

KYT2014 Review Report

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Tiivistelmä Referat Abstract <p>KYT2014 is a research programme which is organised according to the Nuclear Energy Act for the period 2011–2014. The research programme is directed by a Steering Group, appointed by the Ministry of Employment and the Economy. The Steering Group coordinates the programme administration and general trends in research. A Support Group functions as reinforcement for the Steering Group.</p> <p>The KYT2014 research programme was established to ensure that the authorities have such sufficient and comprehensive nuclear engineering expertise and other facilities at their disposal that are needed for comparisons of the various ways and methods of carrying out nuclear waste management. The research themes are divided in three areas: new and alternative nuclear waste management technologies, research into the safety of nuclear waste management, sociological research related to nuclear waste management.</p> <p>The Ministry of Employment and the Economy decided to evaluate the scientific output of the Finnish Nuclear Waste Management Programme KYT in 2012 and asked a panel of three members to carry out the task. The evaluation was based on material supplied by the Ministry and interviews of relevant stakeholders. Those interviewed were members of the Steering Group or of the Support Group or representatives of research projects or financiers. The interviews were carried out 26.11.–30.11.2012.</p> <p>According to the Evaluation Panel, KYT's primary goals are being met. KYT2014 research programme promotes the training of new experts and maintains current research capacities. KYT-funded studies are successfully being exploited and the research programme is well covered and appropriately focused. The results of the previous evaluation have been implemented successfully. In addition to these general remarks, the Evaluation Panel makes several comments and recommendations.</p> <p>Contact person within the Ministry of Employment and the Economy: Energy Department/Jaana Avolahti, tel. +358 29 506 4836</p>			
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1 Introduction

1.1 Background

The Nuclear Energy Law of Finland stipulates that the nuclear waste produced in Finland must be handled and disposed of in Finland, and that the producers of the waste are responsible for their safe handling, management and disposal. This includes the needed R&D and associated costs arising from that obligation. The task for planning and implementation of the facilities required for disposal of spent nuclear fuel, including the needed R&D, is given to Posiva Oy a company jointly owned by Teollisuuden Voima Oyj and Fortum Power and Heat Oy. Discussions on the waste management solution by Fennovoima Oy are under way during the writing of this review.

The Ministry of Employment and the Economy (MEE) has the overall leadership and control in nuclear energy matters in Finland and the Radiation and Nuclear Safety Authority, STUK, is the regulatory authority. Furthermore, STUK has the duty to carry out all the R&D needed for supporting the regulatory decisions.

In addition to the research activities of Posiva and STUK, there have also been research programmes in nuclear waste management publicly financed and administered in Finland. The first one of such a series of R&D programmes, JYT took place in 1989-1993 and it was followed by JYT2 in 1994-1996. The International Atomic Energy Agency (IAEA) set up a team of four experts to review the overall Finnish nuclear waste management programme within the auspices of IAEA's Waste Assessment and Review Programme (WATRP). This evaluation was conducted in 1993 and as a part of that review, JYT activities were also considered. As another important milestone, the Ministry of Trade and Industry (MTI), the predecessor of MEE at that time responsible for nuclear energy matters in Finland, put in 1996 an independent Ad Hoc Group to plan the continuation of the two previous JYT programmes and, in particular, to discuss the programmatic needs to support authorities. As a result, first the JYT2001 (1996-2001) programme was established, and thereafter KYT (2002-2005) and its present successor KYT2010, launched in 2006 and running until the end of 2010, were implemented.

In 2004 the objectives and mechanism for funding of nuclear research in Finland were revised in the Nuclear Energy Law amendment. The law defined the aim of the public research in the area of nuclear waste management as "ensuring that the authorities have such sufficient and comprehensive nuclear engineering and other readiness at their disposal as needed for comparisons of the different ways and means of implementing nuclear waste management". As a consequence the National Nuclear Waste Management Research Programme, KYT, was redefined

and a framework programme for the research period 2006–2010 was published as “KYT2010, Public Nuclear Waste Management Programme in Finland”.

An independent review of the initial KYT Programme was conducted in 2007 and published in February 2008 as “KYT2010 Review Report”. This current KYT2014 review report builds upon that previous report based on a series of interviews with key managers, project coordinators and research students, conducted in November 2012.

1.2 Methodology

The Ministry of Employment and the Economy nominated and constituted an Evaluation Panel to perform a formal review of the KYT2014 programme in accordance with the Terms of Reference cited in Appendix A of this report. The Evaluation Panel was provided background documents on the KYT2014 Programme, including the KYT2010 review in 2008, prior to the formal review. These documents are listed in Appendix B. Interviews with key KYT2014 programme participants were conducted in Helsinki during November 26–30, 2012.

Individual interviews organized by Jaana Avolahti of MEE, included representatives of the MEE, members of the KYT Steering Group (“Steering Group”), members of the KYT Support Group (“Support Group”), and project coordinators and researchers of KYT projects. The interviews were conducted in 30- to 60-minute conferences in which the interviewees were invited to briefly summarize their work and discuss their own insights on the KYT programme guided by a question-and-answer dialogue with the Evaluation Panel. A complete list of interviewees is given in Appendix C. The review covered about the first half of the KYT2014 programme; in addition, some of the KYT2010 results and experiences were noticed.

The purpose of these interviews, it must be stressed, was focused on eliciting views on organizational, operational, and achievement aspects for the current KYT2014 projects, as instructed in the Terms of Reference from MEE (Appendix A); there was no detailed review by the Evaluation Panel on the scientific and technical merits or specific results of KYT2014 research projects.

1.3 Outline of Report

This summary report of the findings of the KYT2014 Evaluation Panel is divided into the following sections: A brief statement of the General Conclusions of the review by the Evaluation Panel, a section providing Responses to MEE Questions, and a final section in which the Evaluation Panel identifies and discusses several Challenges and Recommendations about the current (and future) KYT programme that might be taken under consideration. Some comments by the Evaluation Panel in certain areas may have exceeded the exact scope of the Terms of Reference, however, based on the strong endorsement of the KYT Programme by the Evaluation Panel, the constructive nature of these additional comments seemed judicious to include.

2 Results

2.1 General Conclusions

A successful review was conducted by the independent Evaluation Panel of the KYT¹ Programme during the week of November 26-30, 2012 in Helsinki. The Evaluation Panel found that significant improvements have been implemented since the previous 2008 review report, in many cases the changes closely following the recommendations of that 2008 report. Overall, the KYT programme is now better focused and better managed to meet its stated goals. KYT's primary goal is being met, in the opinion of the Evaluation team, to provide education and training for research workers in order to assure future public protection and safe management of radioactive wastes in Finland. In addition, the Evaluation Panel finds that the KYT programme is building necessary competences in areas relevant and useful to radiation protection authorities, and challenges the KYT programme to maintain a focus on the need for future competences. Finally, the KYT programme is maintaining the key ability to continually track and evaluate alternative nuclear waste management technology options that are being conducted internationally.

2.2 Responses to MEE Questions

Are the achieved results in balance with the funding?

According to the goals of the framework programme of KYT a key task is to assist in securing the continuous availability of essential national expertise in nuclear waste management (NWM). This involves promoting the training of a new generation of experts and to maintain current research capacities. As understood, supplementary funding in addition to KYT is indispensable to provide sufficient volume for these tasks. The need of experts including those in R&D related to nuclear waste management has recently been assessed (Report of the Committee for Nuclear Energy Competence in Finland, Publications of MEE 14/2012). The estimated number of 215 professionals in 2011 will not appreciably increase but one has to note that new experts must enter to replace the retirees. The main stakeholder, Posiva has an overall personnel of about 300 of which 80, 40 and 150 are their own, subcontracted and externally hired people, respectively. The waste management and safeguards programme at STUK also represents a significantly large number of positions, about 20 at the moment. The wide range of disciplines involved in NWM implies that initially only a modest number of new specific experts are required; more comprehensive seniority has to

¹ In the following, the short hand notation "KYT" will imply the KYT 2014 Program unless an explicit distinction between previous programmes like KYT 2010 is made.

be acquired by continuing education and by on-the-job basis. This finding has often been expressed during interviews.

Besides directly offering new recruits to the stakeholders of NWM, KYT₂₀₁₄ has an important role in providing sufficient catalytic and sustaining funding to several research groups and new professionals educated at those institutions. As a reference, the previous KYT₂₀₁₀ produced in 2006-2010 altogether 27 theses. The annual average number of about one thesis per research unit is smallish. The statistics from KYT₂₀₁₄ appear more promising, although one has to note that the deliverables of KYT₂₀₁₀ and KYT₂₀₁₄ result from overlapping educational activities. According to the internal progress reports from 1/2011 to 8/2012 about one dozen BSc and MSc theses are close to completion or being accepted at the respective academic institutions; a similar number of PhD studies are progressing.

A more detailed survey of the research trainees provides some comments. The MSc and PhD output seems to correlate to the academic ambitions of the groups and in some groups the research topics, indeed, are particularly focused on nuclear waste management. The level of scientific goals related to the theses, however, varies to some extent. During the interviews it turned out that possibilities for further employment of the graduates are not straightforward. Universities offer some rather limited positions; VTT and other research institutes staff their strategic research personnel only. It appears that new personnel is primarily selected by the personal talents and secondly by the field of expertise. Further education and on the job training is necessary. The neutral operation field of KYT is challenging as it does directly promote to get a job by creating closer contacts with the final stakeholders. Perhaps, the graduates and their thesis could be more closely integrated into the stakeholders' interests. Some KYT trainees have a wide variety of job opportunities outside the nuclear waste management and therefore some outflow into other fields of experts is inevitable.

The continuity of obtaining expertise implies long-term commitment to fixed research objectives and hence there may appear conflicts with the need to renovate the programme and to launch new R&D topics. According to our assessment the situation is quite satisfactory: new areas have been introduced and launched, and a noticeable evolution from KYT₂₀₁₀ has taken place. Still it is important to point out that the existing R&D groups have sustained and deepened their level of know-how. Of course, the available KYT funding does not suffice for a major expansion of nuclear waste management research activities.

Are the results exploited efficiently in practice?

This question can be addressed at several levels, depending on the interpretation of whom and how results can contribute to NWM in general, and the goals of KYT in particular. The general impression by the Evaluation Panel was that most results from KYT-funded studies were successfully being exploited in various areas, as described below.

In the field of disposal of radioactive waste, the imminent submittal of Posiva's construction license application (CLA) for disposal of spent nuclear fuel (SNF) and subsequent review by STUK dominates the current situation in Finland, and KYT studies reflect this dominance. The results from many of the KYT studies are directly related to issues associated with the Posiva's KBS-3 disposal concept, and thus provide an independent examination and results useful to the authority. Of course, Posiva and other international organizations are conducting much more intensive and long-ranging studies on these same issues.

Besides SNF topics, other KYT studies are related to the disposal of low- and intermediate-level waste (L/ILW), which has previously been licensed by the authorities. The disposal of L/ILW, however, will remain a topic of continuing relevance as authorities will be interested in further performance confirmation of the safety of such disposal systems, which some of the KYT studies support. The current attention to SNF disposal should not deflect KYT from continuing to include some studies, as judged by the Steering Group, that address potential impacts arising from changes in L/ILW waste forms or in disposal methods that may arise in the future.

The current KYT results from various aspects of alternatives to direct disposal of SNF are well-connected to issues associated with topics such as partitioning and transmutation (P&T) options. Appropriately, these KYT studies leverage their KYT funding to aid Finnish participation in and insights from much larger international projects on P&T issues.

The results on KYT-funded social science programmes are too limited at this point to allow a credible assessment of how the results can be used in the area of NWM. Achieving more balance with respect to possible social science participation in KYT is addressed in a subsequent section of this report.

The Evaluation Panel found that results from some KYT-funded R&D programmes were contributing to NWM issues as well as to basic science and engineering endeavors in Finland and internationally. Given that teaming within large basic science and engineering projects has often provided critical supplemental funding to KYT projects, this linkage is both consistent with and prudent for the goals of KYT. The Steering Group, however, should take care that relevance to NWM issues in KYT-funded projects are not unduly diminished or relegated to non-NWM issues in such circumstances.

How well does the expertise cover the field?

The main task of the KYT programme, based on the nuclear energy act (990/1987, Chapter 7A, "Ensuring expertise"), is to partly provide the competence needed for a continued well functioning nuclear waste management in Finland. In more detail, competence is defined as expertise and facilities needed for the authorities to compare the various ways and methods of nuclear waste management. It is also stated that research projects supported shall be of a high scientific standard and

their results publishable. When fulfilling this task KYT takes good account of the implementers (e.g. TVO, Fennovoima, Fortum, Posiva) and authorities (STUK) in this field which are themselves users and generators of competence. These key actors are granted a strong influence on the KYT programme by being all represented in the Steering Group. There, they can help to adjust the programme to specific needs of future competence and integrate with their own efforts to maintain and develop such competence. Consequently, full coverage in this context means that KYT, together with the initiatives of the other actors in Finland, keeps competence in the field of nuclear waste management adequately covered for present and future needs as required by the law. Having competence building and comparison of methods as the main task also means that studies supported by KYT can be more of a fundamental nature as compared to studies made by, for example, Posiva and STUK which need to be more applied to the task at hand.

It is our impression that the field, as defined for KYT, is basically well covered and appropriately focused. Coverage is largely dependent on which proposals are received by the Steering Group. Therefore, the guidelines issued beforehand are important means to attract a wanted offer of proposals. To further assess coverage it is important to keep scanning the field, e.g., go through the content of Posiva's coming application to construct a spent nuclear fuel repository etc. An increase of funding to KYT would of course do much to further improve the coverage. However, it is our sense that with the present programme, and together with the other actors, students are produced in Finland with a reasonably broad competence in this field and also in cross-disciplines common to nuclear waste management.

Is the entire KYT programme balanced to different fields in nuclear waste management?

Balance, like the previously discussed coverage, is understood in relation to the aim of providing competence as required by the nuclear energy act. When analyzing this balance we decided to break it down further. Firstly, regarding the balance of competence building in the field of spent fuel versus low- and intermediate level waste, KYT is mainly concerned with spent fuel but also have some projects in its present programme on durability of concrete in a repository for low- and intermediate level waste. We find that the main focus on spent fuel is motivated in the present situation with Posiva applying for a construction license and with STUK preparing to review it, and spent fuel disposal will remain an important subject for some time. However, the plans to open a new reactor site may give rise to a need of more experts on management of low- and intermediate level waste (e.g., L/ILW cementitious waste forms) in addition to experts already engaged on issues specific to spent fuel. L/ILW is to be taken care of at the reactor sites. The power plant representatives, together with STUK, could presumably provide an input to the Steering Group on that subject.

Secondly, regarding the balance of science versus engineering, scientifically trained people are in much demand now when long-term safety is being scrutinized.

However, in years to come with presumably more focus on construction and operation of nuclear waste management facilities, a relatively greater number of engineers may be needed. Independent engineering expertise to support the regulator may be needed. It is our impression from the interviews that this possibility for the KYT programme will be further examined.

Thirdly, there is the balance of spent fuel disposal versus P&T, i.e. partitioning and transmutation. P&T is studied in many countries but if P&T will ever become a feasible alternative to direct disposal or, for that matter, conventional reprocessing remains to be seen. However, considerable efforts to develop P&T processes are made, for example, within the framework of EU collaborations and in economically strong countries like USA and Japan. If those efforts lead to future innovations, changes in attitude and laws favoring P&T cannot be foreseen. Consequently, the best strategy for Finland is to participate in and closely follow the international development. Skilled experts are needed as candidates for participation in the international development programmes. Supporting education and research in some key areas of P&T is a way to generate such candidates able to participate in and carry home impressions and knowhow from the large international studies. The expertise generated in this way can later be useful to the Finnish utilities, regardless of whether P&T becomes a success or not. KYT is following this strategy having some good quality research on both partitioning and transmutation. It is our impression that the present level of support by KYT on P&T studies is building competence on this alternative in reasonable balance with parallel KYT studies on spent fuel.

Fourthly, we have considered the portion of the KYT programme with respect to social sciences. It has been stated that an ambition is to build competence in the field of social research related to nuclear waste management. Social science aims could include the study and placement of NWM into a broad ethical context, as well as aiding decision making from the perspective of social attitudes. Some initial KYT studies are underway but it is our impression that more could be done. Despite an open solicitation for social science proposals, few proposals of relevance were received so far. One difficulty may be a lack of awareness in the social science community regarding their potentially useful contributions to NWM. Another issue may be the need for material to evaluate. Social science is about finding and describing relations between, for example, attitudes among those involved or affected by a certain activity. Inclusion of social science surveys of attendees at a general-public version of the KYT course on NWM, as discussed later in this report, might be remedy to this situation. Clearly there is a need for some action to attract more interest in the social scientist community with respect to NWM, to look for unexamined linkages between NWM and other societal issues of interest to social science investigators. In addition to risk assessment and risk communication to the general public, topics might also include legal issues, socioeconomic issues, energy and climate policy, international relations, etc.

Does KYT efficiently raise new experts?

Qualitatively, the answer is 'yes'. Most of the KYT projects are engaged in funding studies for students in advanced degree programmes related to NWM. In some KYT projects, it seems that researchers are expanding their original expertise into new fields, which is also consistent with the KYT goals.

Quantitatively, however, it was not possible for the Evaluation Panel to address this question. It is suggested that the MEE or the Steering Group or both ought to conduct a survey of the past KYT and even older JYT programme results, perhaps collecting data on the number of students completing degrees, the basic areas of these studies, and the field or organization that each former student is now working.

One last aspect of 'efficiency' that the Evaluation panel considered was the cost of supporting students in advanced degree R&D. While estimates varied across different institutions, the costs for sustained annual funding per student are about 75,000 euros for a MSc degree and 150,000 euros for a PhD degree. Such basic cost constraints need to be considered by the Steering Group and Ministry with respect to their own judgements regarding the efficiency and expectations in number of new experts developed.

Have the 2007 evaluation results been implemented successfully into KYT2014 programme?

The Evaluation panel was pleased to find that the answer to this question is 'yes' to a welcoming extent. Integrated and coordinated teams along common research areas, such as "bentonite buffer" and "canister", have been instituted and seem to provide the benefits of increased efficiency and enhanced mentoring envisioned. Domestic and international partnerships were increased, deepened and extended, allowing relatively small funding from KYT to be leveraged into involvement with much larger R&D projects, providing access to state-of-the-art analytical techniques and world-class researchers. More active "mentoring" by existing experts from STUK, Posiva and other participating organizations was also noted; mentoring is an area in which sustained and expanded effort provides great benefits to all participants.

The organization of a NWM course was also a notable implementation since the KYT 2008 review. As noted later, there are perhaps variants to such a course, particularly when considering different audiences that might still be envisioned. While it is noticeable that KYT has now reached out seeking proposals in the area of sociological studies, the response so far has been limited. There are likely several reasons for this limited response, and the Steering Group and MEE might attempt to identify such impediments and see if they can be surmounted, while still serving the principal goals and NWM needs of the KYT programme.

3 Challenges and Recommendations

Increase KYT visibility

It is important for the work of KYT to become recognized and able to build partnership both in Finland and abroad. Domestically, there is large potential for further increasing interactions between KYT and new technical departments such as engineering and sociology, as well as perhaps as industrial collaborations. Presumably some brainstorming within the Steering Group could help to identify potential partners and methods of approach. Because of the commonality of the KBS-3 disposal concept in both Finland and Sweden, interaction of KYT with the Swedish Radiation Safety Authority (SSM) might be one avenue to increase KYT visibility. In the EU, there are joint educational programmes and technical resources that could be utilized (e.g. IGD-TP, EFTS). KYT is generally mentioned in the acknowledgement of research papers published with their support in the open literature. Of course potential presenters of results could further act as ambassadors for the KYT programme. The fact that KYT strives for high scientific standard of research and promotes open dissemination its results is never better manifested than by the publications. Internationally, KYT well deserves to be promoted as an innovative and independent activity within Finland's 'first-of-a-kind' disposal programme.

Further development and use of KYT Course

The course on nuclear waste management (the Finnish acronym YJH) developed and held by KYT has been quite successful. This is a timely effort in a field that has developed more or less organically for more than thirty years but so far been much constrained to its actors in the form implementers, authorities and their consultants. The field has now been advanced and established enough for a formal course that offers the opportunity for many to become familiar with the subject. According to response questionnaires, the course has been impressive and its participants have made several helpful suggestions to further improve it. Apart from highlighting a relatively new field of knowledge, the course has clearly promoted networking among its participants with backgrounds ranging from students to different participants in the nuclear waste management field. The course has also been an excellent opportunity to increase the visibility of KYT.

The KYT course could be further evaluated to consider if different versions of the course might be a good idea. Perhaps a shorter version might be useful as means to reach broader audiences who are interested in obtaining an overview of NWM. Even one-day seminars could be considered as a means for reaching non-technical stakeholders, perhaps linked to a survey of their attitudes before and after such a course (social scientists might be particularly interested in conducting and

interpreting such surveys). Further specialized and focused versions of the course, on the other hand, might be of more interest for the implementers.

Suggestions as to the content of the course have been made by the participants. For example, coverage of issues related to low- and intermediate level waste management, and developments of alternatives such as partitioning and transmutation, has been suggested. Maybe even uranium mining and mine closure could be considered in future versions of the course.

Linking the course to EU activities in this field seems to be a good idea in order to increase visibility of both the course and the KYT programme. It could also be considered to use international tutors as a complement to the domestic experts.

Connecting KYT and SAFIR programmes to a greater degree

Two national concurrent research programmes, KYT₂₀₁₄ and SAFIR₂₀₁₄, have similar goals to preserve and create expertise for the nuclear sector, and both are also funded from VYR. The objective of the SAFIR₂₀₁₄ research programme is to develop and maintain experimental research capability, as well as the safety assessment methods and nuclear safety expertise of Finnish nuclear power plants, in order that, should new matters related to nuclear safety arise, their significance can be assessed without delay. Many research units participate in both programmes and use common facilities and personnel. There is clearly no overlap between KYT₂₀₁₄ and SAFIR₂₀₁₄ programmes, but it might be useful to enhance collaboration between them. Good practices have been adopted and some common research areas spotted, for instance, fuel cycle topics, methodology of socio-economic issues, life cycle analyses and impact studies just to mention a few cases. It is important that crucial cross cutting areas are not excluded by the separation of the two programmes.

A good chance to increase and widen the collaboration within nuclear energy is provided by the Finnish roadmap discussions concerning the national research strategies the coming year. A larger picture is available also when next generation fission reactors will be considered. In the very long perspective one should also keep in mind the cross-cutting issues related to fusion energy research, development and demonstration.

National Plan for Education on Nuclear Waste Management

In the KYT₂₀₁₀ assessment several proposals concerning the national plan for education on nuclear waste management were made. Here we briefly review the status of these recommendations. Of course, the resources needed to materialize the recommended activities have to be taken into account.

To increase the interaction between young researchers with rather different backgrounds and educational degrees, annual KYT research seminars were suggested. In 2008 and 2011 KYT₂₀₁₀ seminars were organized; it is expected that similar occasions will be included into KYT₂₀₁₄ schedules. Several topical areas took

place during KYT2010 – similar activities are expected for KYT2014. Also, one must not ignore the informal meetings of the follow-up groups.

A more comprehensive course on nuclear waste management (*Kansallinen YJH-kurssi*) has been carried out in 2010, 2011 and 2012 and should further be developed according to the lines mentioned above. The collaboration between SAFIR and KYT training is discussed within the common co-ordination group in Finland.

Collaboration within KYT related research groups has increased with the national doctoral programme YTERA where Aalto, Helsinki, and Lappeenranta Universities and VTT participate widely on nuclear energy problems. Power companies and Posiva are important sponsors of YTERA.

The numerous EU actions on nuclear engineering education can also be exploited by KYT researchers. The umbrella programme EFTS (European Fission Training System) involves specific nuclear waste management projects like PETRUS, etc. but participation in them has not been fully exploited by the young researchers.

The proposal for organizing an international NWM summer course in Finland is still under pending situation.

A well-defined task for the subsequent KYT2014 assessments is to list the graduates involved in KYT2010 and KYT2014 and to make a brief survey of their career development. KYT2010 provides excellent reference data concerning alumni of this programme.

Centres of Excellence

In the previous KYT2010 review an idea of centres of excellence was mentioned. This was partly based on the frontier, ‘first-of-its-kind’ status of the Finnish disposal programme, and partly based on the assumption that such centres could create sustainable, world-class technological infrastructures for Finland. It was suggested that such centres might catalyze partnerships with academic and industrial groups not only on NWM issues but in broader scientific and engineering studies as well. This suggestion, however, has not led to actions and was not supported by the Steering Group.

It may be that concept “centre of excellence” is perhaps too ambitious for the KYT to promote. As a matter of fact, however, the Finnish research on nuclear waste disposal is in the forefront of technology and science of the field, and this leadership position should be fully exploited where possible. KYT could lift its profile in such efforts.

Funding Issues

Based on discussions and presentation with the Ministry, representatives of the Steering Group, Support Group and project leaders of KYT programmes, it is clear KYT receives far more worthy proposals than the limited budget can fund. The other often-voiced concern was the year-to-year uncertainty in the KYT budget, which has caused certain KYT programmes to experience cuts to the planned multi-year budget

that was initially envisioned. There would seem to be several options that might be considered in this regard:

- Option 1: accept the status quo
- Option 2: selected fewer projects in order to assure each is fully funded over its duration
- Option 3: seek supplemental funds from other national or international sources

Each option has advantages and disadvantages for both the managers and the contractors within KYT, and the Evaluation Panel makes no recommendations on this matter.

With respect to Option 2, one method to be considered by the Steering Group in selection of future KYT projects could be whether the proposed project is viewed as a higher priority for agencies other than STUK and radioactive waste management in general. This approach risks losing some relatively small groups and areas of research that rely on KYT funding. Regarding Option 3, it is worthwhile noting that several of the currently funded KYT projects are part of much larger scientific programmes (e.g., microbial studies of deep boreholes). It should not be a requirement for future KYT proposals, but the Steering Group might wish to specifically ask and consider if proposals submitted to KYT are linked to parallel or supplemental funding in other non-radioactive waste management projects.

KYT funding for MSc projects ought to be sufficient to allow, during the whole recommended graduation period, the research trainees to concentrate on their thesis project and for that sufficient supervision and oversight has to be assured. PhD work clearly requires long enough systematic funding. In this respect, KYT has usually only provided part of the overall funding and the work has been split into smaller subprojects although related to the main field of activity. One critical funding issue is the full-cost modeling that most universities have recently introduced. It means that less direct research months are obtained for a fixed amount of money and the projects require more external and internal competitive funding.

A last issue regarding funding was the nature of the funding commitment that the KYT Steering Group can offer to multiple-year proposals. The current annual renewal and possible interruption or decrease of funding can be problematical for universities with students requiring more than one year to complete a dissertation or thesis that is initially funded by KYT. One option discussed was an approach used in Sweden, where KYT would provide a "Letter of Intent" to universities regarding multi-year degree proposals. A related topic was concern about annual adjustments in university overheads adversely impacting initially proposed KYT budgets.

Tracking of Progress in KYT Programmes

The quarterly reporting requirement for KYT projects was raised as an issue by several of the project leaders. Our KYT Review Panel did not review the formats required for such reporting. In our view, if such reporting tasks are kept to a reasonable length, quarterly reporting does not seem to be unduly onerous and

has clear benefits to the Support and Steering Groups in their need to properly manage the KYT programme. Certainly the KYT programme managers should seek to maintain a flexible and reasonable reporting format, so as to avoid undue diversion of time from actual conducting the proposed research.

The Support and Steering Groups also have a reciprocal responsibility to provide adequate feedback to KYT project leaders on their quarterly and, especially, annual reporting. Again, our KYT Review Panel did not specifically examine how feedback was being conducted by the Support and Steering Groups.

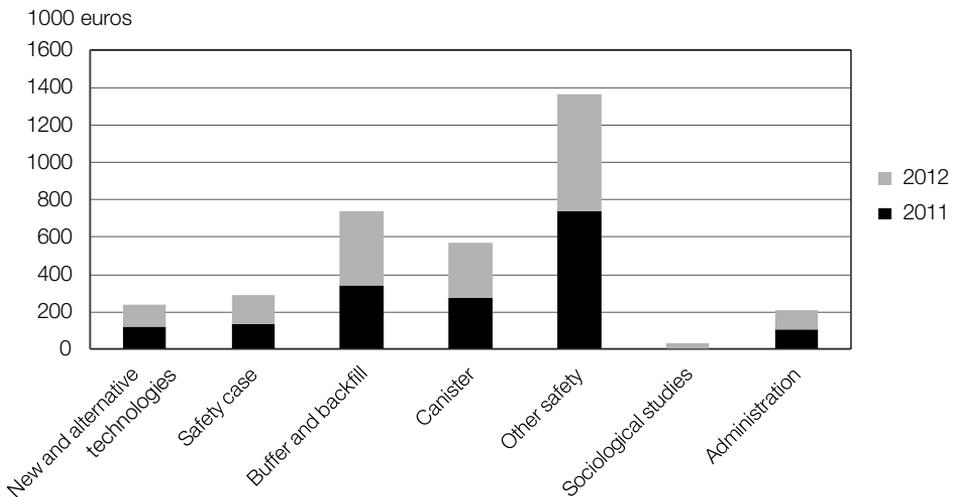
One suggested opportunity is for the KYT programme to consider organizing a full-participation, annual meeting over several days. The focus should be on brief presentations by students regarding plans, progress and results in their KYT projects. Such a unified meeting would provide for a wider range of comments, integration across related fields of study, and networking of workers across KYT projects. Technical experts, from STUK, Posiva, their equivalent organizations in Sweden such as SSM and the Swedish Nuclear Fuel and Waste Management Company (SKB) or independent specialists, could possibly be invited to participate and give overview talks. Enlarging the participation with outside experts would further enhance technical feedback and provide linkage to radioactive waste perspectives from outside of Finland.

Support Group Management

There is an evident imbalance in the number of Support Group leaders assigned to different KYT study areas, ranging from as few as 1 person to as many as 8 people. It would seem sensible to have at least 2 Support Group leaders for any area within KYT. This would help assure that at least one of the Support Group leaders would be available for any issue that might arise, and it would allow decisions and work-loads inherent to the role of the Support Group to be more equitably distributed.

Another imbalance possibly requiring attention by the Steering Group, is matching the number of Support Group leaders to the relative size of the KYT funding under their auspices. Figure 1 shows the 2011 and 2012 funding levels for the several Support Group areas. Support Groups for the larger areas, such as safety assessment (“Other safety”), buffer/backfill, and canister, be adequately staffed in approximate proportion to their total funding and scope.

Figure 1. Relative funding levels for the KYT study areas in 2011 and 2012.



Steering Group Management

Many of the previous sections call for further involvement, consideration or decisions by the Steering Group. In particular, both the Support Group leaders and the individual KYT project managers look to the Steering Group for active and continuing participation and guidance. In addition to the earlier suggestions within this report, a few additional topics for consideration by the Steering Group are noted here.

First, periodic outside reviews such as this one can provide valuable independent insights. Our review, however, cannot substitute for ongoing self-evaluation by the Steering Group as to how best to preserve, protect and expand the successful KYT programme. In this regard, it might also be helpful to add independent international experts to join the Steering Group.

Second, only the Steering Group has the necessary 'long view' of radioactive waste management in terms of current plans and schedules in Finland. A construction license application (CLA) has been submitted recently by Posiva, and much of the current KYT projects are appropriately aimed at topics to be evaluated in this CLA. In 5 or 10 years, however, there will likely be changes in what will be key issues confronting the Finnish radioactive waste management community. Basic scientific research and development that characterized past needs may be challenged by an increasing need to address engineering, fabrication and waste-handling issues. Social issues and community acceptance are a relatively new topic within KYT, and it is not clear if and how the Steering Group thinks this area should be pursued under the KYT programme. Looking ahead to better solicit and shape future KYT projects must be a responsibility of the Steering Group.

Third, the Steering Group is also in the best position to discuss and evaluate whether there are any “missing” capabilities (test devices, analytical facilities, large-scale equipment, etc.) that will be necessary or might prove useful in future waste management activities in Finland. Notable advancements in physics, chemistry, geology, biology and computer science offer many new and relevant opportunities. The KYT programme might be one avenue to identify such national needs, with possible partnerships involving universities or industries to develop such facilities and the requisite trained staff.

Terms of Reference provided to the Evaluation Panel

On 13 April 2012 the Ministry of Employment and the Economy invited a team in an evaluation of the scientific output of the Nuclear Waste Management Research Programme “KYT”. The evaluation of KYT addressed the following main questions:

- a. Are the achieved results in balance with the funding? Are the results exploited efficiently in practice?
- b. How well does the expertise cover the field? Is the entire KYT₂₀₁₄ programme balanced to different fields in nuclear waste management? Does it raise efficiently new experts?
- c. Have the 2007 evaluation results been implemented successfully into KYT₂₀₁₄ programme?
- d. Challenges and recommendations.

The Ministry supplied the evaluators with material concerning the history, status and strategy of KYT. The evaluators made a site visit to the Finnish Counterparts of KYT and interviewed the management and personnel of the different participating organisations of KYT, in an organized manner.

Appendix B

List of reference documents provided to the Evaluation Panel

Steering Group Guidelines for 2009, 2010, 2011, 2012 Research Project Search (<http://kyt2014.vtt.fi/eng/guidelines.htm>)

Operating instructions (<http://kyt2014.vtt.fi/eng/researchprogramme.htm>)

Final Report KYT2010 (http://www.tem.fi/files/30191/TEM_26_2011_netti.pdf)

Framework Programme KYT2014 (<http://kyt2014.vtt.fi/eng/researchprogramme.htm>)

Review Report KYT2010 (<http://kyt2014.vtt.fi/eng/index.htm>)

Review Report SAFIR2010 (<http://virtual.vtt.fi/virtual/safir2010/>)

Appendix C

Listing of interviewees

Pertti Aarnio, Aalto University
Lasse Ahonen, Geological Survey of Finland
Marko Alenius, STUK - Radiation and Nuclear Safety Authority
Jaana Avolahti, Ministry of Employment and the Economy
Leena Carpén, VTT Technical Research Centre of Finland
Risto Harjula, University of Helsinki
Sami Hautakangas, Fortum Power and Heat
Liisa Heikinheimo, Teollisuuden Voima Oyj
Jussi Heinonen, STUK - Radiation and Nuclear Safety Authority
Niina Huittinen, University of Helsinki
Pirkko Hölttä, University of Helsinki
Merja Itävaara, VTT Technical Research Centre of Finland
Mykola Ivanchenko, Aalto University
Petri Jussila, STUK - Radiation and Nuclear Safety Authority
Olli-Pekka Kari, Aalto University
Markku Kataja, University of Jyväskylä
Leena Korkiala-Tanttu, Aalto University
Pertti Koskinen, VTT Technical Research Centre of Finland
Ilmo Kukkonen, Geological Survey of Finland
Rainer Laaksonen, STUK - Radiation and Nuclear Safety Authority
Tapio Litmanen, University of Jyväskylä
Miliza Malmelin, Ministry of Environment
Markus Olin, VTT Technical Research Centre of Finland
Risto Paltemaa, STUK - Radiation and Nuclear Safety Authority
Mikko Paunio, Ministry of Social Affairs and Health
Herkko Plit, Ministry of Employment and the Economy
Jari Puttonen, Aalto University
Juhani Rantala, VTT Technical Research Centre of Finland
Kari Rasilainen, VTT Technical Research Centre of Finland
Lauri Rintala, Aalto University
Päivi Roivainen, University of Eastern Finland
Juho Rousu, Aalto University
Veijo Ryhänen, Teollisuuden Voima Oyj
Timo Saario, VTT Technical Research Centre of Finland
Timo Seppälä, Posiva Oy

Ritva Serimaa, University of Helsinki
Marja Siitari-Kauppi, University of Helsinki
Tiina Tigerstedt, Fennovoima Oy
Mia Tiljander, Geological Survey of Finland
Jussi Timonen, University of Jyväskylä
Tuomas Viitanen, VTT Technical Research Centre of Finland
Ulla Vuorinen, VTT Technical Research Centre of Finland
Marjut Vähänen, Posiva Oy
Elmo Wiikinkoski, University of Helsinki
Mia Ylä-Mella, Fennovoima Oy

Tekijät Författare Authors Michael Apted, Yhdysvallat Fred Karlsson, Ruotsi Rainer Salomaa, Suomi	Julkaisu-aika Publiceringstid Date April 2013	Toimeksiantaja(t) Uppdragsgivare Commissioned by Työ- ja elinkeinoministeriö Arbets- och näringsministeriet Ministry of Employment and the Economy	
Julkaisun nimi Titel Title KYT2014 Review Report	Toimielimen asettamispäivä Organets tillsättningsdatum Date of appointment		
Tiivistelmä Referat Abstract Kansallinen ydinjätehuollon tutkimusohjelma KYT2014 on ydinenergialain mukaisesti organisoitu tutkimusohjelma, jonka ohjelmakausi on 2011–2014. Tutkimusohjelmalla on työ- ja elinkeinoministeriön nimittämä johtoryhmä, joka koordinoi hallintoa ja tutkimuksen yleisiä suuntaviivoja. Johtoryhmän tukena toimii asiantuntijajäsenenä tukiryhmä. KYT2014-tutkimusohjelman tarkoituksena on varmistaa, että viranomaisten saatavilla on riittävästi ja kattavasti sellaista ydinteknistä asiantuntemusta ja muita valmiuksia, joita tarvitaan ydinjätehuollon erilaisten toteutustapojen ja menetelmien vertailuun. Tutkimusaiheet jaetaan kolmeen ryhmään: ydinjätehuollon uudet ja vaihtoehtoiset teknologiat, ydinjätehuollon turvallisuuden tutkimus, ydinjätehuoltoon liittyvä yhteiskuntatieteellinen tutkimus. Työ- ja elinkeinoministeriö päätti toteuttaa vuonna 2012 KYT2014-tutkimusohjelman kansainvälisen arvioinnin ja kutsui tehtävään kolmihenkinen arviointiryhmän. Arviointi perustui ministeriön toimittamaan kirjalliseen materiaaliin ja asianomaisten ryhmien haastatteluihin. Arvioinnissa haastateltiin johtoryhmän ja tukiryhmän jäseniä sekä tutkimusprojektien ja rahoittajien edustajia. Haastattelut toteutettiin 26.11.–30.11.2012. Arviointiryhmä toteaa, että tutkimusohjelman päätavoitteet on saavutettu. KYT2014-tutkimusohjelma edistää uusien ydinjätehuollon asiantuntijoiden kouluttamista ja ylläpitää ydinjätehuollon tutkimuskapasiteettia. Tulokset ovat hyödynnettävissä ja eri tutkimusaihepiirit ovat edustettuina riittävästi. Tutkimusohjelman kehittämisessä on otettu edellisen arvioinnin suositukset huomioon. Yleisten huomioiden lisäksi arviointiryhmä esittää raportissa useita kehittämissuhteita.			
Työ- ja elinkeinoministeriön yhdyshenkilö: Energiaosasto/Jaana Avolahti, puh. 029 506 4836			
Asiasanat Nyckelord Key words ydinjätehuolto, kansallinen ydinjätehuollon tutkimusohjelma KYT2014			
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KYT2014 Review Report

A panel of three members was asked by the Ministry of Employment and the Economy (MEE) to evaluate KYT2014, a research program on nuclear waste management. The panel carried out its evaluation by reviewing copies of relevant documents and, during a one-week period 26 November – 30 November 2012, by meeting with key individuals. The results of the panel are provided as general conclusions, responses to questions posed by MEE, challenges and recommendations and comments on specific projects in each subject area. In general the panel was positive about KYT2014 and provided guidance for the program for the future.

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