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Nuclear and sustainable development – a trans-disciplinary approach

Gaston Meskens & Erik Laes

Introduction

Never before in history has society been so thoroughly permeated by science and technology in all aspects of human life, ranging from economic progress to warfare, often resulting in huge environmental problems. Nuclear science can easily be seen as an exponent of this evolution. Numerous beneficial technologies for medicine and energy have been developed, but mostly against the background of the Cold War culture of military secrecy – thus contaminating the public perception of nuclear technology as a whole from the early beginning. Moreover, these developments were accompanied by the perceived threat of cancer risks.

Gradually, the contours of a new societal paradigm appear to have materialised, driven by the oft-cited dynamics of social change: globalisation, the pace of technological change (notably biotechnology and information technology), changing social identities, mistrust in 'big science' and expert systems and, often, an alienation from politics. In 'the age of risk', people feel insecure about the future. In this social context of uncertainty, a new concept for policy making at the global and local level has emerged: sustainable development. At present, the nuclear expert is struggling with society, and he paradoxically lacks a scientific approach and insight into complex human behaviour and societal interaction.

The restoration of trust will require the integration of humanities and social sciences in a trans-disciplinary problem solving approach, far beyond the technical dimension. 'Transdisciplinarity' is more than the integration of ideas of other disciplines into – in our case – technological research. 'Transdisciplinarity' is about *joint problem solving* among science, technology and society. In the 'ideal case', this problem solving process is preceded by an exercise of joint problem *defining*. While the joint problem solving approach is not yet very common in today's politics or industrial management, we can say that the joint problem definition is even far more exotic. The success of the TD approach is based on the preparedness of all participants (all disciplines, the public, the politicians) to work in an atmosphere of transparency, trust and openness, trying to balance personal interests with interests for the common good.

The general problem with existing complex problem solving tools is that they are relatively strong as far as the use of criteria based on quantifiable indicators is concerned, but very weak when it comes to fine-tuning the decision making process by integrating more qualitative 'social' factors. It seems that the combination of the strong points of formal decision making theories (systematic approach, quantifiability) and of participatory technology assessment (stakeholder involvement) may present a way forward.

This paper looks at a *possible* way forward, as undertaken by the Belgian Nuclear Research Centre (see Annex) and other research institutes or universities. It is also a call for feedback and input – from all relevant disciplines and backgrounds – because it is obvious that research on joint problem solving itself needs a trans-disciplinary approach.

The Context – Our Complex World

Is the world becoming too complex?

The philosophical tradition has always tried to understand the world by way of analysing it in small fundamental parts. Since the Greek philosophers, this has been our rational framework of reason. The similarity with the mathematical approach is clear. We tried to eliminate complexity by trying to discover the underlying simplicity. In certain cases (Newton, Maxwell, Einstein), this approach was successful, in other areas, we have tried to obtain results by focussing only on the manageable parts of the complex problem, while neglecting the others (this has been the case in economics and psychology). Up until now, we have rarely had the courage to tackle a complex problem in all its complexity.

That courage is needed more than ever. As stated in the introduction: never before in history has society been so thoroughly permeated by science and technology in all aspects of human life, ranging from economic progress to warfare. A typical 'modern' complex problem is a 'global' problem in the first place, having worldwide consequences due to our ever growing 'action radius'. In the industrialised world, our action radius has become *the* world (my village), not only as far as our freedom to travel and to communicate is concerned, but also with regard to access to information. Paradoxically, the availability of too much of all kinds of information does not facilitate the solution of a complex problem: it becomes part of the problem itself. In addition, there is a double knowledge gap, which makes the situation even more complex. The first knowledge gap is that between the industrialised and the developing world, in addition to the imbalance in wealth and wellbeing. The second gap is that between the knowledge that is available in our civilised world and the knowledge that is *necessary* to understand and solve the complex problems of this civilised world [1]. This last knowledge gap is the most important one, because it is needed to solve the first. The industrial world is characterised by a well-developed technological ingenuity. The complexity of the world could be manageable, on the condition that it develops social ingenuity in parallel. The difficulty is to tackle this 'raw' complexity without escaping too much into existentialism.

Development: driving forces and boundary conditions

In the following reasoning, it is necessary to make a distinction between 'boundary conditions' and 'pitfalls': boundary conditions are 'factual' and unavoidable limits to our

(individual) societal flexibility or to the flexibility of nature (the ecosystem); pitfalls are problems related to the joint problem solving approach itself and can – in principle – be avoided.

Development is triggered by a combined action of driving and counteracting forces (out of science, economics and politics), directed and subdued by *boundary conditions*. *Simple* boundary conditions are the consequences of our acts for the environment (impact on the ecosystem, depletion of sources). These boundary conditions are simple to represent, but – seen as problems – not always easy to solve or to predict. We – the human beings – are the *complex* boundary conditions: in relation to each other, to our environment and to our society, constantly balancing individual needs, interests and sorrows with those of our local and/or global society. These boundary conditions are far more difficult to describe or represent, and even more difficult to manage. Managing development in combination with these simple and complex boundary conditions is the real challenge. Not everybody has the same perception of the relative importance of the boundary conditions. Sometimes the boundary conditions are seen as so important that the idea of progress itself becomes questioned.

Globalisation and the double paradox

Globalisation and growing complexity make it very difficult for the human individual. In this sense, the relation of the individual to society is nowadays characterised by a double paradox. The first paradox is the fact that, although the world has become smaller (in terms of travel and the availability of information), people's confidence and trust in society is not really any better than before. On the contrary: stress and depression are the diseases of our modern times, camouflaging a certain kind of individual (or even collective?) fear. Failed attempts to adapt to the complex world are translated into self-protection and a growing individualism. The second paradox is one that originates from this individual fear: as a reaction of this feeling of being 'lost in the complex world', people feel the need to express their individuality and independence, doing this, strangely enough, by imitating others (fashion, interior design, hobbies, cars, holiday locations, preferred TV programs, etc).

In this social context of uncertainty, a new concept for policy making at the global and local level has emerged: sustainable development. Sustainable development can be a valuable concept, but it is not 'the solution' itself. On the contrary: it looks as if sustainable development is a kind of 'avoidance' solution: we don't understand how to tackle complex problems *now*, but we will make sure that they will not be transferred to next generations.

The Concept – Sustainable Development

The definition paradox

It is tempting to try to find one single definition of 'sustainable development'. The reason is that, once such a definition is found, it could serve as the touchstone to which all kinds of developments (technical, societal) could be tested on their 'sustainability'. A search of the literature shows that the attempt to find such a single definition is not very realistic. This is not surprising, given the political background of the origin of the concept of sustainable development (developed as a compromise between different States in

different stages of development, different economic backgrounds, different worldviews, etc). However, nowadays, the concept of sustainable development is widely used in all kinds of policy strategies, as if there were a consensus on the definition as such. This is the *definition paradox*.

This paradox makes it clear that there is a need for new views on technological progress, societal development, the economy, ecology and on the relationship between these issues. Instead of trying to find a 'definition', the concept of sustainable development should be seen as a continuous challenge to develop new ideas and/or fine-tune views on how to cope with our 'modern' society. A logical question is: why is this restoration and innovation necessary? Why do we need a concept such as sustainable development? What is the problem?

Characteristics of a complex problem

Sustainability, as a policy principle, emanates from the context of a growing complexity. Technological developments come together with (new) scientific uncertainties related to their possible impact on the environment or on society. As a result, it becomes more difficult to find the necessary objective (factual) arguments to defend one or another policy decision [2]. Implications in this sense for policy supportive research have been studied within the concept of 'post-normal science' [3]. Within this growing complexity, problems themselves become obviously more complex. Complex problems can be characterised by:

Interconnection	There is no *single* problem, but a *related web* of problems.
Incompatibility	Different *points of view* are possible, inspired by different scientific disciplines (economy, sociology, ecology).
Multidimensionality	In *space* (local, global); in *time* (intra-generational, intergenerational).
Pluralism of Values	Lack of generally accepted standards and values to support development.

According to the previous criteria, problems such as the development of responsible energy policy strategies can be characterised as 'complex problems'. (In this context, a 'problem' is not seen as an issue that should be *avoided*, but rather as a *challenge* that should be *tackled*.)

Key aspects of sustainable development as quality criteria for policy supportive research

As a starting point for this kind of complex problem solving, we list some (generally accepted) key characteristics of sustainable development that can be used as 'quality criteria' for further research (a similar approach is taken in Agenda 21):

Participation	Involvement of the general public in the decision making process is one of the key conditions to realise sustainable development.
Inter-disciplinarity	Existing multidisciplinary approaches should be reinforced, more interdisciplinary research should be developed.

Long Term Vision	Development should take into account that the needs of current and future generations can be fulfilled in a fair way.
Managing Uncertainty	Decisions should be based on reliable information. In addition, the knowledge gap should be bridged and information should be made available in a responsible and easy way.
Integration	Research should be done on the interaction between institutional, economical, ecological and social parameters.

The Approach – Transdisciplinarity

Transdisciplinarity: joint problem solving among Science, Technology and Society

In the social context of uncertainty, and given the characteristics of 'complex problems', it is clear that the restoration of trust will require the integration of humanities and social sciences in a trans-disciplinary problem solving approach, far beyond the technical dimension. There is much to be done in relation to the differences between multidisciplinarity, inter-disciplinarity and transdisciplinarity. Without going in too much detail, we can say that in the case of multidisciplinarity, different disciplines are studying a problem independently and come up with their own 'typical' solutions. Inter-disciplinarity is about problem solving by way of taking over some ideas from other disciplines in order to gain new insight. In the case of transdisciplinarity, disciplines work together towards a solution in a mutual simulating process (see ***Figure 1***).

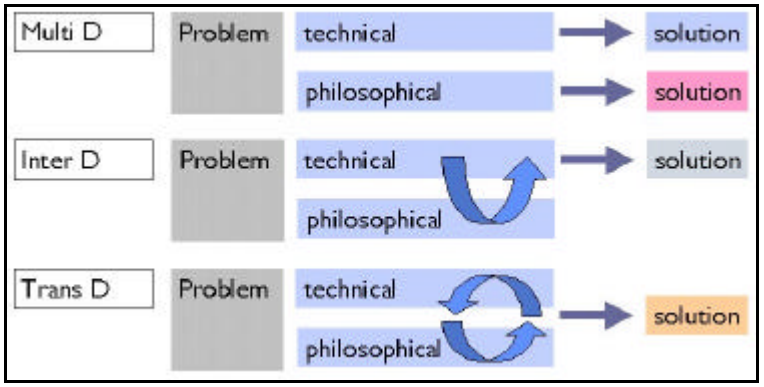

Figure 1.

Even as 'nuclear experts', we do not know it all. Problems that cannot be solved by pure technical reasoning need a trans-disciplinary approach. Within nuclear R&D, more and more initiatives are being taken to invite scientists from other disciplines (sociology, philosophy, ethics, economy, ecology, law) to think together 'out of the box' on the position of nuclear (with its specific benefits and problems) within the concept of sustainable development.

Historically we can see that, during the Enlightenment (the Age of Reason) in Europe, the separation of the pure technical and mathematical sciences out of the philosophical context was seen as a major step forwards in the development of scientific research. Now we can argue that, by integrating philosophy, ethics, social sciences and law into purely technical R&D, the Alpha and Beta sciences are back together again.

There is a need for methods to manage uncertainty and participation, and to integrate it in a global evaluation of technological developments (such as energy technology developments), without affecting its scientific integrity.

Reflections on the TD approach

The TD approach is twofold:

- to generate new insights into 'old problems'; and
- to develop a way of implementing these insights in society (communication, participation).

In order not to lose track of the various possible disciplinary views on a certain problem, it is very important to identify typical aspects of the problem that can then lead to specific perceptions within the different disciplines. As an example, for nuclear in relation to sustainable development, we can specify for each discipline two relevant aspects in relation to each other (eg individual/group and system/global decision making) and see what we can learn if we 'test' typical nuclear related problems, such as 'impact on the environment' to it (see ***Figure 2***). Of course, other (less stringent) approaches are also possible. The synergy within a trans-disciplinary working group, and the willingness to search for a fair solution is much more important than a consensus on all the aspects of the applied TD theory as such.

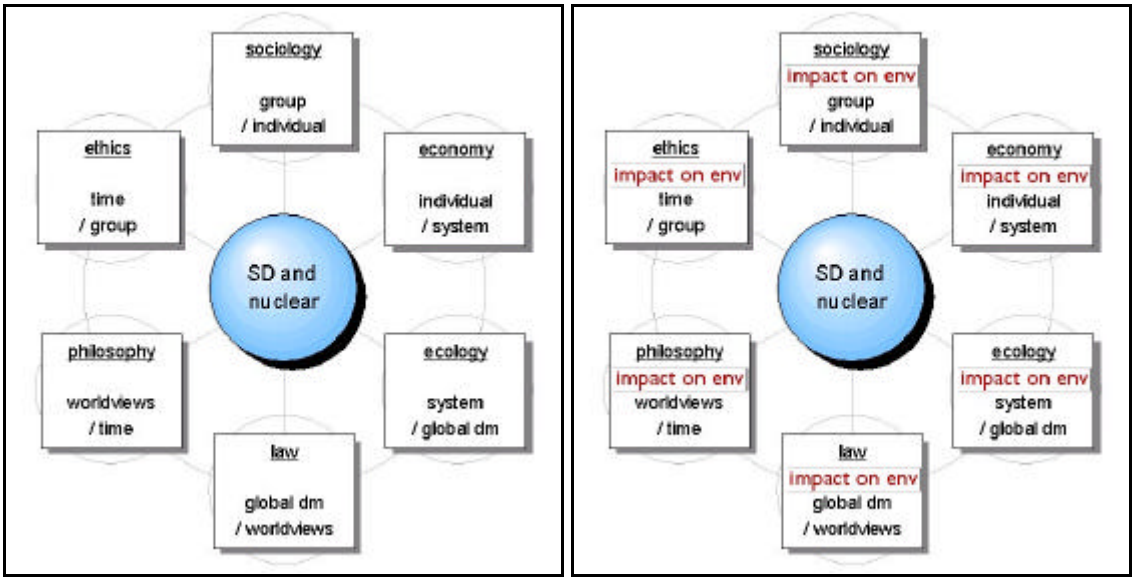

Figure 2.

The Methodology – A Framework for Sustainability Assessment

Existing Technology Assessment tools

Participatory technology assessment (PTA) [4]

PTA groups theories and strategies characterised by the fact that they study the interaction between social and technical development and the ways of tuning them towards each other. The implicit goal is to obtain a more profound social control of technological development. Recently, there has been a growing interest in interactive methods being integrated into scientific evaluation methods. Arguments in favour of this approach vary from a *reassessment of democracy* (anti-technocracy) to a more pragmatic attitude towards policy making (robustness of policy making, stronger social basis, stronger public support).

In this methodology, we intend to study positive and negative aspects of this approach, as already demonstrated in existing assessment exercises, and to identify relevant elements that can be of use for the TD approach.

Formal decision making theories

A lot of work has been done already on the development – and the use – of formal decision-making theories. Within this methodology, we intend again to identify weak and strong points with regard to the credible assessment of different options and with regard to the realistic implementation of selected options (this being an important criterion for the method itself). Examples of existing decision-making exercises are the GaBE project of the Paul Scherrer Institute (a Multi Criteria Analysis) and the ExternE project of the European Commission (based on the 'calculation' of externalities).

Towards a Framework for Sustainability Assessment (FSA)

The general problem with the assessment tools existing today is that they are relatively strong as far as the use of criteria based on quantifiable indicators is concerned, but very weak when it comes to fine-tuning the decision making process by integrating more qualitative 'social' factors. Some research has already been done on the implementation of social factors by making them quantifiable (eg employment), but it is clear that most of the important social factors, such as risk aversion and the NIMBY factor, have to be introduced in the models in another way.

It appears that the combination of the strong points of formal decision making theories (systematic approach, quantifiability) and of PTA (stakeholder involvement) could present a way forward. An approach in this sense could be the combination of insights from Multicriteria Mapping (MCM) [5] and the PRIMA approach (Pluralistic Framework for Integrated Uncertainty Management and Risk Analysis) [6].

We identified the following phases in the planned research:

- Problem definition; framework definition in terms of related existing problems; identification and characterisation of the principal uncertainties.

- Identification of the possible answers to these uncertainties, based on different social perspectives (leading to different visions of sustainable development); this could eventually be based on the four typologies described in an existing study on 'cultural theory' [7].
- Comparison of the implications of these possible answers, taking into account the presupposed criteria.
- Conclusion – concrete recommendations (in general as well as with regard to specific situations, eg the Belgian energy policy).

The Implementation – Reflections on Joint Problem Solving

From theory to practice: back to our complex world

The result of a comparative assessment method, as a possible solution to a complex problem, is normally a set of recommendations addressed to the relevant policy maker(s). In this paragraph, we want to point out some issues that can affect or even obstruct the real implementation of these recommendations. There is nothing mysterious in these issues: they originate from the fact that we are all 'just' human beings, continuously balancing individual and common values. A logical question would be why we cannot foresee the effect of these issues from the beginning, and integrate them in the assessment 'models'. The following will make clear that this is feasible in some instances. What is sure now is that none of today's existing theories have yet taken these 'dynamics' into account.

As before, the distinction is made between *boundary conditions* and *pitfalls*. Boundary conditions are considered as *inherent* and *factual* limits to our (individual) societal flexibility: conditions that unavoidably limit our freedom of movement when it comes to implement solutions in our complex society. We then consider pitfalls, inherent to the approach and the concept, and which, in principle, can be avoided.

Pitfalls of the SD concept

In order to ensure successful decision-making within the context of sustainable development, it is necessary to establish methodological requirements to avoid certain typical pitfalls:

- 'Sustainable development' is an intrinsically ambiguous concept. It cannot be studied in isolation from the political context in which it was developed in the first place. For that reason, any 'definitional' approach to SD is essentially flawed. A typological approach to SD is a more promising endeavour, bringing different dimensions and different interpretations more clearly into focus.
- Different dimensions of SD have to be weighted in a decision-making process. Neither CBA nor MCA can be used as a decision-making method. It is impossible to find a solution to a social problem based on an approach that is essentially mathematical. Both methods rely on the unanimous acceptance of utilitarian ethics as a basis for sound decision-making – an acceptance that is highly questionable.
- It is important to develop a coherent and plausible ethical structure. Incommensurability or incomparability are not the fault of MCA, but a sign of unreconciled value differences between societal actors. Cultural theory typologies

can be used to arrive at narratives, including explicit value judgements. Criteria for the weighting of scenarios should be developed starting from these value judgements, and not from established differences in sciences. Discussion will be more about values that matter than about concrete facts, which are made meaningful only by the whole range of ethical values.

- Applying such a pluralistic method does not guarantee that a specific solution will be found. But the resulting set of possible solutions could yield more robust insights than a 'best' solution found with a superficially accepted decision-making method.
- As far as this approach is concerned, one risk that we have to be aware of is that the TD approach can easily be relegated to a marketing instrument, and thereby lose its credibility as a 'neutral' assessment approach.
- Another pitfall is the risk of losing track of reality behind the models, if focussing too much on the theory or if putting too much 'trust' on the models as such.

Boundary conditions of global decision making – and the consequences for nuclear

The unavoidable mechanisms of political filtering and diluting

No matter what kind of solutions to complex problems such as the energy issue are presented, it is in the end the politicians who are responsible for the implementation of the measures proposed. In an ideal situation, these are the same politicians who originally 'ordered' the exercise. The contradiction is of course that the politicians – being responsible for the development of long-term strategies – only work in a short-term legislature, elected by short-term thinking and 'narrow-minded' members of the public. Within this short-term legislature, the efforts to assure future election are seen as equally important as the 'altruistic' policy measures for the common good. This is normal, and human: one assumes that, even without a normal degree of professional self-protection, a 'fair' politician wants to continue the work he or she started in the legislature period for which he or she was elected.

This contradiction is typical in a democracy, and can only be softened by trying to introduce 'the reasonable' into discussions, hoping that this is picked up by politicians and the public. One can understand that this can result in a very slow process of political decision-making. The real challenge would be to define *together* what is reasonable (joint problem definition), before starting a more detailed discussion on the consequences and the implementation of a certain policy. This is however not always realistic.

Next to the 'self-protection' of the individual politician (influencing policy on a local or national level), an additional obstacle for global decision-making is the determination of each nation to maintain national integrity. Nobody has the power to rule the earth. This is of course positive, but this simple fact makes decision-making on a global level very complicated. A 'world agreement', typically initiated and guided by the United Nations, has to be reached with about 180 countries (Nations) around the table, each bringing along specific wishes and concerns (after succeeding in finding a consensus at their local political level). Every nation that stays outside of the negotiations undermines the global effectiveness of the agreement. In addition, the negotiation process is influenced by 'interest groups': intergovernmental and non-governmental organisations, acting as a kind of ethical antenna (an ethical feeling counterpart), or acting to defend a common interest. Also Member States (Nations) join together in specific groups, in order to feel stronger

when it comes to defend a common viewpoint (this results in less parties in the discussion, but unfortunately also in a stronger polarisation of the viewpoints). The fear that – due to too different interests – an agreement will never be reached can eventually motivate politicians to soften their standpoints. In the case of a real agreement being set up, there is a chance that what remains of the original plans is just a 'hollow' agreement, containing a lot of loopholes. Next to that, there is the risk that the system of guidance, control and sanctions is too heavy and too 'procedural' to be transparent or effective. With this in mind, one can understand that global debates such as the United Nations Framework Convention on Climate Change process are slow, and that, for most of the time, solutions are only a weak or hollow version of the original scope. The agreement on the implementation of the Kyoto Protocol, as it was reached this summer in Bonn, is infected by all the above mentioned problems. Although European politicians gave the impression that the big issues have been resolved, it is clear that even much harder and fairer negotiation will be necessary to work out the practical implementation of this 'symbolic' agreement.

The necessity of cultural and social fine-tuning

Even if an agreement on a certain methodology is reached on a global level (eg European Union member states), it cannot be assumed that the use of the same set of criteria and indicators will lead to the same conclusions. A good example is the indicator 'Value of Statistical Life' (VSL), often used in risk assessment methods studying the impact of energy options on the environment and on society. It is known that – even in Europe – not every country would calculate the same value for this indicator. Another example is 'visual pollution', having a growing importance for public and politicians in industrialised countries, but maybe not seen as a relevant factor in political decision making in countries with an economy in transition.

The practical implementation of an assessment methodology needs first a consensus (a fine-tuning) on the criteria and indicators used, followed by a general recognition of cultural and social differences (leading to different number used for the indicators), but this should also be combined with a reflection on these differences, and on how they can be tackled.

Influences of regional or national policy 'fluctuations'

No matter what kind of methodology is used, even backed up by a kind of political and societal support, elections leading to another coalition can result in a totally different view on the issues, making all the work done previously worthless. This happened, for example, with the perception of nuclear power in Sweden and Germany. The case of Sweden also shows that – next to 'instability of political policies' – public perception is equally not really a stable and predictable factor. Even with rational measuring-instruments (such as referenda), it remains very difficult to understand what makes 'public opinion', and what the influencing mechanisms are.

A good example of the effect of both public opinion as well as political policy 'fluctuations' is the nuclear situation in the US. Until last year, the position of nuclear within the global energy debate was mainly set by ongoing trends in European countries, those trends being mainly negative (except for Finland). Not that much was moving on

the US scene, while Japan's nuclear public image 'recovered' from the Tokaimura accident.

In the meantime, the situation in the US changed dramatically. While, within the deregulated market, two years ago, some NPP's were sold at a price which virtually reflected only the value of the fuel which was stored on site (<US$100/kWe installed), plants are sold now for typically US$800/kWe, on one occasion even after a bidding process between utilities. As these things happened before the Californian power crisis and before the (pro-nuclear) Bush administration was installed, it is very difficult to explain the reason for this turn around. One can assume that the global debate on the possible threats of climate change, and an understanding amongst the public that nuclear can have a positive contribution to this problem, has helped to change the atmosphere. In this view, it is understandable that utilities see existing nuclear plants as a valid option within their future energy strategies, especially because of the very good performance records of these US plants, and – last but not least – because of the fact that the NRC made the regulatory process for life time extension much more stable and 'user friendly' than it had been before. Given these evolutions, it is evident that the Californian power crisis, in combination with the announcement of the Bush administration that the US 'should build more nuclear', has resulted in a new nuclear enthusiasm outside the industry that has never been seen before. Although some industry and university representatives in the debate warn about too much optimism, utilities are already declaring that they will definitely buy more plants and order new ones. They see support from the regulatory side, as well as from the political side, and claim that it must be possible to start building plants after a licensing procedure of about five years, at a competitive price, and without major concerns amongst the general public.

Unfortunately, it looks as if the politicians do not see an urgent need to involve the public in this new enthusiasm. Since Chernobyl, fifteen years of internal reflection and of initiatives to make the industry more transparent and open for debate on the waste and safety issues seem to have been too much of an effort, now that utilities, with political support, are out there, waving new plant orders. Fuel crises, power shortfalls and political support, stimulated by a general fear about global warming are not really the right cornerstones to build up the trust that is needed to cope with the new challenges within the energy debate. In addition, the announcement of the re-launch of the nuclear military program, an improper initiative in itself, will certainly undermine the efforts of the nuclear electricity industry and the scientific world to explain to the public that nuclear electricity production activities have in fact no 'technical' link with military applications. The future will undoubtedly bring more clarity in this tricky situation. It is clear that the 'new optimism' in the US can only survive for a certain time, and that only the first real order of a new NPP can consolidate this optimism. We can only hope that these decisions are not taken 'behind closed doors', but after an open and fair dialogue with all the stakeholders involved – including the general public.

Participation: problems related to our complex society – and its individuals

A key aspect of a framework for sustainability assessment is the involvement of the general public into the process. Because we are all 'just human beings', participation has some 'boundary conditions' to be taken into account:

- People are not able to keep values related to their personal sphere out of reasoning which should lead to a solution which is a function of the common interest; this is not always a bad thing.
- Whether we are trying to solve a local conflict or a world-scale problem, the final solution will always be one or another kind of consensus.
- Parties as well as nations and individual politicians are in principle not able to position themselves more 'down to earth' and to think, in a manner freed from all kinds of self-interest.

This last remark brings us back to some questions about understanding the public and our own position in the public sphere:

- What is 'public opinion'? Does it really exist? Can it be influenced or changed?
- How 'neutral' can we be, while discussing or communicating nuclear issues?
- Do we really want to 'solve problems' while communicating on nuclear and plutonium, or do we sometimes just want to see our own ideas confirmed?

However good the intentions might be, we have to accept that we live in a self-conceived reality, and that we, as human beings, are constantly looking for assurance and self-confirmation. Successful defensive behaviour confirms our ideas, 'defeats' keep us able to learn.

Three kinds of 'participation'

Good ideas resulting from a TD approach are useless unless they are successfully implemented in our society – participation is a must (this is the reason why well-developed ancient societies, such as the Roman and Egyptian, ended 'in chaos': the societies were economically and socially not ready to implement their theories on mathematics and physics – slavery and no capitalism). Social ingenuity is a pre-condition for technical ingenuity. The violence accompanying recent anti-globalisation movement actions in Seattle, Göteborg and Genoa, is an example of failing social ingenuity outside the political world. In this respect, one could say that 'Bonn was better than Genoa': the negotiating process on climate change, although rigid, slow and very complicated, leads to far less frustration with regard to communication on concerns. This might be the reason why there were no violent actions in Bonn (COP6bis), compared with the aggressive atmosphere in Genoa, where it was triggered by political self-defence, as well as by the extreme views on the issues of some protest groups.

In the following paragraphs, we want to highlight three kinds of 'participation', all of equal importance for the implementation of sustainability assessment exercises with regard to energy policy making.

A first kind of participation is 'participation within our own industry'. Highly qualified and motivated people have brought our industry where it stands today. A precondition to continue and build on what has been achieved so far is – again – the availability of highly qualified and motivated people for the future.

A second kind of participation is the participation of the public in the general nuclear debate. Although there exist already good examples of a formalisation of this participation (eg consensus conferences), it is clear that, in most countries, we are still far

away from what should be a routine step in a political decision making process. It is important to note that it should not be the objective to involve the public in order to realise plans in an easier and underhand way, but that decision makers really have to see the general public as a valuable partner in the discussion.

A crucial condition for a successful participation of the public is the preparedness of the politicians to take part in this participation process. This third kind of participation has some specific problems, as stated in the beginning of this chapter. Politicians are responsible for the development and the realisation of long-term energy strategies, in a perspective of sustainability. The political world, however, can only function 'thanks to' elections, and only in a democratically inspired strict short-term calendar (typical periods of four or six years). Within this short-term calendar, the survival of a coalition is as important as the actual political programme to be executed.

Think global, act local

These last thoughts on the participation of the politicians bring us to a final issue, typical for our modern society, and which we will probably never 'solve' completely. We saw that a 'world problem' is a typical issue of our modern times (due to our ever growing 'action radius'), and that it needs a global solution. However, not everybody feels responsible for global problems, and the necessary 'ratio' can only lead to good solutions if everybody who feels concerned has the same good intentions: the 'wellbeing of the human being' (as individual) in his environment. Paradoxically, the human individual himself is not capable of showing the necessary 'all embracing comprehension and good intentions', which, together with those of the others, could lead to the banishment of conflicting interests. Those who take an initiative in this sense are often seen as heroes by the ones and as losers or softies by the others (remember we are all members of the public after all). It is therefore essential that global negotiations go together with local initiatives and communication on a local level.

Conclusions

Nowadays, the nuclear industry and scientific community are facing – or going through – dramatic changes, and a reflection on this situation is needed more than ever. In addition, we should be prepared to see the issues in a broader 'supra-technical' perspective, and invite the others in the debate to do the same.

The goal of our nuclear community is two-fold: to develop the nuclear option as a part of a global environmentally sound energy policy, backed by a consensus on the ethical, political and social aspects, and to maximise – in a responsible way – the benefits of the medical and industrial applications of nuclear technology. Next to even more 'specialisation', nuclear professionals need a broad view on the social, economical and political issues related to nuclear technology. We want our own people to think 'out of the box' and to develop a critical mind about nuclear issues. If they are able to see these issues in a wider perspective, including social, philosophical and ethical aspects, then they will have more confidence in the future role that nuclear technology can play in our society, and they will be more credible in a debate with people who have different ideas and/or who eventually stick to their narrow-minded view on the issues. While reflecting on nuclear issues, our professionals need to have the courage to 'think in public', instead of trying to prepare a defence behind closed doors.

Although sustainable development will remain a subjective and scientifically contested notion, it is possible to develop a framework (a coherent method) wherein everybody feels 'at ease'. Ensuring the future of our industry cannot longer be done only from inside; it needs a TD approach. Keeping in mind the unavoidable market oriented strategies of the industry, it is clear that the related research should be undertaken in close co-ordination between the industry and the scientific world (universities, scientific organisations), in order to use funding in the most effective way. Is it possible to legitimise philosophical and ethical thinking within this rigid market-oriented structure? Yes, but only if managers see the need for people and money for 'hard' *and* 'soft' research.

The transdisciplinary approach, in combination with the proposed methodology, can be a way forward to deal with complex problems that can no longer be solved by way of a purely technical pragmatic approach. The proposed ideas would not lead to dramatic changes in our behaviour in the short term, but they can lead to the development of a coherent method to search for – and to implement – the 'reasonable'.

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Annex – SCK.CEN Nuclear Research and Society

The Belgian Nuclear Research Centre SCK.CEN had already built up experience with multidisciplinary projects (e.g. extending the research on nuclear complexity to economics and liability), when, in 1998, it was decided to integrate social sciences in a more co-ordinated way.

Objectives

- To improve the nuclear research approach by integrating social sciences – where needed.
- To solve complex problems in interaction with society.
- To stimulate university collaboration with social disciplines in a learning process towards transdisciplinarity and improved societal responsibility.
- To improve the training of nuclear experts of SCK.CEN by gaining insight in their expert culture and implicit ethical choices.
- To develop projects and an original transdisciplinary program and project management by involving young and senior scientists, a variety of university opinions and relevant actors from industry and society.
- To participate in national and international networks such as the Technology Watch function of JRC Sevilla or future missions of FANC (Federal Agency for Nuclear Control) and NIRAS/ONDRAF (the Belgian waste handling authority).

Transdisciplinary reflection groups, defining research needs and actions

An original trans-disciplinary approach was set up. A horizontal programme manager is co-ordinating 4 projects, joining 4 senior project leaders, 7 young scientists in social sciences and humanities, and interested SCK.CEN experts. University professors and experts from different disciplines and backgrounds accompany the projects.

All researchers involved meet monthly in 2 reflection groups, with active participation of SCK.CEN's top management. These working groups, extended with selected university experts, are discussing two broad items: *ethical choices in radiation protection* – focussing on ALARA and the precautionary principle within the context of new trends in low dose effects, such as genetic susceptibility – and *nuclear expert: role and culture* – analysing expert attitudes, behaviour and dilemmas in nuclear problem solving and communication.

The four projects are:

· **Sustainability and Nuclear Development** – looking through Technology Assessment at criteria for sustainable development within the nuclear sector.

· **Trans-generational Ethics Related to the Disposal of Long-lived Radwaste** – exploring ethical aspects when dealing with the time scales under consideration.

- **Emergency Communication and Risk Perception** – studying risk perception in the situation of a nuclear incident or accident and its relation with communication and emergency management.

- **Legal Aspects and Liability** – trying to bridge the gap between law and complex technology, paying attention to liability in nuclear medical applications and the interactions with product standards, QA and control principles in law.

A broadening of scientific analysis and involvement beyond the frontiers of exact sciences will offer better insight in the interaction of nuclear technology in society. Therefore, development of technical solutions should be done in an interactive process with ethical and societal questions, based on insights from social sciences.

Find more info on the SCK.CEN Nuclear Research and Society projects on:
http://www.sckcen.be in general and on
http://www.sckcen.be/scientrep/00/radiationprotection_socialsciences.pdf