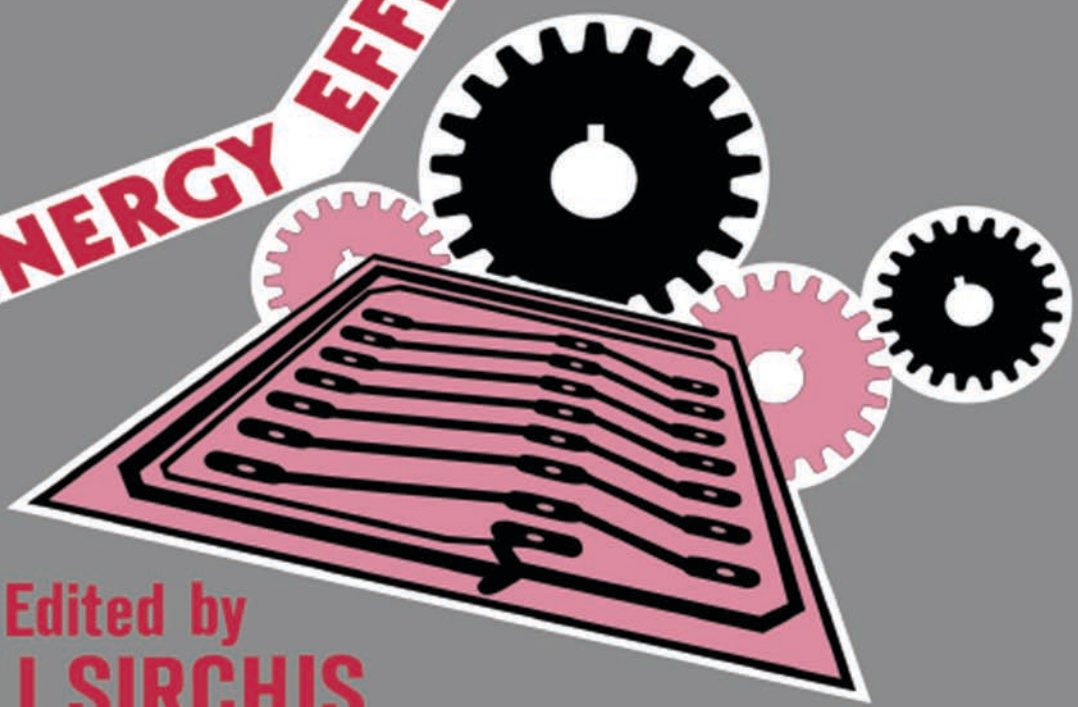
Commission of the European Communities

ENERGY EFFICIENCY IN INDUSTRY



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Proceedings of a workshop organised by the Commission of the European Communities, Directorate-General for Energy, held in Berlin on 19th and 20th October 1987.

ACKNOWLEDGEMENT

Particular thanks are due to Mr G. Vacchelli, consultant to the Commission of the European Communities, for editorial assistance concerning the discussion.

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Taylor & Francis
Taylor & Francis Group
LONDON AND NEW YORK

Taylor & Francis
2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

Transferred to Digital Printing 2005

British Library Cataloguing in Publication Data

Energy efficiency in industry.
1. European Community countries.
Industries. Energy Conservation
I. Sirchis, J.
658.2'6

Library of Congress CIP data

Energy efficiency in industry.

(EUR; 11 490)
Text in English; summaries in French and German.
"Proceedings of a workshop organized by the Commission of the European Communities, Directorate-General for Energy, held in Berlin on 19th and 20th October 1987"—P.
Bibliography: p.
Includes index.
1. Industry—Energy conservation—Congresses.
I. Sirchis, J. II. Commission of the European Communities. Directorate-General for Energy.
III. Series.
TJ163.27.E515 1988 621.042 88-16044

ISBN 1-85166-243-X

Publication arrangements by Commission of the European Communities, Directorate-General Telecommunications, Information Industries and Innovation, Scientific and Technical Communications Service, Luxembourg

EUR 11490

PREFACE

The competitive pressures on industry have never been greater and no company can afford to ignore ways of reducing costs or of using its resources more efficiently. Energy is an input of major significance for many industries, and an appreciable cost element for many others. Furthermore, energy prices are a volatile factor which could again increase significantly in the future.

This conference, organised by the Commission of the European Communities, aimed to make firms fully aware of the different opportunities for improving the efficiency of energy use, and reviewed the latest techniques and systems including:

—process integration,
—industrial plant—process control and optimisation,
—new techniques for low temperature and heat recovery,
—the energy management of utilities,
—sources of finance for energy efficiency investments.

This volume contains the oral papers presented at the conference and the round-table-discussions.

CONTENTS

SESSION III: NEW TECHNIQUES FOR LOW-TEMPERATURE HEAT RECOVERY

SESSION IV: INDUSTRIAL PLANT—PROCESS CONTROL AND OPTIMIZATION

SESSION V: ENERGY MANAGEMENT OF UTILITIES

SESSION VI: ROUND TABLE ON FINANCING ENERGY EFFICIENCY INVESTMENTS

OPENING SESSION

Opening address by G. TURNER, Senator for Science and Research

Opening address by G. BRIGANTI, ENEA

Opening address by C.S. MANIATOPOULOS, Director General for Energy, Commission of the European Communities

OPENING ADDRESS

by
Professor George TURNER
Senator for Science and Research

Ladies and gentlemen,

On behalf of the Berlin Senate, I have great pleasure in opening this conference on "Energy efficiency in industry".

The people of Berlin are very grateful to the Commission of the European Communities for the considerable efforts it has made within and on behalf of Berlin, marking the 750th anniversary of the city by staging three international energy conferences here. The first conference in April was devoted to "Solar-heated swimming pools", in June there was "Coal in the heat market", and to conclude we now have this conference on "Energy efficiency in industry".

Increasing competition in both European and overseas markets has forced every entrepreneur to investigate all possible ways of cutting costs. The most obvious approach is to use energy efficiently, given that expenditure on energy is significant in virtually all fields. In this context, I feel that two of the issues to be discussed in this conference are of particular importance.

The first could be expressed as follows:

"How can process control be improved and techniques optimized ? What positive - or negative - experience has so far been gained ?"

The second major issue is that of funding:

"What sources of finance are available for improving the use of energy ? Who is entitled to request such investment aid for more efficient energy use, and how should this be done ?"

An answer to some of these questions may be found during this conference, and the Berlin Senate is hoping for some interesting tips based on experience gained throughout Europe.

Here in West Berlin, industry is a less significant energy user than in comparable Central European cities - representing only 13.5 % of total energy consumption. Nevertheless, any saving in energy is important since it cuts not only the energy costs of the company but also the pressure on the balance of trade; now an increasingly important consideration.

At the same time, the savings in primary energy help to reduce pollution in the city, particularly in the difficult field of air pollutants.

Here I would like to mention what we in Berlin see as another key issue, and one which will certainly become increasingly significant in the future, this being the generation of energy at the least possible cost to the environment. A decisive step has been taken here in Berlin. With the generous sponsorship of the Berlin electricity company "Bewag" - which contributed DM 4 million - a new department of "Energy conversion and environmental protection" has been set up at the Technical University of Berlin. This is the first step in developing a strong research basis in a field of such importance to conurbations such as Berlin.

In taking this action, it was the intention of the Berlin Senate to set an example by stressing the interrelationship between efficient energy conversion and the greatest possible protection of the environment.

Although there is a quite understandable desire to provide energy at the cheapest possible rates, the economic analysis must also include environmental protection or the expenditure necessary to restore a damaged environment.

In the future, we must invest more in our environment. We in Berlin have already made a start.

Although at present, and in such specific economic sectors as energy generation, environmental protection involves enormous costs, viewed in the long term and across the entire economy there is no conflict between ecology and economy. On the contrary: the development of new, more efficient environmental techniques is not just a scientific challenge. It opens up an international market that is, in view of its vital importance to future generations, in every sense "future-oriented".

We alone, however, cannot deal with the problems that arise. What is needed is intensive contact and cooperation between the scientists of every nation, since our environment is indivisible.

Nowhere in the world is better suited for reaching this conclusion, by "simply following one's nose", than Berlin.

If - not to put too fine a point on it - it stinks here to high heaven, then it is a transnational problem. The waters of the Spree and Havel, and particularly the air, are no respecters of artificial borders.

In a nutshell: if Berlin's air is to regain its once celebrated purity, joint action is the only alternative to failure. Common efforts to achieve efficient use of energy, and thus less pollution from energy generation, are a prime example of vital and feasible cooperation between both German states, and with other countries whose systems are different from our own.

Given the range of nationalities participating, we can expect not only a lively debate but also an exchange of views benefiting the countries involved. As a contribution to this process, there is the Senate's reception this evening at 6.30 pm, to which you are all most cordially invited.

I hope that we will all have a successful conference with many stimulating ideas, interesting discussions and valuable results.

OPENING ADDRESS

G. BRIGANTI
ENEA, Rome

I think this Conference is very timely, interesting and appropriate, and its results should have an impact that goes beyond the circles of specialists. I will try to qualify this statement.

The reduction of the energy content of the gross national products has been one of the three components of the strategic response of Europe to the energy crises, together with substitution of sources and the development of indigenous resources.

If we consider how this reduction has been obtained, we find out immediately that industry is the main responsible for the success of this policy.

However, when we try to interpret these data in terms of efficiency of energy use the task is not simple. There is a number of factors that interplay in this result. The aggregated figures that we are considering are actually the ratios between the energy consumption of industry and the added value of industrial production. This ratio has decreased not only because energy is used more efficiently in industrial processes, but also because the added value of industrial production has often increased. The value of industrial products is larger because they incorporate more technology, more design, more fashion, more response to individual tastes and requirements.

Another reason for the reduction of energy intensity in industry is the shift in the mix of products inside the industrial production. The market of basic goods that have a high energy and materials content is in many cases saturated, and their demand only covers replacement; demand for new goods goes toward more sophisticated, more "immaterial", more innovative products. In a general sense, development can be considered qualitative rather than quantitative: it concerns health, education, quality of the environment, free time, arts and therefore all the products that are instrumental to these objectives.

These two aspects of reduction of energy intensity are part of a general process of "dematerialization" which is common to all advanced societies; it has not been the consequence of the energy crises nor of the policies that were born of these crises, but the long term trend which was there has been accelerated by the energy crisis, through cultural evolution as well as economic pressure.

A third reason for the decrease of energy intensity in industry is perhaps less positive. It concerns the decrease in the productions that have high energy intensity, such as steel, plastics, fertilizers, accompanied by an increase in the import of such products (or by a decrease of previous exports). Such displacements of production from Europe to other countries (often developing countries) move the energy

dependence from primary energy sources to energy rich materials. They may have positive connotations, such as a greater geo-political diversity of supply, or the possibility of cost reductions connected with the availability in some countries of very cheap energy; but it can hardly be regarded as a saving of energy: if the energy budget were to consider the energy content of imported and exported products (as in a way would be more correct) such a displacement would not result in net saving of energy.

The rest of the reduction of energy consumption by industry are linked with the concept of energy efficiency.

Still this reduction derives from a complex and composite panorama of different factors.

They include the elimination or reduction of energy wastage; the recovery and utilization of heat, the recycling of materials; the improvement of process efficiency through more accurate monitoring and appropriate control; the improvement of processes or the adoption of entirely new processes to obtain the same product; the subsitution of materials and other products to perform the same function or service.

Statistics tell us very little about the contribution of each of these factors to the reduction of energy intensity. Indeed, the trend towards goods with less energy content may be reflected by differences in the economic output of various industrial sectors, or by changes in energy consumption of these sectors. However, the analysis is shadowed by the effect of product shifts whithin each sector. For instance, very little sectoral shift appears in Italy, the United Kingdom and Ireland, where the changes of production occurred mostly within each industrial sector.

A better understanding of the mechanisms and of the opportunities of energy saving in industry is important for several reasons. One is to be able to predict in a better way the energy needs in the future. Another is to establish priorities in energy saving policies, incentives, investments, etc. Still another is to present industrial managers and investors with clear signals of what can be achieved and of the economic advantages associated with such policies.

It is from conferences like this that one can collect the basic material on which to base such assessment. The detailed analysis of interventions in specific industries, through process integration, heat recovery, process control optimization and energy management is a precious guide to ascertain results and opportunities of increasing energy efficiency in the industrial sector. The consideration of case studies makes the picture more concrete. Success stories make good example and provide guidelines for replication. Unfortunately, it is much less common to hear about failure stories, although we would have to learn just as much from them, in terms of mistakes to avoid as well as of obstacles to overcome on which to concentrate research and development efforts.

Much of the obvious to eliminate energy wastes and to use energy more efficiently through improved "housekeeping" practices has already been accomplished; the method of energy diagnoses by experts from outside and the preparation of energy managers inside industries have had a major role in bringing about these improvements. The EEC Commission estimates that there is still a great potential of energy reduction (of the order of 25 %) in continuing along these lines. Technical, legislative and organizational instruments to carry further this policy have already been identified and tested. It is now necessary to diffuse and implement this kind of interventions as much as possible. It may be useful to set up ad-hoc services that ensure capillary diffusion and replication of successful cases.

For the future, however, it is important to aim at deeper modifications, that involve prediction processes and renovation of plants. Energy saving in industry is therefore increasingly linked with innovation: it represents an opportunity to introduce new technologies, while at the same time every innovation in industrial processes opens the road to energy saving actions. The necessary investments are higher with respect to the energy management type of actions, but the results that can be expected go beyond the simple result of saving energy costs. They have to be judged in terms of quality of products, overall economic convenience, flexibility, protection of the environment, response to changing demand, etc. All these aspects are difficult to separate when considering process or product changes, and a comprehensive evaluation becomes mandatory.

It may seem trivial to tell this audience how important it remains to deploy the maximum effort in saving energy and using energy more efficiently in industry, no matter what the fluctuations of oil prices may be. I am sure that all of you share the feeling of the importance and of the strategic significance of the work we are all engaged in. Efficiency in energy use is economical, is profitable but its value goes beyond convenience: it is an essential part of a new model of society, a more sparing and more environmentally oriented industry; therefore it is also a model for less developed countries, whose way to development cannot repeat the wastage of resources and environment, the intensity of materials and energy of the traditional industrialization.

In this view, I wish this Conference the best success, also from Prof. Colombo.

OPENING ADDRESS

C.S. MANIATOPOULOS
Director-General for Energy
Commission of the European Communities, Brussels

The Commission of the European Communities is taking an active part in the celebrations marking the 750th anniversary of Berlin in order to demonstrate its firm commitment to the city.

Among the various Commission initiatives, I would mention the organization in 1987 of nine international conferences. As Director-General for Energy, I am pleased to say that three of these conferences were dedicated to energy.

Another three of the conferences were related to industry, concerning water resources, environmental protection and telecommunications.

The Commission has consistently stressed that Berlin is part of the European Community, and eligible to benefit from the opportunities available to every other region of the Community.

In this way it has given practical form to the declaration adopted by the six founding members of the Community on signature of the Treaty of Rome in 1957. In this declaration, which was ratified by subsequent new members of the Community, the signatories confirmed their solidarity with Berlin and their determination to contribute to its development.

Thus, for the purposes of regional policy, Berlin has the same status as the Community regions with an unfavourable location or which are geographically isolated.

In the field of technology, the Commission has been involved in a number of research, demonstration and investment projects. Taking the activities of my own Directorate-General only, these include the liquefaction and gasification of solid fuels, the construction of a more efficient district heating network, a pilot project concerning a large heat pump and the building of the Reuter West thermal power station.

In addition, two studies were launched in 1983 in collaboration with the Berlin Senate. The first concerns the creation of a data bank on the city's energy flow. The objective of the second is to devise a mathematical model for analysing energy problems in conjunction with environmental protection. It will be possible to apply the methods developed in these two studies to other Community regions. Finally, the Energy Institute of Berlin Technical University and the firm Innotec are cooperating with the Commission in organizing training and energy planning in China, the Asean countries and Morocco. Ten experts from Berlin are working in Community programmes for developing countries.

The conference on energy efficiency in industry fits in neatly with the Community's energy objectives for 1995 adopted by the Council of Ministers of the European Community in September 1986, and with the creation of a single market by 1992 decided by the European Council in 1987. Our energy objectives foresee a reduction of at least 20 % in energy intensity compared with 1985.

It is vital that this objective be attained, if our total energy consumption, which increases in step with general economic growth, is not to result in a growing dependence on external supplies.

Energy efficiency in the European Community increased by over 20 % between 1973 and 1983, while the share of imported oil in gross energy consumption was reduced from about 62 % to 44 % between 1973 and 1986. These achievements are largely the result of greater energy efficiency.

However, we at the Commission are not so vain as to believe that the Community can take all the credit for this success story. The period from 1973 to 1986 is characterized by major structural changes in European industry. Traditional industries such as steel and shipbuilding which are heavy energy consumers have declined, while new activities with a lower net energy requirement have made considerable advances. Substantial increases in oil prices between 1973 and 1986 also provided a powerful incentive for greater energy efficiency.

However, the results would not have been so spectacular without the efforts of the Member States and the supporting Community measures. At their recent informal meeting in Copenhagen and the Council meeting on energy, the Energy Ministers emphasized the importance of continuing to pursue our energy efficiency objectives. We are aware that the target of 20 % for 1995 is ambitious and will be difficult to achieve, because the process of industrial restructuring has not been completed and future price movements are uncertain.

Industry, while it has already made an enormous contribution to energy saving, will remain a priority sector because much remains to be done.

In 1985, Community industry accounted for at least 36 % of total consumption when energy as a raw material for the chemicals industry is included.

Compared with the buildings sector including heating and lighting of industrial premises which is responsible for 38 % of Community consumption, and transport with a 26 % share of consumption, industry is of prime importance in energy management at Community level.

As the second largest energy consumer, it is in industry's own interest to maintain and intensify its efforts to improve energy efficiency in order to make its products more attractive. It also has a duty to do so to contribute to the Community's independence in the energy sector.

Conversely, it is vital to the Community that industry does not falter in its efforts to make its prices more competitive. In addition, industry must forge ahead in the application of advanced technologies if it is not to lag behind in the international race.

It can be assumed that there is a considerable reserve of technological know-how that is still incompletely utilized and which could provide industry with the means of improving energy efficiency. The chief problem in applying these means is investment, particularly during periods of low oil prices.

The Commission believes that third-party financing is a possible solution to this problem. It recently organized an international symposium on this subject in Luxembourg, the results of which will be presented at the round table at the close of this conference.

However, the objectives of Community energy policy can only be achieved if Europe compensates for its shortage of primary energy by continuously promoting technological innovation. To this end, the Community is conducting a major research and development programme which has received funding in excess of 1.5 billion ECUs between 1984 and 1987, much of which has been dedicated to research on liquefaction and gasification of solid fuels, renewable energy sources, rational use of energy and environmental protection.

As a follow-up to the research and development work, the Community has carried out demonstration projects, some of which figure in the programme for the conference.

The idea of demonstration projects was born of the realization that success at the research and development stage did not always guarantee the success of a process or product on the market.

The transition from a research and development phase which has shown that an idea is technically and economically feasible to implementation on an industrial scale frequently involves technical and financial risks that act as a disincentive to entrepreneurs.

With the aid of the demonstration programme organized by the Directorate-General for Energy, which is organizing this conference, the Commission can bear part of the financial risks and smooth the way to the marketing stage. Since 1979, the Community has provided financial support of this type worth about 600 million ECUs to over 1 300 projects, 450 of them in the industrial sector. More than 300 projects concerning, among other things, renewable energy sources have already been completed, half of which, including 40 industrial projects, have been a resounding success. Of the 600 million ECUs concerned, almost 300 million ECUs were chanelled to industry.

Every successful project represents in itself a significant energy saving. However, our sights are set well beyond the actual projects. Our objective is to demonstrate the technical feasibility and economic viability of new procedures in the hope that their widespread adoption will lead to substantial energy savings at Community level. The replication of several steel projects, for example, has produced an overall saving of the order of 500 000 toe/year.

We attach great importance to the continuation of this programme after 1989, when the current 4-year period ends. We are devoting considerable attention to dissemination of the results in order to make the projects reproducible and to avoid duplication of effort. The Sesame databank is the main dissemination tool. It is now accessible to the administrations responsible for energy in all the Member States, and will soon be open to the public through the centres serving the european information market.

Information and the exchange of experience are additional objectives of this conference, which will doubtless represent an important step in the necessary progress of European industry to greater international competitiveness through technological development.

Before concluding, let me stress the quality of the speakers here today and the importance of the subjects discussed, which touch on vital aspects of the rational use of energy in industry.

I now have the pleasure of handing over to Professor Schäfer, Director of the Institute for Energy Management and Power Station Technology of Munich, who will give the first paper on fundamental ways of conserving energy and will then chair today's session. Thank you.

SESSION I : OVERVIEW

Ways and techniques in the rational use of energy

WAYS AND TECHNIQUES IN THE RATIONAL USE OF ENERGY

By Prof. H. Schaefer, Munich

1. Introduction

The demand for energy to be used as sparingly as possible in order to preserve our environment and resources involves to some extent a contradictory states of affairs :

- Mankind must free itself from the environmental conditions by means of energy in order to achieve living conditions and a quality of life that can be regarded as humane.

- Any use of energy by man, even for his basic needs, has an effect on the environment and reduces the earth's resources through the consumption of materials, and use of space and fossil and nuclear fuels.

A first way of limiting factors affecting the environment is energy management, which, according to (1) is the sum of measures covering all activities designed to guarantee efficient use of available energy resources. These activities include energy saving, rational use of energy and substitution of energy sources for others, e.g. direct and indirect solar energy for fossil sources.

As shown in Figure 1, energy saving and rational use of energy are only synonymous at the point where they meet (market by "1"), i.e. in the area marked by less specific consumption of energy compared with a comparable state. This is achieved by reducing the specific consumption of useful, final and primary energy for the respective purposes and services. Taking the definition of rational use of energy in (2) as the use of energy by consumers in a way that is best suited to achieving economic aims - taking account of social, political and financial circumstances as well as environmental conditions - it includes the range marked by "2" in Figure 1, where extra specific consumption is brought about by additional energy services, e.g.

- a humane working environment;

- environmental protection technology;

- automation and mechanization; and

- overall optimization of work, materials, space and energy.

The higher specific consumption of energy arising out of these measures is justified by the increase in the quality of life, since in the final analysis energy demand is only one assessment criterion amongst many.

An example is flexitime. Everyone agrees that flexitime leads to more humane working conditions, but it involves a considerable extra outlay on energy since lighting and air conditioning are now needed each day some one and a half times actual working hours and it extends working hours into times of the day when the light of day and outside temperature are less than during the usual working hours previously.

Area 2 in Figure 1 contrasts with area 3 in terms of energy saving. In this area, less specific energy consumption is achieved by reduced demands for goods, services and comfort. This can be achieved by reducing the quality, quantity and range of goods and services, by lowering the room temperatures, by reducing lighting, by changing from individual to public transport and the like. It is difficult to draw a clear demarcation line between measures that contain a real sacrifice and measures that can be offset by non-energy steps. What is certain, however, is that not only the acceptance and social compatibility of the various supply techniques must be thoroughly examined but also energy saving measures themselves.

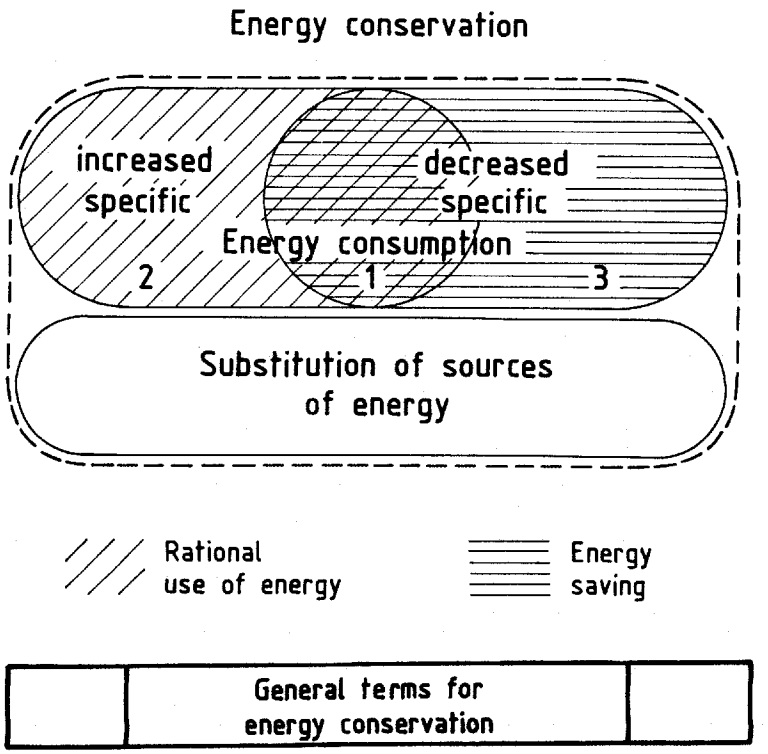
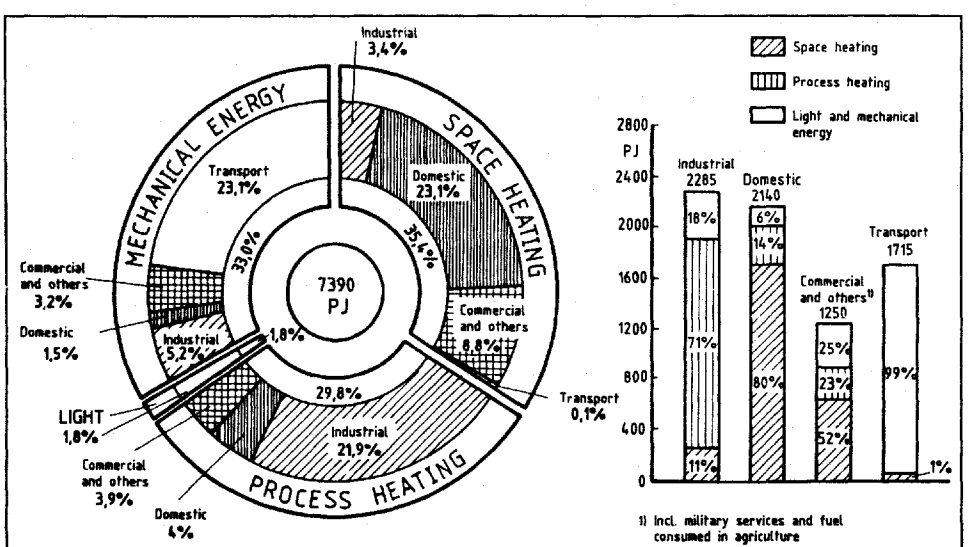


Figure 1

2. Energy analysis as a basis for rational use of energy

An absolutely essential requirement in any plans and measures to rationalize the use of energy is an analysis of the energy situation. An analysis of this kind, if it is to provide a suitable basis, must have the support of actual measurements, regardless of whether they are for individual installations, machines or entire plants. Fairly large areas (e.g. regions or entire countries) are statistically recorded in energy balance sheets.

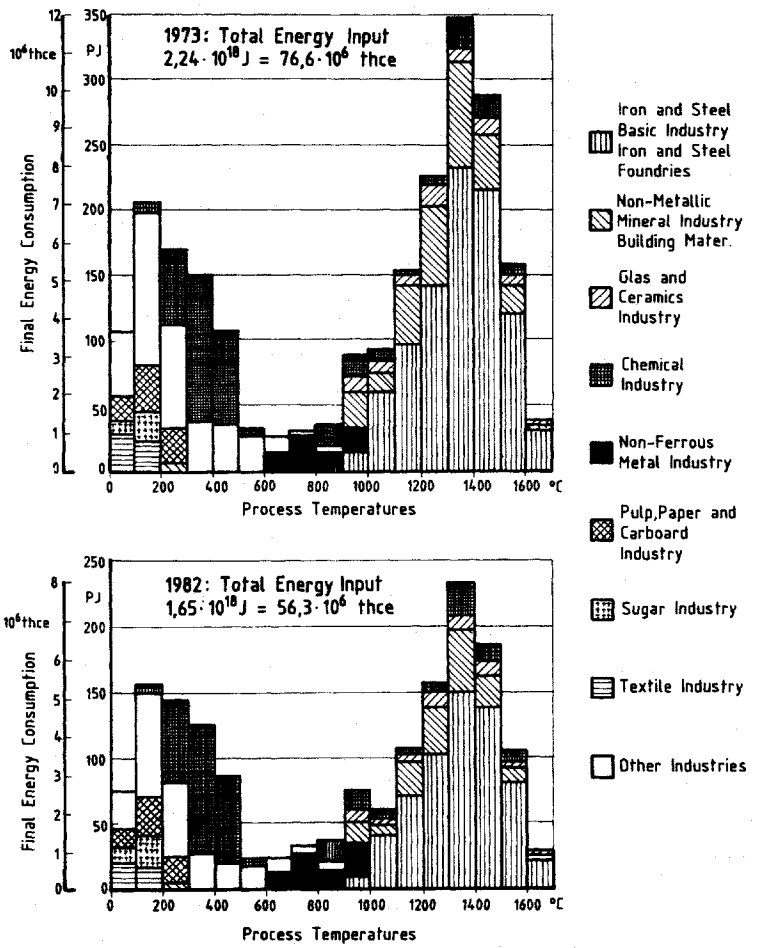
Figure 2 takes the example of Germany to show how the final energy demand breaks down over the various consumer sectors and types of demand. The dominant role of heating, with a view to potential saving, is quite marked. Space heating at 35.4% and process heat at around 30% of the overall final requirements for Germany in 1986 take about two-thirds of the total energy used. Traffic accounts for 23.1% of the remaining final energy consumption while stationary power consumption in industry, the home and small consumers use around 10%. The proportionate share of final energy for lighting is approximately 1.8%.



Final energy demand by consumer groups and types of requirement in the Federal Republic of Germany in 1985

Figure 2

The bar charts on the right hand side of the figure show the final energy consumption for industry, households, small consumers and traffic in absolute amounts and break them down percentage-wise into space heating, process heat and lighting and electricity. This shows the dominance of space heating in households and amongst small consumers (almost 80 and 52%) and of process heat (71%) in industry.
Figure 3 gives an estimate of how the total use of final energy for process heat in industry is distributed over temperature ranges in steps of 100 K and over individual branches of industry.



Final Energy Consumption for Industrial Process Heating in 1973 and 1982 by Groups of Process Temperatures

Figure 3

This is of course a relatively rough assessment based on knowledge of individual production methods and their specific energy requirements. The distribution curves for 1973 and 1982 show two peaks, the first in the temperature range around 200°C and the second between 1 300 and 1 400°C.

Overall results of this distribution had a marked effect on the iron and steel industry and the non-ferrous minerals industry. In 1973 both industries accounted for around 50% of total energy consumption. By 1982 this figure had dropped to well under 50%. Overall energy requirements for process heat in 1982 had dropped to 73% of the 1973 figure, this being caused by the reduction in the proportionate share of the primary industry.

An assessment of future trends cannot be made without an analysis of developments so far in energy consumption. In Figure 4 the specific fuel and power consumption is plotted against the net production index for the manufacturing industry in Germany. Whereas the specific fuel consumption dropped sharply over the period in question the specific power consumption rose slightly. A detailed analysis of the industry as a whole showed that trends in power and fuel consumption were down to three different effects.

The first effect is the activity effect, which gives an indication of what effect the changed production quantities, quantified as industrial net production index, will have on energy consumption.

The structure effect expresses to what extent changes in energy consumption can be explained by structural changes in the range of products.

The intensity effect illustrates how changes in power and fuel consumption can be the result of changes in specific energy consumption values. The results of an analysis of industrial final energy consumption in Germany, as carried out for the period between 1970 and 1983, are shown in Table 1.

	POWER		FUEL	
	s.o.	%	s.o.	%
Change in consumption	+32 679	+100	-135 326	-100
Activity effect	+17 835	+ 54,6	+104 720	+ 77,4
Structure effect	+ 6 805	+ 20,8	- 66 456	- 49,1
Intensity effect	+ 8 039	+ 24,6	-173 590	-128,3

Table 1 : Analysis of industrial final energy consumption 1970-83