities. These are, first and foremost, space - a lot of land per person. Solar energy capture is land intensive. Secondly, and this especially is true of island communities, there is much wind. We need a creative approach to rendering an island steadily more energy independent. Inevitably, this means looking at the community as a whole, not just the technology. There is no point in having locally produced energy, if minor maintenance cannot be handled locally. This is either achieved by abandoning demarcation in work, or by maintaining or building up the communi-
ties to a viable size, with a range of skills.

All over the world there is a move towards the use of renewable energy sources for self reliant development. As members of a developed country, our own remote communities are entitled to be helped along that path, freeing them from the economic shackle of centralist sources. Already so many opportunities have been missed. Let us take the recent example of Skye, where the solution chosen was to lead pylons from the mainland to the island. Not only was an eyesore created, but a golden opportunity in a windy isle to develop and sustain an indigenous energy source, with fruitful activity for local people. It would, of course, have been more expensive in terms of immediate capital. But with rising energy prices, that original investment would soon pay its way, and provide a design guide for others. Coll is another example where an under-water cable will bring in mains electricity whereas the same large capital investment could develop a local renewable source of energy.

Finally, renewables are not the only answer. There are devices, such as the small combined heat and power units (e.g. Totem by Fiat) which make better use of fossil energy. There are more sensible ways of doing many things. There is no future along a path which suggests we do without energy - that is merely to put the clock back. Rather, going forward with new technology for dispersed energy production, hand in hand with encouragement to develop and initiate a self reliant lifestyle on islands and remote communities, unhampered by the mores of the urban centres is the way to protect then develop remote communities.

Fig. 1. Energy consumption in deep-sea fishing.