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ILK Report

Summary of the International ILK Workshop "Sustainability"

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Foreword

The International Committee on Nuclear Technology (Internationale Länderkommission Kerntechnik, ILK) was established by the three German states of Baden-Württemberg, Bavaria and Hesse in October 1999. It is currently composed of 13 scientists and experts from Finland, France, Germany, Sweden, Switzerland and USA. In its capacity as an independent and objective advisory body to the German states on issues related to the safety of nuclear facilities, radioactive waste management and the risk assessment of the use of nuclear power, the ILK aims in particular to make an important contribution to the assessment of the future viability of nuclear power in Germany.

Over the last few years, the question of a sustainable energy supply for the future has repeatedly been raised and discussed under widely varying framework conditions. These include for example, issues related to global warming or the capacity of energy resources. The ILK attaches great significance to these topics and had thus adopted a statement on the sustainability evaluation of nuclear energy and other electricity supply technologies, ILK-16, in January 2004. The aim of the international ILK workshop "Sustainability" on February 23rd, 2005 consisted in mirroring the basic indicators and criteria outlined in the ILK statement against the backdrop of the current state-of-the-art in science and technology and to identify possible aspects that might improve the approach taken by the ILK from an applied technology point of view. The present ILK report summarizes the essential findings of this workshop and was adopted at the 35th ILK meeting on May 24th, 2005 in the Eberbach monastery. This report is not only directed at the regulatory authorities, but at politics and the general public as well.

The Chairman

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1 Introduction

The international ILK workshop on „Sustainability“ was held on February 23rd, 2005 at the Sheraton Frankfurt Hotel & Towers in Frankfurt, Germany.

The workshop's point of departure was given by the „ILK Statement on Sustainability Evaluation of Nuclear Energy and other Electricity Supply Technologies”, ILK-16, published in January 2004 [1] as well as the results of the study commissioned by the ILK “Sustainability of Electricity Supply Technologies under German Conditions: A Comparative Evaluation“ by the Paul Scherrer Institute dating from November 2003 [2]. Participants were given the opportunity to present the current developments within their institutions and to make a cross reference to the stance taken by the ILK statement [1]. To give due consideration to interdisciplinary aspects, the scope of guests ranged from the field of nuclear engineering and the energy industry to representatives of other fields[1]. The aim of the workshop consisted in mirroring the basic principles and methods outlined in the ILK statement against the backdrop of the current state-of-the-art in science and to identify possible aspects that might improve the approach taken by the ILK towards the assessment of sustainability and in particular of electricity generating technologies in a technical application-oriented manner. Furthermore, the workshop aimed to provide experts and scientists with an international and interdisciplinary forum for exchanging thoughts and experiences.

The workshop consisted of three sessions, each with a series of presentations and a concluding discussion:

1st Session „General Approach“,

2nd Session „Set of Indicators“,

3rd Session „Aggregation“.

The individual presentations [3], [5] to [14] can be viewed and downloaded from the ILK website (www.ilk-online.org). The current report summarizes the essential findings of the workshop.

[1] Unfortunately, not all invited organizations were able to participate, e.g., WBGU ("German Advisory Council on Global Change") or WBCSD ("World Business Council on Sustainable Development").

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2 General Approach (1st Session)

In his introduction [3], Prof. Kröger (ILK) presented the background of the ILK statement [1] on sustainability evaluation of nuclear energy and other electricity supply technologies. In view of a substantial rise in substitute demand and additional demand for power plants by the year 2020 and the resulting potential for modernization, attention has to be paid that electricity supply technologies also need to live up to the imperative of sustainability, as defined by the Brundtland Commission. In so doing, a balanced consideration of the dimensions of economy (e.g., guaranteeing the security of supply and „affordability“), environment (e.g., protection of natural resources and climate) and societal well-being (e.g., creating societal acceptance) must be ensured. These dimensions should be operationalized using generally acknowledged criteria and quantifiable indicators. Several organizations, e.g., UN (CSD "Commission on Sustainable Development"), IAEA or OECD, have developed corresponding sets of criteria and indicators. However, a generally acknowledged set of specific indicators does not currently exist and approaches for integrating the varying procedures have not yet been established. The ILK has thus established a methodical approach based on a study by the Paul Scherrer Institute [2] for comparing the electricity supply technologies in Germany and has furnished it with the corresponding data. The intention of this instrument is to enable a broad sociopolitical discussion of the diverse electricity supply technologies with reference to the aspect of sustainability. This ILK workshop represents a first approach to generate opinions among organizations and persons active in this field.

Dr. Bertel (OECD-NEA) explained with reference to an earlier OECD-NEA study [4] that the three dimensions of „economy“, „environment“ and „society“ used by the ILK also take up elementary positions in the considerations undertaken by the OECD-NEA. On the whole, the developments undertaken by the OECD-NEA are very similar to the approach proposed by the ILK statement. Yet Dr. Bertel also pointed out that difficulties were frequently encountered in the practical implementation of corresponding methods because of the uncertainties associated with the used data and information. While these uncertainties can often be handled within a scientific treatment of the data, they may lead to larger problems in public discussions whenever individual pieces of data with varying degrees of uncertainty are taken as a measure for the quality of the overall project. As a result of these difficulties, the OECD-NEA has largely abandoned absolute assessments, i.e., those stating that a particular technology is superior to others, and instead champions relative statements for instance that one option represents the better choice in a specific context than another option. Furthermore, the OECD-NEA currently recommends the use of this instrument for the comparison of different options within one technological area rather than for a comparison of different technologies.

The implications of the data uncertainties mentioned by Dr. Bertel were regarded as an important aspect in the application of a sustainability assessment. In the discussion, it was also emphasized that data are almost always associated with a certain level of uncertainty. However, these uncertainties can frequently be managed. The selection of appropriate indicators and criteria represents the more significant task.

Prof. Grunwald (Research Center Karlsruhe) in his talk [5] first emphasized the necessity for operationalizing sustainability, in order, for instance, to clarify the object under study and thus to also help prevent any ideological abuse. For this reason, the Helmholtz community has developed an integrated concept. Components of this concept are, on the one hand, substantial sustainability rules („what"-rules) that represent the minimum conditions of sustainable development and that are assigned to the three goals of protecting human existence, maintaining societal production potential and upholding development and action possibilities. The second element named by this concept refers to the instrumental sustainability rules („how"-rules) that lay down the requirements on institutional and political circumstances to help the substantial rules to be fulfilled, that is, the minimum conditions of sustainable development. In the case of specific applications, such as electricity supply in this case, a contextualization is carried out for both elements. That is to say, the rules that are relevant for this application are determined. In Prof. Grunwald's view, this manner of proceeding is not sufficiently considered in the ILK statement. In the further assessment of the ILK statement, Prof. Grunwald added that the consideration of the three dimensions represents a good approach which is, however, potentially subject to blind spots. The comparative approach applied by the ILK is appropriate and can be implemented; however, the lack of potential „guard rails", i.e., permissible limits for indicators, is to be noted. The next step should aim for applications of this method involving affected stakeholders or interested citizens, where appropriate.

Agreement prevailed in the discussion of this presentation that next to meeting minimal criteria, the qualitative degree of performance of a criterion also needs to be taken into account. Generally speaking, it was stated that the rather "general" model presented by Prof. Grunwald needs to be adapted to suit the specific case under consideration.

Prof. Voß (University of Stuttgart) focused his talk [6] on the three elements inter- and intragenerational equity, use of natural resources within the framework of a soft sustainability and the 3-pillar model of the ILK statement. The definitions given by the Brundtlandt Commission mention ensuring need fulfillment within each generation (intra-generational) and maintaining the possibility of future generations

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to meet their needs (intergenerational) as normative principles. Thus, the question of the utilization and availability of natural resources becomes a tangible one. Where non-renewable natural resources are concerned, the maintenance or expansion of technical-economically available resource quantities should take place as a trade-off; however, no corresponding indicator is provided in the ILK statement. Instead of applying a 3-pillar model (economic, ecological and social), Prof. Voß advocated a functional perspective of the economic process that essentially consists of a transformation process based on natural resources for meeting the needs for goods and services. In particular, energy supply is not to be taken as the goal, but as the means. This means that the relative sustainability of energy technologies can be measured as the total amount of resources per energy service (source and sink usage). The total amount of resources can be calculated quantitatively as the sum of private and external costs. Questions regarding a just distribution of energy can not be determined at the level of technologies.

In the discussion, Prof. Voß argued for a sustainability time frame spanning the current and the next two generations, without continuing "endlessly" into the future. The full cost consideration was hotly debated (see also 3rd session), as were issues concerning the „soft" or „hard" sustainability and the aspect of „equity", i.e., the just distribution. The ILK statement consciously did not address this point but instead exclusively focuses on the comparison of diverse technologies.

Prof. Renn (University of Stuttgart) began his talk [7] with an overview of the range of possible sustainability concepts, starting with "pillar models" (ranging from (ecological) one-pillar models via diverse three-pillar models to multiple-pillar models). He then touched on models based on negotiation processes and concluded with normative models such as the already mentioned Helmholtz concept. The ILK's analytical approach is based on the three-pillar model coupled with a normative concept with regard to the three essential components. It should be noted that the areas of demand and public goods are not addressed in the economic dimension while the ecological component lacks a consideration of biodiversity. Regarding the social component, the selection made by the ILK can be viewed as relevant, yet a deductive principle cannot be recognized, thus making the selected aspects appear somewhat random. On the basis of a functional deduction of dimensions for the core social area (exchange, relationship, identity and order), Prof. Renn then suggested several specific social indicators such as guaranteeing long-term supply for all consumers, socially acceptable development or impact on social learning processes and ability to innovate. His verdict on the ILK statement was that while the ILK statement by all means represents a well-rounded balance of various factors with an emphasis on functionality, it nevertheless does not give sufficient consideration to core aspects of social sustainability and corresponding reasons.

In the ensuing discussion, the necessity for a more comprehensive justification of the selected indicators and for the deductive approach taken was generally emphasized and acknowledged. At the same time, the aspects of functionality and a more practical-minded approach underlying the ILK statement were endorsed. Regarding this point in particular, it was emphasized that the majority of the discussed social aspects probably cannot be assigned to specific technologies but rather represent a function of the total energy system or energy scenario. Accordingly, these aspects do not differentiate between the individual technologies. It is quite possible that a valuation is already introduced during the determination of indicators. In contrast, the goal pursued by the ILK was to enable a comparison of the different technologies and to separate as far as possible the description of the factual content using indicators from its valuation by assigning weights.

In his summary of the 1st session, Prof. Kröger noted that the operationalization undertaken by the ILK statement was generally welcomed. The chosen approach should, however, be reconsidered in some areas, e.g., where soft sustainability is concerned or regarding the elements and indicators of the social dimension, and ideally be explicitly deduced and justified. The choice of a relative assessment also meets with approval and for instance enables a less critical stance to be taken if any difficulties are encountered with the data sets. For this reason, the approach taken by the ILK statement seems well suited as a pragmatic approach. For the process itself, introducing the relevant stakeholder is essential and should be aimed for. Additionally, the transparency should be improved, i.e., illustrating the impact of individual determinants and decisions.

3 Set of Indicators (2nd Session)

In his introduction [8] to the topic of the 2nd session, Dr. Lindauer (ILK) again emphasized the statement's goal of achieving a transparent comparison of different electricity generating technologies. This objective was pursued using a limited number of indicators that are assessed quantitatively and are summarized in an appropriate way. This last aspect is treated in the third session of the workshop. The indicators are intended to characterize all factors relevant to the assessment with suitable units and correct figures. The questions arising in this respect are thus those asking to what extent, for example, all important aspects have been considered and described by the appropriate units or to what extent the correct level of detail has been chosen.

Prof. Elsässer (E.ON Energie) pointed out at the start of his talk [9] that the topic sustainability has a very high and topical significance to the E.ON Energie corporation as well. The individual indicators of the 3 sustainability dimensions should

above all have a high significance with regard to sustainability and also be as quantifiable as possible. Additionally, with regard to a public discussion, the indicators should be clear and vivid rather than going into too much detail. Given the multitude of existing approaches towards indicators in this area, the approach pursued by the WBCSD (World Business Council for Sustainable Development) was selected and used as a basis for performing a comparison with the indicators named by the ILK. Next to a number of expected agreements, the ILK statement includes some indicators that go beyond the approach taken by the WBCSD. When viewed in more detail and when taking on the above-mentioned postulates, several simplifications of the indicators used by the ILK can be suggested. Thus, for instance, an indicator „real production costs" could span the 3 indicators „production costs", „availability/load factor" and „load following". Similarly, the indicator „risk aversion" could cover the indicators „proliferation potential", „necessary confinement time of critical waste" and „maximum damage of potential accident". Furthermore, it is suggested to dispense with those individual ILK indicators that are ambiguous, unrepresentative or not sufficiently comprehensible to the general public. In conclusion, a simplified set of indicators spanning 11 indicators is suggested.

The discussion centered on the issue of the compatibility of indicator sets that are suitable for a dialogue with the general public versus those that satisfy scientific requirements. In this regard, the ILK statement tries to take a middle way. At the same time, this perspective opens the door for suggested improvements advocating either a reduction (Prof. Elsässer) or an increase (Prof. Renn) in the number of indicators used. During the discussion, it was also underlined that indicators that might be difficult to convey should not be relinquished in favor of clarity since this might pose the danger of discrediting the entire undertaking.

In his talk [10], Mr. Frieß (LfU Bavaria) initially addressed the different phases involved in the development of an environmental indicator system in Bavaria. This development enables the deduction of various generally applicable selection criteria that cover the topics data availability, relevance, functional relationships, target orientation, control, assessment certainty, communicability and compatibility. Thus, first the general protected properties (e.g., climate and health) are considered in terms of their relevance within this model. The next step, consisting of a consideration of the chain of functional relationships (activities -> load factors -> environmental media / resources -> consequences), is followed by an assignment of indicators (e.g., air quality). Based on these experiences, general recommendations for the ILK indicator set, with an emphasis on the environmental dimension, can be inferred. Thus, the attempt should be made to reach agreement on the set of indicators, e.g., by „adjusting" these with the core indicator set of the UMK ("Umweltministerkonferenz", Conference of German Environmental Ministers) and

by testing the relevance for the energy sector. The comprehensibility and clarity should be improved for a broad public discussion, also with regard to applying the valuation weights used in the MCDA (multi-criteria decision analysis) model. Dynamic further developments (such as biomass or technological improvements) should also be considered.

In the discussion, the well-founded deduction of the core indicators was welcomed since it counteracts a subjective or ideological selection of indicators that tends to arise sporadically especially in the ecological area. At the same time, this set of core indicators of the UMK also provides a very good basis for comparison with those used by the ILK and to test the relevance of the ILK indicators.

In his contribution [11], Dr. Kuckshinrichs (Research Center Jülich) presented the approach taken in the development of an indicator set within the framework of the RedImpact project. This project aims to determine the benefits and drawbacks of procedures for reducing radioactive waste such as partitioning and transmutation. The 3-pillar model is used as a basis for assessing sustainability. The indicators aim to satisfy both scientific as well as practical criteria. While an enormous number of indicators exists in the scientific field (about 300), this number is reduced using aggregation methods to about 35 – 100 for decision-makers and is aggregated further to an even smaller number for those indicators that are used in public discussion. In Dr. Kuckshinrichs' opinion, the essential point is that, already in the preliminary stages, very general and pre-existing sets of indicators should be taken into account in order to cover all main factors. Concerning a concrete comparison with the set of indicators used by the ILK, differences arise in the field of economics as a result of considering the public costs in the RedImpact project or as a result of using indicators for biodiversity, for the transport of new or spent fuel elements and the impact of emissions on air and water quality. In the social field, the RedImpact project uses additional indicators such as added value as well as threats posed by terrorist attacks.

In the discussion, mention was made of the indicators developed for the energy sector by the UN in February 2005. The indicator „employment" used in both projects (RedImpact, ILK) was hotly debated in terms of its suitability. Furthermore, the suggestion was made to functionally define some of the indicators by taking cost considerations into account.

Dr. Lindauer summarized the 2nd session by stating that several interesting proposals had been made, such as the suggestion to reduce the number of indicators used by the ILK to date while at the same time receiving suggestions proposing to expand the number of indicators in the environmental and social areas. The

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comparison of the set of indicators of the RedImpact project and the ILK showed a good degree of overlap. Closer attention should be given to the proposal to apply more of a cost-based perspective to some of the indicators.

4 Aggregation (3rd Session)

The aim of aggregation, according to Prof. Weiß' (ILK) introduction [12], is to summarize different indicators in a single specific value. This has been attempted in the ILK statement via the total cost consideration as well as via the multi-criteria decision analysis (MCDA). A consideration of the total costs covers the internal costs (production costs) and external costs, such as the impacts of severe accidents or global warming. The advantage of this aggregation rests in having an approach that is largely free of subjective assessments. However, this approach fails to cover important criteria such as societal indicators. When applying MCDA, first a linear normalization of the indicators is undertaken where the best / worst value is assigned with 100 / 0 respectively. Via a subsequent weighting of indicators, impact areas and dimensions, a single sustainability value results for the individual electricity supply option under consideration. If, in the context of a sensitivity analysis, at any one time one of the three dimensions is clearly over-emphasized, then the weaknesses and strengths of the different electricity supply options are shown in an exemplary way. For instance, weaknesses of the options wind and solar energy lie in the economic dimension while the weakness of nuclear energy can be found in the social dimension. In so doing, moderate changes of weightings for the individual indicators only show little consequence. The benefits of applying MCDA reside in considering all criteria and subjectively different interests; draw-backs of this approach entail the simple linear normalization of indicators and the lack of uncertainty considerations. The use of MCDA for structuring the energy debate is suggested.

In his talk [13], Dr. Hirschberg (Paul Scherrer Institute) delved into the differences between the two mentioned methods of aggregation. A basic requirement for the consideration of total costs is the representation of all indicators in a cost-based format. Once this can be done, the resulting cost-benefit considerations provide a good basis for guiding public policy. However, monetary conversion of some social indicators, for instance, is very hard to do (if at all) and/or not accepted by stakeholders. The overall uncertainties in external cost assessment may be very large, possibly leading to non-robust rankings. Some estimates of specific external costs have a weak basis; for some potentially important externalities relevant cost estimates are not (yet) available. The MCDA approach is advantageous if the goal is pursued of treating complex problems spanning very different interest groups and diverse solution possibilities. In this case, MCDA, far from providing the „only"

solution, should be viewed mainly as an instrument for supporting the decision-making process. The main criticism of MCDA is that it builds on subjective appraisals and assessments. However, these subjective assessments simultaneously provide a reflection of the diverse interests at stake and thus promote the transparency and the quality of the decision-making process. With regard to the selected linear standardization of the individual indicator values, it can be noted that this approach can be easily explained, e.g., to the public. A more sophisticated method in terms of evaluator preferences and qualitative information often does not provide any distinctive advantages. On the other hand, it is indeed the case that linear standardization can partly be viewed as a too simplistic procedure since, for example, risk is usually not regarded as a linear function of the indicator values. Furthermore, there is no possibility of introducing a limiting value.

Prof. Voß (University of Stuttgart) proceeded to point out in his contribution [14] that indicators should be viewed as simplified specific values for a complex aspect of sustainability, yet that at the same time they should have a clear direction, be free of overlap and should in total cover all important aspects. In the subsequent aggregation of a non-monetary evaluation procedure, e.g., MCDA, a scaling of the indicator values in terms of a one-dimensional target yield function and an ensuing determination of weighting coefficients for the relationship between indicators is performed. The appropriate determination of these target yield functions and the weighting coefficients represents the sticking point of these assessment procedures. Given a monetarized evaluation, the intensity of use of the resource represents the central measure of sustainability. Thus, the consumption of this resource is the basis for assessment in which the total costs are viewed as an evaluated total resource consumption. These total costs consist of private and external costs which are assigned via collective societal preferences rather than through individual value assignments as is the case in non-monetary procedures. The two methods commonly applied are to use market prices as value assignments of the market participants and willingness to pay as the value assignment for goods not having a market. In conclusion, Prof. Voß mentioned that the ILK statement has found similar total costs for the individual electricity supply options as those arrived at in investigations performed at his institute.

In the discussion of possibilities and limits of a total cost consideration, mention was made that elements such as the availability range of a resource are already implicitly defined via market prices while, for example the individual differences in willingness to pay for environmental maintenance can only be captured as an average value in the total cost consideration. This highlights an advantage of the MCDA approach that enables representing varying characteristics and thus conveys an awareness for possible existing conflicts. This information in turn can

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be used as a basis for compensation possibilities. One possible solution of this conflict between total cost consideration and MCDA applications that was suggested consisted of using both approaches in parallel in order to be in a better position to harness the strengths of both procedures.

5 Summary and Outlook

Taken as a whole, the ILK members and the participants viewed this workshop and the corresponding exchange of information in very positive terms. The ILK statement [1] had been received with great interest and considerable agreements with other models and approaches were achieved. Among these agreements were the application of the 3-pillar model (economy, environment, society), the operationalization of the sustainability concept to a specific application of electricity supply options, the approach taken towards indicators and the comparative perspective on different technology options. At the same time, the discussion also showed that the model suggested by the ILK still has room for improvement in specific areas. Thus the number and selection of indicators was critically questioned by proposing an aggregation of indicators, e.g., in the economic area, but also by suggesting additional indicators, such as in the social area. The set of indicators selected by the ILK wasconsidered to have insufficient or inappropriate justifications. The different approaches of a total cost assessment and a multi-criteria decision analysis were once again discussed for the aggregation process, however, a parallel use of both methods was viewed upon as a possible approach and recommended.

With regard to the further proceeding, both discussions with the energy licensees as well as more extensive talks with all relevant interest groups (e.g., industry, environmental associations, politics) were encouraged. This workshop will prompt the ILK to evaluate the mentioned topics again in more detail and to mirror the ILK statement [1] against this background. Specific aspects will have to be discussed in additional expert meetings.

6 References

The documents [3], [5] to [14] have been published on the ILK website (www.ilk-online.org).

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(Members are listed in alphabetical order)

ILK-01 ILK Statement on the Transportation of Spent Fuel Elements and Vitrified High Level Waste (July 2000)

ILK-02 ILK Statement on the Final Storage of Radioactive Waste (July 2000)

ILK-03 ILK Statement on the Safety of Nuclear Energy Utilisation in Germany (July 2000)

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ILK-07 ILK Statement on Reprocessing of Spent Fuel Elements (November 2001)

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ILK-09 ILK Statement on the General Conclusions Drawn from the KKP 2 Incidents associated with the Refueling Outage of 2001 (May 2002)

ILK-10 ILK Statement on the Handling of the GRS Catalog of Questions on the "Practice of Safety Management in German Nuclear Power Plants" (July 2002)

ILK-11 ILK Recommendation on Performing International Reviews in the Field of Nuclear Safety in Germany (September 2002)

ILK-12 Internal ILK-Report on the Intentional Crash of Commercial Airliners on Nuclear Power Plants (March 2003)

ILK-13 ILK Statement on the Proposals for EU Council Directives on Nuclear Safety and on Radioactive Waste Management (May 2003)

ILK Publications

ILK-14 ILK Statement on the Recommendations of the Committee on a Selection Procedure for Repository Sites (AkEnd) (September 2003)

ILK-15 ILK Recommendation on the Avoidance of Dependent Failures of Digital I&C Protection Systems (September 2003)

ILK-16 ILK Statement on Sustainability Evaluation of Nuclear Energy and other Electricity Supply Technologies (January 2004)

ILK-17 ILK Statement on Maintaining Competence in the Field of Nuclear Engineering in Germany (March 2004)

ILK-18 ILK Summary Report of the 2nd International ILK Symposium „Harmonisation of Nuclear Safety Approaches – A Chance for Achieving more Transparency and Effectiveness?" (May 2004)

ILK-19 ILK Statement on the Regulator's Management of the Licensee Self-Assessments of Safety Culture (January 2005)

ILK-20 ILK Statement on Requirements on Anticipated Transients without Scram (ATWS) (March 2005)

ILK-21 ILK-Report: Summary of the International ILK Workshop „Sustainability" (May 2005)

- CD with presentations held at the ILK Symposium "Opportunities and Risks of Nuclear Power" in April 2001
- Proceedings of presentations held at the 2nd ILK Symposium "Harmonisation of Nuclear Safety Approaches – A Chance for Achieving more Transparency and Effectiveness?" in October 2003

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