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SOCIO-POLITICAL ASPECTS OF NUCLEAR ENERGY

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1. INTRODUCTION

Since its discovery in 1938 by Otto Hahn nuclear fission has proven to be a reliable source of energy for a large number of countries round the world. More than 300 nuclear power plants representing a capacity of more than 200,000 MWe are in operation to date and nearly the same number of plants is in the phase of planning or under construction. Besides the majority of industrialized countries nearly 20 developing countries are using nuclear energy and have the intention to cover a major portion of their energy demand by this energy source.

On the other hand the introduction of nuclear energy and its expansion in numerous democracies of the western world have been accompanied by an, at times, vehement controversy. This controversy has taken various forms in the different countries, is based on ideological, political and ecological arguments and has led in almost all of the countries to profound effects on the utilization of nuclear energy. It caused considerable delays in the completion of power plants and increased the cost of this energy source in a remarkable degree. The controversy came up just at a moment, when nuclear energy had proven its competitiveness and even economic superiority to conventional sources of energy, reaching an extremely high level of safety. The risk of nuclear energy is by many orders of magnitude smaller for the population than that of other major technical installations of the civilized world.

It is in some way difficult to determine the reasons for this opposition to nuclear energy but it seems obvious that the possibility of military use of nuclear power, the complexity and advanced nature of nuclear technology, and the risk associated with the radioactivity of fission products produced in the fission process, as well as more emotional arguments concerning risk, safety and radioactivity have contributed to the controversy. All this has

occured at a time when participation, qualitative growth, environmental protection and soft technologies are key words in a socio-political discussion about values and goals of human development.

The utilization of nuclear energy offers an excellent chance to increase the level of development of a country and to raise the standard of living of the individual. To introduce nuclear energy to cover the needs of developing countries it nevertheless seems to be necessary to take into consideration socio-political aspects of this energy source, also. In this short presentation it is obviously not possible to deal with the whole scope of questions in this field. So it is necessary to concentrate on those results based on experience gained through past investigations.

Since the technical risk and the perception of risk towards nuclear energy in particular is an important factor for the acceptance of nuclear energy we try to elaborate this topic in some detail. Further it is necessary to evaluate values associated with energy production in order to concentrate on essentials when introducing nuclear energy into to energy system of a country. It is, moreover, helpful to show the differences in attitudes towards nuclear energy in industrialized and developing countries, and finally to present a review of public attitudes towards nuclear energy in Germany since the end of World War II. It may be possible to take advantage of the experience gained in our country.

As a result of these investigations we present a proposal for a special programme for information and education to facilitate the introduction of nuclear energy in developing countries and to create a level of acceptance which is necessary for this step of development in the field of energy production.

2. RISK PERCEPTION AND NUCLEAR ENERGY

In the 19th century, technological progress in the industrialized countries was synonymous with overcoming inflexible hierarchies and postfeudal power structures. Until ten years ago, the development of science and technology was considered to be one of society's most urgent tasks, connected with a highly positive and progressive image. However, within a short time, the problems of large-scale technological plants, an increasing awareness of research and technology in major fields, such as cancer research and unemployment problems, have set in motion a process of re-interpretation which has placed the ambivalence of technology squarely in the forefront of perception. This new attitude has played a large part in fuelling the increasingly critical debate as to the consequences of technology and its specific effects on the environment and on society.

It is for this reason that risk estimation by the general public and by specific groups of the public is investigated with more than merely academic significance. The general value concepts and the specific risk assessment criteria among the public provide important reference points for rational political action in a democratic society, reference points which ensure both legitimacy and expertise in decision making. So far, a paradoxical situation seems to be arising in the political and social debate on energy systems (in particular in the case of nuclear power), in that probabilistic risk analysis assigns a particularly low risk status to those technologies which are intuitively perceived as being of especially high risk by the general public. Here, we are forced to consider the question as to which criteria are actually used by man to assess risks.

Since the general public assesses a risk in a different manner from the risk assessment of experts who work on the basis of scientific risk definition, any of the three causes below may apply:

- People are unaware of the results of risk analysis and construct their own intuitive risk assessments.

- People are aware of the results of risk analysis but do not believe them, preferring to trust their own intuitive convictions.
- People are aware of the results and believe the expert estimations; however, they do not evaluate this information as providing decisive criteria for their own risk assessment process.

So which of the three explanations is correct? Figs. 1 and 2 help to answer this question. The graphs show the results of an American and a German survey. A random sample of several people were asked to estimate the risks involved in various hazard sources, from smoking to nuclear power stations, in terms of losses per year. The estimated values are plotted on the y-axis and the actual statistical figures on the x-axis. Apparently the estimated loss figures and the statistically determined "actual values" are relatively close together. There is a general trend, both in the USA and in the Federal Republic of Germany, to underestimate risks involving very high losses slightly, and to overestimate risks involving very low losses slightly. Nonetheless, the extent of agreement between estimated and actual values is surprisingly high. Therefore, the first premise, that people are merely misguided in their assessment, cannot apply. It is, however, interesting to note that the intuitive ability to determine the order of magnitude of risks disappears as soon as questions are asked relating to the number of lives lost during the span of a lifetime. Either all risk sources are graded almost uniformly (all disaster losses being approximately 3,000), or exorbitant estimates are made, for example, an average of 22,000 deaths for narcotics, 4,000 deaths in skiing accidents and as many as 600,000 deaths caused by nuclear power.

When making estimates, experience and common sense can bring about a relatively good approximation of the statistical values. However, when questions are related to catastrophic situations, these intuitive evaluation processes will not function, since the extent of catastrophies cannot be drawn directly from a person's own experience. Could it be, that fear of disasters is the decisive motive behind the evaluation of risks?

This natural hypotheses does not apply either. People do take account of the perceived loss rate when making risk assessment, but this rate can only explain a very small part of this assessment. Therefore, there must be more important factors which people apply in the evaluation of risks.

But what are the factors according to which risk sources are evaluated? Up to a few years ago one could only answer this question speculatively. Today - thanks also to the antinuclear movement - a whole scientific branch has thrown itself into these problems and is attempting with the aid of experiments and surveys to investigate the mechanisms of intuitive risk perception. In most investigations of the institutions and individuals involved the following factors in risk perception have been empirically determined.

- Qualitative risk features (voluntariness, opportunities for personal control)
- Catastrophe potentials
- Beliefs about the type of consequences
- Social values
- Personal characteristics.

In order to give some insights into the methods of scientific research with respect to this complex, we would first of all like to deal with the area of "Qualitative Risk Features" in more detail and to describe an experiment which was carried out in our department about 2 years ago.

In this experiment, 37 people, who had responded to a newspaper advertisement asking for volunteers to take part in an experiment to test pharmaceuticals, were randomly distributed into two groups of 18 and 19 people.

The experimenter, wearing a doctor's white coat and pretending to be a physician, explained to both groups in identical words that his pharmaceutical company had developed three new capsule coatings, all of which dissolved in the stomach twice as fast as in conventional capsules. In order to achieve this, he explained, one capsule had been given weakly radioactive coating one a coating containing bacteria, while the third included a ring of heavy metal which was toxic if taken in large quantities. The experimenter emphasized that the quantity of the materials contained in the coating was so small that a health hazard was completely ruled out. The capsules, he said, were filled with natural vitamin preparations so that the test subjects would be doing something beneficial for their health. In order to demonstrate the harmless nature of the capsules the experimenter swallowed all three, one after the other, in the presence of the test subjects. In fact they were commercially available vitamin capsules.

Subsequently he requested the members of group I to select any one of the three capsules and swallow it. In group II the experimenter directed that the first six test subjects should take the first capsule, the second six the second capsule, and the remaining subjects the third capsule. After 15 minutes the respondents were requested to state whether they felt any ill-effects, and which of the three capsules they would prefer to purchase, provided that all three were absolutely identical with respect to the amount of risk involved and their medical effectiveness.

Figure 3 provides an idea of the different behaviour patterns between the members of group I (voluntary risk-taking) and group II (involuntary risk-taking). Two basic insights can be obtained from the data:

- (a) when compared to group I, there were more than twice as many test subjects in group II who stated that they felt some kind of ill-effect after taking the capsule; this significant relationship supports the assumption that voluntary risk-taking causes less aversion than involuntary risk-taking;
- (b) although the stated risk was the same in each case, the results show that in both selection of capsules and the distribution of specific complaints, opinions about the source of risk initiated preferences (probably via association of affected ideas) independent of any apparent danger.

That freedom of choice represents a significant parameter in risk perception has long been an important component of psychological risk and decision theory. The former director of the Electric Power Research Institute (USA) Chauncey Starr has underlined the significance of these variables in quite a different way. A comparison of statistical loss rates caused by various risk sources provided the result that socially accepted risks, which are entered into voluntarily, may show a thousand times higher loss rate than risks which can be regarded as imposed by society.

Voluntariness is just one example of a whole chain of variables which are independent of loss rates, and which are described as "qualitative risk/benefit features". Other features of this nature are "personal control possible",

"external consequences conceivable", "danger not subject to sensory perception", etc. Surveys make it possible to estimate roughly the position occupied by these characteristics in the perception and evaluation of a risk source. Qualitative risk and/or benefit properties and to a smaller extent expected losses constitute two important categories of factors according to which people evaluate risk. However, even the capsule coating experiment revealed that not only the abstract risk indication (the experimenter confirmed equal riskiness for all capsules) is regarded as a criterion for decision making but rather the ideas and attitudes about the risk source. The "radioactive" capsule thus triggered the most negative associations and therefore caused the most frequent psychosomatic complaints. With respect to risk perception people do not distinguish between the risk level and the object causing the risk. It is not immaterial to the observer whether the identical risk stems from a nuclear power station or from swimming: on the contrary, the risk cannot be fully apprehended until the individual is able to establish a relationship with his ideas and attitudes towards the object causing the risk.

A different approach has been tried in the research of risk perception which adopts the risk source as such as the key factor of risk perception and draws conclusions about the formation of risk assessment on the basis of associations and ideas about the risk source.

In order to investigate these particular variables, a random group of 100 people were asked to rate their beliefs about 12 different sources of risk. A set of comparable factors was developed which could be grouped under the following five headings:

- (a) effects on the person himself or on his social environment (health, security etc.):
- (b) extent to which a person is directly affected (personal benefits, or injuries, comfort, well-being, freedom, etc.);
- (c) effects on economic and social welfare (employment security, social status, general standard of living, quality of life, etc.);
- (d) socio-political and social values (social justice, democratic rights, equality of distribution of benefits, etc.);

- (e) effects on future conditions (maintenance of economic levels, defence, security of supplies, etc.)

In order to obtain an overall view of the importance and relationship of the five criteria the average values for the individual factors have been compiled for six sources of risk (Figure 4). The bars extending below the zero line in this figure show negative estimations with respect to the risk under consideration, while those above show a corresponding positive evaluation. A comparison of the bar diagrams for coal and nuclear energy clearly reveals why nuclear energy suffers from more serious acceptance problems than coal. The public, on average, associates the utilization of nuclear energy with a negative effect on the social welfare and on the realization of social values. The direct and indirect advantages of nuclear power on one's life, however, are less frequently perceived. The preponderance of the negative aspects can only be compensated by the belief in the future role of nuclear energy for solving the outstanding energy problems. The expectation of the future necessity of nuclear energy prevents a continuously negative attitude to nuclear power. In contrast to this, mainly positive beliefs are associated with coal and it is precisely the criterion public welfare which achieves the highest value. In other words, major acceptance problems are not to be expected for the energy source coal, even considering the problems with acid rain and its effects on forests.

This intuitive preference for non-nuclear alternatives can also be seen by comparing the desire of the respondents to devise their own future energy option with their perceptions of reality. If the beliefs held by individuals what the energy future should be like and their expectations what the future will actually be like are investigated an inversion of the order between personal preferences and expected development is found. More than half of the interview subjects were convinced that by the year 2000 nuclear energy will have become the most important source of energy, but only 20 % would desire this development (Figure 5).

Thus the opponents of nuclear energy believe that it is possible to live without nuclear energy power stations, but feel that this opinion is politically unrealistic. Intuitively the adherents of nuclear energy also prefer alternative energy production systems, but compensate for the negative aspects by three mechanisms:

- (a) Assignment of symbolic values to nuclear energy (such as "progressive", "modern", "prestigious", "scientific", and "adapted to an industrialized society"): This symbolic evaluation was a predominant feature of the euphoric pro-nuclear attitudes of the 1960s; today predominantly older and technically inclined people associate nuclear energy with positive values.

- (b) Belief that nuclear energy may be hazardous, but is absolutely essential to the economy and future standards of living: The perception of economic necessity was one of the central dividing lines between opponents and adherents of nuclear energy. In particular, when people developed a favourable view towards general economic values such as raising the standard of living, they rated nuclear energy as an economically essential precondition in achieving these aims. If people were more inclined towards qualitative values such as pollution control or harmony with the environment, they regarded nuclear energy not only as opposed to these values but also as incompatible with economic values.

- (c) Confidence in groups of professional proponents: Even if people have doubts about the safety of nuclear power stations, they can develop a positive attitude towards nuclear energy, provided that they still have confidence in legal and scientific institutions. People with negative attitudes towards science in general or to the problem-solving capacity of political institutions, are usually opposed to nuclear energy or at least ambivalent.

These three findings of our survey can be well-documented by statistical results. In Figure 6 five general attitude scales (confidence in science, politics and technology; conservatism; participation; political apathy; and environmental awareness) are shown as functions of the risk estimation of nuclear energy.

Especially these three mechanisms are amplified substantially in developing countries and can create a higher level of acceptance for nuclear energy. The use of nuclear power plants is looked at to lead the way to industrialization and progress and to a solution of economic problems by the fact that nuclear energy is one of the cheapest ways of electricity production. An extreme need of environmental protection is not present. To undergo personal financial

sacrifices for the preservation of the environment is completely unintelligible for the public at large. The construction of each industrial plant and also that of a nuclear power station means the creation of additional jobs, the improvement of the standard of living in the related region and a possible improvement in the social position of the country.

In order to investigate further the role of scientific institutions and various social and political factors, we included a scale designed to measure the credibility assigned to these institutions. The numerical data are given in Table 1, which provides some interesting results:

- (a) Where credibility on questions of nuclear energy is attributed to anyone at all, it is most likely to be to the representatives of science and technology or of technically responsible political bodies (such as the Federal Ministry of Research and Technology).
- (b) In their assessments of the credibility of scientific institutions there are only minor differences between the opponents and proponents of nuclear energy. Both groups assign the highest rating to these institutions.
- (c) Central political institutions and technically competent business institutions generally occupy intermediate positions on the scale, while social institutions such as trade unions and churches, and people in certain individual social groups such as journalists, managers or local politicians, are located at the bottom end of the scale.
- (d) On the basic tripartite scale of ratings, opponents and proponents differ very little: science comes first, followed by politics in general and finally the institutions of society. On the whole, however, opponents assigned lower ratings to almost all institutions than did proponents.
- (e) In judging the credibility of scientific experts, opponents attributed the greatest credibility to members of universities and nuclear research centres. This is surprising because the opponents are convinced that the overwhelming majority of the staffs of these two types of institutions are in favour of nuclear energy. Competent scientists engaged in a citizens' action group are given only the third place by opponents (and eighth place by proponents).

What is there to be learnt from these survey results? The artificially constructed contrast between the rational assessment of the experts and the supposedly irrational assessment of the layman has not only disguised the true relationship in the current discussion about risk, but has at the same time put considerable difficulties in the way of the dialogue between the two sides. The technological calculation of risk dimensions must doubtless be regarded as an important component of any decision concerning risk sources and is also an ideal instrument for constantly improving the safety measures for protecting the public. However, the public is not disputing the fact! To make calculations of this kind the sole criteria for "acceptability" and/or "desirability" of technologies or of other civilizing risk sources, however, contradicts the intuitive view of risk acceptance and is also unreasonable from political and social stand-points. What is necessary is an analysis of the concomitant circumstances and an assessment of the consequences for man and for society, so that people's fears and attitudes with respect to the effects of the risk sources they can see can be compared to the actual situation, any aberrations can be corrected or diverted in advance, and, finally, reproducible decisions, reflecting all levels of intuitive perception, can be made. Only when we have learnt to take a serious view of the structure and development of the layman's view of risk and to treat and approach the factors governing intuitive perception purposefully, will it be possible to initiate a fruitful discussion between scientists, decision-makers and the public.

3. THE ATTITUDES TOWARDS NUCLEAR ENERGY IN INDUSTRIAL AND DEVELOPING SOCIETIES

There are distinct differences in the public perception of nuclear energy of people from industrial societies compared to those stemming from developing countries.

First, most citizens in developing countries are preoccupied with fulfilling their basic economic and cultural needs and are more indifferent towards production technologies. Industrialized countries, like Germany and the United States, have reached a standard of living and a level of affluence that make people highly concerned about noneconomic considerations.

Second, in developing countries nuclear power is regarded as a rather remote point of concern, since it is not directly related to consumption.

Third, environmental and health aspects are not in the focus of public interest or can at least be displaced by economic consideration.

Fourth, modernization and national prestige are still national goals in developing countries which shape the overall attitude towards modern technologies.

In spite of the preponderance of indifferent or even slightly positive attitudes of the general public in developing countries it is important to investigate more thoroughly the opinions and points of view of important societal groups, in particular those groups with well educated, socially relevant leaders who have the ability to influence the media as well as the public opinion.

In this respect, parties, unions, religious groups, the technical elite, students, village chiefs and other fractions within society are of special interest. For initiating a nuclear programme it is more essential to reveal the attitudes of relevant opinion leaders rather than interviewing samples of the general public.

For this purpose the Social Science Research Centre of Los Angeles and the Nuclear Research Centre of Jülich have developed a methodological approach, called "Value Tree Analysis".

The value tree analysis is an interactive, iterative and integral method. Individuals or representatives of important societal groups are interviewed in order to determine their relevant values and concerns about the domain of investigation. The values identified as statements about desired states, positive intentions or preferred directions with respect to possible decision options are organized in a value tree representing the hierarchy of values of the particular group. Each group has to approve to its value tree.

The value tree represents a hierarchical structure with the general values and concerns on top, and the specific criteria and value dimensions at the

The main objective of constructing individual value trees is the formation of a combined value tree for all groups. Such a joint tree can be understood as the presentation of major concerns in society without focusing on the differences in weighting and importance for each value item. But the combined tree represents more than just a list of concerns which have been mentioned during group interviews. It is an attempt to structure various, even conflicting values and criteria in a logically consistent, generally acceptable scheme which is meant to be the first step of a meta-semantic framework in forming a societal consensus on conflict resolution.

The value tree approach has been used to reveal the underlying values, criteria and attitudes towards different energy systems by interviewing relevant groups in the Federal Republic of Germany and the United States. A small part of the combined value tree of the German society is illustrated in Figure 7.

At present, we have not applied the value tree approach in developing countries. But we believe it would be a rewarding effort to interview the representatives of leading groups in developing countries in order to analyse their values and concerns and to predict their involvement in the nuclear debate. In particular, the policies of the government could be shaped in such a way that legitimate concerns can be incorporated into the policy making process and more fears and emotions can be met by an intelligent information campaign. In addition to value tree analysis traditional survey methods can be used to investigate the beliefs and attitudes of special social groups in developing countries. In cooperation with the IAEA our research team has been engaged in a large comparative study on attitudes towards energy systems in four industrial and five developing countries. Within the framework of this paper we would like to refer to a study of attitudes towards nuclear power comparing German, Japanese and Philippine students of technical subjects.

The three student samples were taken from Technical Universities. The German students are enrolled in Aachen and Cologne (N = 150), the Philippine students in Manila (N = 174). The data of the Japanese students have been obtained from Tokyo (N = 36) and Osaka (N = 84).

The sample from Germany consisted of 63 % males and 37 % females. Among the Philippine students there were 26 % males and 69 % females (5 % of the sample did not indicate their sex in the questionnaire) and in Japan 96 % males and 4 % females responded to the questionnaire.

The students were asked to fill in a questionnaire asking for their general beliefs in relation to nuclear energy and for their evaluations of each belief. Adding up these weighted beliefs the direction of the overall attitude can be determined. In addition to this sophisticated method, all students were asked to rate themselves on a seven point scale ranging from -3 (totally opposed to nuclear energy) to +3 (totally in favour of nuclear energy). The distribution of values according to this pro/con scale is depicted in Figure 8.

Examination of Fig. 8 where the respondent frequencies are given in percentages for each response category for each sample shows that the Japanese students were predominantly for the use of nuclear energy (categories 2 and 3 account for 68 % of the sample), the Philippine student sample includes two groups one very opposed (category -3 accounts for 25 %) and one slightly in favour (category 1 represents 20 %). The German (FRG) students are also composed of two groups, with 45 % of the sample being for the use of nuclear power (categories 2 and 3) and a smaller group of 25 % ((categories -3 and -2) being against.

As a general remark it could be concluded that except for the Japanese students who are predominantly in favour of the use of nuclear power, the other two student samples from Germany and the Philippines appear to include both interest groups, proponents and opponents.

In order to detect the main differences between the three samples, discriminant analysis was applied. Depending on the parameter that is used for the statistical calculation, all variables can be ordered according to the degree to which their variance discriminates between the samples. Table 2 shows the results obtained with the scores of weighted beliefs. In the first line the most discriminative item is listed followed by the second most discriminative and so on. In total, 15 items out of 30 proved to be significantly different. This rather large number of significant differences is a good indication for the importance of national peculiarities.

Inspection of Table 2 demonstrates that there are distinct differences with regard to the expected benefits of nuclear energy. Whereas German students emphasize the advantages of cheap energy supply and of conserving natural resources, the Philippine students apparently disregard these two benefits, but are convinced that nuclear energy can increase the industrial development of their country and the national prestige. Those two benefits are of no importance for the German students, though. The Japanese respondents lie in between. Similar to the Germans they regard nuclear energy as an inexpensive way of generating electricity, in agreement with the Philippines they believe in the stimulating role of nuclear energy for the development of the national industry.

Regarding the question of conserving natural resources and increasing national prestige the Japanese respondents relate both issues to the utilisation of nuclear energy, but not as strong as the Germans or the Philippines. In contrast to the German and Philippine sample the Japanese regard nuclear power as a long-term solution to their energy problems. All three samples react more homogeneously on the risk side. But there are still some distinct patterns which are worthwhile mentioning. The Japanese respondents perceive hardly any risk in connection with radioactive wastes; the Germans show medium concern, whereas the Philippines have a rather negative view on the waste problem. This negative evaluation is also predominant in the question of environmental pollution and - rather unexpectedly - in the restriction of personal freedom. German and Japanese students are less concerned about environmental pollution as a consequence of nuclear power and do not believe that personal freedom might be endangered by the implementation of nuclear power. According to this response pattern German and Japanese students have just a little fear of the potential threat to society's freedom. This threat, however, has a large impact on the Philippine sample. Only the international threats seem to be more decisive for the German and Japanese negative view of nuclear power. Proliferation is seen as highly probable risk factor by these two samples, whereas the Philippines are not or at least not as much concerned with this possible menace to world peace.

Two more differences should be mentioned. First the Japanese students do not perceive nuclear energy as a competitor for alternative energy sources but as a compliment to them. But both Germans and Philippines believe that the use of nuclear power will restrain the development of alternative energy

sources. Second, while the Germans feel that nuclear energy has the potential to increase scientific research, the Philippines reject this possibility, and Japanese respondents are somewhat undecided on that matter.

Most of the results fit into a consistent mosaic characteristic for each country. German and Japanese students reflect their industrial heritage by ascribing the role of a promoter to nuclear energy which helps to provide inexpensive electricity, encourage economic progress and to increase national independency. The Philippine sample perceives nuclear energy as an imported technology with rather doubtful economic advantages and high risks. But they do link nuclear energy with some positive symbolic attributes: increase of prestige as well as encouragement for modernization and industrial development.

The motivation to go nuclear is more functional on the German side, more symbolic on the Philippine side. The Japanese respondents react more like the German students, however, in some aspects concerning national prestige and economic development they agree with the Philippine statements. Functional attitudes are typical for highly industrialised western cultures; the Japanese are still partly influenced by traditional value systems, but at the same time highly motivated by modern functional evaluations. If the risk aspects had not such a strong impact on the Japanese attitudes, their overall judgement combining functional and symbolic aspects, tends to a rather well-balanced and stable attitude towards nuclear energy.

Thus the main lesson to be learnt from the analysis of different attitudes in various countries is the fact that nuclear energy is a controversial topic in each country, but for different reasons. Whereas in industrial countries, like Germany, environmental and political aspects play a major role in the perception procedure, the educated public in developing countries perceives on one hand the dependence on industrial nations and the technical complexity which is felt to be hardly manageable. On the other hand nuclear energy is seen as a energy source which facilitates economic progress and increases national prestige. Before looking into information and education policies in order to cope with the perceptions of relevant groups in society, one has to consider the time component in the reaction of the public towards nuclear energy. The protest movement in Western countries has to be regarded as a steady process of governmental action and public reaction. The aggravation of conflict which we observe today, is partly due to the handling of the

sceptical opposition by the responsible actors in business and government. This point can be made clearer if we look into the recent history of public opinion in the Federal Republic of Germany.

4. A HISTORICAL REVIEW OF PUBLIC ATTITUDES TOWARDS NUCLEAR POWER IN GERMANY

A brief historical description of the different phases of attitude formation towards nuclear energy is useful for following the trend of public opinion-forming over time.

Until approximately 1950/51, there was an ambivalent attitude toward nuclear energy. There was the fear of the horrors of nuclear warfare, and at the same time the acknowledgement that nuclear weapons were significant to ensure the military superiority of one's own political block. During this period, the peaceful use of nuclear energy plays no role at all and is not perceived.

During the fifties, there was a clear reversal of public opinion against nuclear weapons which found an expression in the Easter demonstrations. A nuclear weapons stop was demanded world-wide, and nuclear fall-out was considered as a general threat in the United States. The Atoms for Peace - Program, initiated by President Eisenhower, created a counter-movement to the military threat and hopes for a reversal of man's destructive intellectual potential into a harnessing of natural resources for human purposes. This metaphysical embellishment of nuclear energy, promoted for political reasons, prepared the first step toward a symbolic role of nuclear energy as a paragon of technology and innovation.

When in 1963 the test stop agreement was signed between the United States and the USSR, the spearhead of protest against nuclear weapons was broken; nuclear weapons took second place after the problems of substitute wars (such as Vietnam). The question of peaceful uses of nuclear energy still had little relevance. While there was still protest against the construction of research reactors in the fifties, where the typical characteristics of traditional technological innovation protest existed, the first commercial nuclear power stations could be commissioned in the late sixties without any appreciable protest or resistance.

In the late 60s and early 70s, the criticism of peaceful nuclear energy uses which started in the United States was seized upon in the Federal Republic of Germany. The problems were first discussed among scientists and then presented to the public by professional critics. At the same time, local resistance to the construction of nuclear facilities developed.

None of this would have had the result that nuclear energy grew into a major political problem if the symbolic nature of nuclear energy which had developed in the 50s had not been seized again and reinterpreted. The developing awareness of the limits of growth, the greater sensitivity of the population for the natural environment, the change of social values, the distrust in central institutions, and the disappointed hopes regarding the effects of technological and scientific progress (such as space flight or cancer research) were the decisive factors that the symbolic attributes of nuclear energy, such as "progressive, clean, centralized and complex", acquired a negative connotation.

In spite of the first opposition, opinion polls confirmed that the number of strong and moderate advocates of nuclear energy still reached approximately 70 %, while less than one tenth of the population considered themselves opponents of the new technology.

The characteristic feature of the second half of the 70s which started approximately with the protest activities in the German town of Wyhl (1975) was the increasing consolidation of nuclear energy opponents. Support by persons engaged in science and technology, the popular protest in the neighbourhood of planned nuclear power stations, the organization of citizens' initiatives and the overreactions on the part of politicians had the result that more and more citizens questioned the motives of nuclear policy and adopted sceptical standpoints. Also, doubts as to the relevance of the nuclear program were increasingly reported in the media.

The discussion of the hazards of nuclear energy and some apocalyptic scenarios published by sceptics created a high potential of active resistance in the local environment of planned nuclear energy facilities which was vented in massive demonstrations and sometimes even militant activities (Brokdorf, Stade, Kalkar). Among the public this resulted in an increased perception of nuclear energy opponents who were regarded as being a majority.

During this phase, a structured attitude formed in most individuals; approximately 25 % were clear-cut opponents, approximately 30 % adherents, and the remaining 45 % were ambivalent between the two extremes depending on the issues of the day and the political mood. Only a small proportion of not more than 10 % were really indifferent.

While the years from 1975 to 1978 were characterized by confrontation between opponents and proponents and the resulting polarization of views, the Iran crisis and the Three Mile Island accident in the following years marked a trend toward less denunciation in the conflict and more attempts to find solutions that would allow political compromises. The conflicts had lost in virulence, and both camps were undergoing an internal consolidation process to develop new arguments and new ideas for future conflicts.

In the general public, the opinion structures which had developed in the mid-70s were more or less retained. An increasingly positive basic attitude in the question as to the necessity of nuclear energy developed again among the population. An interesting feature in this connection was the increasingly critical evaluation of the safety of nuclear facilities and their engineering maturity and the increasingly positive evaluation of their economic necessity.

The latest development since 1982 is characterized by a growing awareness of the military uses of nuclear power, in particular the question as to the installation of American missiles in Western Europe. The renaissance of a new peace movement has absorbed a large number of protesters and hence calmed down the movement against nuclear power stations. At the same time the economic recession in the FRG and the good performance of nuclear power plants in Germany supported a more favourable view towards nuclear energy within the public. According to the most recent opinion polls a large majority of approx. 60 % is in favour of a modest growth of nuclear energy provided that the waste disposal problem can be solved. A complete shut down, or a fast expansion of nuclear power - the two possible extremes - are both options which are supported only by a small minority of the German population.

5. PROPOSAL FOR A COMBINED INFORMATION AND EDUCATION PROGRAMME

What can we learn from history and from the description of socio-political aspects and what lessons can be drawn for developing countries which are at present in the first or second stage of utilizing nuclear energy? We will try to draw some conclusions for the effective management of educational and information programmes to compensate for opposition and protest.

In order to achieve any acceptance it will be necessary to inform the people about the complex correlations of nuclear energy, the future development of energy requirements and the possibility of covering them, the methods of operation of nuclear power plants, their safety, their risk, the problems of environmental protection, the effects of radiation and the excellent experience gained in industrialized countries which nuclear power plants. It must be shown clearly and understandably that the peaceful use of nuclear energy grants security of supply and the advantages of independence in covering the energy demand of a country, and that nuclear energy is an inexpensive and safe way of electricity production. The use of that energy source leads to more employment and to an industrial development in the case when cheap energy is combined with a functioning technology transfer. Finally it must be explained that the use of nuclear energy creates a real relief of the balance of trade either by less imports of fossil fuel like coal and oil or by giving the opportunity to export indigenous conventional energy resources or in addition by exporting the products of a growing industry.

But especially in developing countries this information is to be channelled through the technical elite of a country, the religious groups, politicians, political parties, students, educated persons, village chiefs and other groups highly estimated by the people.

In addition the positive basic attitude towards nuclear energy can be supported and maintained when training and education in the relevant scientific and technical disciplines takes place in combination with information about benefit and risk of nuclear energy.

Information should thus be imparted along with the knowledge required for industrialization. This knowledge must be presented to the relevant groups of persons in a manner which can be easily received in a sufficiently illustrative form, particularly if visible symptoms of nuclear energy development such as research reactors or similar installations do not exist.

Especially groups which are in the position to follow the international discussion on nuclear energy should be interested in gaining knowledge and should be actively involved in an information campaign in order to avoid importing the nuclear controversy from abroad. Universities, scientific institutes, teachers and professional organizations should also be involved in such measures and should be motivated to form the basis for a public information team to travel round the country. Public information teams are necessary to go into the villages equipped with the relevant information material to inform the village leaders and, together with them, the public at large. Special emphasis should be placed on information at schools and universities in order to inform the growing generation in the best manner. Besides a good training for teachers, information experts have to go into the schools to report about the new energy source, to answer questions and to discuss problems associated with nuclear power with the young boys and girls. It is necessary even in the young generation to create a solid basis of knowledge which helps to diminish the fear of hitherto unknown technologies and to increase acceptance.

Informing the media, particularly the press, as early as possible offers the chance for a broad discussion and creates the prerequisites for qualified and unbiased reporting. The electronic media should introduce information about nuclear energy into their educational programme.

Special and timely information should be given to politicians since it is up to them to make binding and responsible decisions on energy programmes. They should be furnished with all information available on the possibilities offered by nuclear energy for the development of their country and on the alternative available to them beyond nuclear energy.

Along this line it is not necessary to duplicate the difficulties in the field of public acceptance in developing countries which some industrialized countries have been confronted with in the near past.

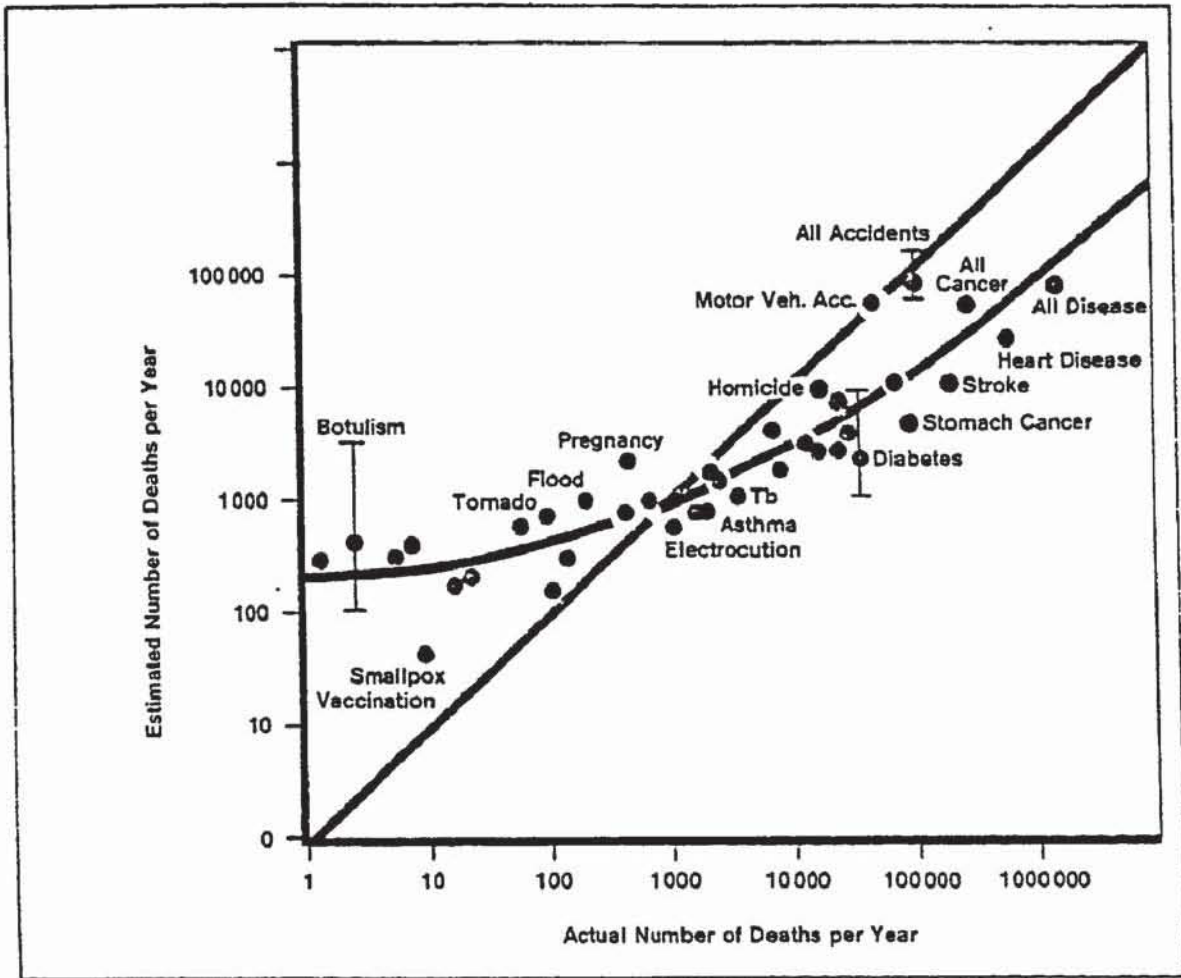


Fig. 1 Risk estimation and statistical data (USA survey)

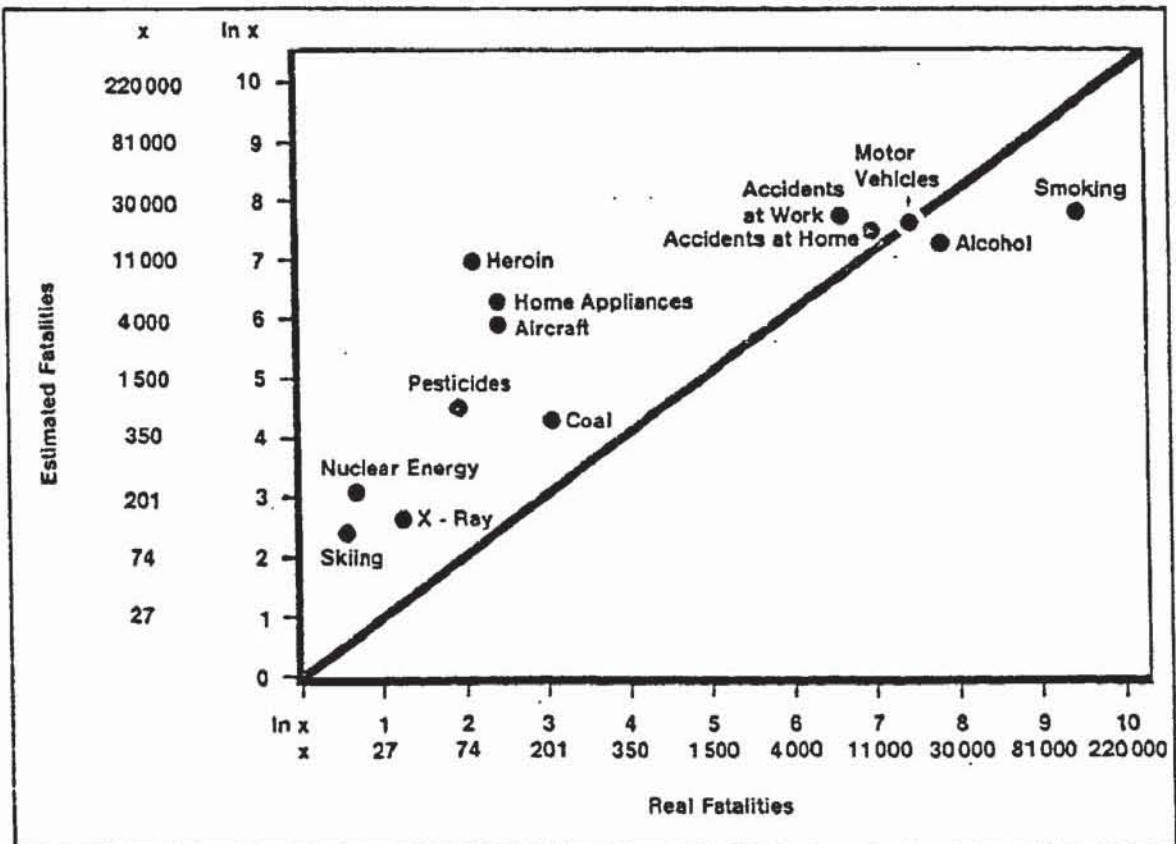


Fig. 2 Risk estimation and statistical data (German survey)

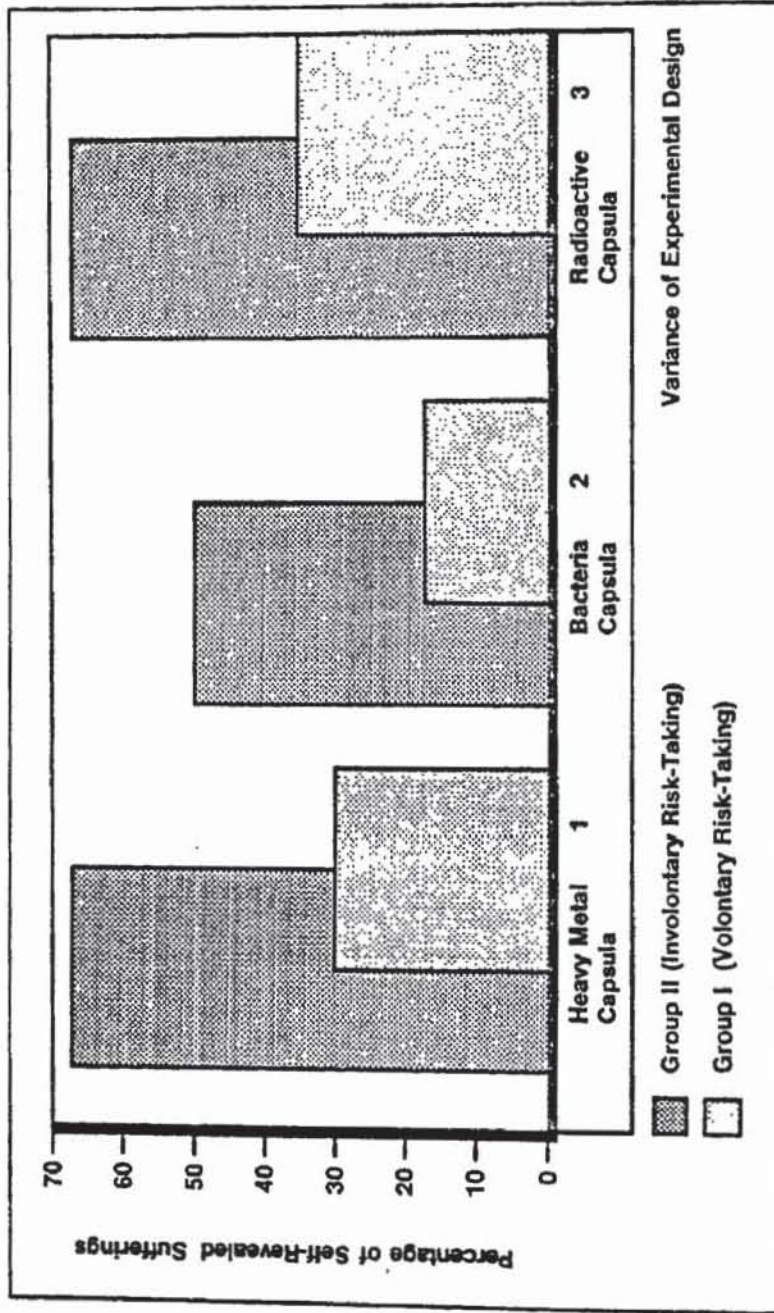


Fig. 3 Results of the capsula experiment

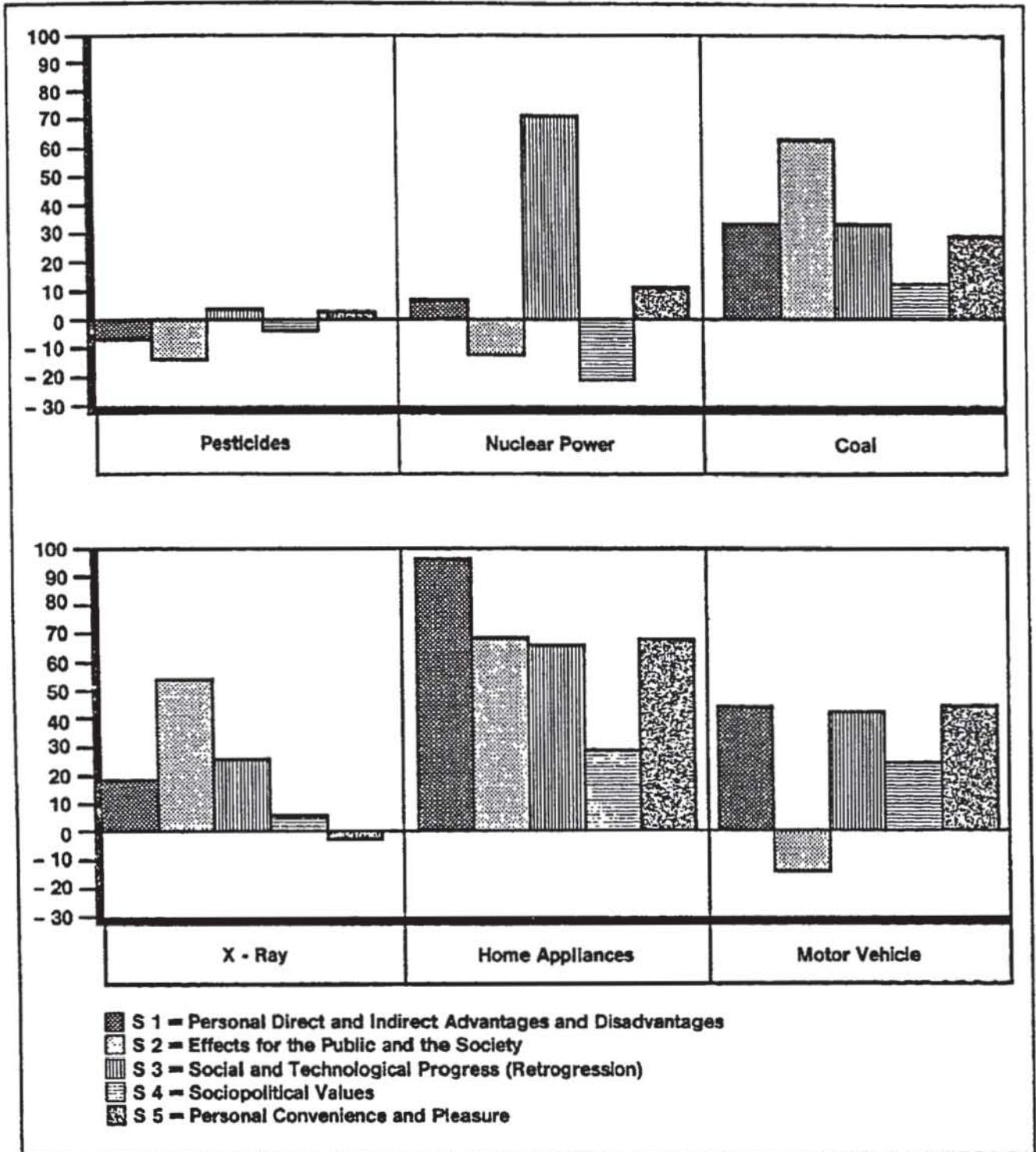


Fig. 4 The importance of five belief factors with respect to the risk estimation of various technologies

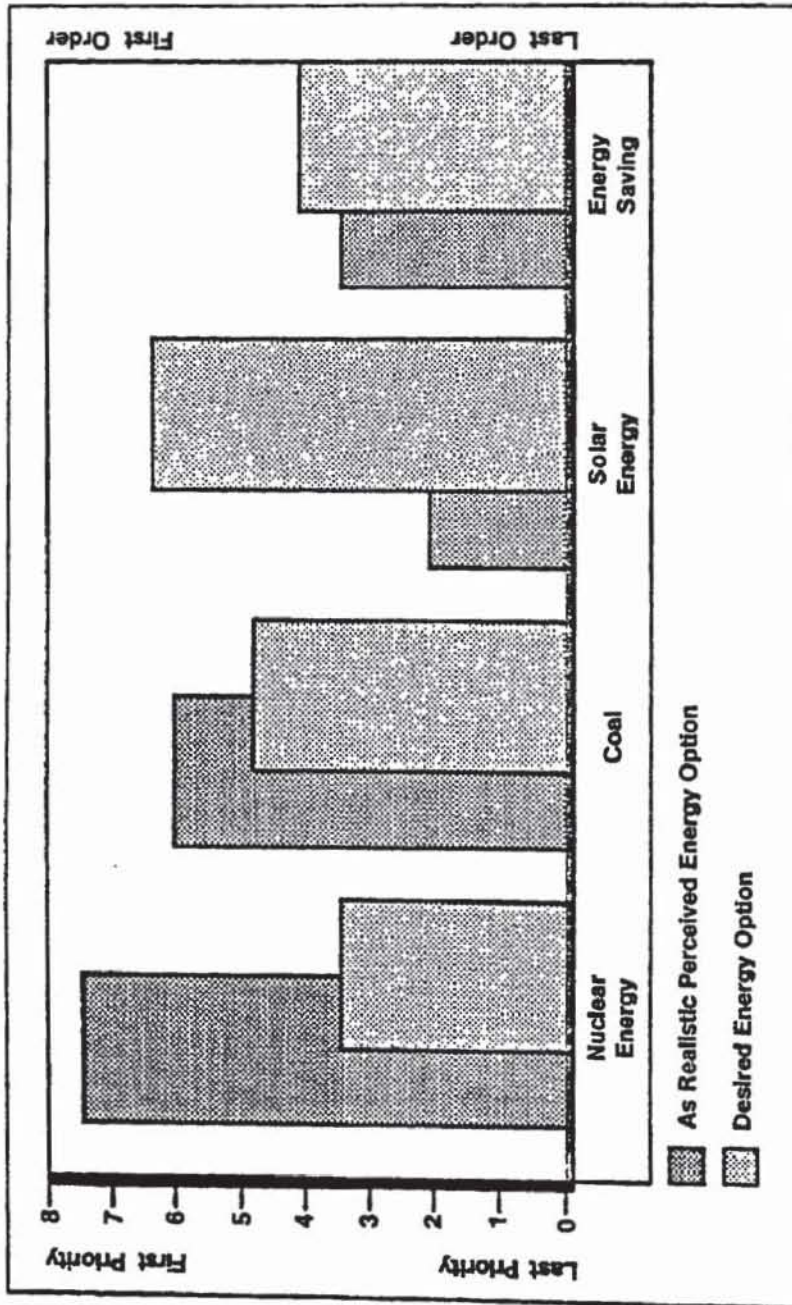


Fig. 5 The discrepancy between desired energy future and perceived reality

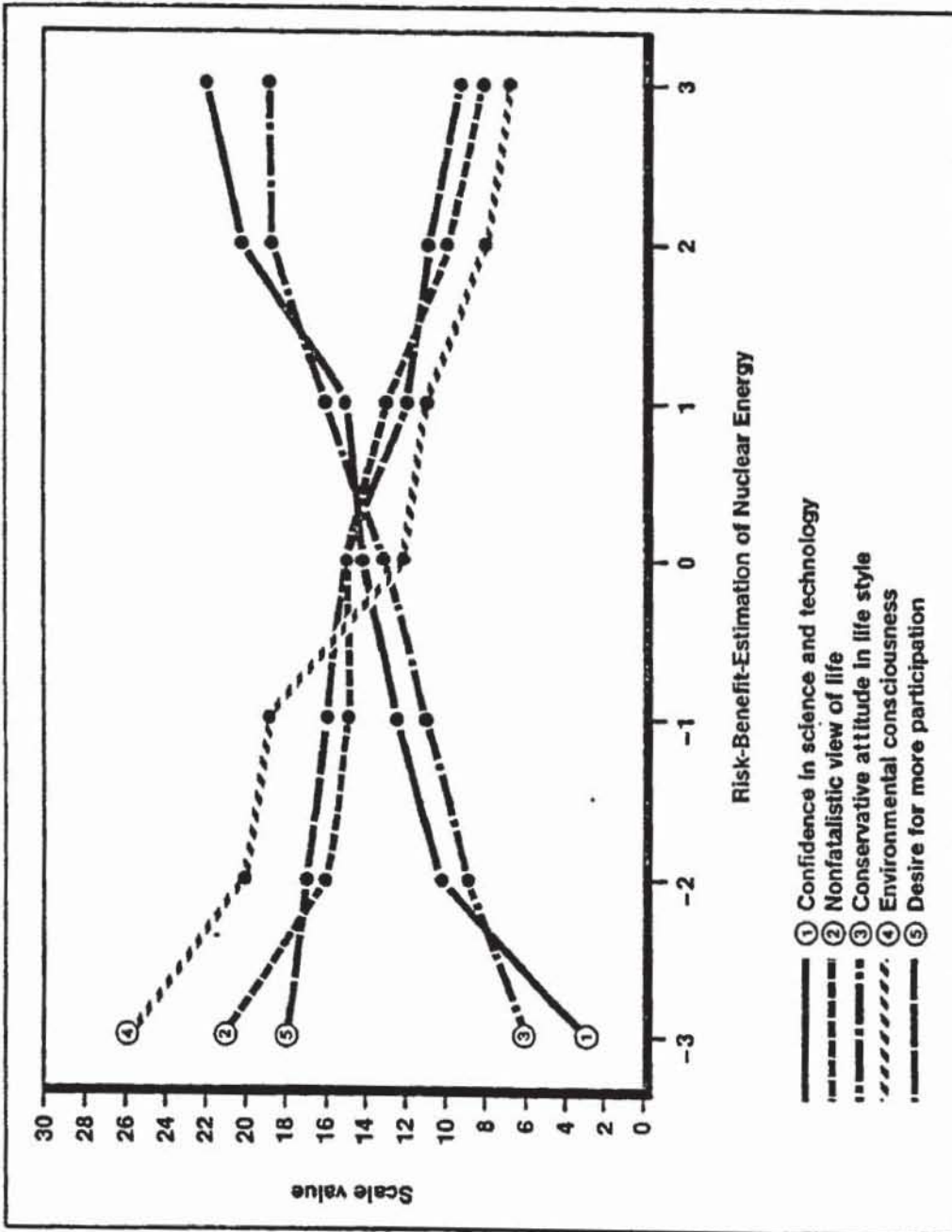


Fig. 6 Risk-benefit-estimation of nuclear energy as a function of socio-political attitudes

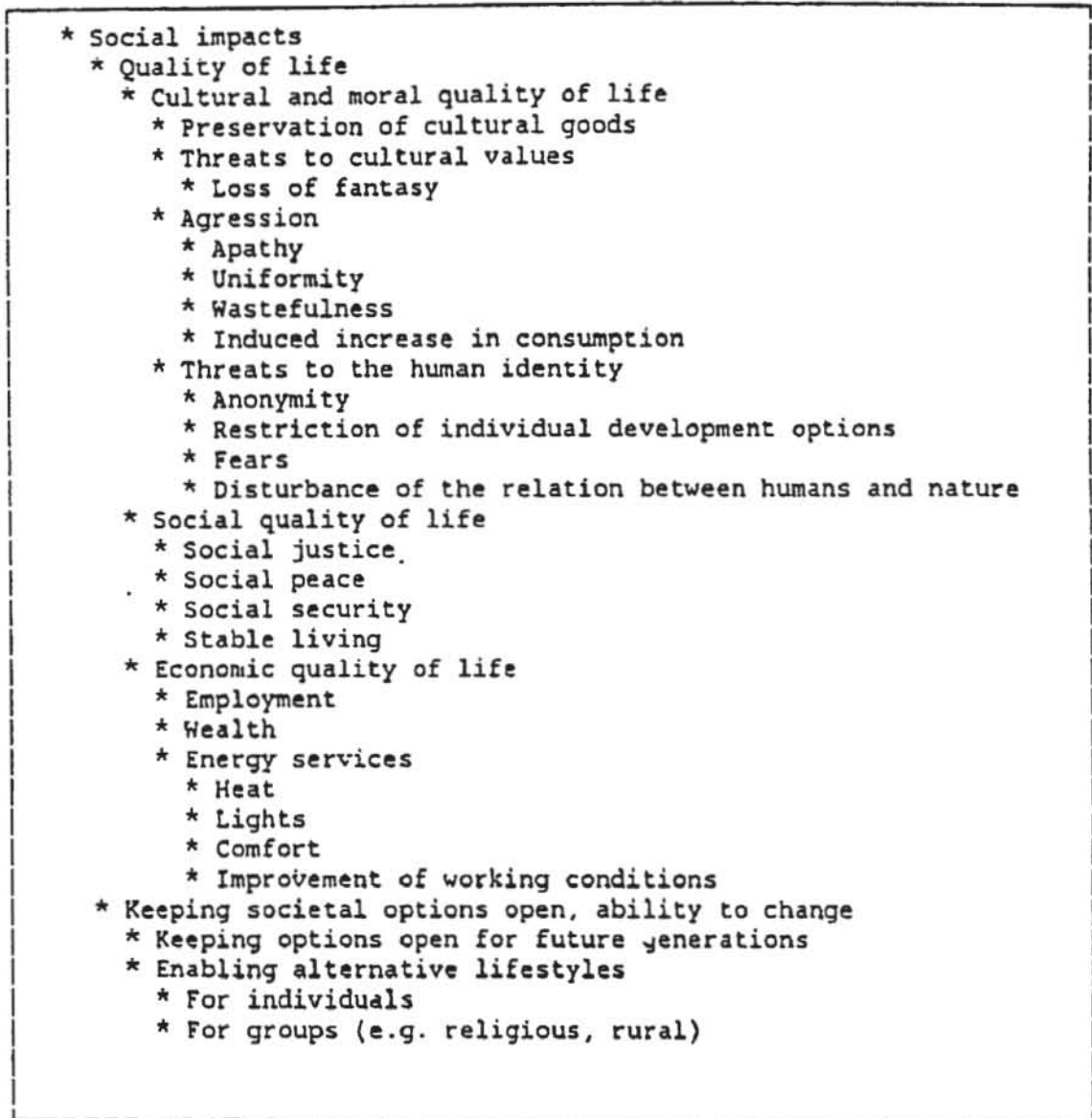


Fig. 7 Part of combined value tree structure "Social impacts"

Table I. Credibility attributed to institutions on questions of nuclear energy

Institution	Total median value	Median values		t-test (p)
		Opponents	Adherents	
Professor at a nuclear research centre	1.44	1.88	1.47	0.00
Scientist at a university	1.72	1.88	1.71	0.03
Reactor safety commission	1.95	2.24	1.80	0.00
Federal Minister of Research and Technology	2.09	2.34	1.99	0.00
Scientist in a citizens' action group	2.32	2.18	2.50	0.00
Representative of the medical profession	2.39	2.42	2.38	0.60
Federal Chancellor	2.40	2.68	2.36	0.00
Speaker for a citizens' action group	2.60	2.39	2.73	0.00
Chairman of a utility company	2.69	2.91	2.43	0.00
TV commentator	2.70	2.77	2.67	0.18
Speaker for Social Democratic Party (SPD)	2.95	3.06	2.84	0.01
Speaker for Christian Democratic Party (CDU)	2.96	3.03	2.86	0.04
Politician	2.99	3.07	2.95	0.09
Speaker for Liberal Democratic Party (FDP)	3.00	3.00	3.01	0.93
Journalist	3.03	2.97	2.96	0.87
Manager of an industrial company	3.10	3.32	2.89	0.00
Local politician	3.12	3.17	3.06	0.15
Trade union chairman	3.20	3.24	3.12	0.10
Priest	3.56	3.37	3.40	0.64
Chairman of the German Football Association	3.87	3.84	3.68	0.01
Average value	2.71	2.80	2.64	0.01
Confidence interval	±0.23	±0.64	±0.38	

Medians; range: 1 = high credibility 4 = zero credibility

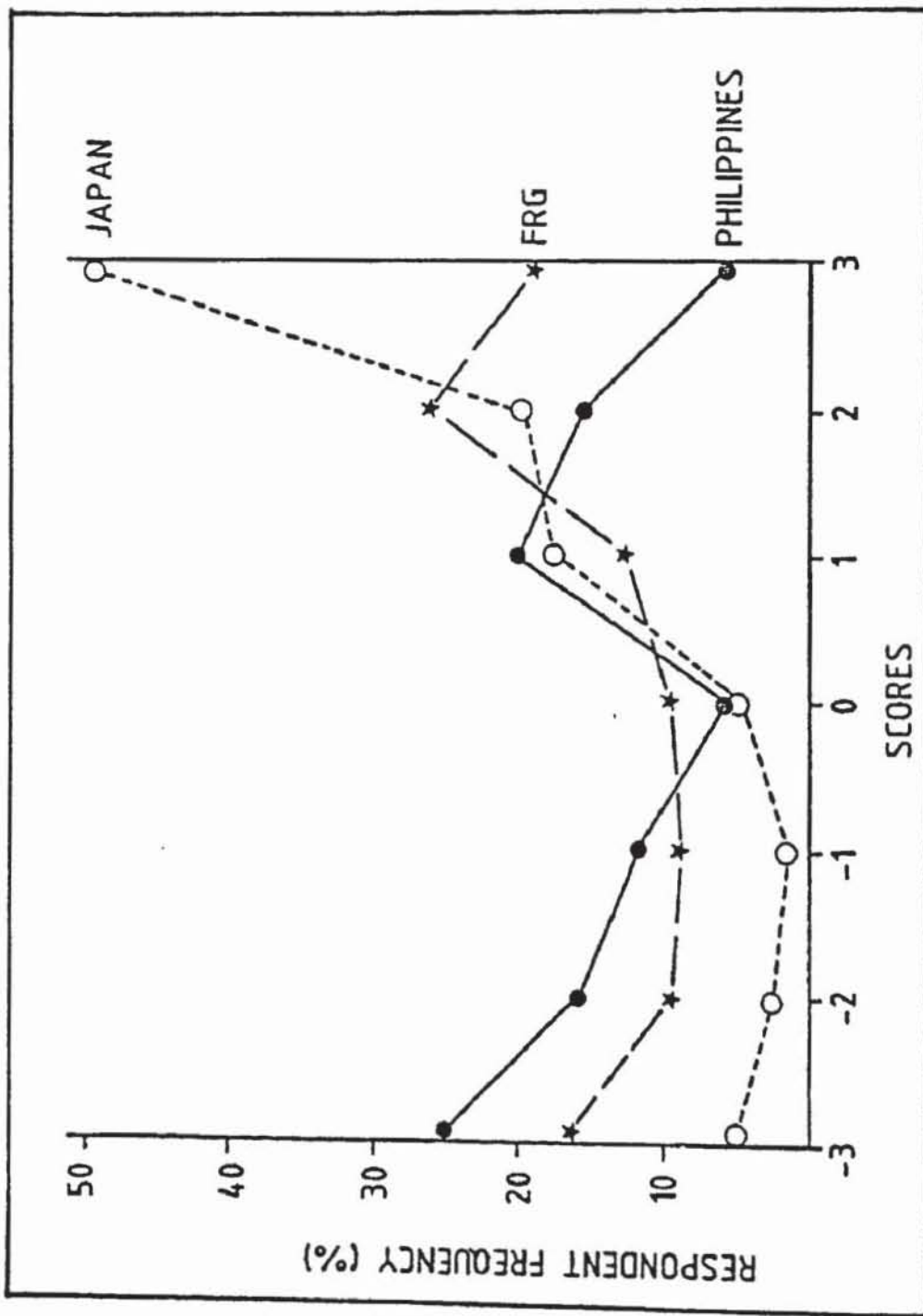


Fig. 8 Pro/Con scale frequencies in different countries

Table 2 Discriminant coefficients and mean differences between three samples

EB	Mean German Students	Mean Japanese Students	Mean Philippine Students
1 Conserve natural resources (7)	4.42	2.09	-0.37
2 Increase nation's prestige (22)	0.09	1.34	2.64
3 Assuring economic independence (12)	1.92	1.33	-2.16
4 Technology as tool in international politics (15)	-1.28	-1.78	0.29
5 Management of dangerous wastes (6)	-0.08	1.73	-2.71
6 Leads to equal income distribution among nations (30)	-2.45	-1.14	-0.94
7 Promotes industrial development (3)	1.93	3.14	3.58
8 Restricts options for future societal development (21)	+2.27	+0.92	+0.31
9 Postpones the development of alternative energy sources (14)	-0.22	2.04	-1.15
10 Provides cheap energy (17)	2.45	2.59	-1.38
11 Long-term solution to energy needs (19)	0.35	2.21	-0.13
12 Restricts personal freedom (2)	1.9	1.3	-2.16
13 Leads to environmental pollution (20)	-1.95	-2.37	-4.84
14 Leads to proliferation (28)	-1.46	-1.35	-0.89
15 Uses up valuable land (9)	-1.28	-1.77	0.29