

VENTILATION TECHNOLOGY - RESEARCH AND APPLICATION

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PAPER S.1

VENTILATION TECHNOLOGY - AIMS OF FEDERAL MINISTRY FOR  
RESEARCH AND TECHNOLOGY IN RESEARCH AND APPLICATION  
KEYNOTE ADDRESS

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Mr Chairman, ladies and gentlemen,

On behalf of the Federal Ministry of Research and Technology (BMFT), it is a pleasure for me to welcome you as the participants of the 8th Air Infiltration and Ventilation Centre Conference here in Ueberlingen, the German Riviera of the Bodensee, at one of the most beautiful and scenic spots in Germany. The sun is shining bright and clear and it seems to me, that after having funded solar energy research during the last 10 years, the sun has now opened the fund to sponsor myself.

We are very proud to have the privilege to host the well renowned AIVC Conference this year. During the next 4 days researchers from 12 OECD countries will again find a forum to present their research activities, to discuss their research results, to exchange their points of view and to get a first hand view of what their colleagues are working on.

May I offer my Ministry's very best wishes for the success of this conference, as well as for the AIVC Steering Committee's meeting and the meetings of the working groups, which follow up this conference.

### Introduction

The Federal Republic of Germany (FRG) joined the International Energy Agency's (IEA) Annex V "Air Infiltration and Ventilation Centre" (AIVC) activity in December 1985 as the twelfth participant. We consider this step consistent with our energy R&D policy, ie, to find new ways and new solutions for practical application by stimulating and supporting relevant research activities, and to stimulate and support international cooperation between the various involved disciplines. Looking back, in 1979 the Federal Republic of Germany established a research program, which was entitled "Luftung im Wohnungsbau", which means "Ventilation and air infiltration in residential buildings."

I remember quite well that there was some rumour which culminated in the question: do we really need these investigations? Today they are accepted. It may be that a German saying, formulated by Schopenhauer, the very famous philosopher, gives an answer to this observation: it reads as follows:

"Each innovation has to pass three stages until breakthrough: in the first one, it seems ridiculous, in the second stage common opinion is fighting against those new ideas; in the third it is business as usual."

This program was also part of two activities within the program "Energy Conservation in Buildings and Community Systems" of the IEA. To this program new annexes were added, and now 18 annexes are in progress or are already completed, with 3 more annexes in preparation. Germany was or is involved in many of them.

The annexes which are of main interest in connection and with regard to this conference are the so called ventilation annexes. They are:

<u>Annex</u>	<u>Title</u>
V	Air Infiltration and Ventilation Centre (AIVC)
VIII	Occupants Behaviour
IX	Minimum Ventilation Rates
XII	Windows and Fenestration
XIV	Condensation and Energy
XVIII	Demand Controlled Ventilation Systems (under discussion)

### Objectives

The main programme objectives for the FRG were to contribute to energy efficiency by identifying proper technical solutions for minimising ventilation losses in buildings and to transfer such solutions into practical applications as soon as possible.

We have been supporting such research and development for many years now, in the fields of ventilation in residential, commercial and industrial buildings, usually by funding specific projects, often in close cooperation with the Federal Ministry for Regional Planning and Urban Development (BMBau). The learning curve to gain the necessary experience with modern infiltration and ventilation techniques is characterised from the early beginning in 1979 until today by about 23 projects funded by BMFT with an amount of 15,4 Mio DM.

As it became more and more evident that aspects of hygiene and comfort play an ever more significant role in defining requirements for air exchange and ventilation, the Federal Ministry of Youth, Family and Health (BMJFG) also became involved in our activity.

When we started the R+D-programme "Ventilation and air infiltration in residential buildings" eight years ago, we focused on energy conservation aspects and therefore we integrated the programme into our framework programme "Efficient energy use". Even today the contributions to the above mentioned IEA annexes are still funded through the "Efficient energy use" programme, but we expect results and technical solutions as spin offs, so to speak, which satisfy hygiene and comfort requirements too.

Facing more and more problems of indoor air quality as a result of new building materials, construction concepts or changes in the inhabitants' behaviour, we learned a lot from the outputs of the ventilation projects and about the important role which ventilation and air exchange play in increasing indoor air quality. But we also learned about the

limitations of controlling indoor air quality by ventilation alone, hence an integrated view of ventilation in conjunction with a total control of the indoor air environment may become necessary.

For this reason the Federal Ministry for Research and Technology initiated a new R&D programme this year named "Indoor air pollutants and the indoor environment", and integrated into this programme some research activities from the programme "Humanization of the place of work", related to maintaining indoor air quality at the industrial work place.

We expect that a closer cooperation between these various research disciplines will initiate novel energy conserving technical solutions which nevertheless meet indoor air quality requirements which are accepted by building occupants.

### R&D efforts and ongoing activities

Energy conservation must be regarded above all, as a practical, short to medium-term contribution towards solving our environmental problem. In my opinion "Energy and Environment" are like Siamese twins or both sides of a medal. The environmental issue, as a whole, is becoming more and more critical and more urgent.

As all of us have become more aware in recent years, the question of energy supply in the future is not only a problem of resources and analyses of their scarcity. Concerns about irreversible changes to our environment which are also caused by increased energy consumption in all parts of the world are more often being mentioned in debates on future supply structures. I would like to mention just two examples:

Climatic changes caused by the "greenhouse effect" are no longer just speculations but phenomena which have to be seriously and intensively investigated. Should these risks be realistically assessed then this could lead to changes in living conditions over the whole world which cannot be estimated. Suitable compensating measures would be necessary. This would directly affect today's energy supply structures and would put the utilisation of renewables, for instance, in a completely different light.

The question of climatic changes and their results cannot be answered today or even in the next few years. However, even now, emissions of gases during the utilisation of fossil sources of energy are made responsible for considerable ecological damage. I would like to mention the new type of forest damage that has occurred particularly in Europe, and the most recent catastrophes caused by bad weather conditions in the Alps during the last few weeks. In public opinion these were the result of emissions and regional climatic changes caused by energy supply. Independent of whether this is provable scientifically or not, these events lead to reactions

in communities which can affect and change the acceptance of the use of fossil sources of energy.

In other words, in addition to the question of resources, environmental acceptability of energy supply has become a new dimension which must be considered. As environmental problems - climatic changes are the best example - do not generally have a regional or national character, then the international exchange of experiences and cooperation in the fields of research and development are particularly important. The FRG has accepted this fact and is looking for cooperation with other countries, first of all in the framework of the European Community and, in addition, the exchange of information particularly with the Western industrialised countries within the framework of the IEA.

For this reason the Federal Government has participated in most of the IEA R&D programmes. A total of more than 110 million DM financial support from the budget of the Federal Ministry for Research and Technology alone has been spent for 43 projects of the IEA in the field of renewables and efficient use of energy over the past 12 years.

As a result of international cooperation in the framework of the IEA, research and industry in Germany has very quickly managed to reach an international standard in the field of solar technology and efficient use of energy.

Even in the future we will attach great importance to this international cooperation and the exchange of information as well as the development of joint strategies to introduce new energy technologies. Here the IEA plays an important role, which goes much further than its original tasks of guaranteeing the supply of energy to member countries independent of disruptions in the oil market.

Measures for efficient use of energy in particular are required therefore still providing reasonable and concrete options for private homes, for the community and for business to maintain indoor air quality without any reduction to comfort. What we need are reliable and broadly available peripheral data, which is not solely or exclusively oriented towards the economic mood of the day.

Hence it follows that all projects within these programmes or within our IEA contribution should focus on practical applications and lead towards a practical benefit. An example are the results and recommendations of Annex IX "Minimum Ventilation Rates", which influenced the standardisation activities in the FRG in a very constructive way.

But on the other side, the mission of the BMFT is limited to that of an initiator and catalyst to bring about technical solutions, which have to be proven by the economics. The possibility of influencing legislation and regulations derived

from it, is limited; setting regulations is the task of other departments with the appropriate instruments and competences. The BMFT must approach these other departments or the parliamentary institutions and convince them, based on the results and experience from the research and development carried out, that the relevant legislation and regulations should be revised and adapted to the latest state-of-the-art technology.

The German ventilation programme and accompanying projects started officially in December 1980 and has a volume in the order of 15.4 million DM (now about 8.4 million US dollars). A major portion of these funds went to demonstration project investigations in occupied buildings. The German contribution to IEA's Annex VIII "Inhabitants Behaviour" had been integrated into these investigations.

During our work in the field of ventilation technology we became aware of a variety of problems. Quite uncommon for engineers – but on the other side very challenging, interesting and important – was the necessity to understand totally foreign subjects and sciences like medicine, hygiene, biology, chemistry and physiology. And at least, after the Indoor Air Conference 1987 in Berlin, we know how important it is, that these sciences influence our further strategies on ventilation developments.

Many international experts from all fields worked together in the IEA-Annex IX "Minimum Ventilation Rates". The final report is about to be finished and a big step has been made towards introducing better ventilation in residential buildings.

The Occupants Behaviour IEA Annex VIII – a very important study – was finished last year and as a next step, these results must be used to develop better ventilation strategies. This can be performed by indoor tests with new advanced ventilating devices, as proposed in the IEA-Annex XVIII and by the very important study on air movement in rooms, which is the objective of the new IEA-Annex XX "Optimization of Air Flow Patterns", presently under discussion as one of the next IEA-annexes.

The last mentioned topic is an example for the engagement of the BMFT. Ventilation technology is a typical technology and business for small to medium sized firms in Germany.

For example they don't have the expertise to develop calculation procedures to simulate the highly sophisticated behaviour of air flow in rooms, including heat mass, heat momentum transfer and turbulence models, and to verify these models by experiments; besides, these firms don't have the necessary computing equipment, the personal capacity and financial resources to do this job. We all know, that we need good tools for simulation, because real-scale experiments are too time-consuming and too expensive, and even can't give

adequate information on optimisation possibilities. For this reason the BMFT provides funds for research to develop simple computing tools, which can be used on personal computers (PC's) by architects and small and medium sized firms in industry.

The German ventilation standards are presently under discussion. These standards have to be revised according to recommendations on Indoor Air Quality (IAQ) to include recommendations on basis- and demand-related additional auxiliary ventilation.

Some regulations in Germany concerning ventilation are not so well coordinated in some points. Among the problems in revising our standards is one difficulty: up to now nobody has come up with a satisfying definition for "good indoor air quality", a precise definition of what can be checked by measurements and used in practice. I see one approach to achieving this and that is to advance our knowledge through international cooperation. Our experience is that a lot of results from our international cooperation - especially in the IEA - have given important inputs to the members of the various standardisation committees.

#### Some aspects of energy consumption in the FRG

After these general comments on air infiltration and ventilation, which are naturally also coloured with German experiences, let me now briefly give some details of the energy situation in Germany.

Energy supply in the FRG is well balanced as far as the utilisation of the different sources of energy is concerned and its supply structure is extremely well organised. On the heating market in particular there is a healthy competition between the different sources of primary energy with a strong interrelation. A dependency on individual sources of primary energy does not exist. Although the Federal Republic is a net importer of energy, the supply structure is so balanced that there is no dependency on individual supplying countries. This has led to the fact that the price of gasoline, for instance, is lower now than before the first oil price crises after inflation has been taken into account. A reaction to this situation by industry and public spending at the beginning of the 1980s could not be avoided. This became noticeable by a reduction in the attention given to energy options necessary for the future, and in particular to efficient use of energy.

During this period of reduced public interest until today, the support of the research and development programmes running internationally, for instance within the framework of the EEC or the IEA, was particularly important both for science and for industry. Today, there is an altered attitude in the Federal Republic resulting from two factors:



The occurrence of forest damage, already mentioned, and increasing warnings of ecological damage and climatic changes have given the environmental acceptability of energy systems more importance. New energy systems such as the utilisation of solar energy, perhaps using hydrogen as a store and efficient use of energy (the so called "NEGAWATT-market"), clearly have an advantage over fossil fuels.

In 1986, the reactor catastrophe in Tschernobyl made the risks of nuclear energy in the case of serious breakdowns only too clear, and particularly in Germany this caused an intense discussion on the dangers and benefits of nuclear power. This event also proved the necessity of investigating new energy options for the future, of developing promising alternatives and so making safe and flexible energy supply structures possible for the future.

Basically it can be assumed that the supply structure in the Federal Republic based on domestic coal, nuclear energy, oil and gas, will only change marginally in the foreseeable future. The awareness of possible risks involved in using traditional sources of energy has induced new initiatives, both in the supply industries and in public spending, to develop processes for the efficient use of energy and to utilise renewable energy sources.

On the other hand, various methods to save energy in industry and housing have already shown successful results. Using more efficient heating plants and improved thermal insulation, the heating demand of houses in Germany was reduced considerably from about 45 litres/m<sup>2</sup> a oil equivalent before the first oil price crisis to about 20 litres/m<sup>2</sup> a as a figure for the average.

If we consider that 25-50% of the total energy for space heating are ventilation heat losses, we talk about an amount of 400-800 Petajoule.

I think you will agree that this amount is worth thinking about carefully and deeply, especially as to whether it can be reduced.

Although the oil price is fairly low today, we shouldn't stop our R&D activities in the field of energy savings. On the contrary we should continue following a very steady path towards more independence of oil and other energy carriers.

But we should consider another very important aspect: every kilowatt hour for heating purpose consumed, puts stress on our environment, and this is important when we consider that the production of electricity is now performed with an efficiency of between 30 and 40% at maximum. In residential buildings, the production of heat for space heating and hot water supply with a common oil or gas furnace has an average annual efficiency of between 50 and 80%.

The picture becomes worse if we look at the transition of our primary energy (fig. 1). We use highly valuable primary energy carriers with which we could produce heat at a level above 1,000°C and we devalue this valuable energy solely to produce hot water between 40 and 70°C. The exergetic efficiency – exergy is the part of the energy which can be usefully transformed – the exergetic efficiency of these processes are often below 8-12%. In other words whenever we do not use all available exergy, we are always wasting energy°

The tremendous amount of wasted energy can be seen by the energy flow diagrams, which show for the FRG (Slide 2) a ratio of wasted to useful needed energy of 2±3 to 1±3, for the USA this ratio is about three quarters to one quarter, for Austria the ratio is about 50:50%. One of the main aspects for modernization of the national economics should be to improve this ratio for instance by district heating, cogeneration, heat pumps and consequently heat recovery and better insulation.

In 1973 the ratio of used to wasted energy for private households was calculated in the FRG to be 45 to 55% (Fig 2).

It was estimated to reverse this ratio on 1990, in changing the figures for used and wasted energy. We reached this goal in 1982, some years earlier than forecasted in the 70's (Fig 3).

#### AIMS OF THE BMFT

At the end I'd like to offer a few remarks about the present status, especially about the necessity and motivation for this program, to give some views as I see it, on the trends for the future:

- The final goal with respect to the German research program "Ventilation and air infiltration in residential buildings" is to minimise ventilation heat losses by means of improvements in building physics and in ventilation strategies in the framework of economic perspectives and – what turned out to be very important – to make the inhabitant sensitive to ventilation, to inform him about the appropriate handling of new ventilation techniques.
- Due to passive measures (better insulation, double and triple glazing) we could decrease the transmission-heat losses so much, that ventilation heat losses become the dominant heat loss. Therefore there might be some advantages in the proper combination of heating and cooling systems with ventilation, by using air and hot water as the heat fluid medium.

- In the FRG for instance with air to air heat pumps already under operation in Denmark and Sweden, the renaissance of the well-known so called "Kachelofen" or Ceramic furnace, or solar collectors (Fig.3), supporting the heating system in commercial and industrial buildings with the result of saving between 30 to 50% of the oil consumption in comparison before installation on the roof is underway.
- It becomes important for architects and design engineers to keep an overall view of the building and of its ventilating system. Building, heating and ventilating system, the user, and the environment are one entity which have to be monitored as a whole. An integrated design method would not only result in better indoor air quality and an efficient use of energy but would also cut back the immense amounts of money for damages to the building fabric.
- This of course implies that R&D activities have to hand in hand with what is needed in practice. The research results have to be translated into a language which can be understood and applied in practice.
- At least it should not be forgotten, that the introduction and diffusion into the market is not only dependent on a proper functioning technical solution. To say it quite frankly, technical innovations can only enter the market and survive, when there are existing innovations too in organisation and administration for example tariffs for surplus electricity produced by cogeneration or renewables and other incentives, which encourage consumers and producers to save energy and not just to sell.
- I'm sure that the exchange of information and experiences at this conference will contribute to achieving better indoor air quality, to reduce ventilation heat losses, and to identify economic and user-accepted ventilating systems.

I wish for all of us fruitful discussions and a successful conference accompanied by having some nice days together here at Ueberlingen in the Bodensee region.

Thank you very much.

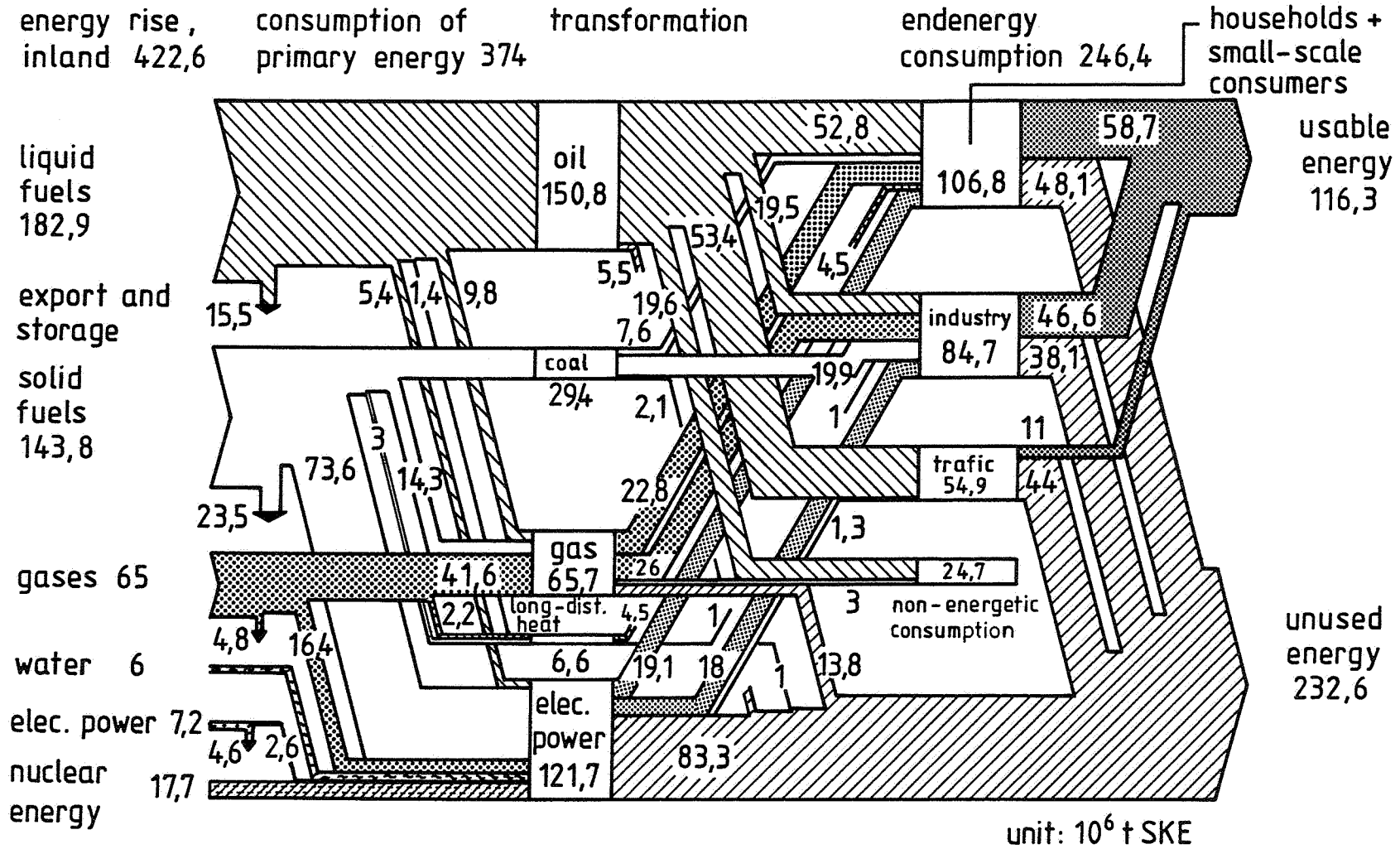


Fig. 1

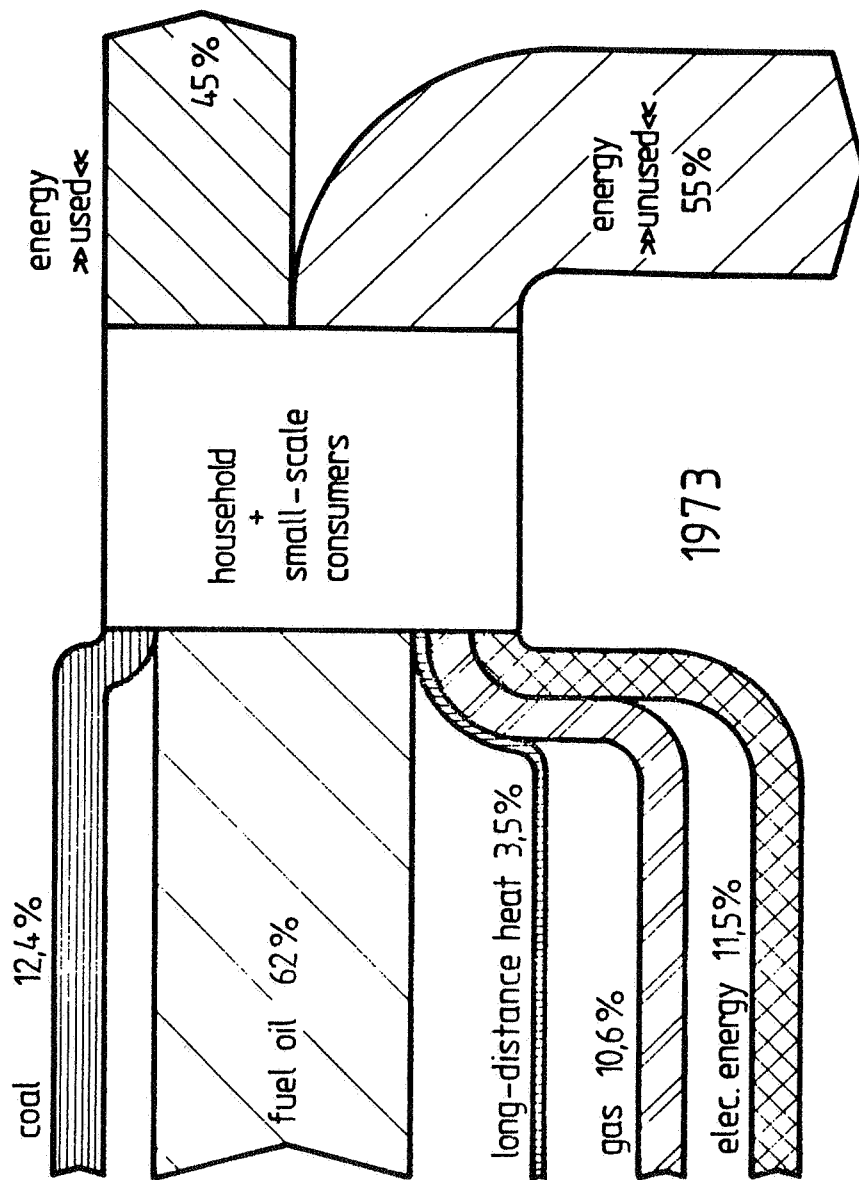


Fig. 2:

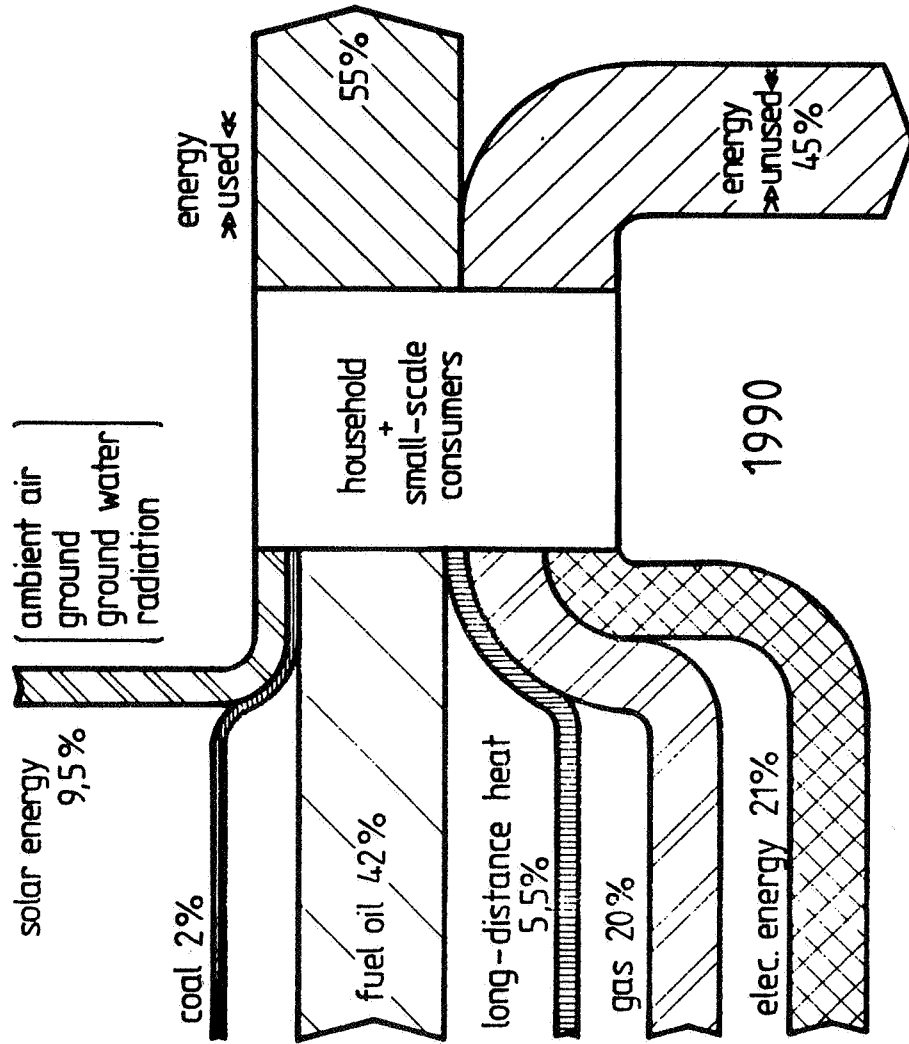


Fig. 3: