

# SIXTH FRAMEWORK PROGRAMME



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**NEEDS**

**New Energy Externalities Developments for Sustainability**

## INTEGRATED PROJECT

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Sub-priority 6.1.3.2.5: Socio-economic tools and concepts for energy strategy.*

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**“Establishment of social criteria for energy systems”.**  
Updated report on social indicators accommodating Delphi results

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#### **Authors:**

Prof. Dr. Ortwin Renn University of Stuttgart

Dr. Jürgen Hampel University of Stuttgart

Diana Brukmajster M.A. University of Stuttgart

#### **Stream Leader:**

Stefan Hirschberg, PSI

#### **Workpackage Partners:**

Ph. D. Helene Connor HELIO International

Christophe Rynikiewicz HELIO International

Ilona Graenitz GLOBE International

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## **Abstract**

This report will inform about the development and selection of social indicators for the measurement of social effects of energy systems. As it is within the NEEDS Project the aim of Workpackage 2 to define social indicators for the assessment of social effects of energy systems we applied a multistep-approach. In a first step, it had been looked for existing indicators available in publications from the last twenty years. The keywords “social indicator”; “sustainability”, “environmental indicator” and “energy indicator” has been used to organise this search process. As a result of this research process 1320 indicators could be found. In a second step, these indicators have been proved according to the following meta-criteria:

1. The clarity of the indicators.
2. Whether the indicators are simple and logical.
3. Whether the indicators can be applied throughout Europe.
4. Whether they combine social and energy-system related aspects.

Only 148 of the 1320 criteria passed this step of the search process. These indicators had been proved according to three main questions, which should make sure that the indicators are suitable with the requirements of the NEEDS-project:

1. Whether they can be applied to future technologies.
2. Whether their focus is on the level of countries and not only on the regional level
3. And whether the indicators allow to differentiate between energy technologies.

Only 26 of the 148 indicators survived this filter process and are able to measure the social dimension of present and future energy systems. These indicators had been attributed to concepts derived from the theoretical concept of social compatibility (Häfele/Münch/Renn 1985). With reference to the theoretical concept of social compatibility we allocated the indicators to four main criteria, this criteria are:

1. Continuity of Energy Service over Time
2. Political Stability and Legitimacy
3. Social Components of Risk
4. Quality of Life

For every criterion suitable indicators have been defined and added. Those mentioned criteria and indicators build the basis of our social indicator-set. The indicators will be measured with reference to the four main life cycle phases of energy systems: energy extraction and processing, transport, power plant (conversion to electricity) and waste management (considering the entire back-end).

An updated version of indicators will be the outcome of a Stakeholder-Delphi. The stakeholders are invited to the Delphi to give a crucial input for the final version of the social indicators. The results of the Delphi and the final set of the social indicators will be added to the present report and complement it.

## 1. The Objective of the NEEDS project

The objective of the NEEDS Project is to evaluate the full costs and benefits of energy systems and energy policies, both for individual countries and for Europe. While the debate on the internalisation of external costs of energy systems is usually focused on environmental costs, the NEEDS-project also addresses the social components. Within the NEEDS-project, one of the genuine tasks of Research Stream 2b is the definition of indicators<sup>1</sup> for the assessment of social effects of energy systems. Doing that, Research Stream 2b intends to extend the evaluation basis for the internalisations of external costs of energy systems. In order to do this, the existing scientific literature has been reviewed to collect existing indicators for the evaluation of the social dimension of energy systems. Where the review of the literature did not lead to applicable indicators, new indicators had to be developed. This report gives an overview on the selected indicators. An updated version of indicators will be the outcome of an Expert-Delphi. This will form the basis for the final selection of social indicators that will be integrated into the corresponding sets of environmental and economic indicators established in Stream 2b. This integration will require some readjustment to avoid redundancy and to identify potential gaps or needs for revisions.

## 2. Internalisation of externalities

According to the economic theory, economic actors act in a rational way, when they maximise the expected output of their investments. But, as the debate on external costs has shown, this is only true when the market prices of a good or a service reflect the full costs. If there are components of the costs, which are not reflected by

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<sup>1</sup> What the term „indicator“ means seems not always to be clear. A lot of varying definitions can be found. For example:

- An indicator is a variable that describes the state of a system. (Walz et al. 2000)
- Indicators arise from values (we measure what we care about), and they create values (we care about what we measure) (Meadows 1998)
- Indicators are presentations of measurements. They are bits of information that summarize the characteristics of systems or highlight what is happening in a system. Indicators simplify complex phenomena, and make it possible to gauge the general status of a system. (...) An indicator quantifies and simplifies phenomena and helps us understand complex realities. (IISD 2000a, <http://iisd1.iisd.ca/measure/faqs.htm>)
- (An indicator is) “A parameter, or a value derived from parameters, which points to, provides information about, describes the state of a phenomenon/environment/area, with a significance extending beyond that directly associated with a parameter value” (OECD 1994:9; OECD 1998: 107).

In this report we like to take on the definition of indicators, which was done by the OECD. By parameters we mean “a property that is measured or observed” (OECD 1994: 9; OECD 1998: 107).

the price, the allocation of resources according to distorted prices leads to sub-optimal solutions.

One of the fields where the appropriateness of prices and their relevance as indicators of the real costs are discussed is the field of energy supply. Among others, environmental NGOs point out, that the environmental effects as well as the social impacts of energy systems are not sufficiently reflected in the prices. Full costs can be defined as the sum of market prices and external costs (benefits), i.e. those costs (benefits) that are not included in the market prices but represent (dis) utilities associated with the production, consumption or disposal of the good. While it is easy to assess market prices, the assessment of external costs is a difficult challenge.

The problem is, how to define assess and measure external costs. The definition and measurement of external costs is far from being trivial and it is more difficult in the sphere of social impact than it is in the sphere of environmental impacts. Theoretical concepts trying to define social functions, which are necessary for the existence of a society, have been contradictorily (compare f.e.: Parsons 1952, Münch 2004, Luhmann 2002).

But it would be misleading to conclude from the problems finding a consensus on essential societal functions that the social sphere should be neglected or ignored. The history of energy politics, in particular with respect of nuclear policies, has demonstrated how important the social dimension is for decision-making processes. The challenge is how to define a rationale for the systematic delineation of social indicators, which allows integrating the social dimension of energy systems into the decision-making process. In order to develop such a rationale it is important to distinguish three sociological approaches to address this question:

1. Social indicators research
2. Research on the social dimension of sustainability
3. Studies on the social accountability of energy systems

## **2.1 Approaches to conceptualise and measure the social effects of energy systems: Social Indicators Research**

In the 1960s growth oriented economic indicators such as the GNP dominated the discussion on the welfare of nations. This dominance of economic indicators has been criticised by social scientists who claimed that these measures are inappropriate to represent the welfare of societies. In consequence, social indicators research was developed to provide the information of an informed social policy and to measure social change in the tradition of William F. Ogburn (1950). The starting point for this development was a NASA project aimed at studying the social impact of space research. Scientists involved in this project did not only claim a lack of appropriate data, but also a lack of scientific methods to study the problem.

“The felt need was for more adequate monitoring and reporting of social conditions and processes – implying a need to develop improved measures of these phenomena, together with expanded data collection capabilities. Thus the dual goals of the social indicators movement were apparent from the start: to establish an improved social reporting capability as soon as possible and to encourage long-term research and development in the general area of social measurement and model-building” (Johnston 1990: 433, cited acc. to Habich, Noll 1993:5). According to a definition from Wolfgang Zapf (1977: 5) social indicators are all statistical information, which are relevant considering quality of live, modernisation and an active societal policy.

## **2.2 Approaches of the social indicators research**

Since its development in the 1960s, social indicators research has mainly concentrated on the measurement of quality of life and the quality of living conditions. One example for such empirical studies is the German Wohlfahrtssurveys (German-Socio-Economic-Panel), a large panel study based on households that allows analyses of the development of individual living conditions. Another example is the world database on happiness collected by the Dutch psychologist Ruut Veenhoven (<http://www2.eur.nl/fsw/research/happiness>). The major task of social indicators research is the production of social reports, which inform society about the conditions of life in a given society.

There are different understandings of what quality of life means. Social indicators research distinguishes between objective and subjective indicators. While the American quality-of-life approach concentrates on subjective indicators and measures the satisfaction of people with their lives and their conditions of life, the Scandinavian resource-approach focuses on objective indicators for the measurement of quality of life. The German approach is a combination of both approaches (for the discussion of theoretical concepts for the measurement of quality of life see Zapf 1984).

Social indicators research has produced different sets of social indicators<sup>2</sup>. The World Data Base on happiness is one of the most widely used approaches. The task group on social indicators of the ZUMA in Germany has collected time series for about 400 different indicators<sup>3</sup>. In general, social indicators research has experienced a wide international application and popularity, at least for the decades between 1960s and 1980s<sup>4</sup>. National reports about the quality of life in various European countries differ slightly in the dimensions they address<sup>5</sup>, but there is an emerging consensus among social scientists that social indicators should reflect topics such as population and demography, labour market, income, housing, health and social security. Most national and international indicator systems do include those aspects.

Despite its success in the field of social reporting, social indicators research faces one central problem: It focuses on individual quality of life and the individual's perception of his or her quality of life. It reflects more the aims of traditional social policy than attempts to internalise external costs. Authors like Esping-Andersen (2000) have criticised social indicators research as being only descriptive and collecting data without an underlying theoretical conception, which ideally should guide the selection of criteria and indicators.

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<sup>2</sup> see for an overview Noll 2002

<sup>3</sup> see Habich/Noll 1993

<sup>4</sup> Noll 2002

<sup>5</sup> Habich/Noll 1993

### 3. The Concept of Sustainability

Another more recent approach to deal with the issue of social impacts of energy systems is linked to sustainability, which addresses the matter in a more sophisticated way. After the publication of the Brundtlandt commission report (1987), the term “sustainability” has become one of the most popular goals of political and scientific actors. The Brundtlandt Commission defined sustainable development as a process meeting “the needs of the present without compromising the ability of further generations to meet their own needs”. The concept of sustainability, as it was formulated by the Brundtlandt commission, was developed in order to address two interrelated problems: the global ecological crisis and the increasing global discrepancies between the North and the South. It assigned equal importance to two time reference levels: the present and the future integrating the intragenerational and the intergenerational dimensions. Combining both objectives sustainability implies that the needs of the people living in the present should be met, but in a way which does not compromise the ability of further generations to satisfy their needs (see Renn 1994; Renn/Kastenholz 1996: 92; Knaus/Renn 1998: 61).

The popularity of the term “sustainability” increased after the Rio Declaration of 1992. According to this declaration, sustainability addresses a healthy and productive life in harmony with nature (principle 1) as well as the health and integrity of the earth’s ecosystem (principle 6). In this understanding, sustainable development focuses on ecological principles, but other goals are added, f.e. eradicating poverty (principle 5), the participation of all concerned citizens (principle 10) and the inclusion of women in decision-making processes (principle 20)<sup>6</sup>.

But despite the popularity of the “sustainability concept”, there is no general consensus about the definition of sustainability. Reflecting very heterogeneous goals, sustainability seems to be far away from producing a common understanding among different science and policy camps (see Tremmel 2003). According to Kreibich (1996: 40), there are about 70 divergent definitions of sustainable development in the international discussion<sup>7</sup>. The lack of analytic precision may be due to the fact that

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<sup>6</sup> <http://www.unep.org/Documents.Multilingual/Default.asp?ArticleID=1163&DocumentID=78&l=en>

<sup>7</sup> Also Jüdes (1997) and Pezzey (1992) point this out.  
Some Examples of definitions of sustainability:

sustainability did not start as a scientific concept but as a political and ethical goal and its conceptual foundations remain at the very general level addressing values such as justice and stability.

Systematically, most authors distinguish the following three dimensions of sustainability (see Weber-Blaschke, Mosandl, Faulstich 2004: 8):

1. Ecology
2. Economy
3. Society

There are different views about the relative importance of these dimensions: some authors place priority on the ecological dimension, others define each of the three dimensions as equally important, and for others (i.e. Brand 1997) the social dimension should take priority. The latter preference seems to be surprising at first glance, but according to Brand (1997: 13), the concept of sustainability transforms the problem of the protection of the environment into a problem of the appropriate use of natural and social resources. He addresses sustainability as a new developmental path leading to self-containment when exploiting natural resources in respect to a) future generations, b) global opportunities for development and c) the interlinkage of ecological, economic, and social aspects of development. But even in this understanding, the dominance of the social dimension in this approach is only linked to a procedural agenda, because also for Brand the central goal of sustainability is the societal organisation of ecological sustainability.

Many authors, who follow an anthropocentric understanding of sustainability, claim that the protection of the environment is not a goal of its own, but is a means for giving future generations the opportunity to satisfy their needs (weak sustainability). Other authors pursue a physiocentric understanding of nature and have developed a

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- “Sustainable development means living on the earth’s income rather than eroding its capital.” (DoE 1996: 1)
  - “Sustainable development means to use less nature, to include more people” (Sachs 1999: 76)
  - “Sustainable development requires integration of economic, social and environmental concerns: Ensuring economic efficiency while respecting social equity and safeguarding ecological integrity”. (OECD 2000: 150)
  - “Sustainable development is not about compromise, but about integrating economic, environmental and social factors for long term benefit.” (J.M. Smith Shell Chemicals 1999: Taking a measure of sustainability. In Morse 1999: 19).

set of inviolate values linked to environmental quality independent of human benefits (strong sustainability).

Given the heterogeneous understanding of sustainability, it is not surprising that there is no consensus how to define, let alone conceptualise, the social dimension of sustainability. While some authors link social sustainability to the contribution of societies to reach the ecological goals of sustainability, other authors associate social sustainability with social justice and equity with respect to living conditions. These two understandings of sustainability are problematic, because an ecological framing of social sustainability ignores the other crucial factors that influence the conditions for meeting the needs of the present and the future generations. But also a welfare related understanding of sustainability raises problems: Social justice or social equality is only weakly correlated with the intergenerational dimension of sustainability. If one follows the understanding that social sustainability is directed towards intragenerational justice, social sustainability addresses more the level of consumption of goods than their production over time. If it is more linked to intergenerational justice the continuity and availability of ecological, economic and social resources are at the core of the analysis.

A concept that addresses intergenerational sustainability has been developed by the World Bank (World Bank 1997). It differentiates between four types of capital: natural capital, produced/man-made capital, human capital and social capital. The goal of sustainability is to pass on to the next generation at least as much natural, economic, human and social capital as the current generation has at its disposal.

Following an understanding of sustainability, which gives the social dimension the same analytic importance as the ecologic dimension, the problem of social sustainability addresses the societal organisation of processes, which lead to a path of overall sustainable development. For that reason, social institutions and institutionalised decision-making processes are as important for human beings as an unspoiled eco-system and the distribution of goods. Societies must be able to cope with problems over time (see Grunwald 2004). In modernization theory, the ability of systems to survive processes of change is described as “ultrastability” (Cadwallader 1959). Ultrastability means, that a complex social organisation sustains even when the environment of the organisation is changing. Cadwallader appoints problems like

information processing and the feedback of information as the central topics for ultrastability.

Reflecting the dual ambitions of social sustainability, more than one goal has to be addressed. According to Grunwald (2004), three general goals have to be fulfilled: Securing Mankind’s Existence, Upholding Society’s Productive Potential and Keeping Open Options for Developments and Action. To reach these goals, (Grunwald 2004:115) has developed a set of rules (see table 1):

**Table 1: GOALS OF SUSTAINABILITY**

Goals	Securing Mankind’s Existence	Upholding Society’s Productive Potential	Keeping Options for Development and Action open
Rules	<i>Protection of Human Health</i>	Sustainable Use of Renewable Resources	<i>Equal Access to Education, Information, and Occupation</i>
	<i>Securing the Satisfaction of Basic Needs</i>	Sustainable Use of Non-Renewable Resources	<i>Participation in Societal Decision-Making Processes</i>
	<i>Autonomous Self-Support</i>	Sustainable Use of the Environment as a Sink	<i>Conservation of the Cultural Heritage and of Cultural Diversity</i>
	<i>Just Distribution of Chances for Using Natural Resources</i>	<i>Avoidance of Unacceptable Technical Risks</i>	<i>Conservation of Nature’s Cultural Functions</i>
	<i>Compensation of Extreme Differences in Income and Wealth</i>	<i>Sustainable Development of Real, Human, and Knowledge Capital</i>	<i>Conservation of Social “Resources”</i>

Source: Grunwald 2004:115

**4. The need of participative decision-making processes for developing social indicators**

As stated earlier, the objective of the NEEDS Project is to evaluate the full costs and benefits of energy systems and energy policies, both for individual countries and for Europe. The specific objective of the Research Stream 2b is the integrated evaluation of sustainability. To achieve this objective, indicators for the economic, the ecological and the social dimensions of external costs of energy systems need to be developed.

While ecological and economic indicators relate to dimensions most of which can be measured in quantitative terms, the measurement of social aspects creates more difficulty, on the conceptual and the empirical level.

Social indicators cannot be derived from an overarching functional societal theory because a consensual widely accepted theory does not exist in the social sciences about basic societal functions. Hence, most social theories restrict their focus on the description and interpretation of social actions at the micro- or mesolevel looking into organisations, institutional settings, subjective orientation and instrumental function etc. Two major types of theories have emerged in sociology to explain how values are selected and mentioned.

The first type of theory is the consensus theory. Consensus theories assess that society is maintained through shared opinions about norms and values, which are expressed in what Durkheim called a “collective conscience” (Etzioni 1993). Consensus theories are based on the assumption that social order is a product of negotiation and agreement and structural changes emerge through evolution. Furthermore, conflicts originate with people or groups who deviate from social norms or societal rules and values. As a counterpart to consensus theories, conflict theories, the second type, try to explain the emergence and stability of commonly shared values and behavioural conformity. Theorists suppose that ruling groups impose their values upon others and that there cannot be an ultimate collective agreement referring to values (Coser 1956, 1967, Blalock 1989). Therefore social order is maintained only through pattern of dominance and power and changes might occur only through sudden perturbations such as revolutions. Consensus has to be reached in a coercive way, because it convinces people to surrender their individual interests in exchange for the (real or alleged) betterment of the majority.

Both types of theories have been criticised. The consensus theories have been criticised for justifying dictatorships and totalitarian regimes (Bachrach 1967). Conflict theories have been criticised for ignoring the importance of order for social reproduction: individual, society and the culture (Bernard 1983).

As it was pointed out, both types of theories are contested among peers and are not able to explain structures and important values of the society in a generally accepted way. Furthermore both types of theories are in their results limited to the macro-level of society. For example, social consensus theories, like structural functionalism

(Parsons 1952) and social theories of conflict like the conflict theory of Marx (Marx 1971, Evans 1972) study the society as a whole. This contrasts with micro level social theories like the theory of social interaction by Weber or Mead, which places individual actions and motives in the centre of sociological explanations (Weber 1962; Mead 1934). Sociology is characterised by competing schools of thoughts and theories and many theories coexist about similar or identical phenomena. There is no common agreement on which theory can claim universal validity for explaining the behaviour of all social groups and individuals. The lack of theoretical agreement is accompanied by a lack of empirical strategies to identify basic functional requirements through observation and experimentation. Since most social interactions are highly interdependent and causal structures are not obvious when reporting human behaviour, any empirical analysis is forced to have a conceptual model about causes, intervening variables and effects in place before the empirical analysis can start. In addition, human behaviour is driven by mental processes that are not directly observable but rely on interactions between the researcher and the subject. Subjects, of course, have the possibility to hide their motives and behavioural options, re-interpret their own motivations, or simply lie to the researcher. Hence, two of the main problems in the social sciences are, first, the reliance on conceptual models for guiding empirical research (that cannot be justified by purely objective criteria) and, second, the empirical filter of research subjects when reporting their motives and pre-behavioural thoughts.

One possibility to treat both problems is the use of participative or recursive analysis. The researcher uses the research subjects for framing the main conceptual model and to revalidate the empirical results by comparing them with the interpretations of the subjects. The advantage of this method is that the subjects are in the driver seat and shape the research process. They have to agree on a common empirical research design and are empowered to assist in the interpretation of the results. The disadvantage is that these subjects can distort the results by having interests drive the research design and the interpretation. Participatory analysis works best when subjects with many divergent interests and values are part of the analytical process. In this case they need to find a common understanding of the problem and the material beyond each individual interest and thus get closer to an intersubjective interpretation of reality.

In our project, this major condition is given since our task is to identify and select indicators for the social dimension of sustainability by reaching out to different value and interest communities. Rather than deducing indicators from theories, we build upon consensus processes within participative procedures involving multiple stakeholders and multiple values and attitudes.

#### **4.1 Participative decision-making processes**

In addition to the knowledge generation aspect of participatory methods in the social sciences, there are normative reasons for choosing this alley of social research. Politicians and experts value the instrumental and legitimising function of feeding the values and preferences of people, who might be affected by decisions that they make, into the formal decision-making process. Traditional decision-making strategies that do not consider citizen's values are vulnerable to two major criticisms: "First, because they de-emphasize the consideration of affected interests in favour of "objective" analyses, they suffer from a lack of popular acceptance. Second, because they relay almost exclusively on systematic observations and general theories, they slight the local and anecdotal knowledge of the people most familiar with the problem and risk producing outcomes that are incompetent, irrelevant, or simply unworkable." (Renn/Webler/Wiedemann 1995: 1) Citizen involvement in decision-making processes addresses these problems. For our understanding and further research we adopt the definition of public participation from Renn et al. (1995). Here public participation is defined as: "forums for exchange that are organized for the purpose of facilitating communication between government, citizens, stakeholders and interest groups, and businesses regarding a specific decision or problem." (Renn/Webler/Wiedemann 1995: 2) This definition explicitly excludes activities like protests or expert workshops. The focus is on the fair opportunity for citizens to take part in decision-making processes and to insert their values into decisions that might affect themselves.

There are several methods to let people participate in decision-making processes. Depending on purpose and intention, methods vary from formal hearings over mediation to consensus conference and citizen panels. These methods can use specific participatory techniques such as multiattribute decision analysis, value tree analysis or meta-plan procedures. The following chapters will illustrate the main

features of participative analysis by using the examples of 'value tree analysis' in the context of the 'citizen panel' method. The combination of value tree and citizen panels was the main characteristic of a study on the social compatibility of energy systems that was issued by the German Bundestag and conducted by a research team at the Research Center Juelich (Häfele et al. 1985).

#### **4.2 Procedural concept of the definition of social externalities:**

##### **The concept of social compatibility**

Lacking a functional theory of society, it is not possible to deduct externalities. What is defined as social effects and how these are evaluated, cannot be assessed without referring to the values in societies. For instance, whether the construction of a power plant is evaluated as a symbol of progress or as a blot in the landscape depends on the judgments of those making the evaluation, and these judgments depend on their value system. In addition to attempts to develop a deductive list of criteria and indicators for the measurement of externalities, there are also approaches, which attempt to define indicator systems with the aid of participatory methods. One of the early attempts in the field of energy indicators is the Jülich Energy study (Häfele et al. 1985; Renn et al. 1985; Renn 1986). Different to the concept of sustainability, which addresses the problem of the future functionality of societies, the Jülich Energy study addresses the problem from the perspective of the main social actors.

The concept of 'social compatibility' is based on the assumption, that decisions, which are made in the economic, political or technological field, should take societal values and visions into account. The considering of societal values in decision-making processes is seen as a crucial factor for understanding public concerns and to affect the citizen's acceptance of decisions. Taking into account societal values is a difficult task because in every society different kind of groups with different values exists. This aspect raises the question of how a consensus on values can be accomplished that is acceptable to all members of society. A second question touches upon the inclusion or integration of the participatory results into the formal decision-making process.

The concept of social compatibility tries to give an answer to this question. It conceptualises values as providing guidance for judging social desirability (Häfele et al. 1985: 50ff.). In this understanding, values describe "desirable circumstances in a

society” (Renn et al. 1985: 56) and give orientations for distinguishing desirable from non-desirable social actions. As a result, decisions that are made by politicians or experts are acceptable to society as long as they adhere to common values and desirable aspects. Therefore it is important to know the values of the society and to reach a consensus on those values that affect collective actions. These common values need to be accepted by every social group and individual. The concept of ‘social compatibility’ considers societies’ values in decision-making processes by combining the three steps of ‘value tree analysis’, ‘impact analysis’ and ‘citizen panel’ (Renn 1986).

### **4.3 The Value Tree and Impact Analysis**

The identification of concerns and values is best accomplished by asking all relevant stakeholder groups (i.e., socially organized groups that are or perceive themselves as being affected by the decision) to reveal their values and criteria for judging different options. It is important that all relevant stakeholder groups are represented and that a variety of value clusters, including economic, political, social, cultural, and religious values, is integrated into the analysis. Although strategic reasoning and hidden agendas may influence the responses of stakeholder groups, the mere listing of concerns as expressed in values and subsequently, the deduction of criteria helps to expose inconsistencies and to avoid hidden agendas. To elicit such values and criteria the technique of value-tree analysis has proven appropriate (Keeney et al. 1984; 1987). A value-tree identifies and organizes the values of an individual or group with respect to possible decision options (Keeney et al. 1984; Keeney et al. 1987). In the process of structuring a value-tree, representatives of different stakeholder groups are asked to identify their criteria and objectives for evaluating different options. Values in this context are abstractions that help organize and guide preferences.

A value-tree structures the elicited values, criteria, and corresponding attributes in a hierarchy, with general values and concerns at the top and specific criteria and attributes at the bottom. Depending on the political context and the nature of the decision to be made, the values of the various stakeholder groups may vary considerably. By giving each group the right to assign a weight of zero to each criterion that they regard irrelevant, it is possible to construct a joint or combined

value-tree that accounts for all viewpoints and can be verified by all participants (Keeney et al. 1984). Table 2 illustrates the six consecutive steps of eliciting value-trees.

**TABLE 2: THE SIX STEPS OF ELICITING VALUE-TREES**

<b>STEP NO:</b>	<b>DESCRIPTION OF THE STEP</b>
1	Personal interview(s) between the analyst(s) and several representatives of the respective stakeholder group
2	Structuring the values, criteria, and attributes into a hierarchical order by the analyst(s)
3	Feedback of the value-tree to the stakeholder group for comments or modifications
4	Iteration of process until stakeholder group is satisfied with the final product
5	Combination of all group specific value-trees into a single "megatree"
6	Validation of the megatree by all participating groups (with the option of assigning zero weights to criteria that they dislike)

Value-trees have proven to be useful instruments in structuring the underlying dimensions of a debate and in linking the general concerns of groups with the concrete options that they favour or disfavour (Keeney et al. 1987). In this respect value-trees help to focus attention on issues that seem to underlie conflicts about the selection of options and to develop a mediation program between conflicting groups. Value-trees are, however, contingent on the basic assumption of decision analytic models; that generating criteria for evaluating options and assessing the performance of each option on the criteria can be analytically separated into two independent tasks (von Winterfeldt and Edwards 1986).

After arranging values and criteria in a joint value tree, indicators for the preferred values are derived that are supposed to cover all dimensions that correspond with the selected values. This step is called 'impact analysis' because it is focused on the impacts that might be associated with each of the values. It is also focused on the aspects, which need to be considered when measuring the values. Values and criteria constitute abstract notions and cannot be measured but only transformed into indicators, i.e. operational rules for measuring the intention of each value. For example if people associate risks with a nuclear power plant they need indicators to measure the various dimensions of risk. Candidates for indicators would be 'health

effects', 'reduced life expectancy' or number of 'children with allergic reactions' etc. If researchers know the preferences and values of the various constituencies, factual information about the consequences of different decision alternatives and the hierarchical model of values and criteria can be used to find the most preferred alternative for the solution of the underlying problem. Therefore, it is the aim of this analysis to collect all criteria and values that are mentioned by social groups and individuals. By using an iterative process, the values are structured according to the subjective importance that different group attribute to them.

After the indicators are determined and the effects of each decision option measured, one still faces the problem of relative weights that can be assigned to each indicator. It is very unlikely that one decision option outperforms all other options on each criterion. Who should be entitled to assign the relative weights to each indicator in order to determine the most suitable decision option? The Juelich compatibility study used citizen panels for this task. This method is further explained in the following section.

#### **4.4 The Citizen panel**

A Citizens' panel is a 'deliberative' form of participation. Deliberative participation differs from normal public participation because it is not aimed to predetermined answers on predefined questions framed by policy makers. Instead, it is the aim of the citizen panel to let citizens express their experiences and priorities on a certain issue, and to frame their own suggestions and recommendations for policy makers to consider.

The model of citizen panels is based on a concept developed by P.C. Dienel in the 1970s. Dienel defines these panels as "groups of citizens who are selected by a random process and are given paid leave from their workday obligations for a limited period of time in order to work out solutions for given, soluble planning problems with the assistance of advisors on procedure" (Dienel 1980). Each panel includes 20 to 25 individuals who work on the predefined task in a group process. In order to encourage them to participate they are assigned the highly esteemed role of a "value consultant" in the public planning process. The characteristics of citizen panels are illustrated in Table 3.

**TABLE 3: CONDITIONAL CHARACTERISTICS OF CITIZEN PANELS**

STRUCTURE	CONDITION
Composition	Random selection of directly and indirectly affected citizens  Involvement of stakeholders and public officials as witnesses, not as participants
Tasks	Evaluation of different decision options in accordance with personal values and preferences  Clear political mandate to draft recommendations for legal decision maker
Operation	Continuous meeting over several days  Education process of participants about likely consequences of each option  Incorporation of uncertainty and dissent through public hearings and videotapes
Roles of Participants	Identification of participants as "value consultants"  Need for external, neutral, and unbiased facilitator  Low involvement of sponsor (confined to witness role similar to stakeholders)
Organization	Payment of an honorarium to each participant for working as a value consultant  Oversight committee for supervising the whole process and guaranteeing its integrity

Citizen panels are organized into three major components: (i) reception of information through lectures, field tours, videos, written material, and others; (ii) processing of information through small group discussions, plenary sessions, and hearings; and (iii) evaluation of impacts of options through small group discussions, personal judgments, and consensus-building exercises in the plenary. Informing the participants about the planning options and their likely consequences is the most vital part of the whole procedure. The major requirement is that all expert camps be equally represented in the information package and that they be allowed to present their own case. For example if a citizen panel is hold to let people assess different kinds of energy supply systems, they are informed about the sources of energy, energy technologies, possibilities of energy conservation etc. In that way, people get

the opportunity to be informed and to ask questions for improving their understanding of the issue.

Citizen panels are used as a sounding board to test different ideas, options and proposals or to examine the needs and values of the community for an issue at stake. The feedback from the panel participants may help to provide information and to develop options and recommendations for collective decision-making purposes. Furthermore, the panels help to identify important issues that require more intensive research and consulting. Because of such diverse application areas, the motivation to establish a citizen panel is widely spread: first, the citizen panel is an opportunity to understand why people have different preferences and why they express specific opinions or attitudes about problems. Second, citizen panels reflect a microcosm of the society at large and provide opportunities to include a large diversity of opinions, including minority groups. Third, they can be organised in parallel or in defined time periods in order to consider regional differences or changes of citizen opinions over time. Fourth, public officials usually cannot acquire sufficient information about citizens' preferences to make decisions that reflect society's expressed needs and values. Citizen panels provide a reliable method to get to most of the public preferences as a result of an informed choice. Fifth, if people are involved in decision-making processes they support decisions and develop ownership over the results of the official decision-making process.

### **5. The concept of social compatibility used for a citizen expertise**

In August 1982, the German Ministry of Research and Technology initiated a large research project to investigate the preferences of the German population with respect to four energy policy options developed by a parliamentary commission in 1979. The Government was interested in eliciting reliable information on which energy scenario was most appealing to the population and on what basis citizens would evaluate the policy options laid out in each scenario. A research team of the Jülich Research Center in Germany conducted a three-year study to collect data on public preferences and to analyse the motivations and underlying reasons for the judgment process of evaluating the predefined energy scenarios. The study was designed in accordance with the three phases of value tree analysis, impact assessment, and citizen panels.

1. Values and criteria to assess and evaluate energy options were identified by interviewing representatives of 13 major stake-holder groups in West Germany (Keeney et al. 1987). In total the groups generated 141 criteria to evaluate energy policies.
2. Approximately 30 energy experts were asked to give their best scientific estimates for the performance of each energy scenario on each of the revealed criteria (Renn 1986). The social, political, and psychological impacts were assessed by expert rating using the method of Group Delphi; the technical, economic, environmental, and international impacts were assessed by independent sub-contractors, such as the Prognos Institute in Basel (Switzerland) and the Institute of Foreign Policies in Bonn (Germany).
3. The resulting profiles of each energy scenario were conveyed to randomly selected citizens for evaluation and comment (Dienel and Garbe 1985; Renn et al 1985). The major tasks of the panels were to review the assessments, include their own values, and to make policy recommendations in accordance with their own preferences.

The study operated with 24 citizen panels (each including approximately 25 participants) drawn from seven communities in different parts of West Germany. The panel meetings were held in public buildings for four consecutive days. Naturally not all persons who were asked to take part in the procedure were able to attend. Around 20 percent of all invited persons did participate.

The objective of the panel meetings was to elicit the preferences of our participants and to lead them to evaluate the different options by taking into account the best scientific estimates of the likely impacts of each option, the political judgments of stakeholder groups, and their personal value judgments. The task for each participant was hence to rate each energy system according to the given criteria, to assign relative weights to each criterion, and to come up with a balanced recommendation as to which energy scenario should be implemented to meet future energy demands.

In addition to a scenario “business as usual” (reference scenario) a research team developed three scenarios describing potential development options for shaping the energy future. The scenario constructors chose two end-points for their three scenarios: 2000 and 2030. Each of the three scenarios represents different political

world-views on desirable energy policies. They were constructed in line with the main political worldviews in contemporary German society: The scenario “business as usual” is based on the assumption that all present trends continue to shape the future energy situation. The second scenario stands for a supply-based approach of placing more advanced energy production technologies such as nuclear power reactors into the economy. The third scenario reflects the vision of a sustainable energy path based on new conservation technologies and demand-driven policies. The fourth scenario captures the vision of a “green” society in which people change their behavioral patterns in addition to improving conservation technologies. This scenario is based on the assumptions that the global environmental problems are so serious that dramatic changes in human behavior towards lower end-energy use are demanded. These three scenarios were designed to capture the major positions of the observable public discussion by means of three models that, according to the stakeholder involved in the process, appear to dominate the public energy debate.

The scenarios were the basic options for the panel to evaluate. The participants had two opportunities for the assessment of the scenarios and energy systems:

1. The participants received the results of the value trees and the impact assessments;
2. The participants had the possibility to develop their own associations that could be used for the assessment of energy systems and policies.

For the assessment process, participants could use the joint value tree. This tree consisted of eight main criteria:

1. Economic costs. The ‘cost aspect’ refers to investments, which are necessary to supply energy. It also includes the cost of energy for the consumer and the present and future costs for investments in technological developments.
2. Security of supply. This criterion addresses the availability of energy and energy resources. Besides, it includes aspects such as flexibility and possible breakdowns of energy systems.
3. Economic effects. This term refers to effects on the employment market and the economic structure.
4. Environmental effects. The ‘environmental effects’ involve environmental damages on water, air, soil, and climate on a local, national and global level.

5. Health and security. The terms 'health and security' are taken together because they are associated with the same good. The criterion focuses on possible occupational and public health effects that might occur during the normal operation in the energy chain as a result of accidents or low safety precautions.
6. Social effects. With 'social effects' aspects like quality of work, income distribution, equity, standard of living or peaceful conflict resolution were included.
7. Political effects. The criterion 'political effects' incorporated aspects of political stability, freedom of action, and political sovereignty.
8. International effects. The term 'international effects' refers to justice over the distribution of global resources and to the lack of resources due to international crisis or war.

All participants at the citizen panel were asked to weigh those eight criteria according to their subjective importance and to develop recommendations in small groups of four or five people. During the four-day period participants were asked to fill out questionnaires with standardized categories as a means to learn more about their reasoning.

### **5.1 Results of the citizen panel**

By taking a closer look on the results of the panel, it becomes obvious that the most important criteria are all related to non-economic and material aspects. Over 35% of the participants decided that the criterion 'health and security' should be the most important criterion when assessing energy systems. The high importance of 'health and security' is attributed to the aspect that people are concerned about potential threats and health effects caused by energy systems. In particular the continuing discussion about nuclear energy and possible risks of this technology has probably contributed to the high weight given to this criterion. The second most important criterion for the assessment of energy systems is the criterion 'security of energy supply' (26%). Reasons for this might be the high dependence on oil resources and the concern about increasing energy prices. The third most important criterion, which was mentioned by the participants in the citizen panel, was 'effects on environment' (19%). It is assumed that the need of an intact environment and the awareness of

environmental threats caused by technological systems are of crucial importance for citizens' decision-making process<sup>8</sup>.

The three most important criteria 'health and security', 'security of energy supply' and 'environmental effects' show that non-material aspects are the most important criteria for the panelists in assessing energy systems. Neither cost nor other related economic aspects were rated as similarly important. Due to the relative low weighting by the panelists the problem of high costs seems to be less pronounced than it otherwise appears in actual policy making circles.

When asked for free associations linked to the evaluation of energy systems and scenarios, the participants rated 'guarantee of peace' the highest (70%), followed by 'employment guarantee' (68%), 'environmental protection' (42%) and 'citizen participation in decision-making processes' (34%)<sup>9</sup>. This, again, is an indicator that people prefer non-material arguments when they are asked for their basis for evaluating energy systems.

The study demonstrated that citizens are able to assess complex issues such as energy systems. Also, it proved helpful for policy makers to learn about citizens' values for decisions, because the emphasis of the citizens on non-material values came as a surprise to most of them. For considering social values in decision-making processes, it is important to have methods such as citizen panels in place and do not rely on anecdotal evidence or non-reflected opinion poll results. Especially for such difficult decisions such as investing in a new energy system, citizens need to be involved in the process because if f.e a new power plant will be built and citizens do not agree with the decision they can imitate a strong movement against the technology. This can be avoided if politicians and experts take into account the "desirable circumstances in a society" (Renn et al. 1985: 56).

The concept of social compatibility and the use of participative research methods have demonstrated that social indicators need to be derived in a procedural and participatory way. Only by using such a method, values and attitudes of citizens can become visible and productive for further decision-making processes.

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<sup>8</sup> For further information see Dienel/Garbe 1985: 77ff.

<sup>9</sup> For further information see Dienel/Garbe 1985: 86ff.

The preceding chapters have informed the reader about the problems of the theoretical and empirical sustainability of social indicators. It was shown that social indicators cannot or only in a very difficult way be derived from theoretical models since these do not make a claim for universal validity. Thus, participative discourse processes were suggested for the development of social indicators. The advantage of this procedure is that the citizens are involved in the development of values, which are commonly regarded as being socially worth striving for. These values function as the frame model for the development of social indicators, as it was especially shown in the concept of social compatibility.

The opportunity to carry out a participative discourse process is not given for the development of the social indicators in our project. The development of social indicators – as presented in the following chapters – refers to a process consisting of several steps: Firstly, we searched in the latest literature for social indicators and collected them. Secondly, the collected indicators are checked for their suitability within the NEEDS project and its aim to measure “full costs and benefits of energy systems and energy politics”. In a further selection, we will orientate ourselves at the explained concept of the social compatibility and its resulting social values. This means that social indicators will be developed for and assigned to energy systems based on the criteria which were analysed within the discourse process of the Jülich research team as absolutely necessary and important for the society

## **6. The development of social indicators for the evaluation of energy systems:**

### **The selection of social indicators**

The collection of already existing social indicators was carried out by a literature and desktop research. The literature research was based on the information system of the academic libraries in South-West-Germany and on the information system of public libraries. We looked for publications - books, newspapers, magazines and journals - referring to sustainability and energy - published within the last twenty years. For the search procedure we used the following keywords: "social indicator", "sustainability", "environmental indicator" and "energy indicator", both in English and German. As a result of this search process we found about 1320 different

indicators<sup>10</sup>. All indicators and criteria were tested against a set of meta-criteria for quality. Those meta-criteria were:

1. The clarity of the indicators. Does each suggested indicator present a clear, measurable entity or state of affairs? Does the criterion refer to aspects that can be indirectly operationalized by different kinds of indicators? For example 'health' can be operationalized by different indicators such as the 'average life-expectancy' or the 'number of people with allergic reactions' etc. but an indicator measuring "health" in a direct way could not be found. Therefore aspects, which cannot be measured on their own, need to refer to observable facts that are measured with indicators.
2. The indicators are simple and logical. Are all indicators accompanied by a clear objective for the measurement? Are the criteria logically linked to their operational indicators and is there a clear measurement rule that defines units and yardsticks?
3. The indicators can be applied throughout Europe. It is the aim of the NEEDS project to assess the external costs of energy systems for the European Union as a whole. Therefore it is important that all indicators can be used in the European countries and are not only related to specific regional aspects. So we asked the question: Can each of the suggested indicators be applied in all European countries?

After collecting the existing social and energy indicators by key words, the collected indicators have been categorized into new classification schemes (see tables 4-6). This scheme did not refer to any theoretical considerations and only served as an overview of all collected indicators. Since indicators always belong to certain facts or values and show them in an empirical way, we have tried to receive an overview of the dimensions that are shown by the indicators by splitting up the indicators into the prevailing schemes. The schemes distinguish between indicators that relate to the main criterion of 'societal' aspects, 'environmental' aspects and indicators that are related to the main criterion 'energy' aspects. In addition to these three main criteria, we developed sub-criteria of which we assumed that they might cover all dimensions of the collected indicators. As mentioned above, those subcriteria do not relate to any

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<sup>10</sup> The social indicator-set of the 'Zentrum für Umfragen, Methoden und Analysen' counts on it's own 400 indicators with more than 3000 time series (for further information see: ZUMA 2004).

theoretical background or concept. They were inferred from the main indicators on the basis of existing proposals for indicators. For example the criteria ‘financial and material expenditure’ was included because we found in the literature indicators referring to financial situations, such as ‘share of the effective electricity costs in a social welfare receiver budget’ or ‘poverty gap’. We also identified many environmental related indicators in the literature, which highlighted different aspects of environmental quality. Examples are indicators such as ‘number of communities’ that document progress or regress in sustainable development on the basis of indicator measurements’ or the ‘environmental quality index’. The first one belongs to the criteria ‘sustainability’ the second one was allocated in the category ‘environmental effects’.

The subcriteria of the energy sector are related to the concept of energy indicators for sustainable development, which were defined by the International Atomic Energy Agency (IAEA: 2005). In our scheme, all criteria are expressions of the consequences of the production and the use of energy, as they have been defined by the IAEA (see table 6).

Table 4: categories for criteria related to societal aspects

Societal aspects		
<ul style="list-style-type: none"> <li>• financial and material expenditure</li> </ul>	<ul style="list-style-type: none"> <li>• supply guarantee</li> </ul>	<ul style="list-style-type: none"> <li>• job effects</li> </ul>
<ul style="list-style-type: none"> <li>• policy issues</li> </ul>	<ul style="list-style-type: none"> <li>• safety</li> </ul>	<ul style="list-style-type: none"> <li>• technical accessibility</li> </ul>
<ul style="list-style-type: none"> <li>• education</li> </ul>	<ul style="list-style-type: none"> <li>• risk</li> </ul>	<ul style="list-style-type: none"> <li>• acceptability</li> </ul>
<ul style="list-style-type: none"> <li>• Welfare</li> </ul>	<ul style="list-style-type: none"> <li>• Population growth</li> </ul>	<ul style="list-style-type: none"> <li>• health effects</li> </ul>
<ul style="list-style-type: none"> <li>• participation opportunity</li> </ul>		

Source: own considerations.

Table 5: categories for criteria related to environmental aspects

Environmental aspects		
<ul style="list-style-type: none"> <li>• Sustainability</li> </ul>	<ul style="list-style-type: none"> <li>• Agenda 21</li> </ul>	<ul style="list-style-type: none"> <li>• environmental effects</li> </ul>
<ul style="list-style-type: none"> <li>• environmental policy issues</li> </ul>	<ul style="list-style-type: none"> <li>• environmental friendly activities</li> </ul>	<ul style="list-style-type: none"> <li>• pollution</li> </ul>
<ul style="list-style-type: none"> <li>• effect on long term resources</li> </ul>		

Source: own considerations.

Table 6: categories for the indicators related to the energy sector

Energy sector		
<ul style="list-style-type: none"> <li>energy efficiency of energy conversion and distribution</li> </ul>	<ul style="list-style-type: none"> <li>energy prices</li> </ul>	<ul style="list-style-type: none"> <li>energy use</li> </ul>
<ul style="list-style-type: none"> <li>renewable energy</li> </ul>	<ul style="list-style-type: none"> <li>waste</li> </ul>	<ul style="list-style-type: none"> <li>energy intensity</li> </ul>

Source: IAEA 2005: 5ff.

After the categorization into the categories of 'environmental', 'societal' and 'energy sector' aspects we checked whether the indicators that we found through the literature research combined social and energy aspects. Our interest, of course, lies in the identification of indicators that measure social impacts as a result of using different energy options. Unfortunately, only few indicators that we identified through the literature research measure related social impacts to energy systems. In general, social indicators deal with problems like income, education, demographic structure, health, and culture. On the other hand, most of the energy indicators are related to issues such as energy consumption and new technological developments in the energy sector. Consequentially the intersection between energy indicators and social indicators is small. As a result, only 148 of the 1320 indicators we found met our criterion of linking social aspects to the use of energy systems. These indicators can be found in the appendix.

In a further step, the 148 collected social indicators have been checked for their suitability within the aims of the NEEDS project. This check took place according to 3 main criteria. On the one hand, we had to ask ourselves whether the indicators had been suitable enough to check technologies of the future. This step is important because it is the task of the NEEDS project to evaluate external costs of energy systems at the present point and for the future. Addressing future, prospects turned out to be especially problematic for social indicators because most of the social indicators relate to perceptions and attitudes that are usually measured for a current state<sup>11</sup>. Many indicators did not meet this test. The next test referred to the question

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<sup>11</sup> Those indicators might quantify future technologies in different kind of ways. First of all, there is the possibility to ask today's young generation in the age between 16 and 20 years about their attitudes and values they've got today. It is assumed, that the attitudes and values of this young persons are firm until they are in the age of 30 or 40 years. In this age, people are in positions, in which they bear responsibility for their decisions and actions.

Another way to measure attitudes and perceptions for future technologies, relates to scenarios. In this method, people are confronted with models about the possible state of the future. For the scenario building, general frameworks are postulated and the scenarios are built in relation to those frameworks. After the scenario building, people are called upon to evaluate future technologies on the basis of the scenarios.

whether all indicators can be generalised for all of the European countries or if they were only of local importance. As our project-work is devoted to social aspects of energy systems in the whole of Europe, it was necessary to check the indicators for their regional specification and if necessary, to decimate those indicators that are only of local importance. The last test referred to the technology specificity of the social indicators. It was important to make sure that all selected indicators are technology-specific and able to discriminate between different kinds of technologies. As the objective of the NEEDS Project is to evaluate the full costs and benefits of different kinds of energy systems and energy policies, this is an essential criterion. To make sure that the collected indicators fulfill all these aspects, the selection was performed on a case-by-case procedure. This means, each single indicator was checked whether it applied to all European countries, whether it could be quantified for future-technologies and whether it discriminated between technologies and applications.

The result of this process was that only a few indicators survived this testing method. So we added other indicators that we did not find in the literature but seemed to represent important social aspects. Such important social aspects refer, for example, to political stability and legitimacy or social components of risks. These new indicators could be found in the Juelich social compatibility study but also in studies on risk and benefit perception of technologies<sup>12</sup>. These studies show that individuals do not primarily assess risks on the basis of their probability, which is an important parameter for scientists and experts, but on the basis of qualitative characteristics, such as catastrophic potential or familiarity, when assessing risks. Furthermore the emphasis on political stability in the Juelich study confirmed out that a political culture, in which people have the opportunity to participate in political decision-making processes, was appreciated by most groups and seemed to be a prerogative for political stability<sup>13</sup>.

Combining the social indicators, which we have found in the literature, and the new indicators derived from empirical studies on citizen preferences and risk perceptions, we ended up having 26 indicators that meet all test criteria. The indicators were allocated to four main criteria that summarise the intentions of related indicators. The

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<sup>12</sup> For further information see: Jungermann, H./Slovic, P. (1993); Slovic (2000): Charakteristika individueller Risikowahrnehmung.

<sup>13</sup> Renn et al 1985.

criteria correspond with the concept of social compatibility (Häfele/Münch/Renn 1985) that was explained in section 5. As pointed out above, these criteria had been developed on the basis of citizens' values. They represent the desirable state of the society as influenced by energy choices. The citizens emphasised values such as 'security of energy supply', 'financial and material costs of the energy chain', 'environmental effects', 'international' and 'social effects', 'health and security', 'policy' and 'economic' effects. For the NEEDS-project we have considered and taken over nearly all criteria of this concept although we have reformulated some criteria for a better understanding of the dimension they rely on. Therefore we developed the following criteria (see all criteria and Indicator in the indicator-set in the appendix):

**Criterion 1: security/reliability of energy provision.**

This criterion refers to the stability of the energy system and points out the importance of the security of supply for every person and society. In our Opinion considering four aspects can test the safety of the energy supply: On the one hand the question arises whether energy reserve capacities are needed. On the other hand the diversity of the energy supplier will be discussed. Therefore an indicator was developed which explores the "market concentration in the supply or primary sources of energy". The considering of this aspect is important because a high market concentration of an energy supplier in the primary energy sector could cause possible lacks in the energy supply if unexpected problems occur (for example technical damages etc). Beside those indicators that are directly linked with the aspect of energy suppliers, indicators were developed that focus on energy resources and the use of these resources. So we ask for the "time span for known reserves and assumed resources for each energy system if used at present rate" because a long-term energy supply depends also on the available resources and energy reserves. Furthermore, we raised the question about management concepts for waste and developed the indicator "probability of the not-in-time availability of a complete waste management concept". Consequently, the criterion „security/reliability of energy provision" will be discussed on the basis of the specific sub criteria:

- a) system availability on demand
- b) diversity of energy suppliers
- c) reserves and resources and
- d) waste management.

As a sub criterion of the, security and reliability of energy provision we focus on the „flexibility and adaptability of energy systems“. This criterion refers to the ability of a system to be responsive to changes of prices at the supply and demand side or technological developments in the energy field. We discuss this aspect by using the indicator "system flexibility to react to market changes, in particular sudden fuel price fluctuations". Just in the current market situation that is characterised by raising oil prices and an increasing energy demand on the Asiatic market, flexible reactions on changing market situations become important. Beside the market flexibility, the flexibility of the energy systems can also be seen by the reactions to technological developments and breakdowns. Therefore we implement into our set of social indicators the indicator "flexibility to incorporate new technological developments and breakthroughs".

### **Criterion 2: Political stability and legitimacy.**

These two closely related criteria include the need of participative decision-making processes for different kinds of technologies or the availability of peaceful procedures to resolve technology-induced conflicts. Such conflicts might arise if the acceptability of the energy system or political decisions is perceived as low. Often the acceptability is low because citizens do not recognize their own values in political decisions and do not understand reasons for different kinds of decisions. Therefore, we developed four subcriteria to cover the political stability and legitimacy. Those criteria are:

- e) the potential of social conflicts induced by energy systems
- f) the willingness of people to act (mobilization potential)
- g) the reliance on participative decision-making processes and actually
- h) citizens acceptance of energy systems.

The first subcriteria, potential of conflicts induced by energy systems, will be measured by conflicts that are based on historical evidence. The potential of mobilization will be measured by the indicator „willingness of NGO's and other citizen movements to act for or against the realisation of an option“. This indicator considers not only the willingness to act but also the whole extent of actions. For example the resistance against specific power plants might occur on regional, national and cross-national levels. Due to the fact that a strong movement against power plants might endanger the political stability, this indicator has to be involved. The indicator "reliance on participative decision-making processes" refers to the necessity of the accomplishment of participative decision procedures. This indicator discriminates

strongly between different kinds of energy technology. It can be said that citizens like to be involved when politicians decide to build a new nuclear power plant but against the building of solar power plants (until now) no citizen movements have been seen. Nuclear power plants intend for citizens a higher risk potential, which also affects the acceptance of the technology. The indicator „empirical survey results about citizens' acceptance of the power plant” will consider this aspect. A lot of surveys have dealt with this question and their results can be used in our project.

### **Criterion 3: Social and individual risks.**

In this case we differentiate between subjective and objective social risks. Terrorist threats will also be handled in this category but this subject is only being seen from an objective side. Subjective social risks are such risks that individuals perceive. The perception of those risks is often influenced by qualitative risk characteristics such as personal control, familiarity or equitable distribution of risks and benefits. Beside those psychometric variables we will ask citizens after their subjectively expected health consequences from normal operations at the energy system. This indicator includes the “worst case scenario” that can occur in case of accidents in the energy system. If such accidents will happen or not also depends of the risk management and safety arrangements. Therefore we raise the question if people trust in risk management or not. This indicator does not only relay to the safety arrangements on a power plant, it also involves citizens' trust in public and private risk management agencies. To sum it up, the criterion ‘subjective risk estimates’ will be discussed by three main aspects:

- a) the perceived risk characteristics for accidents. Those are psychometric variables like the personal control
- b) perceived risk characteristics for normal operation and
- c) trust in risk management.

On the objective side, we define risks according to statistically measured health effects from normal operation and accidents. While survey data and other social science instruments measure subjective risks, objective risks are measured by empirical data through statistical forms of analysis. Therefore, we rely on the indicators ‘mortality due to normal operation’ and ‘mortality due to severe accidents’.

In order to completely cover the criterion of the social risks, it is necessary to consider the risks perceived from a subjective point of view as well as the risks,

which are objectively comprehensible - those risks that refer to terrorist threats. In our set of indicators, we have established the aspect of terrorist risks as an objective criterion. For example, we ask for the risk potential of a successful attack that is by experts assigned to certain power plants. This indicator considers the argumentation that a successful attack on, for example, a nuclear power plant would result in catastrophic consequences. On the other hand, it also considers that, due to high security precautions, an attack is hardly possible. Thus, not every technology consisting itself of a high extent of damage also consists of a high terrorist potential. Nevertheless, it also might possibly happen that a successful attack takes place. Thus, we also enquire about the “maximum potential effects of a successful attack”. In doing so, we also consider damages to the environment as well as personal damages (evacuated people, dead people, etc.)

#### **Criterion 4: Quality of Life.**

The criterion “quality of life” is a very common one, which can be split up into two categories:

- a) social compatible development and
- b) effects on the quality of landscape area.

A social compatible development, which can be derived from energy systems, will be measured on the basis of three specific indicators. Firstly, the “share of the effective electricity costs in a social welfare receiver budget” is determined. This indicator aims at the financial charge persons receiving income support are subject to due to electricity costs. According to statistics, the kilowatt-hour for power can be produced at different prices depending on the technology. The mentioned indicator takes this aspect and the financial charge into account. Secondly, the indicator “technology specific job opportunity” determines the professional opportunities in the energy sector. Thirdly, the indicator “perception of the fairness of the distribution of risks and benefits of the energy facility in the neighbouring communities” aims at the subjective fairness evaluation of the citizens with regard to the advantages and risks of energy systems. For example, citizens might consider it as unfair if close to their residence area gas pipelines are laid although they are not supplied from this station.

The “effects on the quality landscape area” will be determined on the basis of six different subcategories and their accompanying indicators. For example, the restriction of rural areas is considered by determining the area, which is needed for

the energy systems. Furthermore, the impairment of public areas is analysed. The indicator “inaccessible public area because of energy systems” determines in how far public areas are blocked by cables, buildings, pipelines or machines. Besides from this, negative effects on the quality of one’s home will be discussed. This impairment is determined on the basis of the aspects noise, aesthetics, traffic and, finally, citizens satisfaction with the power plant. To measure the importance of aesthetic aspects, the indicator “part of the population that perceives an aesthetic impairment of the landscape area which is caused by the power plant” has been developed. Beside this, the indicator “number of residents feeling highly affected by noise caused by the energy facility or transports to and from the energy facility” has been developed. It focuses on the aspect of noise. Referring to the different energy technologies, this indicator might mainly give information about the noise pollution f. e. of wind energy plants situated close to local residents. However, other energy technologies also face the problem of being the reason for a partly high noise pollution. Especially arriving and leaving trucks, which transport material to and from the power plants, can be mentioned as reasons for noise. Arriving trucks can also be the reasons for traffic jams. In order to not neglect this aspect, the indicator “contribution to congestion in traffic peak periods through transports to energy facility” has been developed and implemented. The aspect of how much the residents are subjectively satisfied with the power plants serves as a kind of summary of most of the mentioned indicators. In how far the local residents are satisfied with the power plant might depend from such various aspects, as the risk potential, the noise pollution, professional opportunities or the aesthetic impairment. In order to implement a criterion summarizing all these aspects, the indicator “subjective satisfaction of the inhabitants with the power plant” has been developed.

Those mentioned criteria and indicators build the basis of our social indicator-set. In a further step of the project those indicators will be measured in reference to the four main life cycle phases of energy systems: energy extraction and processing, transport, power plant (conversion to electricity) and waste management (considering the entire back-end). An ordinal scale will measure most of the selected social indicators. In measurement theory, the term ‘ordinal’ means that researchers establish an order between the elements of the scale by assigning ascending or descending numbers to each element without specifying the exact distance between the scale points. For example, if people are asked about their perceived risk potential

of energy systems, they have to mark on the ordinal scale one of 4 categories, like: 4 "high risk potential" 3 "middle risk potential" 2 "low risk potential" 1 "no risk potential". The distances between the four categories are not equal and therefore cannot be interpreted as if the number would represent an interval scale. If researchers know exactly the distance between scale points, they talk about 'interval scales' or even 'ratio-scales' when the scale has a natural zero point (like a metre rule). There are also nominal scales where researchers can only say that there is a difference but without a ranking. Gender for example is on a nominal scale, men and women are different, but it cannot be said, that the one is more or higher than the other.

## **7. The Delphi method**

According to the project work, which has been done so far, the next step was the preparation of a Delphi. The Delphi was being carried out to get the final set of social indicators. Therefore stakeholders have to evaluate and discuss the set of indicators, which we had developed.

The Delphi method is a scientific process, which helps to get arguments and patterns for decision-making processes. The outcome of a Group Delphi is a clear distribution of patterns and new arguments for diverged positions. For the NEEDS project the Delphi was prepared to get an evaluation of the collected social indicators by stakeholders. The Delphi method that was used in the NEEDS Project is a further development of the classical Delphi, which was developed by Rand and Co. in the 1960s. At that time the Delphi was used to evaluate defense technologies and weapons, later it was used within the technological assessment. The Delphi concept contains the following steps:

1. A questionnaire will be prepared by the research team. The questionnaire contains questions about the expected consequences of a stimulus (for example environmental standards) and is send to stakeholders. Apart from the questions concerning the stimulus, the subjective certainty in answering the questions is asked for.
2. After filling in the questionnaire, the stakeholders send the questionnaire back to the research team, which has made the questionnaire. The research team evaluates the statements in the questionnaires and calculates statistical data for every question such as the mean values or variances. Also they check the

stakeholders' certainty while answering the questions. Those subjective uncertainties can be used for the weight of the results.

3. The original questionnaire and the analysis from the primary questionnaire will be send back to the stakeholders. In this case, all names of the stakeholders are handled anonymous and the stakeholders are asked to fill in the questionnaire once again but this time in consideration of the results of the primary questionnaire. The aim of this second step is it, to reduce the variances of replies and to raise the collective certainty in answering the questions.
4. Steps 2 and 3 will be repeated until the stakeholders have no more changes to add. As a result of this iterative survey the frequency of the replies shifts either to a normal distribution (that's the case when all stakeholders who have taken part on the survey agree on the same statements) or the frequencies are splitted into different distributions. This might be the case, if there are two or more different points of views that cannot come to an agreement.

For the NEEDS project a variation to the classic Delphi was employed called Group Delphi (Webler et al. 1991). The major objective of a Group Delphi is to divide a group of experts (in the case of the NEEDS project not experts but stakeholders will be invited) into small working groups, to compare the judgments of these groups in a plenary session, and to identify the areas of uncertainty and dissent among the experts. The more one of the group's ratings deviate from the median of all other groups the more time is allocated to this group to defend and substantiate its judgment. This justification procedure assures that relevant information is shared among the participants so that differences in evaluations are not based on ignorance but on different interpretations of the existing data. There is direct testing for dissent in a "peer review" process. In addition, the Group Delphi produces not only numerical values and distributions, but also verbal explanations for deviations from the median.

Each round contributes to the clarification of the issues and leads either to a consensus or the formation of dissenting camps with diverging views and corresponding argumentation. The typical sequence of a Group Delphi is shown in Table 7.

A Group Delphi encompasses the traditional elements of the conventional Delphi such as feedback of responses into the successive round, assessment of group judgment, and opportunity for participants to revise their views, but anonymity is not preserved. Another difference between the Group Delphi and the conventional Delphi is the time. The Group Delphi is accomplished in one or two days whereas the conventional Delphi may take several months. In spite of these two specific shortcomings of the Group Delphi process, it provides three major advantages that are not offered by the traditional Delphi method.

1. It produces a clearer picture of the dissension among the expert panel.
2. It requires justification for the dissent.
3. It provides direct testing of dissent in a peer review.

As a technique to reduce uncertainty, the Group Delphi has shown promise. It is an example of how the conventional Delphi can be altered to include verbal explanations for different viewpoints and establish a common level of background knowledge among the experts participating in the event.

**TABLE 7: SEQUENCE OF A GROUP DELPHI**

<b>STEP</b>	<b>DESCRIPTION</b>
1. Development of Questionnaire	Based on the criteria and options, a numerical scale should be developed that is best suited to elicit expert judgments on the performance of each option on each criterion.
2. Selection of Experts	Selection of experts with different points of view about the subject and representing relevant, but diverse disciplines.
3. First Plenary Session	Introduction into the Group Delphi process and the issue in question. The procedure of how the options and the criteria were derived is explained to the participants.
4. First Group Session	All participants are randomly divided into groups of 3-4 people. Each group is asked to complete the questionnaire. Group consensus is the goal, but minority votes are allowed.
5. Second Plenary Session	The results of the group assessments are handed out to all participants. The groups whose ratings deviated the most from the median values of all groups are asked to defend their point of view in front of all participants. The defenses are openly discussed (and taped for evaluation).
6. Second Group Session	The participants are divided in small groups again, this time according to the principle of systematic rotation. The groups are asked to complete the same questionnaire, taking into account what they learned in the plenary discussion.
7. Iteration of Plenary	Steps 5 and 6 are repeated until no further changes occur Session and Group Work Session and Group Work in the responses of groups or the positions of the participants are established and all arguments have been exchanged.
8. Evaluation of Results	The ranges of the numerical results of the last round are taken as the best expert estimates for the impact analysis. The (video) tapes provide arguments and evidence for the final scale values or explain the distribution of expert opinions.
9. Validation	The results and the justifications are sent to all participants for final comments or second thoughts on the subject. In addition, the results can be peer-reviewed by other experts who did not participate in the process

SOURCE: WEBLER ET AL. 1991

## **8. The Needs-Delphi**

As mentioned when the different conceptualisations of social sustainability have been described, sustainability in general and particularly social sustainability are not analytic concepts, which can claim to be value free. They depend upon an understanding of what is positive and what is negative for humans and for societies and this relies on value judgments, which cannot be done in a genuinely scientific procedure (Weber 1988). As a result, we checked whether our defined set of criteria and indicators is supported by the relevant stakeholders in the energy field. In order to do that, we organised an Expert Delphi, which was done in two phases. In the first phase, we asked stakeholders in the domain of energy economics and policy making to rate each of the criteria and indicators developed by the project team on appropriateness and suitability. They were also asked to decide which of the indicators it should be included in the final selection. Based on our initial set, we composed a questionnaire, which in November 2005 was sent to 52 experts representing the different stakes in the energy sector, including industry and industry associations, political and administrative institutions, environmental groups, associations representing energy consumers, trade unions and scientists. They were asked to fulfill the following tasks:

1. They should rate the adequacy and suitability of the criteria and indicators for the measurement of social effects of energy systems
2. They should give an estimate of their subjective confidence (in percent) in their judgments
3. They were asked to indicate whether the list of criteria and indicators needed to be complemented.

Although the experts had been selected because of their membership in stakeholder organisations, they participated in the process as individuals. So both the survey results and the Delphi-results do not correspond to institutional views. In total 39 stakeholders filled in the questionnaire. The response rate of 75% is remarkably high. One major result is that the set of criteria and indicators developed by the project team has been evaluated as being complete. A consistent trend to reduce specific criteria and indicators could not be observed from the outcome of the survey. There was no majority for the reduction of any part of the list.

In a second phase, a Delphi workshop was organised in January 2006. It took place on January 23<sup>rd</sup> and 24<sup>th</sup>. The participants of the Delphi were selected from the sample of the survey during phase 1 of the Delphi process. The decision to organize a two-day Delphi workshop instead of a one-day workshop was taken to reduce the risk that participants would not show up on time because of flight or train delays and cancellations caused by bad weather, a condition that is not unlikely in January. However, this decision increased the hurdles for the participation and reduced the willingness to participate in the Delphi workshop. In particular, the representatives from industry were unable to attend a two-day-workshop. To increase the balance of stakes for the Delphi-workshop, we decided to invite an industry representative who did not participate in the first round.

The Delphi-workshop was professionally moderated by Dr. Marion Dreyer from the DIALOGIK gGmbH in Stuttgart (<http://www.dialogik-expert.de/en/>). DIALOGIK has expertise and experience in the field of participatory processes and conducts systematic research into practical forms of communication and cooperation in the conflict-laden triangle of politics, economy and civil society.

The Delphi-workshop was attended by eleven participants, who came from the following stakeholder groups (the numbers are in brackets): industry (2), economic research (1), energy research (2), trade unions (1), political and administrative institutions (2), NGOs (2), others (1). Running the Delphi-workshop we were faced with two problems: One representative from industry could only join the Delphi-workshop for one day and one representative from political and administrative institutions and one NGO-representative were not external observers of the project but related to the project and thus certainly more involved in the results than the other participants.

As described above (see table 7), the Delphi-workshop consisted of several stages. The group reached consensus about the general structure of criteria and indicators after two rounds of group and plenary discussion. Every participant agreed to the structure of indicators that finally evolved after the two rounds. Compared to the initial structure, the Expert Delphi suggested a minor but essential modification to the structure of criteria and indicators.

**Table 8: Results of the Delphi meeting in Brussels (23rd/24th of January 2006)**

Criterion	Indicator
Continuity of energy systems over time	reliability of energy supply (short + long term perspectives, internal aspect)
	vulnerability of energy systems (short + long term perspectives; external aspect)
flexibility and adaptation of energy systems	flexibility to incorporate new technologies
institutionalised participatory decision making processes	conflicts induced by energy systems
	citizens' perception of risk and benefits
Objective risk assessment	Morbidity due to normal operation
	Effects of catastrophic events
socially compatible development	technology specific job opportunities
	share of electricity costs for low income households
social and environmental amenities	land use caused by the energy system
	probability of the timely availability of decommissioning and waste management
	population affected by emissions of energy systems

Comparing Table 8 with Table 9, we can see that no criterion or indicator had been added to the originally proposed structure, but that there are some shifts in weight as a result of the Delphi-process. Some criteria and indicators were evaluated as more important than others.

The participants of the Delphi agreed that the stability of the energy supply is a crucial factor. They distinguished two different aspects that determine the stability of the supply, the reliability of the energy supply, which represents the internal dimension of the energy system, and the vulnerability of the energy system, which represents the external aspect. While the internal aspect is mostly related to energy production, the external aspect also addresses other aspects of the energy system such as the distribution and grid system.

Regarding the criterion “flexibility and adaptation of energy systems”, the Delphi participants assigned high weight to flexibility with respect to innovation and new technology. This was regarded as being more important than the flexibility to respond to changing market signals.

Regarding the conflict dimension, a re-naming of the criterion was suggested. The new criterion was called: institutionalised participatory decision making processes.

The most important indicators representing this criterion were “citizens perception of risk and benefits” and “conflicts induced by energy systems”.

The Delphi participants also came to the conclusion that the results of objective risk assessment should have more weight in decision making than the subjective risk estimates by laypeople (risk perception). The most important indicators to measure risks are “morbidity due to normal operation” and “effects of catastrophic events”. At the same time, terrorist threats were not seen as being of equal importance.

Regarding the socially compatible development, the two indicators: “technology specific job opportunities” and “the share of the electricity costs for low income households” were seen as important and suitable representations of this criterion. On the same criterion “social compatible development), the Delphi process led to some modifications. First, the title of the criterion was changed after long discussions into social and environmental amenities to indicate the subjective and emotional quality of landscape and residential area, too. The best indicators to measure this aspect included according to the Expert-Delphi “land use caused by the energy system”, “probability of the timely availability of decommissioning and waste management” and “population affected by energy systems”.

Having the results of the Delphi workshop, social scientists got the task to look again at their original developed indicator set and taking into account the results of the Delphi meeting. Focusing on the fact that a multi-criteria-analysis will encompass all dimensions of sustainability the original 26 social criteria needed to be further condensed by employing a “ranking” procedure. This was done by taking into account three aspects:

First of all we focused on the recommendations of the Stakeholders and tried to rank the indicators in a squaring way. Furthermore we made the ranking by heeding the availability of data and of course considered the feasibility of getting the data. The results of the ranking are shown in the next chapter.

## **9. The reasoning behind selected social indicators and their ranking**

In the NEEDS project the full cost assessment of energy systems includes economic, ecologic and social aspects.

Referring to the social aspects, eight main criteria have been developed. These criteria are:

- Criterion 1: Continuity of energy service over time
- Criterion 2: Flexibility and adaptation
- Criterion 3: Political stability and legitimacy
- Criterion 4: Subjective risk estimates
- Criterion 5: Objective risk estimates
- Criterion 6: Terrorist threat
- Criterion 7: Socially compatible development
- Criterion 8: Effects on the quality of landscape and residential area

A total of 26 indicators have been generated to capture the extension of each criterion. As one input to a multi-criteria-analysis that will encompass all dimensions of sustainability the 26 criteria need to be further condensed by employing a “ranking” procedure. Out of the 26 indicators, 13 were selected to be very important for the assessment of energy systems and labelled with a priority number 1. Nine indicators were regarded as less important but still significant. They were assigned the priority number 2. Three indicators were regarded as complementary and could therefore be omitted from further analysis. These indicators received the priority number 3.

What were the rationales for making these priority assignments? The following paragraphs provide some explanation for the selection.

### **Criterion 1: Continuity of energy service over time**

- Need of reserve capacity (2)
- Market concentration in the supply of primary sources of energy (2)
- Time span for known reserves and assumed resources for each energy system if used at present rate (1)
- Probability of the not-in-time availability of a complete waste management concept (1)

The criterion “continuity of the energy service over time” was judged very important for the overall assessment of energy service. Having energy services available over time is the basis for securing energy supply. This criterion includes the assessment of reserve capacity and the time span for known and assumed resources. In industrialised countries prevalent commercial energy sources such as coal, gas, atomic energy, hydro and mineral oil are all not renewable and have a limited life span.

In 2002, commercial energy consumption in the European Union was 3,32 T crude oil per inhabitant<sup>14</sup>. From 1999 till 2004 the final energy consumption caused by European services and households was increasing<sup>15</sup>. The reasoning might be that more and more domestic appliances are used, and industrial production procedures are becoming more and more reliant upon electricity driven devices (this refers only to electricity).

The first indicator “need for reserve capacity” covers the strategy of European countries to have sufficient amount of primary energy stored if there is a shortage or even a disruption of supply. In addition, the indicator includes the installation of extra capacity in converting primary energy to secondary energy and energy services. This indicator was regarded as important, but may be less significant than diversity of supply and taking account of the physical time span for known reserves. Therefore it was assigned a priority number 2.

The indicator “market concentration in the supply of primary sources of energy” refers to three potential problems: First, a high market concentration of an energy supplier

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<sup>14</sup> Statistisches Bundesamt 2004. See further more for the figures of primary energy resources: BP 03, June 2003; for the figures of population: UN, World Population Prospects, The 2002 Revision; Eurostat, Databank New Cronos; Taiwan: Statistical Databook 2003.

<sup>15</sup> European Commission 2006: energy statistics 2004.

in the primary energy sector could cause possible shortages in the energy supply if unexpected problems occur (for example, technical damages, etc.). Second, concentration may lead to monopolistic pricing of energy. It can be demonstrated for the electricity and gas sector that a lack of business competition within the European Union leads to price hikes that cannot be explained by cost development alone. Third, reliance on a few or even one supplier(s) for primary energy may increase the dependence on supplier company or supplier countries with many uncertainties about political stability and market dominance. Energy supply depends more and more on regions that are politically unstable<sup>16</sup>. Although this indicator refers to an important aspect of energy security, it has been assigned priority number 2 as part of this indicator is already covered in indicator “time span for known reserves”.

The indicator “time span for known reserves and assumed resources for each energy system if used at present rate” describes the physical as well as economic availability of primary energy source. It goes without saying that this indicator is essential for judging the continuity of energy services over time. Therefore it was assigned primary importance (1).

The indicator “probability of the not-in-time availability of a complete waste management concept” refers primarily to nuclear power plants and addresses the problem of waste disposal of fuel assemblies. At the present time, a concept for the final disposal of spent fuel assemblies is still missing; at present, nuclear waste is mostly stored at the reactor site or in intermediate facilities<sup>17</sup>. This indicator was judged as very important as it drives much of the nuclear debate all over Europe and determines much of the nuclear policy throughout Europe.

For the measurement of the criterion “continuity of energy service over time”, all four of these indicators are important. Since the request has been to choose and minimize the number of indicators, we assigned the indicator “market concentration in the supply of primary sources of energy” and “need for reserve capacity” a lower weight, as we think that the continuity of energy service over time can also be guaranteed if reserve capacity is limited and the market is dominated by a few energy suppliers.

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<sup>16</sup> See Prognos 2000.

<sup>17</sup> for further information see also European Environmental Agency 2002, International Atomic Energy Agency 2004

The assumption here is, however, that supplier countries are experiencing political stability.

### **Criterion 2: Flexibility and adaptation**

- System flexibility to react to market changes, in particular sudden fuel price fluctuations (2)
- Flexibility to incorporate new technological developments and breakthroughs (1)

Criterion 2 refers to the ability of energy systems to react to new technological developments and market changes. Concerning the European climate protection policies and the need for energy diversity<sup>18</sup>, flexibility of the energy system is an issue of great importance. Flexibility in the energy sector is directly related to energy efficiency strategies, and provides an adequate approach to the challenges of energy markets in a global economy.<sup>19</sup>

Since the NEEDS project focuses on new and sustainable energy strategies, the indicator “flexibility to incorporate new technological developments and breakthroughs” was given primary priority as it signals the degree of adaptability of energy systems. The incorporation of new technological developments can lead to more efficient and especially more sustainable energy production.

The indicator “system flexibility to react to market changes, in particular sudden fuel price fluctuations” is also important. But similar to the indicator “market concentration” this indicator takes second seat in comparison with the availability of new technological means of energy conversion, storage and transportation. Literature shows that the fluctuation of fuel prices has an impact on industry and the availability of energy. Sauter and Awerbuch suggest that even relatively small oil price increases yield sizeable economic losses<sup>20</sup>. At present, we witness a high increase of oil prices, thus this indicator might become more and more important. Nevertheless under the pressure to assign priorities among indicators, the decision was to place this indicator in the second category.

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<sup>18</sup> see the EU sustainable development agenda/Gothenburg strategy. Furthermore: the interview with Jacqueline McGlade, Director of the European Environment Agency (EEA). The interview was given on March 14<sup>th</sup> 2005 to EURACTIV. Also: <http://www.euractiv.com/en/environment/sustainable-development-eu-strategy/article-117544>

<sup>19</sup> See for example: Wuppertal Institut 2005

<sup>20</sup> Sauter/Awerbuch 2003

### **Criterion 3: Political stability and legitimacy**

- Potential of energy system induced conflicts that may endanger the cohesion of societies (2)
- Willingness of NGOs and other citizen movements to act for or against the realisation of an option (2)
- Reliance on participative decision making processes for different kinds of technologies. (3)
- Empirical survey results about citizens' acceptance of the power plant (1)

For the ranking of these four indicators, we referred to the feedback provided by stakeholders consulted in a stakeholder Delphi procedure in January 2006 in Brussels. The Delphi participants rated the understanding of citizens' acceptance of different kinds of power plants essential for the measurement of political stability and legitimacy of an energy system. If citizens do not accept the respective power plant, they might initiate actions to oppose this facility. The resulting conflict potential can be expressed through protests and demonstrations or even in violent acts by citizen movements or NGOs. Such movements can threaten the political stability and legitimacy of political decisions.

Scientific studies suggest that wind power stations and nuclear power plants are considered most controversial by citizens when compared to fossil or renewable energy facilities<sup>21</sup>. To construct a reliable and valid database, it is desirable to conduct empirical surveys about citizen acceptance of different types of power generation. The acceptance of power plants is also a key indicator for the conflict potential that may be induced by energy systems.

The two indicators "Potential of energy system induced conflicts that may endanger the cohesion of societies" and "Willingness of NGOs and other citizen movements to act for or against the realisation of an option" are measuring the same dimension as the acceptance indicator, i.e. the mobilisation potential of individuals and groups with respect to different means of energy production. One is more related to the characteristics of energy systems that trigger mobilisation, the other one related to

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<sup>21</sup> See for example:

FORSA 2004: Meinung zu Windenergie.

Interreg III-C/WindTechKnow 2005: Regional Wind Technology And Knowledge Transfer Strategies.

Renn, O./ Zwick, M. 1997: Risiko und Technikakzeptanz.

Renn, O. 1984: Risikowahrnehmung der Kernenergie.

organisations and their evaluation of energy systems. Since both indicators are highly correlated with individual's acceptance they were assigned second priority. It should be noted, however, that individual acceptance does not determine collective mobilisation potential. It is rather a necessary but not sufficient condition for political protest. If organisations or groups do not place the issue high on their agenda, individual lack of acceptance has hardly any resonance in society.

The last indicator "Reliance on participative decision making processes for different kinds of technologies" is already largely covered by "Potential of energy system induced conflicts that may endanger the cohesion of societies". In addition, there is not enough data available for reaching meaningful conclusions. It is also not clear whether the need for more participative decision-making processes implies a positive or negative connotation. On the one hand, the need for more participative decision-making processes can be regarded as something positive because citizens are involved and empowered to co-determine their energy future, thus improving overall social cohesion. On the other hand, it can be argued that only controversial technologies need such participative processes so they should be avoided in the first place. Because of these ambiguities and the need for reducing the set of indicators, we would recommend to exclude this indicator from the multi-criteria assessment (assignment of 3).

#### **Criterion 4: Subjective risk estimates**

- Psychometric variables (personal control, catastrophic potential etc.) (1)
- Subjectively expected health consequences from normal operation (2)
- Trust in risk management (private and public agencies) (2)

The indicator "subjective risk estimates" covers the perception and evaluation of individuals and groups with respect to the risk of a given energy technology. It is known from the literature that risk perception is a main driver for acceptance but also for social mobilization.

All three indicators promise to deliver interesting data. Since the indicator set needs to be reduced, a priority assignment was also performed for this criterion. The indicator "Psychometric variables" received highest importance in our rating exercise. This indicator measures the reasons (other than expected health and environmental consequences) for differences in individual rating of risks. If individuals are asked for

an evaluation of the seriousness of risk, the resulting judgment correlates highest with psychometric variables such as voluntariness, personal control, familiarity and others (in multiple regression analyses these independent variables yield the highest amount of declared variance).

By contrast the indicator “subjectively expected health consequences from normal operation” is less important for the overall subjective risk estimate. It may be interesting to contrast the subjective with the statistical estimate but for the purpose of capturing risk perception the qualitative variables are more relevant than the single estimate of expected impacts. The same is true for trust: although most studies show that trust in institutions shape individuals judgments with respect to perceived seriousness of risk the correlations are rather modest for most risk sources. However, trust adds another dimension and may become a decisive factor if acceptance of technology is closely associated with perceived performance of organizations that manage or control these technologies (for example genetically modified organisms). People do protest against the construction of a power plant if they do not trust in the risk management of the operator or if they associate health and environmental impacts with the risk source. Yet both aspects are partially covered by the psychometric variables and indirectly addressed by the indicators of criterion 3.

#### **Criterion 5: Objective risk estimates**

- Mortality due to normal operation (reduced life-expectancy) (1)
- Mortality due to severe accidents (1)

This criterion refers to expert-based statistical or modelled data. For the assessment of energy systems, one needs to include both: the subjectively perceived as well as the expert-based estimations. Research has shown that the two estimates differ considerably depending on risk source and context<sup>22</sup>. Since both normal operation and accidents are equally important when assessing overall risks, one needs to assign both of them the same importance value. They both receive the importance rating of 1.

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<sup>22</sup> See for example:  
Slovic, P., Fischhoff, B., Lichtenstein 1980.  
Slovic, P. 1987

### **Criterion 6: Terrorist threat**

- Potential for a successful attack (3)
- Maximum potential effects of a successful assault (1)

This aspect was included in the list of criteria to recognize the growing importance of terrorist attacks and sabotage for energy safety and security. It was isolated from the overall risk indicator because reliable models for calculating the probability distribution of terrorist attacks are not available.

The “maximum potential effects of a successful assault” indicator was ranked as particularly important to measure the potential of a terrorist threat. Terrorists choose their target for an assault to accomplish maximum damage. The maximum damage will obviously be the goal. Terrorists are likely to perform a trade-off between impact and effort. For example, the impact of attacking a nuclear power station may be considerable; at the same time the effort to release this impact is quite high. Since it is hard or even impossible to anticipate how terrorists will make this trade-off between impact and effort, one is on the safe side to choose the maximum impact that can be accomplished with reasonable means. This is covered by the indicator “Maximum potential effects of a successful assault”. The second indicator “Potential for a successful attack” refers to the probability of choosing target 1 over target 2. As this indicator relies on speculation rather than empirical measurements, a priority rating of 3 appears justified.

### **Criterion 7: Socially compatible development**

- Share of the effective electricity costs in a welfare receiver budget (1)
- Technology specific job opportunities (direct) (1)
- Perception of the fairness of the distribution of risks and benefits of the energy facility in the neighbouring communities (2)

Criterion 7 addresses the impacts of the different technology choices on socially highly esteemed values such as equity, prosperity and employment. Since these values have high importance rankings in all surveys the overall importance of this criterion is undisputed.

For ranking the three indicators that were attributed to this criterion we referred once again to the aforementioned stakeholder Delphi procedure and its results. The

stakeholders found it very important to include technology-specific job opportunities, as this would provide long-term employment possibilities. As employment tops the list of public concerns in almost all European countries, there is a compelling reason to assign the importance value of 1 to this indicator.

The stakeholders also recommended to assign high weight to the indicator “share of the effective electricity costs in a welfare receiver budget”. This indicator includes two aspects: first, the relative share of energy costs in comparison with other costs of infrastructure, and an equity dimension by looking specifically at low-income groups in society. Since equity is addressed in this indicator, there is less need to consider the perception of equity. One should note, however, that similar to real and perceived risks the perception of equity might differ from the statistical data on distribution of resources. Unlike risk perception, however, equity judgments have not such a direct impact on the judgment about energy technologies. For this reason an importance value of 2 has been assigned to this indicator.

#### **Criterion 8: Effects on the quality of landscape and residential area**

- Land use caused by energy system (1)
- Inaccessible public area because of the energy system (3)
- Part of the population that perceives an aesthetic impairment of the landscape area which is caused by the power plant (3)
- Subjective satisfaction of the inhabitants with the power plant (2)
- Number of residents feeling highly affected by noise caused by the energy facilities or transports to and from the energy facility (1)
- Contribution to congestion in traffic peak periods through transports to energy facility (1)

This criterion has a major impact on the judgments of the population in the vicinity of the energy generating facilities. Out of the six indicators, three were chosen as being most important for measuring the quality of the landscape and residential area. The indicator “land use caused by energy system” was selected because the land that is used for constructing facilities is lost for other purposes such as infrastructural development, agriculture, etc. Depending on the type of facility and the energy system, the amount and degree of land use may vary considerably<sup>23</sup>. The other two

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<sup>23</sup>See for more information f.e.: IPCC 1998: Special Report on Land Use, Land-Use Change And Forestry,

indicators that we assigned the importance value of 1 include impacts that have direct effects on residents. One indicator refers to the noise caused by the facility, including transportation, and the other aspect refers to the amount of traffic that can be caused by transports to and from the energy facility<sup>24</sup>.

Three indicators were rated as less important in this respect: The indicator “Inaccessible public area because of the energy system” was rated 3 on the importance scale. Since much of the intention of this indicator is already covered by the indicator “land use” it was seen as less important for inclusion in the multi-criteria analysis. The indicator “Part of the population that perceives an aesthetic impairment of the landscape area which is caused by the power plant” was seen as a subset to the indicator “Subjective satisfaction of the inhabitants with the power plant” (thus also receiving a 3 in the importance rating). This remaining indicator was assigned an importance weight of 2 since it is less decisive on social compatibility than land use or noise, yet it does include subjective factors such as aesthetics and emotional feeling about the facility that is not covered by any of the other indicators.

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<sup>24</sup> See also Krewitt 2002., Voß 1999.

**Table of selected indicators**

Criteria	Stages of the energy system	Whole Energy System	Indicator	Unit of measurement	Indicators have been developed by drawing on following references:
1.Security/Reliability of Energy Provision					
1.1 Continuity of Energy Service over Time			Need of reserve capacity	Load factor	This work
a. System availability on demand	<ul style="list-style-type: none"> <li>Extraction and processing</li> <li>Transport</li> <li>Power Plant (conversion to electricity)</li> <li>Waste management</li> </ul>	Energy System	Market concentration in the supply of primary sources of energy	Ordinal scale	Prognos AG (Hg.) 2000: Energiereport III. Die langfristige Entwicklung der Energiemärkte im Zeichen von Wettbewerb und Umwelt. Schäffer-Poeschel: Stuttgart
b. Diversity of energy suppliers			Time span for known reserves and assumed resources for each energy system if used at present rate	Interval scale	Renn, O. 2005: Social indicators for the project 'New Energy Externalities Developments for Sustainability'. Stuttgart
c. Reserves and resources			Probability of the not- in- time availability of a complete waste management concept	Ordinal scale	<a href="http://www.environment-agency.gov.uk/subjects/waste/1019330/1029396/?lang=_e">http://www.environment-agency.gov.uk/subjects/waste/1019330/1029396/?lang=_e</a> Internet access: 12.08.2005
d. Waste management					
-					
1.2. Flexibility and Adaptation					
a. Flexibility to respond to market signals	<ul style="list-style-type: none"> <li>Extraction and processing</li> <li>Transport</li> <li>Power Plant (conversion to electricity)</li> <li>Waste management</li> </ul>	Energy System	System flexibility to react to market changes, in particular sudden fuel price fluctuations	Sensitivity to fuel price fluctuations	Hirschberg et al. 2004: Sustainability of Electricity Supply Technologies under German Conditions: A Comparative Evaluation. Villigen: PSI Report Nr.04-15
b. Flexibility to incorporate technological developments			Flexibility to incorporate new technological developments and breakthroughs	Ordinal scale	Häfele, W./Münch, E./Renn, O. (Hg.) 1985: Zukünftige Energiepolitik. Ein Bürgergutachten. Tech: München

Criteria	Stages of the energy system	Whole Energy System	Indicator	Unit of measurement	Indicators have been developed by drawing on following references:
2. Political stability and legitimacy  a. Potential of conflicts induced by energy systems. b. Willingness to act (mobilization potential) c. Reliance on participative decision-making processes d. Citizens acceptance of the system	<ul style="list-style-type: none"> <li>• Extraction and processing</li> <li>• Transport</li> <li>• Power Plant (conversion to electricity)</li> <li>• Waste management</li> </ul>	Energy System	Potential of energy system induced conflicts that may endanger the cohesion of societies	Ordinal scale	Häfele, W./Münch, E./Renn, O. (Hg.) 1985: Zukünftige Energiepolitik. Ein Bürgergutachten. Tech: München
			Willingness of NGOs and other citizen movements to act for or against the realisation of an option	Ordinal scale	Hampel, J./Weimer-Jehle W./Brukmajster D. 2005: Identification and measurement of social indicators for the sustainability of selected Swiss electric power systems
			Reliance on participative decision-making processes for different kinds of technologies	Ordinal scale	Nennen, H. U./Hörning, G. 1999: Energie und Ethik. Leitbilder im philosophischem Diskurs. Campus: Frankfurt/N. Y.
			Empirical survey results about citizens acceptance of the power plant	Ordinal scale	Arbeitsgemeinschaft DLR/WI/ZSW/IWR/FORUM 1999: Klimaschutz durch Nutzung erneuerbarer Energien. (Hg.): Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit Bonn

Criteria	Stages of the energy system	Whole Energy System	Indicator	Unit of measurement	Indicators have been developed by drawing on following references:
3. Social and individual risks					
3.1 Subjective risk estimates a. Perceived risk characteristics for accidents b. Perceived risk characteristics for normal operation c. Trust in risk management	<ul style="list-style-type: none"> <li>Extraction and processing</li> <li>Transport</li> <li>Power Plant (conversion to electricity)</li> <li>Waste management</li> </ul>	Energy System	Psychometric variables such as personal control, catastrophic potential, perceived equity, familiarity and others	Ordinal scale	Lee, R. 1996: externalities studies: why are the numbers different? In: Hohmeyer, O./Ottinger, R.L./ Rennings, K. (Eds.) 1996: social effects and sustainability. Valuation and implementation in the energy and transport sector. Springer: Berlin
			Subjectively expected health consequences from normal operation	Ordinal	This work
			Trust in risk management agencies (private and public)	Ordinal scale	Nennen, H. U./Hörning, G. 1999: Energie und Ethik. Leitbilder im philosophischem Diskurs. Campus: Frankfurt/N. Y.
3.2 Objective risk estimates (Expert based) a. health effects from normal operation b. Health effects from accidents	<ul style="list-style-type: none"> <li>Extraction and processing</li> <li>Transport</li> <li>Power Plant (conversion to electricity)</li> <li>Waste management</li> </ul>	Energy System	Mortality due to normal operation (reduced life-expectancy)	YoLL /GWh	Hirschberg et al. 2004: Sustainability of Electricity Supply Technologies under German Conditions: A Comparative Evaluation. Villigen: PSI Bericht Nr.04-15
			Mortality due to severe accidents	Fatalities/GWh	Hirschberg et al. 2004: Sustainability of Electricity Supply Technologies under German

					Conditions: A Comparative Evaluation. Villigen: PSI Bericht Nr.04-15
3.3 Terrorists threat (only objective side)  a. Potential for a attack b. Effects of a successful assault	<ul style="list-style-type: none"> <li>• Extraction and processing</li> <li>• Transport</li> <li>• Power Plant (conversion to electricity)</li> <li>• Waste management</li> </ul>	Energy System	Potential for a successful attack	Ordinal scale	This work
			Maximum potential effects of a successful assault	Maximal number of fatalities	Hirschberg et al. 2004: Sustainability of Electricity Supply Technologies under German Conditions: A Comparative Evaluation. Villigen: PSI Bericht Nr.04-15

Criteria	Stages of the energy system	Whole Energy System	Indicator	Unit of measurement	Indicators have been developed by drawing on following references:
4. Quality of Life					
4.1 Social compatible development	<ul style="list-style-type: none"> <li>Extraction and processing</li> <li>Transport</li> <li>Power Plant (conversion to electricity)</li> <li>Waste management</li> </ul>	Energy System	Share of the effective electricity costs in a social welfare receiver budget	%	Delfino / Casarin 2001: IEA Statistics: World Energy Statistics Surveys. WPS3599. Internet access: 19.05.2005
a. Equitable life conditions b. Technology specific job opportunities c. Perception of the fairness of risks and benefits			Technology specific job opportunities (direct)	Person-years/GWh	Hirschberg et al. 2004: Sustainability of Electricity Supply Technologies under German Conditions: A Comparative Evaluation. Villigen: PSI Report Nr.04-15
			Perception of the fairness of the distribution of risks and benefits of the energy facility in the neighbouring communities	Ordinal scale	Hampel, J./Weimer-Jehle W./Brukmajster D. 2005: Identification and measurement of social indicators for the sustainability of selected Swiss electric power systems
4.2. Effects on the quality of landscape and residential area	<ul style="list-style-type: none"> <li>Extraction and processing</li> <li>Transport</li> <li>Power Plant (conversion to electricity)</li> <li>Waste management</li> </ul>	Energy System	Land use caused by the energy system	m <sup>2</sup> pro KWh	Maibach, M./Masuhr, K. P. Ott, W. 1996: Die vergessenen Milliarden. Externe Kosten im Energie- u. Verkehrsbereich. Bern: Haupt
4.2.1 Effects on the quality of the landscape a. land use b. Impairment of public area			Inaccessible public area because of the energy system	km <sup>2</sup> pro MWh	Hampel, J./Weimer-Jehle W./Brukmajster D. 2005: Identification and measurement of social indicators for the sustainability of selected Swiss electric power systems

<p>4.2.2 Effects on the quality of the landscape area</p> <p>a) Aesthetic impairment</p> <p>b) Subjective satisfaction</p> <p>c) Noise exposure</p> <p>d) Contribution to traffic</p>	<ul style="list-style-type: none"> <li>• Extraction and processing</li> <li>• Transport</li> <li>• Power Plant (conversion to electricity)</li> <li>• Waste management</li> </ul>	<p>Energy System</p>	<p>Part of the population that perceives an aesthetic impairment of the landscape area which is caused by the power plant</p>	<p>%</p>	<p>Hampel, J./Weimer-Jehle W./Brukmajster D. 2005: Identification and measurement of social indicators for the sustainability of selected Swiss electric power systems</p>
			<p>Subjective satisfaction of the inhabitants with the power plant</p>	<p>Ordinal scale</p>	<p>Hampel, J./Weimer-Jehle W./Brukmajster D. 2005: Identification and measurement of social indicators for the sustainability of selected Swiss electric power systems</p>
			<p>Number of residents feeling highly affected by noise caused by the energy facility or transports to and from the energy facility</p>	<p>Ordinal scale</p>	<p>Hampel, J./Weimer-Jehle W./Brukmajster D. 2005: Identification and measurement of social indicators for the sustainability of selected Swiss electric power systems</p>
			<p>Contribution to congestion in traffic peak periods through transports to energy facility</p>	<p>Ordinal scale</p>	<p>Hampel, J./Weimer-Jehle W./Brukmajster D. 2005: Identification and measurement of social indicators for the sustainability of selected Swiss electric power systems</p>

## **Overview of a desktop and literary summary of social indicators**

### **Financial accessibility**

- Part of the taxpayers which have an deviance of more than 50% of the average income from all taxpayers
- Number of Millionaires (by 100.000 inhabitants)
- Number of homeless people (by 1.000 inhabitants)
- Part of the indebted households accounting to all households (%)
- Percent of population living below poverty line
- Gini index of income inequality
- Unemployment rate
- Wealth distribution
- Poverty gap index
- Average income

### **Improved learning abilities**

- Education-investigation
- Part of the population with a high education level
- Environmental instruction in schools
- Quality of the environmental education in the population
- Expense for education referring to the gross domestic product
- Number of the patents and licenses per annum
- Part of expenses for investigation and development depending on the whole expenses of private companies
- Part of new innovative products
- World trade parts at investigation-intense products
- Production and diffusion of scientific knowledge
- Number of investigators
- Technological developments and/or transfer

### **Long-term health effects**

- Number of children with allergic reactions
- Individual life expectancy
- Average life expectancy
- Total national health expenditure as a proportion of GDP
- Nutritional status of population
- Social health index
- Human Well-Being Index
- Sanitary effects of illnesses in connection with environmental impacts
- Costs for national health service
- Global distribution of the population
- Human development index
- Communal expenditure for health
- Number of people with cardiovascular diseases
- Number of people with pulmonary diseases
- Number of respiratory diseases by children
- Changes on atmospheric loading
- Number of days with atmospheric ozone

### **Participation on decision-making process**

- Number of collective decision-making processes in a country
- Costs of collective decision-making processes

- Number of hours that people work honorary for the aims of the Local Agenda 21 (per 1000 inhabitants)
- Number of the visitors at environmental events
- Number of the municipalities which are participating at the concept of Sustainability
- Number of public events within the scope of Sustainability
- Possibility of participation on decision-making processes for all members of the society
- Competence of inhabitants for decision-making processes
- Number of citizens taking part on municipal decision-making processes

### **Technical accessibility**

- Supply guarantee of Energy use
- Technical possibility of Energy supply

### **Contribution/Integration to local Agenda 21/EMAS**

- Environmental friendly actions taken
- Environmental Quality Index:
  - Environmental Pressure Index
  - Ecosystem Risk
  - Ecological Footprint per capita
  - Land use
- Environmental policy issues
- Understanding of global warming
- Centrality of the idea to handle with nature as a resource
- Sum of the environmental investments
- Number of companies with environmental investments
- Number of public activities containing aspects of the Local Agenda 21 and Sustainability
- Information quota for Agenda 21 regarding to the local government
- Number of honorary done jobs regarding to the Agenda 21 per 1000 inhabitants
- Participation of local clubs on the Agenda 21
- Parts of recreation areas which became inaccessible
- Shift of the middle routing distance to recreation areas
- Part of the population that notices a significant aesthetic influence
- Part of the residential area and traffic area regarding to the whole landscape area
- Structure of the use of area

### **Neighbourhood pollution**

- Number of persons which are affected from environmental pollution
- Concerns about air pollutions
- Complaints about environmental pollution
- Environment contentment
- Number of households with new, non-polluting heating systems
- Number of people with significant noise admission in a larger way than n decibel

### **Long term resources and waste management/entropy measurement**

- Probability for a not in time availability of disposal concepts

### **Risk perception**

- Willingness to take over risks
- Perception of own control possibility
- Habituation on risks
- Experience with the power plant

- Perception of the risk potential
- Number of industrial accidents
- Risk appraisal through the community
- Land-use planning controls around risk installations
- Layman estimate from employees and inhabitants: estimated illness and death cases
- Inhabitant appraisals of the risks regarding to already existing plants
- Inhabitant appraisals of the risks regarding to future plants which are build at the moment
- Risk appraisal through the community
- Hierarchical importance of the security management regarding to power plants

### **Risk management**

- Number of people affected by a successful assault
- Existence of a supply loss through a successful assault
- Investment requirement for the restoration of the previous state after a successful assault
- Risk assessment: possible environmental disruption due to accidents, based upon historical records and mean expected values as well as on technological risks
- Prevention plans approved and risk-prone municipalities
- Preventive information: progress in implementing the procedure in risk-prone municipalities
- Sufficient authenticity of the power plant operator
- Confidence into the risk management of the plant operator
- Off-site emergency plans and public information
- Technological know-how of the supervision

### **Compliance with Kyoto targets**

- Number of communes with a regular indicator supported documentation of the sustainability
- Part of renewable energies referring to the consumption of electricity
- Expected progress referring to the Kyoto-Protocol
- Number of communes with Agenda-Resolutions
- Number of communes who take regularly report on the state of sustainability

### **Reliability of energy supply**

- Energy intensities: energy supply per unit of GDP and per capita.
- Energy mix: i.e. the structure of energy supply and changes in energy supply.
- Energy prices for industry and households with changes in real energy end-use prices.
- Economic and environmental trends in the energy sector
- Main energy consumers
- Use of the energy
- Final consumption of electricity
- Energy intensity (per capita, per unit of GDP)
- Energy efficiency (energy production/energy consumption)
- Energy efficiency, by relating energy use to GDP (Wh/SK<sub>r</sub>)
- Amount of electricity used to heat homes and other premises (TW/year)
- Total final consumption of energy
- Total final consumption of energy by type
- Total final consumption of energy by sector
- Number of imported fossil energy resources
- Energy (gas and electricity) consumed by domestic and industrial users per year
- Energy intensities: energy supply per unit of GDP and per capita

- Changes in energy efficiency
- Possibilities of alternative use of primary energy

### **Access to electricity**

- Number of people/households who have access to electricity

### **Process for conflict resolution**

- Conflict difference between layman perception and expert appraisal
- Action willingness for or against the realization of a certain option
- Favouring an option through NGO's
- Existence of conflict implementation concepts

### **Long-term job opportunities**

- Number of people moving into a region and moving away from that region

### **Good job**

- Direct and indirect jobs created in the sector of renewable energies
- Net employment generation: number of jobs/tons of avoided GHG emissions in Co2 equivalent
- Number of qualified working places
- Number of working places which are affected from emissions
- Number of working places which are affected from potential technical breakdowns

### **Regional economic development**

- Attractiveness of the area for employees
- Attractiveness of the area for visitors
- Expansion of the plot prices
- Influence of the site quality according to appraisals of economic experts

### **Distribution of positive/negative outcomes**

- Distribution of the emissions between site and use place
- Potentially endangered groups of persons which are involved in the plant production
- Inhabitants' subjective perception of the fairness, regarding to the risk-chance-distribution of the power plant

### **Perceived acceptance**

- Power plants acceptance of inhabitants and actors, which are affected by power plants. Actors: inhabitants, energy producer, power plant producer, public bodies
- Acceptance of used energy technique
- Acceptance of renewable energies in the population and affected stakeholders, like energy producer
- Subjective contentment of the employees referring to the acceptance of the power plant

### **Proportion of energy cost in the family budget**

- Part of the effective electricity costs regarding to a social welfare receiver budgets
- Part of the effective electricity costs regarding to an average household budget
- Transport infrastructure
- Contribution to the traffic utilization at peak times
- Part of the Energy amount regarding to traffic
- Per capita consumption of fossil fuel by motor vehicle transport
- Energy consumption by the transport sector

**Political risks**

- Options for reforms regarding to economic sustainability

**Life cycle of technologies/full marginal costs**

- Probability of the early closure

## Bibliography

- Akademie für Technikfolgenabschätzung/Projektgruppe 'Indikatoren' 2003: Ein funktional-normatives Konzept zur Operationalisierung einer nachhaltigen Entwicklung.
- Allardt, E. 1975: Dimensions of Welfare in a Comparative Scandinavian Study. University of Helsinki, Research Reports 197,9, P. 1-25
- Arbeitsgemeinschaft DLR/WI/ZSW/IWR/FORUM 1999: Klimaschutz durch Nutzung erneuerbarer Energien. (H.g.): Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit Bonn, Münster, Stuttgart, Wuppertal.
- Bachrach, P. 1967: The theory of democratic elitism: a critique. Little Brown: Boston.
- Bell, S./Morse, S.1999: Sustainability Indicators. Measuring the Immeasurable. Earthscan: Sterling.
- Bernard, T. 1983: The consensus-conflict debate: form and content in sociological theories. Columbia University Press: New York
- Blalock, H.M. 1989: Power and Conflict. Towards a general theory. Sage: Newbury Park.
- BMU- Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit 2000. BMU/StBA- Umweltbundesamt, Statistisches Bundesamt 1998.
- BP 03, June 2003
- Brand, K.-W. 1997: Probleme und Potentiale einer Neubestimmung des Projekts der Moderne unter dem Leitbild „nachhaltige Entwicklung“. Zur Einführung. P. 9-32 in: Brand, K.-W. (Ed.): Nachhaltige Entwicklung. Eine Herausforderung an die Soziologie. Opladen, Leske & Budrich
- Brundtland, G.1987: Our Common Future: The World Commission on Environment and Development. Oxford, Oxford University Press
- Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit 2003: Umweltforschungs-plan. Indikatoren zur Zielkonkretisierung und Erfolgskontrolle im Rahmen der lokalen Agenda 21.
- Cadwallader, M.L. 1959: The Cybernetic Analysis of Change in Complex Social Organizations. In: The American Journal of Sociology (65), p. 154-157
- CGSDI- Consultative Group on Sustainable Development Indicators 2000: Dashboard of Sustainability.
- Coser, L.A. 1956: The function of social conflicts. Free Press: Glencoe
- Coser, L.A. 1967: Continuities in the study of social conflicts. Free Press: Glencoe

- Department of the Environment, Transport and the Regions 1999: Quality of Life Counts. Indicators for a Strategy for Sustainable Development in the United Kingdom: A Baseline Assessment.
- DETR-Department of the Environment, Transport and the Regions 1999: The Environment in your Pocket 1998.
- Diefenbacher, H. et al. 2004: Indikatoren nachhaltiger Entwicklung in Deutschland- ein alternatives Indikatorensystem zur nationalen Nachhaltigkeitsstrategie. Heidelberg: FEST
- Diekman, J. et al. 1999: Energie-Effizienz-Indikatoren. Physica: Heidelberg
- Dienel P.C. 1980: Umwelterziehung in Schule und Erwachsenenbildung. Berlin: Umweltbundesamt.
- Dienel, P.C./Garbe D. 1985: Zukünftige Energiepolitik. Ein Bürgergutachten. HTU Edition: Technik und sozialer Wandel: High Tech Verlag: München.
- Deutscher Bundestag 1980: Bericht der Enquete-Kommission "Zukünftige Kernenergiepolitik". Drucksache 4/4341, Bonn 1983
- DoE – Department of the Environment 1996: Indicators of sustainable Development for the United Kingdom. Department of the Environment/Government Statistical Service/HMSO, London.
- ECD - Organisation for Economic Co-operation and Development 1997: OECD Environmental Data Compendium 1997.
- Esping-Anderson, G. 2000: Social Indicators and Welfare Monitoring. Social Policy and Development Programme. Paper No. 2, Geneva: United Nations Research Institute for Social Development.
- ES- Eurostat European Communities (1997) Guinomet1: Indicators of Sustainable Development. A pilot Study following the Methodology of the United Nations Commission on Sustainable Development.
- ES- Eurostat- Statistisches Amt der Europäischen Gemeinschaft 1997: Umweltstatistik 1996.
- ES- Eurostat- Statistisches Amt der Europäischen Gemeinschaft 1997: Eurostat Jahrbuch 1997
- Etzioni, A. 1993: The spirit of Community. Rights, Responsibilities and the communitarian Agenda. Crown: New York.
- Europäische Umweltagentur 2004: EUA Signale 2004. Aktuelle Informationen der Europäischen Umweltagentur zu ausgewählten Themen. Europäische Umweltagentur: Kopenhagen

European Environment Agency 1999: Environment in the European Union at the turn of the century. Environmental Assessment Report No.2.

European Commission 2006: Energy statistics 2004. Luxembourg

Evans, M. 1972: Karl Marx and the concept of political participation. In: Parry, G. (Hg.): Participation in Politics. Manchester University Press: Manchester, pp.127-150.

FORSA 2004: Meinung zu Windenergie. Berlin

Friedrich, R. 2004: Ermittlung externer Kosten mit der ExternE-Methodik: Methode, Ergebnisse, Unterschiede. P. 25-39 in: Ziesing, H.-J. (ed.): Externe Kosten in der Stromerzeugung. Frankfurt, Berlin, Heidelberg, VWEW-Energieverlag.

Grunwald, A. 2004: Conflicts and Conflict-solving as Chances to Make the Concept of Sustainable Development Work. P. 107-122 in: Wilderer, P.A., Schroeder, E.D. and H. Kopp (eds.): global Sustainability. The Impact of Local cultures. A new Perspective for Science and Engineering, Economics and Politics. Weinheim, Wiley-VCH

Habich, R., Noll, H.H. 1993: Soziale Indikatoren und Sozialberichterstattung. Internationale Erfahrungen und gegenwärtiger Forschungsstand. Expertise für das Bundesamt für Statistik, Bern, Schweiz. Berlin und Mannheim.

Häfele, W./Münch, E./Renn, O. (Hg.) 1985: Zukünftige Energiepolitik. Ein Bürgergutachten. Tech: München

Hampel, J./Weimer-Jehle W./Brukmajster D. 2005: Identification and measurement of social indicators for the sustain-ability of selected Swiss electric power systems

HGF-Helmholtz Gemeinschaft Deutscher Forschungszentren 2000: Vorläufige Liste der Indikatoren für das HGF Verbundprojekt "global zukunftsfähige Entwicklung-Perspektiven für Deutschland

Hirschberg et al. 2004: Sustainability of Electricity Supply Technologies under German Conditions: A Comparative Evaluation. Villingen: PSI Bericht Nr.04-15

IFEN- Institut Francais de'l Environment 2000: Spatial Planning and Environment. Policies Indicators.

IISD- International Institute for Sustainable Development (2000a): Compendium of sustainable development indicator initiatives and publications. IISD, Environment Canada Winnipeg.

International Atomic Energy Agency 2004: Nuclear Safety Review for the Year 2004: Austria

- International Atomic Energy Agency 2005: Energy indicators for sustainable development: guidelines and methodologies. Austria: IEA
- Interreg III-C/WindTechKnow 2005: Regional Wind Technology And Knowledge Transfer Strategies.
- Johnston, D. F. 1990: Some Reflections on the United States. In: Journal of Public Policy, Vol 9, p. 433.-436
- Jüdes, U. 1997: Nachhaltige Sprachverwirrung. Politische Ökologie 52 Juli/August 1997, p.26-29
- Jungermann, H./Slovic P. 1993: Charakteristika individueller Risikowahrnehmung. In: Bayerische Rück (Ed.), Risiko ist ein Konstrukt. München: Knesbeck (p.90-107)
- Keeney, R., Renn, O., von Winterfeldt, D. und Kotte, U. 1984: Die Wertbaumanalyse. Entscheidungshilfe für die Politik. München (HTV)
- Keeney, R.L., Renn, O. and von Winterfeldt, D. 1987: Structuring West Germany's Energy Objectives. Energy Policy, Vol. 15, No. 4 (August 1987), pp. 352-362
- Knaus, A./Renn, O. 1998: Den Gipfel vor Augen. Unterwegs in eine nachhaltige Zukunft. Metropolis: Marburg.
- Kreibich, R. 1996 (ed.): Nachhaltige Entwicklung. Leitbild für die Zukunft von Wirtschaft und Gesellschaft. Weinheim/Basel, Beltz
- Krewitt, W. 2002: Externe Kosten der Stromerzeugung. In: Rebhan, E. (Hrsg.): Energie – Handbuch für Wissenschaftler, Ingenieure und Entscheidungsträger. Springer Verlag, 2002
- Landesanstalt für Umwelt und Geologie 2000: Umweltindikatoren für Sachsen. Indikatorenliste Sachsen.
- Luhmann et al. 2002: Einführung in die Systemtheorie. Heidelberg: Carl-Auer-Systeme-Verlag.
- Maibach, M./Masuhr, K. P. Ott, W. 1996: Die vergessenen Milliarden. Externe Kosten im Energie- u. Verkehrsbereich. Bern: Haupt
- Marx, K. 1971: Zur Kritik der politischen Ökonomie, In: Karl Marx und Friedrich Engels: ausgewählte Werke. Progress Verlag: Moskau, pp.186-190.
- Mead, G.H. 1934: Mind, Self and Society. University of Chicago Press: Chicago.
- Meadows, D. 1998: Indicators and Information Systems for Sustainable Development. A Report to the Balaton Group. The sustainability institute, Hardtland Four Corners VT 05049, USA
- Ministry of the Environment Sweden 1999: Green Headline Indicators. Monitoring Process towards Ecological Sustainability

- Morosini et al. 2001: Umweltindikatoren. Gegenüberstellung, Bewertung und Auswahl. Arbeitsbericht der Akademie für Technikfolgenabschätzung Nr. 185, Bd.1. Stuttgart: Akademie
- Morosini et al. 2002: Umweltindikatoren. Grundlagen, Methodik, Relevanz. Arbeitsbericht der Akademie für Technikfolgenabschätzung Nr. 185, Bd.1. Stuttgart: Akademie
- Münch 2004: Soziologische Theorie. Band 3: Gesellschaftstheorie. München: Campus
- MUNF- Ministerium für Umwelt, Natur und Forsten Schleswig Holstein 2000: Entwicklung eines Indikatorensystems für ein strategisches Steuerungssystem.)
- Nennen, H. U./Hörning, G. 1999: Energie und Ethik. Leitbilder im philosophischem Diskurs. Campus: Frankfurt/N. Y.
- NLÖ-Niedersächsisches Landesamt für Ökologie 2000: Vorschläge von Umweltindikatoren für Niedersachsen
- Noll, H.H. 2002: Social Indicators and Quality of Life Research: Background, Achievements and Current Trends. In N. Genov (Hrsg.): Advances in Sociological Knowledge over Half a Century. International Social Science Council, Paris
- OECD 1991: Environmental Indicators. Towards sustainable Development 2001: Organisation for economic Co-operation and development. Paris
- OECD 1993: Environmental Performance Reviews –Germany. Organisation for economic Co-operation and development. Paris
- OECD 1994: Environmental Indicators. Core Set. Organisation for economic Co-operation and development. Paris
- OECD 1998a: Towards sustainable development. Environmental Indicators. Organisation for economic Co-operation and development. Paris
- OECD 2000: Frameworks to measure sustainable development. OECD Proceedings of the workshop held in Paris 2-3September 1999. Organisation for economic Co-operation and development. Paris
- Ogburn William F. 1950: Sociology. Boston: Mifflin.
- Parsons, T. 1952: The Social System. Glenoce: Free Press.
- Pezzey, J. 1992: Sustainable Development Concepts. An Economic Analysis. World Bank Environment Paper No.2. The World Bank, Washington World Bank
- Pfisterer, G. 1998: Ein Konzept zur Messung einer nachhaltigen Entwicklung. In: Knaus, A./Renn, O. Den Gipfel vor Augen. Unterwegs in eine nachhaltige Zukunft. Metropolis: Marburg, S.235-256

- Prognos AG (Hg.) 2000: Energiereport III. Die langfristige Entwicklung der Energiemärkte im Zeichen von Wettbewerb und Umwelt. Schäffer-Poeschel: Stuttgart
- Renn, O. 1984: Risikowahrnehmung der Kernenergie. Frankfurt am Main: Campus.
- Renn, O. 1986: Decision Analytic Tools for Resolving Uncertainty in the Energy Debate. Nuclear Engineering and Design, Vol. 93, Nos. 2&3, pp. 167-180
- Renn, O. 1994: Ein regionales Konzept qualitativen Wachstums. Pilotstudie für das Land Baden-Württemberg. AB der Akademie für Technikfolgenabschätzung in Baden-Württemberg Nr.3: Stuttgart
- Renn, O. 1996: Ökologisch denken - sozial handeln: die Realisierbarkeit einer nachhaltigen Entwicklung und die Rolle der Kultur- und Sozialwissenschaften. In: Kastenholz HG, Erdmann KH, Wolff M. (Hg.): Nachhaltige Entwicklung – Zukunftschancen für Mensch und Umwelt. Springer: Berlin
- Renn, O./Kastenholz G. 1996: Ein regionales Konzept nachhaltiger Entwicklung. GAIA 5, 2: p.86-101
- Renn, O./ Zwick, M: 1997: Risiko- und Technikakzeptanz. Hrsg.: Enquete-Kommission "Schutz des Menschen und der Umwelt" des 13. Deutschen Bundestages. - Berlin: Springer.
- Renn, O./ León, C./ Clar, G. 2000: Nachhaltige Entwicklung in Baden-Württemberg. Statusbericht 2000
- Renn, O., Stegelmann, H.U., Albrecht, G., Kotte, U. and Peters, H.P. 1984: An Empirical Investigation of Citizens' Preferences Among Four Energy Scenarios. Technological Forecasting and Social Change, Vol. 26, No. 2, pp. 12-46
- Renn, O./Münch, E./Häfele, W. (Hg.) 1985: Sozialverträgliche Energiepolitik. Ein Gutachten für die Bundesregierung. High Tech: München
- Renn, O., Albrecht, G., Kotte, U., Peters, H.P., Stegelmann, H.U. 1985: Sozialverträgliche Energiepolitik. Ein Gutachten für die Bundesregierung. München, High-Tech Verlag
- Renn, O., Albrecht, G., Kotte, U., Peters, H.P., Stegelmann, H.U. 1986: Das Projekt „Sozialverträglichkeit von Energiesystemen. P. 15-26 in: Jungermann, H. et al. (eds.): Die Analyse der Sozialverträglichkeit für Energiepolitik. München, High-Tech Verlag
- Renn, O./Webler, Th./ Wiedemann, P. 1995: Fairness and Competence in Citizen participation. Evaluation models for environmental discourse. Kluwer academic publisher: Dordrecht
- Renn, O. 1997: Wahrnehmung und Verdrängung technischer Risiken. In: Bender, W. (Hg.): Verantwortbare Energieversorgung für die Zukunft. Darmstadt: TuT

- Ruge, R.: National Goals Accounting. In: Hoffmann-Nowotny, H.- J. et al. 1976: Soziale Indikatoren. Internationale Beiträge zu einer neuen praxisorientierten Forschungsrichtung. Huber&Co. AG: Frauenfeld. S.95-125)
- Sachs W. 1999: Planet Dialectics: Explorations in Environment and Development. ZED Books, London
- Sachs, W. 2000: Globalisation and sustainability. Heinrich Boell Foundation: Berlin
- Sauter, R./ Awerbuch, S.2003: Oil price volatility and economic activity: a survey and literature review. IEA Research Paper: Paris
- Sdi- Interagency Working Group on Sustainable Development 1998: Sustainable Development in the United States: An Experimental Set of Indicators
- Slovic, P./ Fischhoff, B./ Lichtenstein, S. 1980: How Safe is Safe Enough?, Schwing, R. and Albers, W.A. Eds.; Societal Risk Assessment, pp. 181-216.
- Slovic, P. 1987: Perception of Risk. Science 236 (17 April), pp.280-285
- Slovic, P. 2000: The perception of risk. London: Earthscan.
- Statistisches Bundesamt 2004: Datenreport. Wiesbaden
- Teichert, V./Diefenbacher, H./Dümig, D./Wilhelmy, S. 2002: Indikatoren zur lokalen Agenda 21. Ein Modellprojekt in sechzehn Kommunen. Leske+Budrich: Opladen.
- Tremmel, J. 2003: Nachhaltigkeit als politische und analytische Kategorie: der deutsche Diskurs um nachhaltige Entwicklung im Spiegel der Interessen der Akteure. München: Ökom-Verl.
- Umweltbehörde Hamburg 1999: Kursbuch zukunftsfähiges Hamburg. Werkstattbericht für ein Umweltprogramm
- UN, World Population Prospects, The 2002 Revision; Eurostat, Databank New Cronos; Taiwan: Statistical Databook 2003
- UNDP - United Nations Development Programme: World Resources 2000-2001- people and Ecosystems- The Fraying Web of Life.
- United Nation Environment Program 1999: global environment outlook 2000
- UNEP's Millenium Report on the Environment 1997. United Nation Environment Programm Nairobi.
- Voß, A. 1999:Nachhaltige Entwicklung ohne Kernenergie? DAfF Wintertagung 1999. Bonn
- Un-United Nations 2001: Indicators of Sustainable Development: Framework and Methodologies. United Nations: New York

- Walz, R. et al. 1997: Grundlagen für ein nationales Umweltindikatorensystem - Weiterentwicklung von Indikatorensystemen für die Umweltberichterstattung. (Hg.): Umweltbundesamt: Berlin
- Walz R. et al. 2000: Development of environmental indicator systems: experiences from Germany. *Environmental Management*, Vol. 25 No.6, pp.613-623
- Watson, R.T. / Verardo D.J. 1998 : IPCC Special Report on Land Use, Land-Use Change And Forestry
- Weber, M. 1962: *Basic concepts in Sociology*, translated and introduced by H.P. Secher. Philosophical library: New York.
- Weber-Blaschke, G., Mosandl, R., Faulstich, M. 2004: History and Mandate of Sustainability: From Local Forestry to Global Policy. P. 5- 19 in: Wilderer, P.A., Schroeder, E.D. and H. Kopp (eds.): *global Sustainability. The Impact of Local cultures. A new Perspective for Science and Engineering, Economics and Politics*. Weinheim, Wiley-VCH
- Webler Th., Levine, D., Rakel, H. and Renn, O. 1991: A Novel Approach to Reducing Uncertainty: The Group Delphi. *Technological Forecasting and Social Change* . Vol. 39, No. 3 pp. 253-263
- Winterfeldt D./Edwards W. 1986: *decision analysis and behavioral research*. Cambridge University Press: Cambridge
- Wirtschaftsministerium Baden-Württemberg 1999: *Energiebericht 1999*  
WSI- Wirtschafts- und Sozialgeographisches Institut 2000: *Indikatoren zur nachhaltigen Regionalentwicklung in den Ballungsräumen Nordrhein-Westfalen*
- World Bank 1997: *Expanding the Measure of Wealth. Indicators of environmentally sustainable development*. *Environmentally sustainable development studies and Monographs series No.17*. the world Bank: Washington
- Wuppertal Institut 2005: *Fair Future. Begrenzte Ressourcen und globale Gerechtigkeit*. C.H. Beck: München
- Zapf, W. 1977: Soziale Indikatoren – eine Zwischenbilanz. P. 231-246 in: H.J. Krupp, W. Zapf (eds.): *Sozialpolitik und Sozialberichterstattung*. Frankfurt a.M./New York, Campus.
- Zapf, W. 1984: Individuelle Wohlfahrt: Lebensbedingungen und wahrgenommene Lebensqualität. S. 13-26 in: Glatzer, W., Zapf, W. (eds.): *Lebensqualität in der Bundesrepublik. Objektive Lebensbedingungen und subjektives Wohlbefinden*. Frankfurt/New York, Campus.
- Zentrum für Umfragen, Methoden und Analysen. Abteilung soziale Indikatoren 2004: *System Sozialer Indikatoren für die Bundesrepublik Deutschland: Schlüsselindikatoren 1950-2003*. ZUMA: Mannheim

**Internet Research:**

[http://www.gesis.org/sozialindikatoren/Daten/System\\_Sozialer\\_Indikatoren/PDFs/Tabellen/11\\_umw\\_tab.pdf](http://www.gesis.org/sozialindikatoren/Daten/System_Sozialer_Indikatoren/PDFs/Tabellen/11_umw_tab.pdf)

[http://www.gesis.org/sozialindikatoren/Daten/System\\_Sozialer\\_Indikatoren/PDFs/Tabellen/14\\_wof\\_tab.pdf](http://www.gesis.org/sozialindikatoren/Daten/System_Sozialer_Indikatoren/PDFs/Tabellen/14_wof_tab.pdf)

<http://www.helio-international.org/Helio/anglais/climate/cdm2.html#project>

[http://www-newmdb.iaea.org/help/NEWMDB\\_ISD-RW.pdf](http://www-newmdb.iaea.org/help/NEWMDB_ISD-RW.pdf)

[www.unep.org](http://www.unep.org)

<http://www.epa.gov/indicators/docs/scnotes.pdf>

[http://esl.jrc.it/envind/sip/en/Sip\\_en04.htm#Heading48](http://esl.jrc.it/envind/sip/en/Sip_en04.htm#Heading48).

<http://www2.eur.nl/fsw/research/happiness>

<http://iisd1.iisd.ca/measure/faqs.htm>

<http://www.unep.org/Documents.Multilingual/Default.asp?ArticleID=1163&DocumentID=78&l=en>

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<http://www.euractiv.com/en/environment/sustainable-development-eu-strategy/article-117544>

[http://reports.de.eea.europa.eu/environmental\\_issue\\_report\\_2002\\_31-sum/de/energy\\_low\\_sum\\_de.pdf](http://reports.de.eea.europa.eu/environmental_issue_report_2002_31-sum/de/energy_low_sum_de.pdf)