IGD-TP Competence Maintenance, Education and Training Strategy and Action Plan for 2013-2016

DELIVERABLE (D-N°:3.2) Work Package 3

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IGD-TP Competence Maintenance, Education and Training Strategy and Action Plan for 2013-2016

DELIVERABLE (D-N°:3.2)
Work Package 3

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Production and Review

The CMET StrAP has been produced and discussed in the CMET group on all of the CMET meetings (1-6). Further it was edited in a editing workshop at TU Delft in June 2014 prior a presentation to the IGD-TP EG (no 14). The StrAP summary was submitted for the CMET working group review in connection with the CMET meeting no 6 on 8 December 2015 and the final draft was sent for approval and last comments to the CMET group and Secretariat on 29 December. The report presents the views of the authors and those of the CMET working group as indicated in Appendix 1 of the report. This document does not represent the views of the IGD-TP Executive Group and has not been submitted to their review beyond what was represented in the EG no 14 meeting.

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Project coordinator, Jacques Delay, Andra

IGD-TP CMET Working Group

Strategy and Action Plan

31 December 2015

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Preamble

The purpose of this document is to define how the working group on Competence Maintenance, Education and Training (CMET) can support the IGD-TP Vision "2025". Also it was and it is still intended for outlining the activities of this working group and Joint Activity (no 14) during 2013-2016. In connection with its Vision statement (IGD-TP 2009 Vision Report) the IGD-TP committed to among its other goals to "Facilitate access to expertise and technology and maintain competences in the field of geological disposal for the benefit of Member States".

The CMET working group was established in 2012 when its first Terms of Reference (ToR) version was approved by the IGD-TP Executive Group (EG). During 2013-2015 resourcing to support the group was received under SecIGD2 project with the EURATOM FP7 grant and with a direct contribution from the IGD-TP Executive Group members.

This document was planned for production already during the first SecIGD2 project year. It was to be based on the needs of the IGD-TP's Joint Activities that were already deployed or planned to start in 2012, and on the needs of the CMET group members. The role of CMET group was to address Competence Maintenance, Education and Training needs from the demand side. However, at the early stage of deployment, it was somewhat difficult to express or the identify competence gaps in the activities or they had already been identified and resourced at the beginning of the joint activity. Thus there was not adequate amount of input for the first CMET working group meeting as a direct basis for a strategy formulation beyond the action plan, which had been prepared for the SecIGD2 project proposal. The SecIGD2 project's Work Package 3 in the project's description of work (DoW) that was originally prepared in alignment with the CMET Terms of Reference included the main action plan for the CMET group. With the exception of this document, the actions foreseen to be carried out by the CMET in the action plan have been implemented according to the original timetable. The actions are described in this report and two other public project documents, which are included in this report's references.

The CMET working group members have contributed to the content of this report either directly via email commenting or by participating in the work group meeting discussion providing input to this report. The editors mentioned on this report's front page have been the persons who have produced this report document itself.

The document represents the views of the authors and of the CMET working group. This document does not represent the views of the IGD-TP Executive Group.

Abstract

This report is a deliverable of the "Secretariat of the Implementing Geological Disposal of Radioactive Waste - Technology Platform - Phase 2" or SecIGD2 project's Work Package 3. The purpose of the work package was to support the Competence Maintenance, Education and Training (CMET) activities of the IGD-TP and specifically the CMET working group that was established in 2012. The report covers the strategy and actions and action plan of the CMET group for the period 2013-2016 and represents the CMET group's views only.

The CMET group's objectives are to assist in defining the competence maintenance, education and training (E&T) needs in geological disposal. The group is not intended to be a training provider, but to assist the education and training providers to meet the end-user needs in E&T. In this way it is seen that also the sustainability of education and training in Europe could be maintained.

The main activities of the group have been the organisation of the group itself. The group has met eight times during the three years (2013-2015) when it has been supported by the Euratom FP7 project SecIGD2 (EC-GA 323260). One of the venues was a special session at the IGD-TP's fifth Exchange Forum. In this session the views of the participants were collected concerning the feasibility of a sector internal voluntary accreditation scheme. A separate report was produced about the feasibility. In addition to the regular meetings of the group twice a year, a special training session on the use of social media and digital tools for outreach was organised for the CMET members and the FP7 project PETRUS III participants.

The recommendations of the CMET group for the future in the field of Competence Maintenance, Education and Training are:

The recommendation for the CMET community of practice is to discuss how to select and continue working together one or two of the activities that the group found to be of most interest out of the commonly identified activities.

The main recommendation for the IGD-TP Executive Group is to ensure that there are training workshops and courses carried out in connection with future the IGD-TP's Technical Projects (TEP), too, since the current Horizon 2020 (H2020) calls does not require that training courses or other educational activities to be included into the project. In carrying out the future E&T activities in TEP's, European wide cooperation with the nuclear education association ENEN is highly recommended.

The European Commission's role here is recommended to further bridge and integrate the developments in Education and Training across the different DG's especially in this case between the DG RTD in Fission and Fusion and the DG EAC for learning faster from the current good European practices. ECVET is one example area to take advantage of. In this way, one can ensure that the community's different stakeholders like universities, research institutes, WMOs, and other industry organizations are aware of European level developments and in alignment with the aspiration to avoid overlapping activities, and to maximise the existing opportunities.

EXECUTIVE SUMMARY

Background

This report is deliverable of the IGD-TP's support SecIGD2 project's Work Package 3. The purpose of the work package was to support the Competence Maintenance, Education and Training (CMET) activities of the IGD-TP and specifically the CMET working group. The CMET group was established in 2012. By the time the SecIGD2 project started, there was no European level strategy related to competence maintenance, education or training (E&T) or knowledge transfer in geological disposal.

The CMET working group is a voluntary community of practice representing 29 different stakeholder organisations in geological disposal with interest and expertise in competence development and education and training. In the first meeting, the group members mapped the E&T scene in the participating European countries (14 countries in total), which were represented by the group member.

The preparation of a European level CMET and knowledge transfer strategy was seen to be somewhat outside the scope of this group. In this report, an attempt is made to make recommendations to assist with the strategic challenges in CMET in a similar way as with other challenges identified by the CMET working group. According to the CMET group the main challenges include:

1. There is no strategy to maintain and develop European competency in geological disposal. The current directive 2011/70/Euratom (1) states that "*member states shall make arrangements for education and training of their staff*" in its Article 8. However, the strategy how to implement these arrangements is left to the Member States.
2. Repository license will also require confidence in the human capability to implement safe geological disposal. The IAEA Safety Guide for the management system for the disposal of radioactive waste GS-G-3.4 (2) states e.g. (in chapter 4.3) the need for senior management to "*determine the competence levels for individuals at all levels"* and the need to "*provide training or take other actions to achieve the required level of competence".* The oversight authorities on their behalf oversee how this is implemented by a license holder. Equally, the oversight authorities need to ensure their independence also in terms of competence.
3. Required human competencies change now as the waste management programmes move from a selected site to a safely operating repository. Competency frameworks in geological disposal changes as the stage where the programme is currently in advances and the regulator has more oversight powers over the license holders based on the national legislation. Further these frameworks are also dependent on the selected disposal concept.
4. The supply of highly competent personnel is integral to the development of cost effective industrial schemes and to the continued improvement of safety of repositories and related nuclear facilities.

The European Member States were obligated in 2015 to report to the European Commission according to the directive 2011/70/Euratom on the state-of-the-art of their national programme including the requirements of Article 8. These reports will be evaluated by the Commission in the near future.

Objectives and Purpose

Philosophy and objectives for CMET in support of the IGD-TP's vision commitment (3) were defined in 2011 at the IGD-TP Exchange Forum no 2 and then expressed in the first version of the CMET Terms of Reference. At

the same time, the Finnish Ministry of Employment and the Economy had carried out an extensive study on nuclear competence in Finland. European Human Resources Observatory in the Nuclear Energy Sector EHRO-N as one of the three ENEF[1] initiatives for competence was just initiated and was running. Joint Research Centre Institute for Energy and Transport (JRC/IET) had organised the first ECVET workshops for identifying nuclear job profiles. The Petrus II[2] project was at its final year, and the ITC-School association had just become insolvent and ceased operating as a training provider in geological disposal.

The CMET working group (in **Appendix 1)** has developed into a community of practice in geological disposal competence development consisting of both education and training providers and end-users of E&T (professors, professionals dealing with competence development and consultants). In the beginning the CMET group had a stimulating role for the on-going work and for initiating discussions related to competence maintenance, education and training.

The main motivations of the group members to participate were addressed during CMET group's first meeting under the SecIGD2 project and were as follows:

- To have a forum to discuss E&T related matters beyond the R&D and technical points of view in geological disposal, and exchange knowledge and information about on-going and planned E&T activities inside the group;
- To emphasize and promote the importance of competence maintenance and education and training in the maintenance, promotion of safety in, and acceptance of geological disposal;
- To work together for the sustainability of the existing training initiatives, and to provide for more structure into the competence maintenance, education and training actions, and to catalyze cooperative actions between the CMET group members;
- To find out methods to address the need for knowledge transfer to new staff, to retain the knowledge in the face of retirements, and to maintain competence resulting from the geological disposal implementation schedule uncertainties;
- To be able to provide underground research and training facility services for helping out in the CMET activities. Learning in geological disposal cannot take place only in the office or laboratory setting, but one needs to be in touch with the actual underground work, too;
- To address the funding challenges of URL access and activities;
- To be able to provide a full Master's programme to complement the knowledge maintenance for the full professional life of the students and personnel in geological disposal;
- To discuss specific content areas like safety case, and e.g. identify E&T courses in geological disposal for actual training provision for the Member States in their programmes (as an example the European Nuclear Safety and Security School, EN3S);
- To provide capabilities as an intelligent customer in demonstrating to the regulators that the personnel working in the field is competent and skilful, and also pioneering in areas where there are currently no

[1] European Nuclear Energy Forum's Subgroup for Education launched three different competence development initiatives in 2011: EHRO-N - European Human Resources Observatory for the Nuclear Sector; ENELA - European Nuclear Leadership Academy (discontinued around 2012, not financially feasible); and EN3S - European Nuclear Safety and Security School.

[2] Towards an European training market and professional qualification in Geological Disposal

specified jobs due to the general state-of-the-art of the global geological disposal programmes.

The first selected focus by the group was to address the needs in the strategic research agenda areas (SRA 2011, 4) of geological disposal. The group provided information for the potential actions, but did not carry out the work itself beyond the action plan of Work Package 3 (WP3). Sufficient pooling of resources and funding was not available during the SecIGD2 for other actions. The group was formed on a voluntary participation basis and evolved into an exchange community. Each organisation contributed themselves to their participation except for the SecIGD2 project assistance and cooperation with PETRUS III project. The cooperation with the PETRUS III project has created the main possibility for the group members' work. The motivation to have such a group to interact in exchange of information and to initiate ideas was intended to avoid overlapping work and activities in the E&T community in geological disposal that is limited in its resources for international cooperation. The aim was to get synergies from sharing ideas, needs, and resources to some degree.

The objectives for the CMET group were formulated as follows in its Terms of Reference (version 2 of the ToR in **Appendix 2**). The second version of the CMET ToR was the outcome of the CMET Meeting no 2 in November 2013. In the ToR, the CMET objectives remained unchanged. Under each objective it is stated what this objective would mean for the CMET working group's actions during 2013-2015.

1. Transfer of the state-of-the-art and the new competence needs of the geological disposal community to reach “Vision 2025”
    - Meaning a review of the current status of competency and competency development of IGD-TP members and participants
2. Quality assurance of training for professionals with the support of a voluntary accreditation scheme
    - ECVET[3] approach seems to be the tool in the EC now
3. Compile E&T approaches and content into a type of curriculum/curricula for professionals in geological disposal
    - SecIGD2 emphasis on the deployment of the SRA
    - Overall E&T recommendations in the nuclear sector (e.g. SNETP[4]) and their link to IGD-TP
4. Ensure indirectly that both providers and new personnel will be available, now and in the future.

From the strategy point of view the key questions that the group tried to address during its six meetings in 2013-2015 were:

- What are the immediate competence needs in the European Union on geological disposal?
- What should be the vision related to competence needs in the European Union in geological disposal?
- What are the key assumptions underpinning the priorities and the development of competence?
- What is the output and impact that could be foreseen, it the development of these priorities is successful?
- What are the bottlenecks, risks, and uncertainties? And how can they be addressed?
- Which science and technology gaps and potential game changers need to be taken into account in geological disposal?

[3] ECVET = European Credit system for Vocational Education and Training, http://www.ecvet-team.eu/en

[4] SNETP = Sustainable nuclear energy technology platform, http://www.snetp.eu

- What is the role of the Euratom research in competence maintenance and development in geological disposal? And what are the perspectives for cross-thematic activities with other areas of Euratom research and in Horizon 2020?
- And what are the current and future perspectives for supporting horizontal activities like international cooperation, education and training, and social studies and humanities in the context of geological disposal?
- Especially for the CMET members a relevant question is the development of teaching science in a changing and digitalizing learning environment.

The waste management programmes that have progressed closer to licensing, have built up of a solid knowledge base regarding especially the early stages of repository development that have been identified in the IGD-TP's SRA 2011. The change in the competence needs is depending on the programme stage and it is continuous for the waste management programmes moving forward. During 2015, the first ever construction license for spent fuel disposal facility was granted and the programmes now move to a stage of the repository development not yet implemented anywhere.

The first challenge is to maintain the existing knowledge base and to transfer this knowledge to the future professionals. This knowledge has historically been built up through multidisciplinary international cooperation. Any strategy for competence maintenance, education and training should contribute to ensure that the knowledge base does not disappear and is transferred to future experts. The most actual needs for programmes to advance relate to the siting process. Thus the knowledge maintenance needs are not only scientific and technical but also about public acceptance of the siting activities, the site itself, and about the related decision-making.

The second challenge is to identify the competence needed at the pioneering stages of the repository construction and operation. For these stages more focussed qualifications are needed and at the same time there is a need to understand the cross-disciplinary requirements underlying the technical solutions and that need to be met by all functions for and during the implementation. These cross-disciplinary competences requirements are in general much wider in their scope than in more traditional engineering projects or even in nuclear new-build. Further any strategy for addressing this challenge needs to ensure that the current experts are able to produce technical solutions meeting the requirements and thus closing the remaining open questions standing in the way of obtaining a construction and an operating license.

Actions

The key questions and challenges described above cover a much wider scope than what was foreseen for the CMET working group's scope and support. According to the SecIGD2 WP3 scope the main task was to inform the CMET working group about the end-users needs on the demand side of CMET so that the providers could develop CMET solutions to those needs. This was expected to ensure at the same time that a sufficient participation (= funding) would be also available to implement the solutions. Such information was not available, so the work started with a quick survey trying to map the IGD-TP SRA's needs. Further the CMET collected information about the education and training programmes in geological disposal from the countries that were present in the CMET. Also the Joint Convention[5] Reports' Article 22 on Human Resources and the country reports based on directive 2011/70/Euratom were used to some degree in mapping the overview of the current state-of-the art in

[5] Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management http://www-ns.iaea.org/conventions/waste-jointconvention.asp?s=6&l=40

E&T. The CMET purpose was to identify on-going actions on the E&T programme level, not just an individual course offering.

The CMET development of strategy and actions represented in this report is more limited to the aims outlined at the IGD-TP EF2, when the CMET working group was formed. However, the strategy discussion has resulted also in some European wide recommendations from the group related to capturing the knowledge and setting up a sustainable E&T umbrella also for geological disposal. The Strengths, Weaknesses, Opportunities and Threats (SWOT) were identified for this purpose by the group. Collaboration between the group and the PETRUS III[6] project and European Nuclear Education Network, ENEN[7] association was active. The working group has produced two conference papers on the group's on-going activities and organised a special session towards assessing the feasibility of voluntary accreditation at the IGD-TP's Exchange Forum no 5 in 2014.

Further actions included organising a joint social media training session for CMET and PETRUS III. Dissemination on the CMET activities and about other CMET related events on the IGD-TP website and s in the IGD-TP newsletters and Master Deployment Plans has taken place. Two presentations were given to IGD-TP's Executive Group about the group's work and regular updated of the progress have been conveyed to the other EG meetings via the Secretariat. A set of predetermined deliverables was produced. The group has also been in regular contact with ENEN association through PETRUS III, and in 2015 ENEN decided to join the group. Also the IGD-TP and the CMET group have been represented in the EHRO-N[8] Senior Advisory Group (SAG). During the SecIGD2, the number in the group membership has steadily increased, though the participation of the members in the CMET meetings has represented only around half of the members.

The challenges discussed in the group related to the competence maintenance, education and training scene were presented back to the IGD-TP Executive Group at EG meetings no 14 (June 2014) and no 17 (June 2015) on invitation. The IGD-TP Executive Group recognized the importance of Competence Maintenance for the sustainability of its activities and the need to maintain certain skills over very long timescales and for the need for knowledge capture from experienced experts, but they consider that the CMET work does not represent their current view. Since CMET Joint Activity was no longer considered IGD-TP EG priority, the EG decided to close the activity in spring 2016. JOPRAD[9] project was asked to take over the knowledge sharing in the future.

Findings

The CMET findings that are relevant for the CMET strategy include three areas: The survey on the CMET needs; the existing E&T programmes in geological disposal and the strengths, weaknesses, opportunities and threats identified as a basis of the CMET strategy.

Findings from questioning the CMET needs of the SRA

The main findings from the work during 2013-2015 were that even competence and knowledge maintenance is valuable, the awareness of explicit competence needs in terms of translating them into educational or training plans was not highly developed in the on-going Joint Activities or the needs' gap had been filled at the early stage of the project planning. It is a potential cause that the activities were at their initial state when the

[6] http://www.enen-assoc.org/en/training/petrus-iii.html
[7] http://www.enen-assoc.org/en/about/what-is-enen.html
[8] http://ehron.jrc.ec.europa.eu/
[9] http://www.igdtp.eu/index.php/secretariat/h2020-joprad

questionnaire was sent out and the new needs were not so apparent early on in the project. For example in the largest demonstration project DOPAS project, the training planning[10] could be directly based on and carried out from the needs emerging from the project work. Thus survey carried out did not provide a sufficient or a concrete enough starting point for the E&T providers.

Findings about the E&T programmes in geological disposal

The first priority in the existing E&T programme in geological disposal and radioactive waste management is the need of having first educational and training programmes run in the national language. Full degree programmes exist in the United Kingdom, Germany, France and Czech Republic and Slovakia, where a student can select a radioactive waste management, decommissioning or geological disposal orientation in his or her nuclear fuel cycle, environmental or geosciences studies as a part of an existing programme. On European level in educational setting at Master's level educational subject content enabling geological disposal orientation can be shared between the different countries like it is done within the Petrus network. Barriers slowing down the implementation of teaching and studies still exist due to the differences in national degree structures and on the requirements, how to incorporate these collaborative modules into the national degree structure. These barriers still need to be worked with even though the ECTS[11] instrument is available for the European Higher Education Area (5). Further challenges are imposed by the different timing and lengths of the university semesters and funding of the costs related to travelling and to access to the other universities or to their educational facilities as a group. Mechanisms for individual student exchange and its funding do exist, but not for larger scale collaborative learning schemes.

Results from strategic SWOT analysis on the CMET objectives

The CMET group identified the Strengths, Weaknesses, Opportunities and Threats related to each of the group's objectives. The SWOT mapping addressed each objective separately and the main points identified are summarised in the following Figure 1:

[10] http://www.posiva.fi/en/dopas
[11] ECTS = European Credit Transfer and Accumulation System

Strengths	Weaknesses
• More than 40 years' experience in geological disposal • Many organizations / institution /companies, exist that can contribute • Funding is available, but not necessarily identified • Facilities for E&T exist and access is available with funding • Widely accepted that nuclear waste is an important topic to take care of • Identification of the KSC for the stages of repository development helps in identifying any KSC shortfalls	• High risk of loss of knowledge and experience due to retirement of experts • Competition for well educated new staff especially with STEM background • Terminology/taxonomy pending for geological disposal related KSC • Energy market situation not favorable in terms of attractiveness of the industry (post-Fukushima era) or for the economy of the producers

CMET SWOT SUMMARY

Opportunities	Threats
• Environmental protection is needed and of interest; need for low-carbon solutions exists • Sector offers good challenging jobs related to the multidisciplinary challenges with professional development opportunities • Long-term projects and very long time perspectives • Underground facilities exist that provide very good practical E&T opportunities • Provides a positive (environmental) solution as a good example to be followed by others	• Partly adverse public image of nuclear energy and radioactive waste issues/companies resulting in limited public acceptance • Not many universities offer education/training related to geological disposal and with a small number of students there is a threat of existing programmes closing down in some countries • E&T in geological disposal is very expensive (in URLs with only small number of students ~ 10) • For KSC identification a lot of systematic work is needed • Accreditation /mutual recognition not favored by some stakeholders

Figure 1. Summary of the SWOT analysis of Competence Maintenance, Education and Training scene as seen by the CMET group in 2013.
Abbreviations: KSC = Knowledge, Skills and Competence; SWOT = Strengths, Weaknesses, Opportunities and Threats.

Recommendations for the Future

Recommendations for CMET communities of practice and ongoing projects in this cross-cutting activity

The CMET group produced during its early meetings a list consisting of total 33 proposals (in **Appendix 4**) that the members thought would benefit from CMET cooperation. From the listing, each member marked those suggestions, which they would be interested in and at the same time they stated when they thought this activity would be needed and how important they considered it was. A similar compilation and interest expression approach was used by the IGD-TP SRA working group in 2009-2010 in the screening of the Key Topics and Cross-Cutting Activities for the IGD-TP's SRA 2011.

The member's listings were compiled and as a result a short list of suggestions having the major number of expressions of interest resulted. The top listing is a follows:

1. Define some more professional's profiles and related learning outcomes for civil engineers, geologists.
2. Use repository/URL sites for practical training or for training in site related work.

3. Produce (IAEA style) E-learning course/s on a specialised topic by an international working group by sharing competences and expertise.
4. Share what has been learned in the countries with more advanced programmes with other countries at earlier stages of repository development.
5. Collect/Refresh the geological disposal community's memory around the RD&D that has been conducted in geological disposal in the past.
6. Produce a strategy that is in alignment or aligns with the European Commission's strategy and potential funding requirements.
7. Make an IAEA URF network type geological disposal workshop to train people. Provide experts for the workshop.

With the exception of suggestion no 1, none of the listed actions are in alignment with the original CMET strategy to focus on the demands and needs of the SRA or the end-users. These suggestions include mainly activities that are carried out with E&T providers, but in co-operation with end-users and especially with experienced experts.

Since the group itself under the IGD-TP will be discontinued in Spring 2016, some of these activities, if large enough, can be formulated into E&T proposals under the Euratom H2020. Or if they include wider disciplines than just geological disposal the Marie Skłodowska-Curie / Lifelong learning programme calls could be responded to. The need to apply for external funding seems currently the only feasible way of overcoming one of the main weakness i.e. lack of funding for cooperation, preventing the implementation of the activity/activities.

In addition to continuing the preserving and maintaining actions group needs to follow-up the ISO Technical committee TC288 now developing the new ISO standard "Quality systems for Education Organizations". The follow-up is needed to ensure that the proposals made in the standard are in alignment with the other international and European developments. If the alignment is not ensured, this will result in additional overlapping work for the E&T providers and potentially also for training development and implementation.

Recommendations to the IGD-TP

The main interest on the IGD-TP EG level is to ensure that there are training workshops and courses carried out in connection with the IGD-TP's Technical Projects (TEP) (6) as expressed by the EG in EG no 17 meeting in June 2014. The current H2020 does not require that training courses or other educational activities need to be included into the project like it was in FP7. However, the IGD-TP EG can require such training to be included into a TEP before it endorses a TEP project if this is considered important. Alternative IGD-TP can join to create larger umbrellas than an individual project consortium for competence maintenance, education and training activities in support of the TEPs. ENEN association is the main forum collecting the European E&T providers in cooperation. It is made up of the majority of the European universities and other organisations including nuclear industry. ENEN members offer and they can be asked for nuclear related education including geological disposal. The first step is to create a formal link to ENEN e.g. in the form of Memorandum of Understanding (MoU). Formal cooperation includes the IGD-TP e.g. into the invitation list of the specific ENEN industry events.

Nuclear knowledge management (NKM) is also seen important by the IGD-TP EG for retaining skills for the long-time frame. The recommendation is to revitalize and put into action its Joint Activity no 15 on Nuclear Knowledge Management (NKM) in line with the proposal presented by Nagra to avoid the loss of knowledge and expertise in the face of retirement of experts.

The IGD-TP Exchange Forum 5 participants were reserved but open also to other approaches like the potential to have mechanisms for mutual recognition

and accreditation established. The amended directive 2005/36/EC on recognitions of professional qualifications gives a workable framework for the existing regulated professions and for future professions to be included into the national list of professions under the directive.

In the future the IGD-TP EG could interact with the ENEF initiative EN3S through a Joint Programming initiative. At the same time it is important to maintain the links with the other active ENEF initiative EHRO-N. EHRO-N has produced timely surveys and reports on the demand and supply of workforce in the nuclear sector and complemented the surveys with modelling exercises for validating the survey and study results under various European energy scenarios. The participation to the EHRO-N Senior Advisory Group (SAG) was made under the SecIGD2 project. For the future, it is recommended that the IGD-TP EG nominates a representative into the SAG.

Recommendations for the Commission and on the European level

Competence maintenance, education and training in Europe and especially in European Union are attributed directly to the national level. Several policy decisions related to education and qualifications are made under the DG Education and Culture (EAC) and the Euratom policies are not necessarily always in the same timeline with the European Union developments that take place in other fields of education and training. The difficulties of using e.g. the Marie Skłodowska-Curie grant funding for nuclear or geological disposal education and studies widens the gap between the educational development trends even further. This can certainly not be of European value added.

The 2011/70/Euratom directive on waste management also requires that education and training programmes exist in the Member States. An assessment on the state-of-the-art is now possible based on the national reporting submitted to the DG ENER and potential gaps on European level can be identified for future recommendations by the Commission.

Even though it is advantageous to give the basic induction education or training into geological disposal in a national language, E&T is certainly an area where further studies into the topic either on university level or for professional benefit from international cross-fertilisation. Here training modules in English are needed or in another major European language. The strengths of competence acquisition and E&T are that they are (or should be) an area with non-conflicting interests in the aims to provide a solid scientific and technical knowledge base related to the topics taught.

The European Commission's role here would be to further bridge and integrate the developments in Education and Training across the different DG's especially in this case between the DG RTD in Fission and Fusion and the DG EAC for learning faster from the current good European practices. ECVET is one example area to take advantage of. In this way, one can ensure that the community's different stakeholders like universities, research institutes, WMOs, and other industry organizations are aware of European level developments and in alignment with the aspiration to avoid overlapping activities, and to maximise the existing opportunities.

Final words

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1. Introduction to IGD-TP and Background for Competence Maintenance; Education and Training

1.1 IGD-TP and Its Vision 2025

The Implementing Geological Disposal of Radioactive Waste Technology Platform (IGD-TP) community according to its vision (Vision 2025 (3)) aims to proceed to obtaining licenses to construct and to operate deep geological repositories for spent fuel, high-level waste, and other long-lived radioactive waste in their respective Member States.

The IGD-TP's vision is that by 2025, the first geological disposal facilities for spent fuel, high-level waste, and other long-lived radioactive waste will be operating safely in Europe.

IGD-TP's commitment related to this "Vision 2025" is to:

- build confidence in the safety of geological disposal solutions among European citizens and decision-makers;
- encourage the establishment of waste management programmes that integrate geological disposal as the accepted option for the safe long-term management of long-lived and/or high-level waste;
- facilitate access to expertise and technology and maintain competences in the field of geological disposal for the benefit of Member States.

In 2009 a technological platform was launched in Europe to promote the sharing and pooling of resources to carry out jointly research, development and demonstration activities that are needed to address the remaining scientific, technological and societal challenges in deep geological disposal. This European wide cooperation was established by producing a common shared vision for the technology platform stating that the IGD-TP's vision (Vision 2025) is that by 2025, the first geological disposal facilities for spent fuel, high-level waste, and other long-lived radioactive waste will be operating safely in Europe (3). The vision was supported by three commitments. This vision led to the formulation of a Strategic Research Agenda, SRA (4) and its Deployment Plan, DP (6).

The commitment of the IGD-TP's founding organisations to the Vision 2025 includes developing joint means to facilitate access to expertise and technology and maintain competences in the field of geological disposal for the benefit of the European countries. The commitments are share by the organisations applying for participation in the IGD-TP.

1.2 Competence Maintenance, Education and Training Working Group

Competence Maintenance, Education and Training (CMET) Working Group was set up as a permanent Working Group of the IGD-TP in 2012 in alignment with the platform's' commitment to facilitate access to expertise and technology and maintain competences in the field of geological disposal for the benefit of European Member States. The first Terms of Reference (ToR) by the IGD-TP Executive Group in 2011 (for latest 2013 version, see ref. 7) included also the first version of the CMET ToR. The first draft for CMET ToR was prepared already in 2010 under the SecIGD project (EC-GA no 249396) and discussed in 2011 further in the Exchange Forum no 2 work group in Helsinki, Finland.

Philosophy and objectives for CMET were defined in details in 2011 at the IGD-TP Exchange Forum no 2 and then expressed in the first version of the CMET Terms of Reference of 2011. The CMET is one of the 16 Joint Activities

(JAs) defined in the IGD-TP's Deployment Plan 2011-2016 (6). The members of the CMET group at the end of 2015 are listed in **Appendix 1** including their participation to the group meetings.

At the same time, the Finnish Ministry of Employment and the Economy had carried out an extensive study on nuclear competence in Finland. EHRO-N as one of the three ENEF[12] initiatives for competence was just initiated and was running. JRC/IET had organised the first ECVET workshops for identifying nuclear job profiles. The Petrus II project was at its final year, and the ITC-School association had just become insolvent and ceased operating as a training provider in geological disposal.

The CMET working group first convened in connection with the Exchange Forum no 3 (EF3) in 2012 in Paris, France. At the time, there were five participating members from five different countries and organisations. The CMET launch took place in EF3 with a call for volunteers to the group. In the beginning of 2013 the work of the CMET group was supported by the FP7 SecIGD2 project's Work Package 3 and it had its first documented meeting in Berlin, Germany. At the end of the year 2015, the group had a total of 36 members signed to it (**Appendix 1**).

During the years 2013-2015 the CMET group has met eight times. The CMET group has had six official meetings. One of the meetings (no 3) was split into two different meetings. This was necessary to ensure that the interested CMET group members were all able to contribute to the content of the special session that the CMET group organised at the Exchange Forum no 5 in 2014 in Kalmar, Sweden.

The CMET working group itself has developed into a community of practice in geological disposal competence development consisting of both education and training providers and end-users of E&T (professors, professionals dealing with competence development and consultants). In the beginning the CMET group had a stimulating role for the on-going work and for initiating discussions related to competence maintenance, education and training.

The main motivations of the group members to participate were addressed during CMET group's first meeting under the SecIGD2 project and were as follows:

- To have a forum to discuss E&T related matters beyond the R&D and technical points of view in geological disposal, and exchange knowledge and information about on-going and planned E&T activities inside the group;
- To emphasize and promote the importance of competence maintenance and education and training in the maintenance, promotion of safety in, and acceptance of geological disposal;
- To work together for the sustainability of the existing training initiatives, and to provide for more structure into the competence maintenance, education and training actions, and to catalyze cooperative actions between the CMET group members;
- To find out methods to address the need for knowledge transfer to new staff, to retain the knowledge in the face of retirements, and to maintain competence resulting from the geological disposal implementation schedule uncertainties;
- To be able to provide underground research and training facility services for helping out in the CMET activities. Learning in geological

[12] European Nuclear Energy Forum's Subgroup for Education launched three different competence development initiatives in 2011: EHRO-N - European Human Resources Observatory for the Nuclear Sector; ENELA - European Nuclear Leadership Academy (discontinued around 2012, not financially feasible); and EN3S - European Nuclear Safety and Security School.

disposal cannot take place only in the office or laboratory setting, but one needs to be in touch with the actual underground work, too;
- To address the funding challenges of URL access and activities;
- To be able to provide a full Master's programme to complement the knowledge maintenance for the full professional life of the students and personnel in geological disposal;
- To discuss specific content areas like safety case, and e.g. identify E&T courses in geological disposal for actual training provision for the Member States in their programmes (as an example the European Nuclear Safety and Security School, EN3S);
- To provide capabilities as an intelligent customer in demonstrating to the regulators that the personnel working in the field is competent and skilful, and also pioneering in areas where there are currently no specified jobs due to the general state-of-the-art of the global geological disposal programmes.

The first selected focus by the group was to address the needs in the strategic research areas (SRA 2011, 4) in geological disposal. The group provided information for the potential actions, but did not carry out the work itself beyond the action plan of Work Package 3 (WP3). Sufficient pooling of resources and funding was not available during the SecIGD2 for other actions. The group was formed on a voluntary participation basis and evolved into an exchange community. Each organisation contributed themselves to their participation except for the SecIGD2 project assistance and cooperation with PETRUS III project. The cooperation with the PETRUS III project has created the main possibility for the group members' work. The motivation to have such a group to interact in exchange of information and to initiate ideas was intended to avoid overlapping work and activities in the E&T community in geological disposal that is limited in its resources for international cooperation. The aim was to get synergies from sharing ideas, needs, and resources to some degree.

The objectives for the CMET group were formulated as follows in the CMET Terms of Reference (**Appendix 2**). The current and second version of the CMET ToR was the outcome of the CMET Meeting no 2 in November 2013. In the ToR, the CMET objectives remained unchanged. Under each objective is included what this objective would mean for the CMET working group during 2013-2015.

1. Transfer of the state-of-the-art and the new competence needs of the geological disposal community to reach “Vision 2025”
    - Meaning a review of the current status of competency and competency development of IGD-TP members and participants
2. Quality assurance of training for professionals with the support of a voluntary accreditation scheme
    - ECVET approach seems to be the tool in the EC now
3. Compile E&T approaches and content into a type of curriculum/curricula for professionals in geological disposal
    - SecIGD2 emphasis on the deployment of the SRA
    - Overall E&T recommendations in the nuclear sector (e.g. SNETP) and their link to IGD-TP
4. Ensure indirectly that both providers and new personnel will be available, now and in the future.

From the strategy point of view the key questions that the group discussed and addressed on during its six meetings in 2013-2015 were:

- What are the immediate competence needs in the European Union on geological disposal?
- What should be the vision related to competence needs in the European Union in geological disposal?

- What are the key assumptions underpinning the priorities and the development of competence?
- What is the output and impact that could be foreseen, it the development of these priorities is successful?
- What are the bottlenecks, risks, and uncertainties? And how can they be addressed?
- Which science and technology gaps and potential game changers need to be taken into account in geological disposal?
- What is the role of the Euratom research in competence maintenance and development in geological disposal? And what are the perspectives for cross-thematic activities with other areas of Euratom research and in Horizon 2020?
- And what are the current and future perspectives for supporting horizontal activities like international cooperation, education and training, and social studies and humanities in the context of geological disposal?
- Especially for the CMET members a relevant question is the development of teaching science in a changing and digitalizing learning environment.

The waste management programmes that have progressed closer to licensing, have built up of a solid knowledge base regarding especially the early stages of repository development that have been identified in the IGD-TP's SRA 2011. The change in the competence needs is depending on the programme stage and it is continuous for the waste management programmes moving forward. During 2015, the first ever construction license for spent fuel disposal facility was granted and the programmes now move to a stage of the repository development not yet implemented anywhere.

The first challenge is to maintain the existing knowledge base and to transfer this knowledge to the future professionals. This knowledge has historically been built up through multidisciplinary international cooperation. Any strategy for competence maintenance, education and training should contribute to ensure that the knowledge base does not disappear and is transferred to future experts. The most actual needs for programmes to advance relate to the siting process. Thus the knowledge maintenance needs are not only scientific and technical but also about public acceptance of the siting activities, the site itself, and about the related decision-making.

The second challenge is to identify the competence needed at the pioneering stages of the repository construction and operation. For these stages more focussed qualifications are needed and at the same time there is a need to understand the cross-disciplinary requirements underlying the technical solutions and that need to be met by all functions for and during the implementation. These cross-disciplinary competences requirements are in general much wider in their scope than in more traditional engineering projects or even in nuclear new-build. Further any strategy for addressing this challenge needs to ensure that the current experts are able to produce technical solutions meeting the requirements and thus closing the remaining open questions standing in the way of obtaining a construction and an operating license.

One underlying value of the CMET group members is in the quality of learning and contribution to ensuring that competence is maintained by high quality learning opportunities besides our engagement in the various activities in the geological disposal community. The CMET members' contribution to the work of the group is a voluntary (non-paid) action. The organisation and membership in the working group is based on volunteering. Some support to the CMET work is provided by the second IGD-TP's Secretariat project SecIGD2 and especially by its Work Package 3.

CMET group members work daily with the questions and challenge related to competence maintenance, education and training. As the group members are

well aware of the changes in its part, the group has tried to proactively stimulate the industry and the providers to address the state-of-the-art of demand and its nature in this changing scene. In the learning and competence development, informal, non-formal and formal learning activities are rapidly merging and at the same time the need of having faster routes to learning and "certification"/proof of competence and capabilities. In such a scene, there is a need to increase confidence in the learning outcomes resulting from the diverse learning paths. A benefit of merging various paths to knowledge, skills and competence is an increased amount of opportunities for lifelong learning independent of time and place improving the quality of the personnel working in the geological disposal community.

The CMET working group's vision is to have a sustainable geological community with competent professionals now and in the future in the face of changes in the European demographics, various changes in the political and public responses related to the nuclear sector and waste solutions, in the industry level changes and moving forward or backward in the stages of repository development.

2. How Competence Was Developed and What Drives Competence Maintenance?

In geological, Research, Development and Demonstration (RD&D) started over 40 years ago. The new experts who entered the field where bright young minds coming from various disciplines though a majority came with degrees from physics, chemistry, and geosciences. They were challenged with the research questions and multitude of open issues about the processes, phenomena, events and features taking place around the nuclear waste issues and about the solutions to handle this long-lived dangerous waste safely. The concepts of geological disposal emerged and the expertise of the people in the field increased over the years within their naturally multidisciplinary work context. Today they are in leading positions in the industry (if not yet retired).

Over the years many open issues have been addressed as identified when preparing the IGD-TP's SRA (4). The new challenges are more and more related to the implementation stage of geological disposal i.e. large scale demonstration in-situ and further the cost effective development of industrial type solutions to operate repositories. More people have entered the industry: some are recent graduates, and some more experienced professionals from other industries who need to implement the nuclear safety principles in their new working environment (need to be nuclearised[13]).

The current personnel has more diversified backgrounds / or none and due to the number of tasks and larger numbers of staff needed, the expertise level required in several areas is more specialized than before. Also in several areas the research questions now need to be turned into engineering solutions.

However, there is no longer such a long time for the personnel to learn the various aspects in geological disposal neither is there such a chance to learn over a long time frame the wider multidisciplinary understanding of the nature of geological disposal.

[13] The word "nuclearisation" was used in the OECD/NEA report 2012 (8, e.g. p. 11) to describe a set of competence requirements related to nuclear safety while working in the nuclear sector.

Here novel approaches to learning are needed. Also today the information is much more available for the students (like internet, social media, research databases, eLearning courses) at any place on anytime. A smart a student learns despite the level of quality of the teaching provided. And this learning is now achievable not only by following a traditional route of education but one can have the qualifications recognised irrespective of one's educational background (and even age).

Today's challenges regarding the nuclear energy sector's human resources have been identified in various international events and reports of European and international organisations (e.g. OECD/NEA (8) and EHRO-N (9) as describe in more detail in the following. They include more general challenges related to the demographic developments in the European countries and specific challenges related to the nuclear energy sector; both which apply also to the management of nuclear waste. The following recaps some of these general and nuclear waste management and geological disposal specific challenges.

As an impetus for this document was the request from the Commission in the negotiations of the Euratom FP7 project SecIGD2 to prepare a document on the CMET strategy. This document is partly the response to this request. Preparation of a European level CMET and knowledge transfer strategy is seen to be somewhat outside the scope of the CMET working group, however. In this report, an attempt is made to make recommendations to assist with the strategic challenges in CMET in a similar way as with other challenges identified by the CMET working group. According to the CMET group the main challenges include:

1. There is no strategy to maintain and develop European competency in geological disposal. The current directive 2011/70/Euratom (1) states that "*member states shall make arrangements for education and training of their staff*" in its Article 8. However, the strategy how to implement these arrangements is left to the Member States.
2. Repository license will also require confidence in the human capability to implement safe geological disposal. The IAEA Safety Guide for the management system for the disposal of radioactive waste GS-G-3.4 states e.g. (2, Chapter 4.3) the need for senior management to "*determine the competence levels for individuals at all levels"* and the need to "*provide training or take other actions to achieve the required level of competence".* The oversight authorities on their behalf oversee how this is implemented by a license holder. Equally, the oversight authorities need to ensure their independence also in terms of competence.
3. Required human competencies change now as the waste management programmes move from a selected site to a safely operating repository. Competency frameworks in geological disposal changes as the stage where the programme is in advances and the regulator has more oversight powers over the license holders based on the national legislation. Further these frameworks are also dependent on the selected disposal concept.
4. The supply of highly competent personnel is integral to the development of cost effective industrial schemes and to the continued improvement of safety of repositories and related nuclear facilities.

The European Member States were obligated in 2015 to report to the European Commission according to the Directive 2011/70/Euratom on the state-of-the-art of their national programme including the requirements of Article 8. These reports will be evaluated by the Commission in the near future and this evaluation will provide a wider perspective to the current state-of-the art in the Member States.

2.1 Generic Demographic Challenges in Europe

The generic demographic challenges taking place in Europe are also adversely impacting the geological disposal community as a part of the nuclear energy sector. In several European countries the number of population over 65 years is approaching and exceeding 20 % of the total population at a quick pace. The interest of young people in science and technology is also a fluctuating phenomenon. Especially at economic growth cycles that coincide with a major accident in the nuclear energy sector, the sector has difficulties in getting new students to enter the field and to attract new personnel. This is further influenced by the setback in the future prospects of the sector. The generic challenges faced by Europe include:

- Aging of population (proportion of the young population decreasing and remaining smaller in the demographic pyramid than the number of population retiring) (10);
- The attractiveness of science, technology, engineering and mathematics (STEM) studies is varying but the total number of STEM students in the 2000's has been decreasing. This means that less human resources will be available not only for the industry, authorities and research organisations but also for the academia (9, pp. 56-63) and (11, p.16)
- Many sectors in the society compete for the STEM graduates also outside the sectors specifically requiring STEM studies. Sectors like finance and insurance are also looking for STEM students;
- The legal frameworks for education are of national subsidiarity. Resulting from them structural barriers are slowing down the free movement of graduates from one country to another still exist despite the various European policy efforts to lower these barriers. Language barriers still remain a big mobility barrier, too (11 & 12).

2.2 CMET drivers in European Union

The main driving force behind the initiation of the CMET Joint Activity (no 14) was the Strategic Research Agenda (4, p. 46) of the IGD-TP published in 2011 and its Cross-Cutting Activity no 2 (CC2). For this purpose the CMET group aimed at addressing the needs of the IGD-TP's other Joint Activities and especially the Technical Projects. The needs were collected by the means of a short survey. The size of the geological disposal community is limited and spread across different European Member States at different levels of repository development. A further characteristic of the community is that it is also spread across several language zones and deals in addition with multidisciplinary scientific and technical knowledge base.

A second driving force is the change taking place in the way individuals learn. With the development and piloting in the European Union on implementing the ECVET as an approach to recognise learning accumulated by individuals the attainment of knowledge, skills and competence can become more transparent. A need to make these more transparent requires also an acceptance mechanism. For this aim the European Member State shall have a system in place that can be used by individuals to have their informal learning recognised. This will also mean a new environment for the E&T providers. The feasibility of introducing the ECVET system to include non-formal or informal learning in the geological disposal community is covered in a separate project deliverable report *"D3.4 CMET report on the feasibility study on the informal or sector internal accreditation body*" (13) that is published by the IGD-TP Secretariat on the JA14 site on www.igdtp.eu webpage as a deliverable of the SecIGD2 project.

New ways to access knowledge, skills, and competence are increasing with the help of digitalisation. More and more different types of learning resources are available for access via mobile networks and broadband. The web search tools enable a wide access to different type of resources stretching from data and information to wider knowledge bases. Scientific data bases can be accessed also easily via the web either from one's one access tools or via public libraries. Open access to data, information and knowledge created with public funding is enlarging these opportunities on a continuous basis. Open eLearning resource development is also increasing among the education and training providers in the community. Database are set up to provide information on European wide education and training courses in the nuclear field (incl. radiochemistry, radiation protection and radioactive waste management, too). On the global scale, the IAEA Nuclear Knowledge Management Section[14] is providing eLearning platform and SharePoint accesses for interested community members to develop shared training courses and information storages.

Taking into account the increased opportunities for informal learning and skills acquisition, competence-based qualifications can be efficiently supported by the development of mutual recognition mechanisms that are current endorsed by the European Union policies for easier mobility, mutual recognition and higher quality of education and training i.e. learning in Europe.

In this new environment the role of the educational and training institutions can and will change. Changes will reflect on how students and professional will learn, what is the role of qualifications and the way of attaining them in the future, what will be the role of educational institutions and training organisations, how are the end-user organisations going to be impacted by these changes.

How all of this reflects to geological disposal community and how it has driven the work of the CMET working group? The community itself is small. In a small community pooling resources and working together are the main means of creating critical mass of learners to participate and also enough learning providers. This cooperation is faced with several challenges that new technologies will partly assist in overcoming:

The in-depth expertise related to the interfaces and interactions between different disciplines may be dwindling due to retirement of those experts who have developed their knowledge since the start of the first concept developments for safe passive disposal of high-level nuclear waste and spent fuel. More expertise and critical mass is available in the management of Low and Intermediate Level Waste and Decommissioning of facilities, but also here the demand is likely to increase in the near future due to some countries energy policy changes. How can the interest for the future jobs in the industry be maintained if there is less interest in new build and more on dismantling? What is considered as a nuclear renaissance can turn to a sunset industry in a very short time period.

Private training providers have a challenging time in recruiting sufficient number of participants to their training courses even though the training fees would be close to an "at cost basis". This lack of financial means does not only apply to commercial training, but also to publicly supported training courses that are not fully subscribed, since just the travel and accommodation costs are out of reach for many potential participant. At the same time the new ways of accessing learning are competing with traditional offering.

The ENEN association member universities provide education on the widest scale for the nuclear sector. Further, a large training provision in terms of

[14] https://www.iaea.org/nuclearenergy/nuclearknowledge/

volumes seems to take place in the United Kingdom by Universities (Dalton Institute initiated around 2004) and by independent consulting companies. Further active training providers are in France (CEA, ENSTTI, IRSN and the universities especially the Ecole de Mines' both in Nantes and Nancy), in Belgium (SCK•CEN) especially in radiation protection and in Italy CIRTEN network of universities. In Portugal at IST, programmes have been set up to address radiation protection requirements in compliance with the Basic Safety Standard (BSS). Germany has also initiated a national co-operation for competence development between universities and also in cooperation with the Commission's Joint Research Centre/ITU. Also a full-time Master in Environmental Sciences and Radioactive Waste Management is available at TU Clausthal. The nuclear geochemistry group has established a new education network sharing e.g. education and training content via wikispaces and developing a Moodle based eLearning platform for the members' use. In Finland, the radiochemistry education is strongly linked with geological disposal and also a national training programme in a national language on a collaborative basis is running in nuclear waste management including geological disposal (14). Globally top ranking universities on the contrast are offering voluminous distance learning (MOOC[15]s) via fully fletched videoconferencing studios circling the tutor with widescreen screen access to participants resembling more a primetime talk show on television than a traditional classroom.

Hands-on learning and research however, needs to be carried out in large scale facilities supported by eLearning of the actual knowledge base. Learning in nuclear requires also large simulators and geological disposal requires the opportunities to work in underground research facilities may in a good way complement the web learning unless, it too, is to be replaced with 3D simulation tools and learning environments. For such opportunities, several of the underground research facilities like Äspö HRL in Sweden, Mont Terri and Grimsel in Switzerland, Josef URC and Underground Laboratory in Czech Republic, and Hades in Belgium exist.

For addressing the needs a survey was carried out targeting the joint activities of the IGD-TP that had been initiated by the IGD-TP Executive Group by 2013. The target group was quite small and an equally small amount of replies was received to the survey. Half of the joint activities stated that they were already in possession of the competence they needed in their project, the existing needs were either very specific or related to cross-cutting competence needs.

The reason to survey the competence needs was that the education and training providers wish to work in cooperation with the end-users and provide learning products to supply for their direct needs. Developing the education and training is not free. When the needs are explicitly expressed then the assumption is also that the end-users would be willing to send participants to such an education and training. Getting a sufficient number of participants is a big challenge to the providers.

As an outcome, the respondents provided a limited expression on their exact needs to assist the CMET in defining the needs. The challenging part is to find professionals to contribute time for the definition of the needs because of lack of time or funding and due to work on other business priorities.

The dialogue about the activities worked in the CMET group has not been successfully either with the IGD-TP Executive Group. Only two direct encounters have been available to present the work to the EG during the three project years. The outcome is the discontinuation of the CMET activity under

[15] Massive Online Open Courses

the IGD-TP Deployment Plan. The IGD-TP EG states as their preference that CMET related activities are carried out on the job in projects and training is provided as individual training workshops under the Euratom projects like BELBaR training course (http://www.skb.se/belbar/).

Currently the training workshops are not a requirement in the Horizon 2020 projects like they were under FP7. Therefore, the IGD-TP EG needs to communicate to the project groups preparing the proposals that the organisation of such training is desirable.

The future CMET activities in the current community of practice are discussed under Chapter 6.

2.3 Nuclear Sector Specific Drivers

The specific challenges of the nuclear energy sector's human resources stem from several specific features of this field and are further impacting also the nuclear waste management and geological disposal mission.

Once a commitment to nuclear power is made, expertise and specialisation in the sector needs to be maintained over several decades and for over hundred years when waste management is taken into account. The long-time of operations and the related long-time need for Knowledge, Skills and Competence (KSC) in the field needs to be addressed in a committed and systematic way.

The first major wave of nuclear reactors was constructed in the early 1980's (15, pp. 33-34). The first generation in nuclear started to retire in larger volumes in the 2000's even though the personnel in nuclear has a low turnover. Also the first programmes in geological disposal started in late 1970's and early 1980's. The available pool of expertise is now adversely influenced with an increasing number of retirements from the waste management activities. At the same time, when the nuclear sector is competing with other sectors over young graduates; the waste management sector is in competition over the human resources with all other actors within the nuclear sector.

Organisations working in the nuclear industry sector need to take into account in their operations the specific features of safety critical organisations (16) dealing especially with probabilistic risk management and human factors. Another similar sector is for example the aeronautics industry. Due to the long-time frames in geological disposal, not only probabilistic risk assessment is enough but broader approaches like the Safety Cases (17 and 18) have been developed and they need to be maintained during the geological disposal facilities' time of direct oversight as defined by IRCP in their publication (19).

Some nuclear reactor or other nuclear power related accidents that have had wide stretching local or regional impacts have undermined the confidence in the safe operation of nuclear facilities, and not only the confidence in the use of nuclear reactors but of nuclear in general during the history of its civil use. This influence is seen in at least the following:

- The development of international guidance with the need to enhance the confidence that the disposal system development and its implementation processes is required to ensure the protection of humans and the environment for as long as needed. Thus a management system, which integrates safety, security, health, quality and economic aspects, is not only important and necessary, but mandatory (20). Ensuring the required knowledge, skills, and competence and their development is one facet of such a system.
- As the goal of a geological disposal facility is to contain and isolate the waste in order to protect humans and the environment for time scales

that are comparable with geological timescales (19), a proactive approach needs to be built for the design, operation, closure and post-closure of a radioactive waste facility considering the long life-cycle time scale. A culture of the "long-term" should be instilled in order to assure sustainability in safety.

- It is important to address not only technical contents but also social aspects, such as stakeholder involvement and communication. It is important that these aspects are identified in a transparent way to all involved stakeholders, and that their safety implications are generally and broadly understood (19).

2.4 Scientific and technical drivers

The needs in geological disposal and repository development change over the very long lifetime (over 100 years) in the waste management programmes. The waste management programmes are therefore characterized not only by a stepwise approach to decision-making but in their long-term need to build up their capabilities in geological disposal.

Furthermore as stated by Zuidema and Johnson at their presentation at the Euradwaste '13 conference (21) each geological disposal facility is to some extent "a first of its kind" and therefore specific RD&D is needed for the implementation. The uses of RD&D are to provide input for the system design and its optimisation, contributing to the siting of the facility, achieving a sufficient level of understanding of the geological disposal system for the evaluation of its safety and for addressing stakeholder concerns.

The IGD-TP has defined the current scientific and technological state-of-the art in geological disposal in their SRA (4). CMET group defined itself a common interest list for first potential joint actions in a similar way as the SRA was defined. Also the CMET mapped the on-going and developed E&T programmes in geological disposal in its member countries.

Tasks in nuclear waste management and geological disposal are by their nature both interdisciplinary and multidisciplinary. In geological disposal, the dealing with new processes and technological applications is based on consolidated theories and existing teaching disciplines e.g. geosciences, chemistry, and physics, structural and material sciences. Achieving a critical mass for specialised training and education on specific areas in geological disposal and the overall need for specialised training also in terms of employability of graduates or the staff already working in the field are specific challenges derived from this multidisciplinary context. The compiling of curricula that combine the different disciplines and working cultures to forge new generations of professionals and to address the needs of the different stages of repository development (4, pp. 16 and 21) is indeed in demand. At the same time, one should not strive for tertiary level graduates who have too narrow a specialisation upon their graduation impacting adversely their range of job opportunities. The assumptions behind the curricula development warrant extensive background discussions by its own. The impact of the nuclear phase-out policies and the need of personnel for decommissioning is not currently addressed either within the CMET as its main focus is on the SRA needs.

Even though the application of interdisciplinary sciences are a specific feature of geological disposal and the demand is currently to go beyond natural and technical sciences since the issue is also economic and societal as extensively addressed in the Interdisciplinary Study (22) made as a contribution to the decision-making process on the Euratom part of Horizon 2020 in 2013.

2.5 Cultural and social drivers

Uncertainty and lack of authorisation to proceed with nuclear waste management programmes has occurred in many European Member States (wait and see, and this is not even related to High Level Waste/Spent Fuel but also to Low and Intermediate Level waste management) has now been addressed by the "nuclear waste directive" 2011/70/Euratom (1). The uncertainty of progress has caused concern on the sustainability of employment in the field at the different stages of the waste management programme development as programmes may slow down. Uncertainty is caused also in the opposite case when totally new knowledge, skills or competence (KSC) are needed when a programme moves to the next stage of development.

Many foreseen locations for geological disposal are also situated at less populated regions in the European countries making it more challenging to attract well educated young graduates or well established professionals to relocate.

The experiences related to training provision have revolved around the difficulties to sustain training providers; and especially to maintain and further develop the training contents to attract a continuous flow of participants to the courses and training events. These need to be met with further development of the training providers' approaches: i.e. to incorporate into the training of the students/professionals more of a culture of transfer of knowledge, and to assure the continuity of work practices and knowledge across the different generations. Adoption of learner-centred and collaborative methods is needed to complement the ways of transmitting information to the learners. This has also implications for the training of trainers. Also, English in fact has become the common language in training language at European level to produce critical mass in training participation. But its use poses a challenge for learning new concepts and abstractions as these are more profoundly and efficiently learned in the mother tongue at first.

Achieving a sufficient number of human resources European wide that possess the desired learning outcomes is a main favourable driver. During the past years, several European initiatives have addressed the different issues in quality assurance and mutual recognition of the professional competence.

3. CMET Objectives, Strategy and Actions

3.1 CMET Objectives

Already in the IGD-TP's Strategic Research Agenda (4, pp. 46-47) a need for the Cross-Cutting Activity, Competence Maintenance, Education and Training (CMET) was identified. The objectives of the CMET group were included in its Terms of Reference originating from 2011 and further refined in the CMET no 2 meeting in Madrid in November 2013 (**Appendix 2).**

The CMET Working Group provides a forum for discussing the education and training matters in nuclear waste management and especially geological disposal as state already previously. Interaction within the CMET group is seen as a source for innovation beyond the current activities too. The group has four main objectives as defined in its Terms of Reference:

1. To carry out transfer of the state of the art of strategies and activities for Competence Maintenance, Education and Training related to the implementation of Vision 2025. This requires identifying what the specific CMET needs are for implementing the SRA 2011 and the IGD-TP's first Deployment Plan (DP 2012) until 2016 (6).

2. To develop quality assurance of training aimed at new and experienced professionals in the field of geological disposal. This is done by developing quality assurance procedures and criteria for the voluntary accreditation of training (and education) for the sector. The work starts with carrying out a feasibility study for an accreditation scheme for informal learning that will be undertaken and that can also be applied to the formal setting. The background of the scheme is derived from the European Credit system for Vocational Education and Training (ECVET) approach (23), (24) initiated by the Copenhagen process .

3. To compile the content of training i.e. a type of "curriculum or curricula" for professionals in geological disposal for pooling joint training efforts or alternatively engaging educators and trainers to address the IGD-TP's RD&D work's education and training (E&T) needs. Identifying the current state of curricula that have already been developed for geological disposal is required. Mapping their content in relation to the generic stages of repository development identified in the SRA 2011 is a starting point of the CMET work towards this objective.

4. To ensure indirectly the sustainability of providers and the necessary infrastructures/facilities for CMET, and the new personnel and their development in the future. The first three objectives and the voluntary pooling of resources for the development and implementation of CMET action plan are also foreseen to strengthen the sustainability of supply of expertise.

The CMET working group's objectives address very long-term objectives. Within the SecIGD2 project, the working group identified more partial objectives that are linked to the main objectives to work with. The partial objectives have acted as the agenda for the CMET group during 2013-2015 and also for the year 2016.

3.2 What has been and is the CMET's strategy?

Strategy in general is defined by how one gets from the existing position to the desired position. In a traditional sense as defined by Michael Porter in the Competitive Advantage (26) the strategic options are related to cost leadership, to differentiation or to focus strategy with either cost leadership or differentiation. In the case of geological disposal, the options in CMET could be a focused cost leadership (under the wider umbrella of ENEN) or cost leadership focus (strictly geological disposal). The most feasible way of achieving such a position would be to pool resources for initiating and carrying out actions on a non-commercial basis. However, the non-profit basis also requires also money besides the human resources. Direct funding is required for travel and transport, accommodation, coordination work and for facility maintenance and consumables even if work hours of tutors would be contributed pro-bono or at cost, and electronic means decrease the costs of training material production and distribution.

What the CMET group can do alone is limited. The composition of the active group members consist mainly of education and training providers and end-users that are strongly linked with e.g. the PETRUS III[16] project. However, the activities could not have been implemented to the degree now carried out without the EC support. One direction that was suggested early on in the CMET meetings was that in the face of the diminishing funds for RTD in

[16] http://www.enen-assoc.org/en/training/petrus-iii.html

geological disposal and in terms of the use of E&T competences, it would be desirable that a project would exist that would integrate and address the education and training needs of the different RTD projects.

During the first H2020 call, the ENEN led ANNETTE[17] proposal was the first initiative into this direction. It is fortunate for the future that ANNETTE proposal receives EC funding for its activities in 2015.

The IGD-TP EG has also suggested that the JOPRAD project's Task 3.4 would address this topic in the future after the closing down of the CMET Joint Activity.

The CMET members' aim is through collaboration to achieve cost effectiveness, to address European level value added and gain sufficient number of participants and providers to ensure a more sustainable offering regarding education and training in geological disposal. This is needed in contrast with the single offering of generally very high quality training workshops organised under the individual RTD projects under Euratom research frameworks.

Development of professional competences/qualifications in geological disposal by collecting information on existing learning outcomes is essential for both curricula development and for individual professional development and life-long learning. The use of learning outcome definitions (as in ECVET) will enable an individual to identify one's own learning path toward the needed knowledge or skill or competence or even towards a qualification. The comparison of one's existing KSC to the desired KSC enables this in a more systematic way also when an individual is not working in an organisation that uses a systematic competency framework for their staffing and staff development.

To enhance the use of the existing underground research facilities is important part of the competence maintenance. Already existing initiatives include the IAEA Underground Research Facilities (URF) network[18] including both European Union and other countries outside Europe in a network collaboratively organising training at the underground facilities. The early 2000's driver stemmed from the closing down of the Canadian underground research laboratory. The secure the sustainability of other European underground research facilities is needed. These include Grimsel rock laboratory in Switzerland, Josef Underground Laboratory in Czech Republic, and Bure Laboratory in France. Within the PETRUS - network (25) training cooperation takes advantage of the Josef Underground Laboratory. Äspö Hard Rock Laboratory (HRL) has been used in the KIC InnoEnergy Master programme[19] education in Sweden.

The CMET provides a forum to share and to learn from good practices of its members and from the other European initiatives in human capital development, competence maintenance and education and training (especially from EHRO-N[20], PETRUS III, CINCH[21] and ENEN[22]).

The main activities that were included in the CMET strategy were:

[17] Advanced Networking for Nuclear Education and Training and Transfer of Expertise
[18] https://www.iaea.org/OurWork/ST/NE/NEFW/home.html - see Waste management networks
[19] http://www.kic-innoenergy.com/education/master-school/msc-emine-european-master-in-nuclear-energy/
[20] http://ehron.jrc.ec.europa.eu/
[21] Under CINCH II, http://cinch-project.eu/?art=workshop_helsinki
[22] http://www.enen-assoc.org/en/about/what-is-enen.html

- To discuss on CMET topics in geological disposal, since the other existing forums are more nuclear generic;
- To pool existing and new resources both for the actions of the plan and for other initiatives emerging from the cooperation and discussion;
- To initiate actions based on the objectives of the CMET and arising from the CMET participants' needs cost efficiently;
- To produce learning /training activity/activities for the CMET members to support the work of the group;
- Aiming at a practical approaches with a clear focus and deliberate cost-effectiveness;
- Sharing with and from good practices of other European initiatives; and
- Organisation of the group as a network and bringing together CMET working group members.

During the years 2013-2015, the group has succeeded in all of the activities above except on the pooling of resources for actions and initiating new actions that were not included in the WP3 work plan.

3.3 CMET Actions According to the SecIGD2 Work Plan

The SecIGD2 Work Package 3 plan identified three tasks and five deliverables for this work package. These tasks are also the major outcomes of the CMET working group's work in addition to a large amount of discussion topics that were covered and shared inside the group meetings.

The three tasks were:

Task 1: Organization and operation of the CMET Working Group including a strategy and action plan for the period of the IGD-TP's Master Deployment Plan (2013-2016) and an agenda based on its objectives and Terms of References.

Task 2: To study the feasibility of an informal or sector internal accreditation body within the IGD-TP for approving learning outcomes, this could then be applied to the various existing training schemes and concepts in geological disposal in Europe.

Task 3: To support the CMET Working Group to carry out the planned actions, collect the results and experiences of those activities and disseminate them at the IGD-TP's Exchange Forum meeting(s) taking place during the second and/or third project year.

The five deliverables are:

Under Task 1: D3.1 Organization of the CMET working group meetings and producing their minutes. This includes a set of six minutes distributed inside the IGD-TP CMET group on the IGD-TP Projectplace. Production of the deliverable D3.2 IGD-TP Competence Maintenance, Education and Training Strategy and Action Plan for 2013-2016 being this document. In addition, the CMET activities were updated to the IGD-TP's Master Deployment Plans annually. The last update is in **Appendix 3.**

Under Task 2: D3.3 CMET input for the content of IGD-TP's Exchange Forum Meeting no 5 or no 6. This input was provided for the EF5 and the presentations were published on the http://www.igdtp.eu website. The planning and implementation for the EF5 session is reported separately. The content of the EF5 session focused more on the view of the Exchange Forum audience on the potential feasibility of a voluntary accreditation scheme than on the needs of the Joint Activities. Two EF5 walkabout stations also addressed the potential needs of the geological disposal community.

Under Task 3: D3.4 CMET report on the feasibility study on the informal or sector internal accreditation body. A separate report has been produced. This report was based on the previous experiences of the Petrus group, on the Workshops organized by JRC/IET around ECVET system and on the Exchange Forum no 5 inputs from October 2014. In addition, the amended Directive 20025/26/EC was used as background material. D3.5 CMET activity report for 2012-2015 is a short document produced assessing the CMET work carried out under the SecIGD2 project.

In addition to the above, the CMET group identified their future interests as discussed in Chapter 6 and in **Appendix 4.** Under Task 3, a one day training workshop was organized for the CMET and PETRUS III members in 2015. The training workshop was reported and the training materials were published as a separate SecIGD2 project deliverable D3.3.1 (27).

The CMET Actions according to the SecIGD2 Work Package 3 are summarized in **Figure 2**.

CMET and SecIGD2 Work Package 3 Actions 2013-2015		
2013	**2014**	**2015**
CMET group formed, two annual meetings (1 & 2) and discussion forums including minutes.	CMET group meetings 3 & 4 (three meetings) including minutes	CMET group meetings 5 & 6 (two meetings) including minutes. Action suggestion listing for 2016.
Preparations for Strategy and Action Plan (StrAP) initiated	EF5 preparation – questionnaire for walkabout	CMET Training Workshop and PETRUS III Extended End-User Council
Updated Terms of Reference (v.2)	Activity presentation of StrAP to EG no 14	SecIGD2 project meeting no 3 organisation; Activity presentation to EG no 17
Major presentations, papers to • EHRO-N SAG no 7 • Euradwaste13 • NESTet13 conferences	EF5 feasibility study walkabout session in Kalmar including preparatory meeting and reporting.	EHRO-N workshop for ECVET feasibility evaluation Major presentations: •ENEN General Assembly special event •Nuclear Radiochemistry Workshop •EHRO-N SAG no 12
Continuous activities: Annual Master Deployment Plan; SecIGD2 newsletters, dissemination of information to CMET group and from group, and to and from linked activities and IGD-TP Secratariat; updates of CMET member lists and access rights; CMET activity updates to the IGD-TP EG on activities; reporting of deliverables.		

Figure 2. Actions of CMET and SecIGD2 Work Package 3 during 2013-2015.

The CMET objectives and related actions for 2013 - 2015 included the following four objectives. The discussions and work around these objectives are covered in more detail in Chapter 4, but in a summary the outcomes related to the objectives (in short) are:

1. Transfer of the state-of-the-art and the new competence needs of the geological disposal community to reach "Vision 2025"
   - Meaning a review of the current status of competency and competency development of IGD-TP members and participants.

Actions and outcome status related to Objective 1:

- Data collection on Joint Activity Needs and mapping of the existing E&T programmes in geological disposal in the 13 CMET member countries was done. The awareness of the KSC needs vary at the different stages of the repository programmes and in the Joint Activities. One may need the expertise that is now about to disappear in some programmes in another European country.
- Current status of competence development was surveyed at the EF5 walkabout session.

2. Quality assurance of training for professionals with the support of a voluntary accreditation scheme
   - ECVET approach seems to be the tool in the EC now

Actions and outcome status related to Objective 2:

- Scoping of the accreditation scheme was carried out inside the group in the update of the CMET Terms of reference, in the EF5 CMET session on the feasibility of the voluntary accreditation scheme, in presentation to the IGD-TP EG 17 and with the reference to the work of the JRC/IET on ECVET and with a reference directive 2005/36/EC on recognition of professional qualifications (28) which was last amended in 2013 by 2013/55/EU (29).

For an accreditation scheme to be feasible, it needs to be a networked action. One major prerequisite is that it needs to be accepted by all stakeholders, which is currently not the case. The scheme needs to concern the individual, the employer, and the E&T providers. A common platform for training is favoured by the providers. Equally, the providers favour a common accreditation scheme in alignment with ECVET system, since the system provides an adequate structure for analysing the learning outcomes and for the harmonisation of KSC objectives. This is necessary for a degree of commonalities between the job profiles or job functions in the Member States to ensure mutual recognition. A single (European level) or several (each Member State) accreditation bodies and fixing of the terminology and taxonomy specifically for geological disposal would still be needed. For individuals, the accreditation would be most feasible on a professional level, excluding new entrants. The European Professional Card is one of the tools assisting in the recognition of professional qualifications in another European Member State. Also the other amendments in this directive are welcome. The future work would be facilitated by a common database for the collection of the existing work done in defining the job profiles and job functions according to the ECVET system.

3. Compile E&T approaches and content into a type of curriculum/curricula for professionals in geological disposal
   - SecIGD2 emphasis on the deployment of the SRA
   - Overall E&T recommendations in the nuclear sector (e.g. SNETP) and their link to IGD-TP

Actions and outcome status related to Objective 3:

- The framework for any curricula development should be in line with the identification of stage of the repository development (4, p.16) the curricula addresses. The KSC needs depend directly on the on-going and following stage into which a waste management programme is moving to. The amount and need for

in-depth expertise in the specific knowledge areas depends directly on the stage of development. The closer to the licensing, the more focused the KSC needs are.
- A collection of learning outcomes of the job functions on the expertise accumulated in the earlier stages is advisable as it helps directly in the design of professional development programme curricula.

4. Ensure indirectly that both providers and new personnel will be available, now and in the future.

Actions and outcome status related to Objective 4:

- Sustainability requires as strong will and strategy from both the WMOs and the E&T providers, including well-defined "business" models to attract sufficient number of participants to E&T and enough STEM students to be interested in the industry.
- Well defined professional development paths are a source of attraction. Providing sandwich structures for lifelong learning with the validation of also non-formal and informal learning provide for more flexibility and opportunities to pursue also formal education goals.
- Finding funding solutions especially for the sustainability and for the wider use of the existing E&T underground infrastructures is a crucial element.

4. CMET's Four Main Objectives Guiding the Actions

The objectives of the CMET Working Group were defined in two guiding documents. The first document is the Terms of Reference (ToR) of the CMET group as it was included into the IGD-TP's Terms of Reference (7) in 2013 (D.1.3 of the SecIGD2 project).

The second document defining the objectives and the work is the SecIGD2 EC-Grant agreement no 323260 and especially the Description of Work of the Work Package 3 that provides support to the CMET group by organizing the meetings and supporting the final documentation of the work. The latter is addressed in Chapter 3.3.

The CMET working group meetings have partly been traditional meetings and partly the six meetings have taken the form of a workshop on specific actions on the group's agenda.

In the first CMET meeting the participants broke into smaller groups and each group addressed one of the four CMET objectives during the meeting. The objectives, the strengths, weaknesses, opportunities and threats (SWOT) related to them and suitable course of action identified were discussed by the CMET group members. The summary of the discussions that was recorded by the small groups working on the individual objectives are presented in the following under three relevant objective as the SWOT analysis did not cover all of the four objectives. The objective descriptions are further complemented here with text produced by four CMET group members for the Euradwaste' 13 (10) and NESTet 2013 (30) conferences.

The CMET group selected the life cycle perspective of the geological repositories as the starting point for formulating the Strategy and Action Plan. This first CMET meeting identified that there is a clear need to look at all of the stages of the repository development (**Figure 3**), when discussing the competence maintenance in geological disposal.

Stages of repository development

	Generic studies and concept development	Selection of host rock & site	Technology development and repository design	Technology development and repository construction	Industrial-scale manufacturing and repository operation
Safety strategy and methodology	Development of safety assessment methodology	Application of methodology in safety case and improvement of methods	Application of methodology in safety case and improvement of methods	Application of methodology in safety case	Application of methodology in safety case
Long-term safety: **Scientific and technical basis**	Broad-based research	Research narrowed to deal with host rock-specific aspects and specific aspects associated with the selected EBS	In situ experiments and improvement of data bases and understanding	Scientific work sharply focused on small number of residual issues, large-scale in situ experiments and component tests	Confirmation studies on components under site conditions incl. monitoring
Facility and component design	Concept variant studies	Repository design concepts adapted to specific rock type	Component design and layout design Operational safety studies	Full-scale prototypes constructed Industrial scheme developed	Full-scale production and operation
Site-related characteristics	Surveys of potential host rocks and their characteristics based on available information	Host rock characterization and site-specific studies	Detailed site characterization Excavation	Construction of main underground facilities Confirmation of rock properties for final design	Construction, confirmation, monitoring

Figure 3. Stages of repository development - an example of the varying needs. Source: IGD-TP SRA 2011 (4, p.16)

The interest in the work of this group demonstrates the strong desire of the training providers to meet the needs and the demands of the end-users in geological disposal and waste management in general and in support of the RD&D needed to realize the SRA in identifying also E&T needs not yet known. Wide range of development ideas emerged already in the first meeting and these were complemented and listed for later screening (see **Appendix 4**).

4.1 CMET Objective 1: To carry out transfer of the state of the art of strategies and activities for Competence Maintenance, Education and Training related to the implementation of Vision 2025.

The first objective in the CMET ToR is to carry out transfer of the state of the art of strategies and activities for Competence Maintenance, Education and Training related to the implementation of Vision 2025.

Addressing the objective, the specific CMET needs for implementing the SRA 2011 and the IGD-TP's first Deployment Plan (DP 2012) until 2016 are needed (6). Part of this work started with preparing an ad hoc web-questionnaire to the IGD-TP's on-going joint activities about their needs. This activity was not foreseen in the original project plan.

The needs first action to identifying the Competence Maintenance, Education and Training needs of the Joint Activities was carried out by the SecIGD2 project in the form of a web questionnaire sent to the Joint Activity Leaders that were included in the first Deployment Plan (6) and by another questionnaire that was intended for anyone active in the on-going Joint Activities to reply. The replies (**Table 1)** to the questionnaire were received from JA 14 - CMET, JA 15 - NKM; JA 2 - DOPAS, JA 1 - First Nuclide, REDUPP, JA3 - CAST and from INSOTEC and IPPA projects linked with the IGD-TP's Interfaces Working Groups. For three respondents, the needs had been defined in at this stage of the Joint Activity, for the rest, they did not identify any needs.

Table 1. A summary of the needs from survey questionnaire to the Joint Activity leaders and on-going RTD projects in 2013 (n =8 replies)

Type of competence needed (definition) and source of expertise	
High burn-up fuel behaviour and reactor operation	external expertise or new member required
Low concentration radiochemical and speciation analysis, preparation of samples, radiochemical and solids analytics, modelling	external expertise or new member required
Corrosion, radiochemical and analytical and safety assessment expertise	new member required
Remote work and devices with active materials and like (e.g. hot labs, shielded boxes, glove boxes, (radio) analytical methods, XPS, SEM-EDX, gas analysis, fuel rod characterisation, autoclaves)	infrastructures needed
Backfill design	exists in the JA
Quality assurance of full scale demonstrations	exists in the JA
Reviews of scientific papers	external expertise or new member required
EC reporting guidance	specific knowledge required
Application of the legal framework for ECVET implementation	external expertise and/or infrastructures for accreditation

Type of competence needed (definition) and source of expertise	
Knowledge management approaches (for the different activities under knowledge management)	external expertise and sharing of information

As the sources for acquiring the needed competence the following where listed as main sources:

- Competence exists in the Joint Activity or Project consortium Competence is acquired In cooperation with other Waste Management Organisations (WMOs)
- Competence is acquired In cooperation with subcontractors incl. training and
- Competence needs are acquired in cooperation with research infrastructures

The universities or other educational institutions were not mentioned as the main source of competence for these activities.

A further effort to look at the means of acquiring competence was done at the Euradwaste'13 conference, when the participants were asked to reflect on their best learning experience. Most of the respondents 18 respondents replied that learning from peers or from more experience colleagues were their most rewarding learning experiences. These replies address the individual preferences in the geological disposal community where most of the knowledge, skills and competences have accumulated on the job and in RD&D projects.

Further the identification of the existing curricula for geological disposal and E&T programmes was needed, too. This mapping could be carried out in the CMET group itself as it represented fourteen European countries. Main programme providers are identified in Chapter 2.2. Only few geological disposal specific programmes exist. Often the E&T programmes address the whole nuclear cycle and special programmes or programme modules covering decommissioning are given e.g. in Slovakia and at JRC in ISPRA in Italy. United Kingdom and Germany make a positive exception in terms of the large scope of either programme content and/or number of students who participate in the programmes.

4.1.1 Strengths, Weaknesses, Opportunities and Threats Related to the Transfer of the State of the Art

OBJECTIVE 1. To carry out transfer of the state of the art of strategies and activities for Competence Maintenance, Education and Training related to the implementation of Vision 2025.

In the first CMET meeting one break-out group discussed the first CMET objective on competence needs and transfer of the state of the art. Within the time available the breakout group focused primarily on producing input information on current and future Knowledge, Skills and Competences (KSC) needed to implement geological disposal, and how it is possible to best capture such requirements. Once the requirements for such KSC have been identified the group recognised that they would need to be appropriately phased into a programme (e.g. not all KSC are required throughout the duration of a geological disposal programme, some are more and less prominent at different stages of implementation). It was discussed that following such a competence requirements capture exercise, it would then be possible to identify gaps or shortfalls in KSC within individual waste management programmes, or the wider IGD-TP participants as a whole. Such

shortfalls in KSC could then readily be used to input into broad, longer term academic courses or more focused and shorter term courses aimed more at waste management organisations' (WMOs) employees with specific and identified KSC gaps.

They produced the following analysis (**Figure 4**) about the strengths, weaknesses, opportunities and threats related to the first CMET objective.

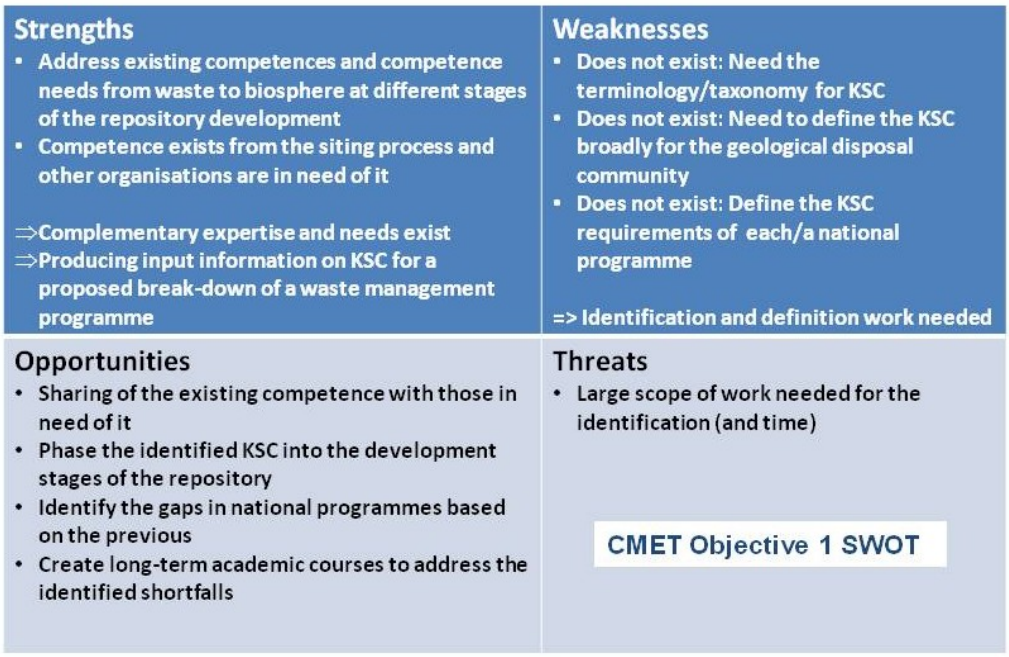

Figure 4. Strengths, Weaknesses, Opportunities and Threats related to the CMET Objective 1 on Transfer of the state-of-the-art in geological disposal.

The group discussed how a geological disposal programme could be broken up into various high level areas, and how the act of conducting this breakdown could be used to identify particular KSC associated with each are, that an organisation would need to have, or have access to in order to successfully deliver geological disposal. Much of the details were based in NDA RWMD business plan. They was noted that different terminology may be used across different nations/waste management programmes, but it was thought that broadly about several general areas KSC would be required. The group decided to focus further discussions on science based KSC thought to be required to implement geological disposal. The two areas that discussions were focused upon were 'Supporting Science' and 'Site Characterisation' within the time available. A listing of various KSC was produced as a result and documented into the meeting minutes.

It was discussed that the above exercise could be undertaken for all of the functions, topic areas and sub topic areas thought to be required to successfully deliver a geological disposal programme. Such an undertaking once assessed against in house KSCs and KSCs already available to a Member State or WMO (e.g. through academic interaction or link and through their respective supply chains) would serve to highlight any KSC gaps or shortfalls that exist either to an individual Member State or WMO, or to the wider IGD-TP community.

Discussions were then held concerning the timing of the requirements for certain KSCs related to the various topic areas discussed above. For example the KSCs required for 'Site Characterisation' will pass through a hiatus at the point that a nation or WMO has a site and needs to characterise it. The idea that KSCs' requirements differ from topic to topic depending on where a

nation/WMO is with their respective disposal programme was therefore thought to be a key consideration.

4.2 CMET Objective 2: To Develop Quality Assurance of Training Aimed at New and Experienced Professionals in the field of geological disposal.

OBJECTIVE 2: To develop quality assurance of training aimed at new and experienced professionals in the field of geological disposal.

The CMET group wishes to contribute to the quality of and confidence in the professionals' Knowledge, Skills and Competence (KSC) and to the quality of a professional's training in geological disposal for lifelong learning by

- collaborating in establishing high quality learning opportunities; formal or informal;
- promoting setting up voluntary accreditation scheme/s for geological disposal, targeting accrediting both
  - an individual's learning outcomes, and
  - the training programmes leading to specified Learning Outcomes in geological disposal.

The main means for assuring quality is the development of accepted quality assurance procedures and criteria based on the voluntary accreditation of training (and education) for the nuclear and/or waste management sector.

The importance of both formal and informal training activities for the development of adults and professionals was recognised in the 2013 PIAAC study by OECD on adult skills (for adults of 16-64 years of age). This study indicates that the skills and competences levels (in literacy, numeracy and problem-solving in technology-rich environments) have a positive correlation with the overall educational level but also participation in both formal and non-formal training activities independent of their context (job related or extra curriculum activities) has a favourable impact on the studied skills and competences (see 31 for PIAAC, pp. 37-39 & 45-46).

The European Credit system for Vocational Education and Training (ECVET) as a recognition system can thus also contribute to making such non-formal and even informal learning activities more attractive to the European labour force and including professionals already having a high basic education. The main motivation for the CMET feasibility study (13, D3.4 report) was the foreseen benefits for the geological disposal community and also for the wider nuclear and other industry sectors from having individual's learning outcomes recognised by the use of such a voluntary system.

ECVET system (23), (32) was initiated by the Copenhagen process and is already operational in several other industry sectors in the European Union. The use of ECVET system helps in the development of a common understanding on standard job requirements and the mutual recognition of qualifications (24). With this translation mechanism also informal learning that has been achieved can be recognised in the formal educational setting. These benefits were identified in terms of the labour market, mobility and for flexible career pathways in the 2012 ECVET Seminar for the Nuclear Energy Sector (in **Table 2**) (32 & 33). The European Human Resources Observatory for the Nuclear Energy Sector[23] (EHRO-N), who organised the seminar, has also worked together with the ECVET team in DG Education and Culture (EAC) to train various stakeholders in the implementation of the ECVET principles (833, pp. 10-12). EHRO-N has initiated ECVET workshops (24) that have produced complete sets of Learning Outcomes (LOs) for various nuclear new build job profiles and for decommissioning. The on-going work in EHRO-N is also expected to provide further generic approaches and tools for the implementation of the ECVET approach in the sector.

Table 2. Identified benefits from the use of the ECVET instrument (30 & 32). KSC = Knowledge, Skills and Competence; NIFL = Non-formal and Informal Learning.

Benefits of ECVET	
For the labour market in general	
	Competence gap analysis Training including on-the-job learning and mobility Mobility - higher safety culture Planning for the future needs
For the employer:	
	Enlargement of the recruitment area Broadening the Human Resources Management (internal flexibility) Mixed careers for young professionals (combining training and job)
For the individuals:	
	Enhanced career opportunities Intersectoral mobility Upward mobility and job rotation
For the education and training providers:	
	Fostering faster and improved employability of graduates and trainees
For mobility	
	Mobility of personnel at all levels Streamlining of human resources allocation to where needed Knowledge preservation about the needed KSC Tool for transparency, quality improvement and excellence Mutual recognition of KSC and qualifications Common assessment standards
For flexible pathways	
	Flexible pathways to qualifications Less overlapping training Faster way to qualification NIFL[5] can be assessed Harmonized terminology in use New perspectives on how to increase competence Recognition of learning (outcomes) acquired in various schemes Opportunity to be exposed to different cultures Access to different technical approaches

The quality assurance of higher education is address for example with the Bologna process framework. For non-formal (mainly training) and informal learning such a mutual recognition system is missing.

The CMET group sees that the ECVET system benefits can help the geological disposal community to overcome some of the main challenges (see ref. 10 for more details) related to the competence maintenance over the long timeframes inherent in the management of radioactive wastes. Identification and definition of KSC is a way to maintain detailed knowledge about Learning Outcomes needed in geological disposal for the future especially if the risk of the loss of competence is realised at least documented state-of-the-art of KSC would exist. It would be an unfortunate state of affairs, if this would not be transferred to the new generation of professionals after so much that has already been learned about geological disposal and about its safe implementation steps.

During the recent years, the ECVET has also provided a good basis for piloting its use also on higher levels of qualifications in the European Qualification Framework (EQF) and especially on the EQF levels starting from level 5 to even to level 8 (Doctoral level) of KSC. Such pilots have been

carried out in the Euratom FP7 European Fission Training Scheme (EFTS) [24]. projects. The pilot activities that provide input also to the CMET work towards the voluntary accreditation are the EFTSs like PETRUS II and its continuation PETRUS III (25), ENEN III and several training schemes in radiation protection and radiochemistry like CINCH. Some CMET group members have already collaborated (in the PETRUS network, ENEN III, and in the JRC/IET ECVET Workshops) in collecting and defining job functions in geological disposal and in the nuclear sector.

The existing work on Learning Outcomes (ECVET framework) could be applied to different stages of repository development, too. Such work has been carried out under JRC/IET and EHRO-N[25] starting with the CAPTURE project for nuclear new build and most recently in nuclear decommissioning qualifications (24), (34).

In the first CMET meeting, the second break-out group addressed the following points related to the quality assurance. They recognised the main target groups whom the accreditation concerns the employer, student, and training provider organisation/s. The discussion focused on how to implement a voluntary accreditation scheme and the following points were emphasised. It suggested that the training courses would falls under one organisation for training i.e. a platform looking after their quality. A network of institutions working together on common accreditation process for training seems to be more efficient and should implement the needed background work and further the related ECVET system for certification. The learning outcome process needs to be linked to this common accreditation process and some harmonisation is advisable, in order to satisfy a specific job profile or set of units of learning in geological disposal. Operationally, it was believed that a system should demonstrate that an adequate structure exists for analysing the training programme but harmonisation of goals/learning objectives and terminology meanings need still to be fixed. The national terminology and approaches related to the EQF and ECVET need to be identified for the users of the system.

One emphasis in ECVET is that a person is able to reached defined learning outcomes independent of the means one has acquired the learning. Drivers to ECVET have not only been the mutual recognitions of vocational knowledge, skills and competence (KSC), but also to promote life-long learning of individuals in accumulating and recognising the learning that has been acquired either by education, training, on the job learning, at free-time activities or as in the context of geological disposal in research and project activities. The CMET Terms of Reference outlined in the modification of the version 2 (**Appendix 2**), the need of voluntary accreditation to both the individuals (including validation of non-formal and informal learning) and for training courses.

The amendments made into the Directive 2005/36/EC with the Directive 2013/55/EU (28, 29) provides a framework for the individual to request for the recognition of professional qualifications in another European Union Member State. Training courses provided by higher educational institutions can apply the ECTS system for the transfer and accumulation process of the learning between similar institutions. For training courses that fall under the non-formal learning regime, the recognition needs to be handled case by case as there is not yet any existing European framework for their mutual recognition. For some training courses accreditation may be provided by professional associations.

[24] http://www.enen-assoc.org for more information on the different EFTS
[25] http://ehron.jrc.ec.europa.eu/

The ECVET objectives (**Figure 5**) are both about transnational mobility and lifelong learning for all labour force in Europe independent of their status on the labour market or of their sector of work. In the core of ECVET is the recognition of learning outcomes in view of achieving or recognising qualifications or parts of them. The use of the ECVET approach requires the definition of units of learning and related knowledge, skills and competence. In the case of geological disposal this would need to be done for each stage of the repository development with an emphasis on the KSC needs at each stage.

The ECVET contributes to the quality assurance objective by making the qualifications transparent, enabling the accumulation of learning outcomes and providing for a transfer and communication mechanism for the learning outcomes from one organisation to another and further from one context to another (35, p. 7). This approach can potentially be used for complementing missing KSC for having professional qualification recognised in another Member State.

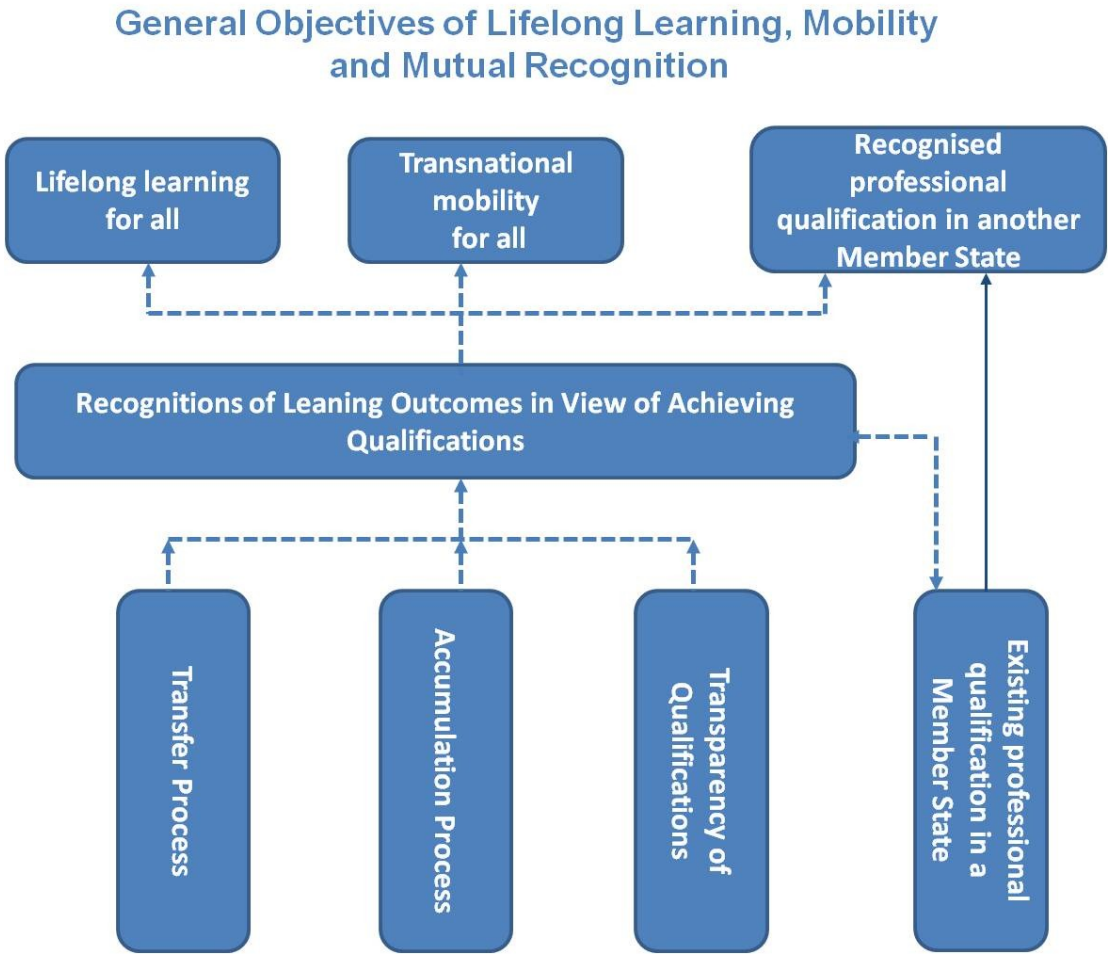

Figure 5. General objectives of the ECVET system and linking to mutual recognition of professional qualifications. in support of Lifelong Learning and Mobility. Modified from ECVET User's Group 2012 (35).

The ECVET monitoring report by CEDEFOP[26] addresses the progress in the area of ECVET implementation in the European Member States (23) in addition to the D3.4 deliverable report. The deliverable report D3.4 (13) addressed the ECVET system itself in details and the reader is asked to consult this report for more information and for more references. **Figure 6** presents the identified Strengths, Weaknesses, Opportunities and Threats related to the quality assurance using the ECVET system.

Formal education was considered a priority for the new entrants by the IGD-TP EF5 participants. Formal education or organised professional development training curriculum was not considered important by the geological disposal community members. The role of stand-alone training courses was the preference.

Potentially due to the pioneering work that the community professionals themselves have experienced, the role of education and training beyond basic education and doctoral studies is not recognised as an efficient and fast way to speed up learning in the geological disposal community for professionals after their basic education.

This is an area that needs to be addressed in the work of the CMET group on a more philosophical level in the future as it is also one key to the sustainability of training schemes by the various providers.

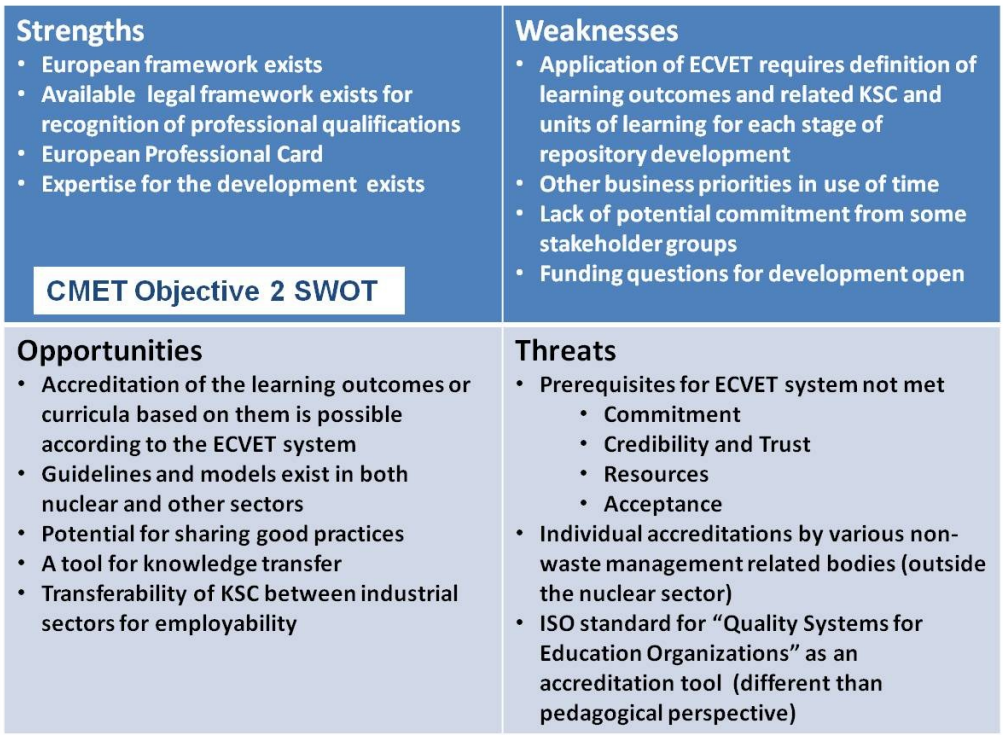

Figure 6. Strengths, Weaknesses, Opportunities and Threats related to Objective 3. Quality Assurance of Training as identified during the CMET work.

The CMET objectives also recognise the value of informal learning and thus the objective of having a potential voluntary accreditation scheme developed aims at mutually recognising in the community the fact that is appreciated as the best way of learning. However, also implementing such an accreditation scheme requires the geological disposal community to take a systematic look

[26] CEDEFOP = European Centre for the Development of Vocational Training

at the learning outcomes that are required to implement the repositories for spent fuel, high level waste and other long-lived radioactive waste. As the repositories are developed in stages (**Figure 3**), these learning outcomes also need to be identified by stages i.e. what is specific for the stage in question and what is needed throughout the lifetime of a repository.

The role of the IGD-TP as a forum with authority on expertise can have also a significant role in the quality assurance of learning outcomes and their mutual recognition if they would be willing to be engaged in the development of such a system. Here the work has not yet been successful.

The outcome of the CMET activities on the feasibility of the quality assurance system using the ECVET system was that the implementation or even the actions that would contribute to its implementation i.e. the identification and definition of the Learning outcomes (in KSC) was not favoured by the IGD-TP EG. the IGD-TP Exchange Forum no 5 participants even though they had a more favourable view, were still quite unaware about the system and therefore may have hesitated about it.

The activity under this objective has continued through-out the SecIGD2 project in the CMET working group. The first meetings discussion was the starting point of the feasibility study reported in the SecIGD2 deliverable D3.4 "*CMET report on the feasibility study on the informal or sector internal accreditation body* " (13). The perspective in the early discussion was from the training providers' point of view. Wider perspectives to this topic were received from the special session on voluntary accreditation carried out in the Exchange Forum no 5 in 2014 and they are reported in the D3.4.

4.2.1 A review of the current status of competency and competency development of IGD-TP members and participants

The CMET session at Exchange Forum 5 included a question about the current competency frameworks and means of competence development of the participant organisations. The results from this walkabout station were not included into the D3.4 report as they were only partly linked to the feasibility study. The preliminary results were presented at the closing plenary of the EF5. The results were further discussed at the CMET meeting no 4 following the EF5. At the walkabout station 3 the participants gave the answers to the station's questions. The discussion summaries are presented in the following.

1. Does your organisation have a competence maintenance approach? What type?
2. How competence is currently assessed? How is it maintained?

   Most of the representatives of the participating organisations stated that their organisation has a competence maintenance approach (19 replies); only one respondent stated that they do not have it.

   The approaches in use for the existing personnel and those newly recruited when applicable include:

   - Organisation of internal seminars by the human resources related to the development of competence, internships and in-house training from other organisations.
   - Assessment of existing personnel by training course certificates and/or by job performance.
   - Discussions formal or informal about competence between the employer and employee. A formal annual grading/ranking of employees as an assessment method. Grading based on a scale of job performance or e.g. on the internal training courses followed and to be followed. Especially for universities and research institutes for

example the number of students and/or of doctoral students a tutor has to guide, or publications produced during the year.

- Participation in internal and external training is the main means. Some training provided by an external organisation that provides a certificate and the training is accredited. Such training is nuclear safety related.
- In support of achieving educational goals, time-off or other support may be granted for the purpose.
- Chartership is one means of professional progression in addition to PhD and other University degrees.

The financial resources for competence maintenance include internal pricing systems for training and the cost of external courses, and also a devoted competence development budget as a percentage of the organisations income.

3. Would you / your organisation apply a competence assessment (accreditation) system, if a scheme was available? (total 20 replies)

   In one organisation a competence assessment (accreditation) system exist, 7 respondents were ready to apply such a system, and the remaining respondents said that it would depend on the type of the system requirements, costs and time needed.

4. Would you prefer/require/push your staff to be accredited?

   More than half of the respondents would prefer their staff to be accredited, which was more favourable than the replies to the question number 2.

5. To what level of job hierarchy?

   The most favoured level (over half of replies) of jobs suitable for accreditation were the professionals/experts (corresponding to EQF levels 6-8) and in some cases senior management.

6. Would you require accreditation from new staff on entry?

   The majority (over half) would not require accreditation from new staff members or they would require it only when an accreditation system would be available and that the transition to the system is taken care of. Major constraints identified related to the compatibility of the accreditation system to the existing system, the costs and need of resources and potential additional bureaucracy caused by the system.

7. Would you be willing to integrate or do you see benefits in integrating your current system into a European accreditation system? (total 17 replies)

   Three out of four respondents would see benefits in integrating their current system into a European system.

Some respondents hoped that the internal transmission of experiences as a part of the competence assessment and development would be improved and at the same time some organisations use an overlap of working time between key experts retiring and new people taking on the position as a good practice in transferring the expertise. For some organizations examinations either internal or external are used and the regulatory body also provides an authorization for certain job function or roles.

4.3 CMET Objective 3: To compile the content of training i.e. a type of "curriculum or curricula" for professionals in geological disposal

OBJECTIVE 3: To compile the content of training i.e. a type of "curriculum or curricula" for professionals in geological disposal for pooling joint training efforts or alternatively engaging educators and trainers to address the IGD-TP's RD&D work's education and training (E&T) needs.

Identifying the current state of curricula that have already been developed for geological disposal is required since a lot of work is involved in it. Also lot of work has already been carried out in the field. Avoiding overlapping work would be of value in terms of saving labour and time in the future. The work is to map the learning content and needs in relation to the generic stages of repository development. The CMET group identified that if suitable curricula for geological disposal are developed, a starting point is to address the different implementation and development stages of the repository development identified in the SRA 2011 (4). This was also the CMET group's starting point towards this objective.

For curriculum development and for E&T providers it is easier and the most appropriate starting point would be to use the defined job profiles with the relevant learning outcomes including the details related to knowledge, skills and competence (KSC) of the earlier stages of the waste management programmes.

In the first CMET meeting, third break-out group dealt with the development of content for the implementation of the SRA and looked at "curricula" formulation for the different stages for various specific areas, such as the "Safety Case" KSC needs. The group addressed topics such as stages of repository development in the overall framework; discussed awareness versus expertise as not everyone has to be educated in the same topics at the same level and generic versus stage- or country-specific knowledge; WMO's "in-house" knowledge (i.e. specific site, waste container specific); and education versus training as there are different objectives and approaches. Then the group carried out a SWOT analysis highlighting the Strengths, Weaknesses, Opportunities and Threats in Europe related to the curricula development **(Figure 7)**.

Within the PETRUS II project, a curriculum has been developed for Master of Science with a geological disposal subject orientation. The extent of the orientation the so called "PETRUS Master" is 60 ECTS (25). TU Clausthal provides a full Master in Science curriculum in geological disposal.

Within PETRUS III, a profile and a matching curriculum is now under finalisation for a safety engineer in geological disposal. All of these efforts show that carrying out the definition of the job profiles or functions is a time consuming work that also needs to be validated with the end-users including Waste Management Organisations, regulators and research organisations. The D3.4 report also addresses the methodology for developing such job profiles according to the ECVET system and more details are available in the reports of JRC/IET and EHRO-N.

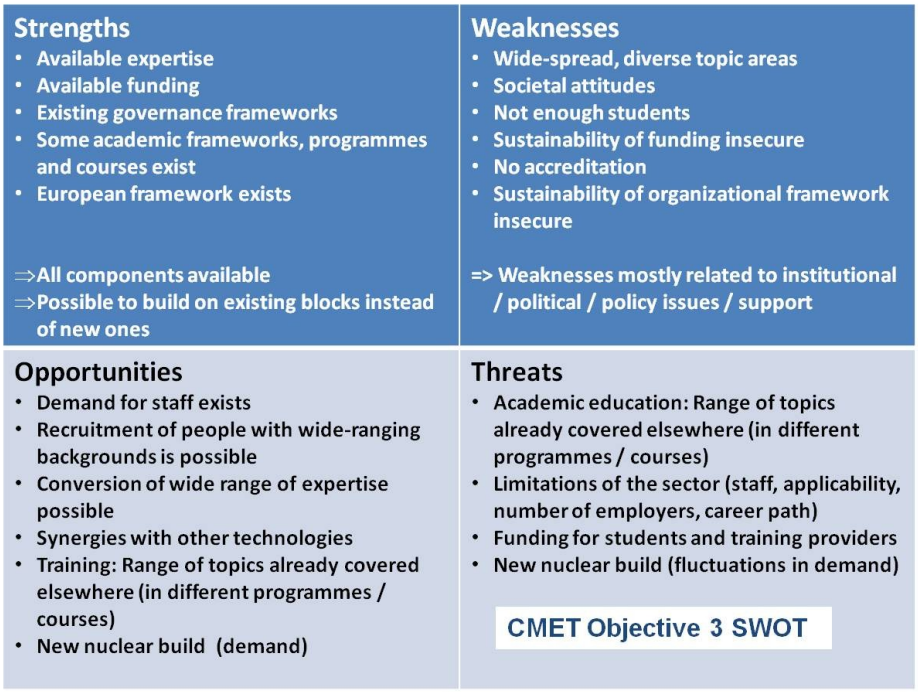

Figure 7. Strengths, Weaknesses, Opportunities and Threats related to the CMET Objective 3 Curriculum Development.

At the Exchange Forum no 5, one of the questions posed to the participant in Walkabout station 4 was *" In which areas is the definition of learning outcomes most urgently needed, and why?"* A total of 22 replies were received and on the top of the list are safety and environmental areas like: Safety strategy, safety case as the most popular area, environmental impact, the relationship between the repository concepts and the safety case, and the interdisciplinary connections and application to safety case. The CMET group noted that partly due to the EF5 working group, many participants had the safety assessment and safety case background, which influenced the replies. A safety case needs to be prepared at the corresponding level for all stages of the repository development (17 & 18). It is necessity for the programmes to move forward to the next stage after the regulatory scrutiny of these safety cases. The work done for the safety engineer profile in PETRUS III is therefore very timely for the geological disposal community.

They concluded that it is advisable to build on existing knowledge / experience / frameworks rather than to develop new one structures or approaches. Reference was made to ECTS, ECVET, ENEN, PETRUS, and IAEA, existing courses / curricula as a source of content to be used and further developed for the curricula. It was suggested to work according to a co-operative European approach.

On the European it would be of benefit to have an open access database for all interested users and voluntary contributors. The database could contain the individual and group efforts made in defining the Learning Outcomes in terms of KSC by various stakeholders. This proposal has been made to EHRO-N for consideration. CMET group shall follow this activity and make use of the database in the future work, if such a resource would be available.

4.4 CMET Objective 4: Sustainability of CMET for the IGD-TP's Vision (i.e. Ensure indirectly Providers and Personnel in the Future)

OBJECTIVE 4: To ensure indirectly the sustainability of providers and the necessary infrastructures/facilities for CMET, and the new personnel and their development in the future.

The first three objectives and the voluntary pooling of resources for the development and implementation of CMET action plan are also foreseen to strengthen the sustainability of supply of expertise. Pooling of resources has not yet commenced beyond the inputs provided in the CMET meeting.

By addressing the three previous objectives, the CMET group and stakeholders can contribute to the provision of qualified and competent professionals in geological disposal

- by developing a path of recognised professionalism via voluntary accreditation we contribute to careers of lifelong learning, and
- by supporting approaches to internationalisation of technical and scientific education through mobility of professionals and graduates,
- by expressing the Learning Outcomes the E&T providers are asked to address. In this way continuity in supply of students will be achieved both for initial education and professional development.

The fourth break-out group discussed how to ensure indirectly the providers of E&T and personnel in the future. The discussion addressed points such as the need of a strong strategy in the implementing organisations and providers, with well-defined business models for the providers and the ability to reach public acceptance. Longer term topical course programmes with a sandwich structures (alternating use of time and efforts to study and for working) were suggested, underlining that scientific programmes need to mirror the WMOs' needs and solve relevant issues. Different type of providers, from universities and research institutions to local communities and regional organizations with specific interests related to a territory, were proposed to be taken into consideration. Among human resources, problems such as the knowledge conservation in the field, the strategies for continuous training to keep track on research, development and demonstration (RD&D) knowledge building, and addressing adverse public perceptions, were identified and discussed. These are linked together with actions, such as the supply chain where companies and training providers, academia and research institutions are working in close co-operation with WMOs and where these organisations could be more involved in training strategies since they act as a major resource for specialists and young scientists. The importance of the funding support e.g. by the WMOs was emphasized, too.

The Strengths, Weaknesses, Opportunities and Threats related to the sustainability question are collected in **Figure 8**.

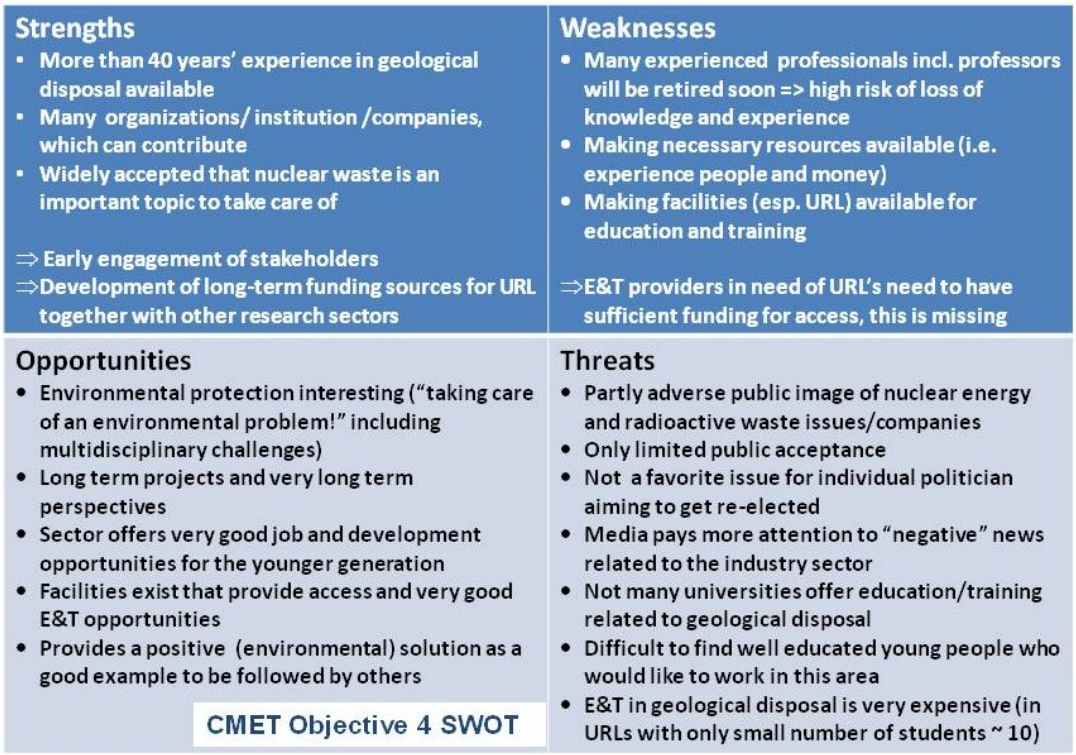

Figure 8. Strengths, Weaknesses, Opportunities and Threats related to CMET Objective 4 Ensuring sustainability of E&T providers and new personnel for geological disposal.

Major barriers identified were the funding and the public acceptance in the advancement of the waste management programmes and their implementation. To remove the barriers the suggestions did not directly relate to CMET domain, but the key requirements included

- strong national waste management strategy and a clear waste disposal programme,
- political framework and support combined with public acceptance and
- a strong implementing organisation.

The sustainability of the training provision and increase in the number of participants and funding related to them, would follow from the above.

5. CMET Approaches, Perspectives and Complementing European Initiatives to CMET Working Group's Actions

The CMET working group is currently the only European level initiative as a discussion forum on CMET related topic in geological disposal and has as its main perspectives both the pedagogical and the research and development perspectives. There are several on-going initiatives that do address also geological disposal or are directly related to geological disposal, but their perspective is different.

For the continued discussions, the different types of perspectives identified in the various actions are listed in the following. The perspectives and backgrounds influence the thinking and practices related to the Competence Maintenance, Education and Training are reflected in the chosen approaches producing different tracks of actions:

- **The competitiveness and economical perspectives.** The need to secure competitiveness and ensure growth and employment in the European economy are reflected on the policy level by addressing the availability of competent human resources for a knowledge based economy. Knowledge and innovation are seen essential as Europe is unable to compete directly with the prices of factors of production like labour costs, when a sustainability perspective of the environment and social responsibility are respected on the level stipulated in Europe. Innovation is therefore put on high on the agenda as the major objective and RD&D activities and Education and Training are seen as a way to boost innovation. Educational institutions are the sources for the knowledgeable and innovative human resources. Further an economic/business driven human resource perspective addresses the means and tools, competence development being one of them, to enhance human performance for the economic benefit.
- **Educational, human resource administration and competence growth and development perspectives.** The competence development needs are reflected on the policy level especially when addressing the human resources supply to the economy. On organisational level, the aim is to meet the changing business needs by boosting the quick capability of businesses to up-skill personnel or on the job market to up-skill job seekers for employability in the face of structural changes in the labour market. Human resources perspective looks at both maintaining and developing the personnel competences to keep up with the business needs and to new recruitment for new skills and competences or for replacement needs of existing personnel.

  The educational or pedagogical perspective has a focus on learning and personal growth both in the private and professional life and on how learning can be both effective and efficient. On the education policy level the objective for efficiency is to reduce overlapping training and education e.g. by the means of mutual recognition of knowledge, skills and competences acquired. For this purpose several instruments and systems have been produced.
- **Knowledge management perspective.** Knowledge management in a broad sense addresses both the human resource administration practices and the knowledge artefacts (generally information systems and databases) that incorporate data, information and knowledge and forums for knowledge sharing. The KM questions is more on the storing, retrieving, using and sharing of information on the business level or inside communities of practice and information technology has a large role in providing solutions to these questions. This despite the fact that the

general definition of knowledge management is much broader then indicated above.

- **Research and Development perspective.** Research is about creating new knowledge that can be applied to the understanding of existing problems in a new way or coming up with the previously unknown. Typically research contributes to an existing body of knowledge after it has been approved by peers in the research community. Based on the existing body of knowledge, research poses new questions about the completeness of this body of knowledge i.e. looks for uncertainties. Development tests out this new knowledge whether it can be turned into practical solutions or artefacts.
- **Engineering perspective.** This perspective focuses on existing norms and standards and industry conventions that have worked out previous when solving similar problems. Inherently norms, standards and conventions contain a certain status quo and a solution orientation that is based on the use of the existing knowledge base that is embedded in the previous. New practical questions, lead to further development of the norms, standards, and conventions over time, but this is often a slow process.
- **Organisation perspective**. This perspective is very much influenced both by the industry practices and by the organisational culture depending on a large set of factors related to the planning, division of work, staffing, and management and control in addition to boundary and environmental conditions of an organisation. For any organisation in question, its influencing factors define which ones of the above perspectives are most prevalent in each organisation.

The perspective that mostly drives the CMET working group discussions is the educational perspective with a focus on professional learning especially in science and technology.

On the European Union level all activities have the competitiveness and economical perspective in mind. On European Union and Euratom level, the **Directorate General for Education and Culture (DG EAC)** focuses on the educational and competence development perspective. The on-going activities influencing also the CMET work include the Bologna (ECTS) and Copenhagen (ECVET) processes, development of other systems like the European Qualification Framework (EQF) and the European quality assurance in vocational education and training (EQAVET). The EQF levels correspond to the latest Unesco ISCED classification for education statistics from 2011 (36).

Databases for European, skills, competences, qualifications and occupations like ESCO[27] have been set up together with the DG Employment, Social Affairs, and Inclusion. The directive for mutual recognition for professional qualifications 2005/36/EC (28 & 29) has been amended to correspond to the evaluation made in 2011 by the DG Internal Market and Services and to the changes taking place in the labour market. The directive is aimed at promoting geographical mobility. But at the same time there is an increasing need for inter-sector mobility. Subsidiarity of the Member States concerning the national legal educational framework and its requirements still exists in the European Union.

The Directorate General for Energy (DG ENER) is overseeing the adaptation of the Council Directive 2011/70/EURATOM (1). This directive clearly states “ultimate responsibility of Member States for the safety of spent fuel and radioactive waste management” and its Article 8 addresses as a norm for Expertise and Skills that *"Member States shall ensure that the national framework require all parties to make arrangements for education and*

[27] https://ec.europa.eu/esco/portal/home#modal-one

training for their staff, as well as research and development activities to cover the needs of the national programme for spent fuel and radioactive waste management in order to obtain, maintain and to further develop necessary expertise and skills." The directive includes thus both an educational perspective and the research and development perspective as a part of ensuring competent personnel for the waste management community including geological disposal.

The two other related directives[28] (2009/71/Euratom and 2013/59/Euratom) recently published and/or updated also require a graded approach and include some requirements on education and training of staff and for certain professions in radiation protection.

The **Directorate General for Research and Innovation (DG RTD)** addresses both the research and development perspective and the engineering perspective in terms of developing European standards. The work in the field of the Euratom and European Union Research Framework Programmes and the Horizon 2020 specifically assist the nuclear sector's fission research and European Fission Training Schemes with the help of these programme calls. The FP7 projects needed to have a training component included into each project. In the H2020 this requirement no longer exists.

International Atomic Energy Agency (IAEA) has two units, whose work relate to the geological disposal. One section is the Nuclear Knowledge Management Section[29]. This section has produced several online learning resources like a Moodle based learning environment[30] that can be used by contacting the administrator at IAEA **NKM Section**. The agency is also planning to update in early 2016 its report on "Risk Management of Knowledge Loss in Nuclear Industry Organizations" first published in 2006[31].

The other is the IAEA's Division of Nuclear Fuel Cycle and Waste Technology[32] (**NEFW**) that has set up communities of practice on several areas of waste management. The one of the networks mostly linked to geological disposal is the URF Network. Another one is DISPONET that deals with low and intermediate level waste. These networks and other networks working under the NEFW division use a SharePoint based database CONNECT for knowledge sharing. CONNECT also incorporates some self-study modules.

OECD NEA addressed their concern about the availability of Human Resources in 2011 in its report. Nuclear Education and Training: From Concern to Capability (8). This account includes both the human resources development and administration and also the regulatory perspective. The work was further complemented with the EHRO-N study on the supply and demand for Nuclear Experts (9), with the complementary modelling studies (e.g. 15), and with the different ECVET workshops and seminars (e.g. 34) organised by JRC/IET.

[28] Council Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations amended by the Council directive 2014/87/EURATOM of 8 July 2014 includes requirements on expertise and skills including arrangements for education and training (Article 7) ("Nuclear Safety Directive")
Council Directive 2013/59/Euratom laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation ("BSS Basic Safety Standard").
[29] https://www.iaea.org/nuclearenergy/nuclearknowledge/
[30] https://www.iaea.org/nuclearenergy/nuclearknowledge/Online-Learning-Resources/CLP/index.html
[31] STI/PUB/1248
[32] https://www.iaea.org/OurWork/ST/NE/NEFW/home.html

A study *"Staff Management, Training and Knowledge Management in geological disposal programme"* was initiated by the Integration Group for Safety Case (IGSC) that is a subgroup of the OECD NEA Radioactive Waste Management Committee (RWMC). This study questionnaire perspective relates to the competency framework and knowledge management perspectives.

RWMC addresses their concerns related to the maintenance of the long-term memory in geological disposal in the Records, Knowledge and Memory (RK&M) initiative that organised a conference in 2014 in Verdun, France on "Radioactive Waste Management and Constructing Memory for Future Generations" with the Proceedings[33] published in 2015 on alternatives for a broad multidisciplinary discussion. The perspectives underlying these actions are mainly RD&D and NKM perspectives combined with some Human Resource Administration perspectives.

The **European Strategic Energy Technology Plan (SET-Plan)**[34] was launched in 2007 as the technology pillar of the EU energy and climate policy in order to address the energy innovation challenge. Since then, it has established a strategic frame for the development and advancement of low carbon energy solutions in EU Member States with the aim to pool resources and achieve quicker and cost-efficient implementation. SET-Plan has recognised that one of the key elements for successful implementation at EU level is the availability and mobilisation of the right human capital.[35] The energy sector is an evolving field which creates new job opportunities but at the same time requires the development of new skills and competences, in line with the objectives of the Europe 2020 Flagship Initiative "An agenda for new skills and jobs". The growing education and training needs in the low carbon energy area have already been highlighted in a number of recent Commission education and employment policy frameworks[36] such as the Communications "Rethinking Education" and "Towards a job-rich recovery". Two areas of challenges are identified in the roadmap. On the one hand, the sector requires the education, training or re-skilling of a significant number of additional workforces in the coming decades. At the same time, energy innovation creates a massive need for new talents and upgrade of existing There is a pressure to deliver researchers, engineers and technicians with knowledge and competences responsive to the evolving market needs.

The **SET-Plan Education and Training Roadmap** deals with the human resource challenge for the energy research and innovation sector, and complement the SET-Plan agenda. It puts forward recommendations for key education and training activities to address the challenges. For the energy sector, the roadmap has been published (37) by **EHRO-N**[37], one of the three **European Nuclear Energy Forum - ENEF**[38] **initiatives.**

[33] Available online at: http://www.oecd-nea.org/rwm/pubs/2015/7259-constructing-memory-2015.pdf

[34] http://setis.ec.europa.eu/

[35] COM(2007) 723 final

[36] COM(2012) 173 final "Towards a job-rich recovery" and its accompanying SWD(2012) 92 final "Exploiting the employment potential of green growth"; COM(2012) 669 final "Rethinking Education: Investing in skills for better socio-economic outcomes"; COM(2011) 567 final "Supporting growth and jobs – an agenda for the modernisation of Europe's higher education systems"; COM(2012) 392 final: "A Reinforced European Research Area Partnership for Excellence and Growth"

[37] http://ehron.jrc.ec.europa.eu/

[38] https://ec.europa.eu/energy/en/events/2015-european-nuclear-energy-forum-enef-plenary-meeting

The SET-Plan E&T Roadmap encourages three types of actions: Virtual Learning and Information Platforms; Knowledge, Skills and Competences Recognition and Transfer Programmes; and Human Resources and Skills Observatories (37, pp. 18-20). From these main actions, the actions most directly linked with the CMET and PETRUS network activities are the Action 1.1.8 Advanced Network(s) for Nuclear Fission Education and Training (37, pp. 32-33) and Action 1.2.8 Vocational Education and Training Network(s) for Nuclear Fission (37, p. 47). The main perspectives driving the SET-Plan actions are the competitiveness and economical perspectives combined with a sustainable environment with a focus on low-carbon energy supply future.

Since its establishment **EHRO-N** operating agent under the **Joint Research Centre Institute for Energy and Transport in Petten** (JRC/IET) has implemented several European seminars together with the DG EAC ECVET Team to train the stakeholders in the sector about the ECVET system. In addition, JRC/IET has organised six ECVET workshops for the definition of Job profiles, Learning Outcomes, Knowledge, Skills and Competence, for the definition of nuclear taxonomy for KSC, and for qualifications. The outcomes of the work have been published on the EHRO-N web pages[39].

During the past years, several European initiatives have addressed the different issues in quality assurance and mutual recognition of the professional competence by taken into use the ECVET system. Several good examples of the ECVET application are provided in the CEDEFOP monitoring report (23) and in some national pilot project publications (e.g. FINECVET[40]).

The second initiative of ENEF, the European Nuclear Safety and Security School **EN3S** is running under JRC/ITU in Karlsruhe with the aim of delivering highly specialised courses in various topics of nuclear technology (38, p.21). EN3S aims[41] also to make its nuclear research facilities better accessible for graduate and post-graduate training and education programmes in Europe.

The third initiative "European Nuclear Energy Leadership Academy - ENELA" was closed down in 2012 due to lack of sufficient number of participants to its programmes. ENELA was planned to be an initiative for leadership recruitment and development of young graduates with management potential, high potential professionals, executive managers, opinion formers and policy makers.

In addition to the above, two other forums in nuclear field have been set up. They are:

- **SNETP ETKM**[42] Working Group on Education, Training and Knowledge Management of the Sustainable Nuclear Energy Technology Platform and
- **FORATOM/ENS ETKM Task Force**[43] that is a common working group for members, coming from both organisations, who have an expertise in education, training, knowledge management and human resources in the nuclear energy.

Unlike the CMET, these forums focus on nuclear in general, not solely on nuclear waste management.

ENEN association[44] was established over 10 years ago and has become the leading sustainable network in nuclear E&T in the European Union. The main ENEN members are universities. Also other stakeholders are welcome to join

[39] http://ehron.jrc.ec.europa.eu/public-ecvet-documents
[40] http://www.oph.fi/english/publications/publications/2012/finecvet_as_a_pioneer
[41] Global 2011 conference presentation
[42] http://www.snetp.eu/education-training-and-knowledge-management/
[43] https://www.euronuclear.org/1-education-training/etkm-tf.htm
[44] http://www.enen-assoc.org

the associations if they comply with the ENEN bylaws. ENEN cooperates practically with all the other networks.

A universal challenge of the education and training developers relates to the cost of E&T infrastructures and general funding of the E&T activities. Universities and educational institutions are demanded to collect more external funding to support their activities and sometimes the different intellectual property right policies of training providers and their external funding sources can differ. This can also delay in some cases the speed to market of new knowledge i.e. the time in which the new research results are used as the basis of new teaching.

PETRUS network (25) has interacted in geological disposal since 2005 and their work has been carried out in several Euratom projects (ENEN II, PETRUS II, and PETRUS III) together with the ENEN association and with the end-users especially from Finland, Czech Republic Spain and Slovenia. PETRUS network addresses both the education of Master students and doctoral students in geological disposal and the professional development of professionals and developing the basis for mutual recognition of non-formal and informal learning with the help of the ECVET system. The main perspective underlying these actions is a pedagogical and educational perspective combined with research and development.

6. Selection and Implementation of a CMET Special Action

The CMET group started in the beginning of the SecIGD2 project with CMET members from eleven organisations. At the end of 2015, the 36 CMET members represented 29 different organisations in geological disposal. As the special action in the action plan, in 2015 the CMET group finalised their interest mapping related to the identified cooperation areas and the following seven areas received most interest. Originally CMET group produced during its early meetings a list consisting of total 33 suggestions that the members thought would benefit from CMET cooperation (**Appendix 4)**.

The member's listings were compiled and as a result a short list of suggestions having the major number of expressions of interest resulted. These results were listed in the **Table 3** below:

Table 3. Top listing of CMET identified interest for future actions based on the number of interested members

Rank	Content of potential action	Interest (N =)	Internal no and CMET Obj. no
1	Define some professional's profiles (learning outcomes) for civil engineers, geologists. (ECVET model exists for this).	6	9.15; OBJ. 2 & 3
2	Use repository/URL sites for practical training or for training in site related work (potential use of Josef, CZ; Grimsel, CH facilities and related access funding solutions needed).	6	9.9; OBJ. 1 & 3
3	Produce (IAEA style) E-learning course/s on a specialised topic by an international working group by sharing competences and expertise.	6	9.21; OBJ. 1, 3 & 4
4	Sharing what has been learned in the countries with more advanced programmes with other countries at earlier stages of repository development (sharing method development needed, too).	6	9.3; OBJ. 1
5	Produce a strategy that is in alignment or aligns with the European Commission's strategy and potential funding requirements. The purpose is to provide inputs to where the E&T priorities in geological disposal should focus on in Europe.	4	9.12; OBJ. 1
6	Collect/Refresh [the disposal community's] memory around the RD&D that has been conducted in geological disposal in the past (state-of-the-art "summary").	4	9.8; OBJ. 1 & 3
7	Make a (IAEA URF network type) Geological disposal workshop to train people. Provide experts for the workshop (a model exists for this)	4	9.20; OBJ. 1

According to the SecIGD2 WP3 work plan, the CMET group's work was also to address the future actions beyond the SecIGD2 project. Thus CMET group's future planning is based on this listing in Table 3. From the listing, each member marked those suggestions, which they would be interested in and at the same time they stated when they thought this activity would be needed and how important they considered it was.

A similar approach was used by the IGD-TP SRA working group in 2009-2010 in the screening of the Key Topics and Cross-Cutting Activities for the IGD-TP's SRA 2011.

After the prioritisation, the action list will be taken up for discussion in the coming CMET no 7 meeting that takes place in April 2016 in collaboration with the PETRUS III project.

7. Recommendations for the Future

In the course of the preparation of this Strategy and Action Plan (StrAP), in the June 2014 editing workshop at TU Delft, the team decided to produce recommendations for different levels in the geological disposal. In the following is the current summary for the near future of the CMET recommendations, starting from the CMET communities of practice, addressing the Implementing Geological Disposal of Radioactive Waste Technology Platform and finally the European Commission.

7.1 Recommendations for CMET communities of practice and suggestions for new activities

The CMET group produced during its early meetings a list consisting of total 33 suggestions that the members thought would benefit from CMET cooperation (**Appendix 4)**. From the listing, each member marked those suggestions, which they would be interested in and at the same time they stated when they thought this activity would be needed and how important they considered it was. A similar approach was used by the IGD-TP SRA working group in 2009-2010 in the screening of the Key Topics and Cross-Cutting Activities for the IGD-TP's SRA 2011.

The member's listings were compiled and as a result a short list of suggestions having the major number of expressions of interest resulted. These results were listed in the Table 3 and are listed below:

1. Define some more professional's profiles and related learning outcomes for civil engineers, geologists. A workable ECVET system model exists for this resulting from the EHRO-N initiatives and from the PETRUS III project work.
2. Use repository/URL sites for practical training or for training in site related work. Within the CMET group and in connection with the PETRUS III project, the contact network exists now for the universities and companies to be in contact with at least three underground facilities for the use of practical education and training. These facilities are Josef Underground Laboratory in the Czech Republic and Grimsel Rock Laboratory in Switzerland. There is also a further need to develop suitable funding solutions for the potential users of these facilities to make providing access financially feasible for all parties involved.
3. Produce (IAEA style) E-learning course/s on a specialised topic by an international working group by sharing competences and expertise. The IAEA's two sections provide web tools for the provision and sharing of training materials on request. The Moodle based solution provides more tools directly also for the production of training materials and CONNECT provides a distribution channel for materials already made. The URF Network has historically produced collaboratively on-site training courses to meet the Network needs. This suggestion would extend such collaboration to the production of stand-alone or tutored distance learning solutions via the web.
4. Sharing what has been learned in the countries with more advanced programmes with other countries at earlier stages of repository development. Training and holding seminars are typical ways of sharing information. Participating in joint research projects is one more activity. Most fruitful activities include longer (i.e. months) practical fellowships in on-going underground research programmes or programmed expert staff exchanges. The transfer of tacit knowledge requires either observation or direct dialogue with the experts in the field. The level of utilisation of the information and knowledge received is also dependent on the knowledge level of the personnel with whom the information is shared with. This suggestion not only requires a pool of experts who would be willing to

share information but also effective and efficient methods to be developed or applied to the sharing.

5. Collect/Refresh the geological disposal community's memory around the RD&D that has been conducted in geological disposal in the past. Produce a state-of-the-art "summary" on the RD&D carried out.
6. Produce a strategy that is in alignment or aligns with the European Commission's strategy and potential funding requirements. The purpose is to provide inputs to where the E&T priorities in geological disposal should focus on in Europe. This requires a constant follow-up of the Commission's research and innovation policies and education policies to identify the shifts on the focus regarding the future Horizon 2020 calls and communication with the national contact points. Further participation in the IGD-TP Exchange Forums is also necessary and one needs to be proactive regarding the recommendations that will be made by the JOPRAD project. In such a way an alignment is possible to make.
7. Make a (IAEA URF network type) Geological disposal workshop to train people. Provide experts for the workshop. A model for this type of activity already exists.

The recommendation for the CMET community of practice (as the group itself will be dissolved in Spring 2016) is to discuss the possibility select for further working one or two of these activities for example under the future activities carried out by the community of practice in geological disposal.

Since the resources of the CMET group itself are limited, the first action of the group is to come up with a prioritization regarding the short list together with a resourcing plan before any of the actions can be initiated.

The activities, if large enough can be formulated into E&T proposals under the Euratom H2020. Or if they are wider disciplines than just geological disposal the Marie Skłodowska-Curie / Lifelong learning programme calls could be responded to. The need to apply for external funding seems currently the only feasible way of overcoming one of the main weakness i.e. lack of funding for cooperation, preventing the implementation of the activity/activities.

In addition to continuing the preserving and maintaining actions group needs to follow-up the ISO Technical committee TC288 now developing the new ISO standard "Quality systems for Education Organizations". The follow-up is needed to ensure that the proposals made in the standard are in alignment with the other international and European developments. If the alignment is not ensured, this will result in additional overlapping work for the E&T providers and potentially also for training development and implementation.

7.2 Recommendations to the IGD-TP

The main interest on the IGD-TP EG level is to ensure that there are training workshops and courses carried out in connection with the IGD-TP's Technical Projects (TEP) as expressed by the EG in EG no 17 meeting in June 2014. The current H2020 does not require that training courses or other educational activities need to be included into the project like it was in FP7. However, the IGD-TP EG can require such training to be included into a TEP before it endorses a TEP project if this is considered important. Alternative IGD-TP can join to create larger umbrellas than an individual project consortium for competence maintenance, education and training activities in support of the TEPs. ENEN association is the main forum collecting the European E&T providers in cooperation. It is made up of the majority of the European universities and other organisations including nuclear industry. ENEN members offer and they can be asked for nuclear related education including geological disposal. The first step is to create a formal link to ENEN e.g. in the form of Memorandum of Understanding (MoU). Formal cooperation includes the IGD-TP e.g. into the invitation list of the specific ENEN industry events.

Executive Group's continued support to ENEN's future project proposals is an important means for ensuring E&T activities on the European level

Nuclear knowledge management (NKM) is also seen important by the IGD-TP EG for retaining skills for the long-time frame. The recommendation is to revitalize and put into action its Joint Activity no 15 on Nuclear Knowledge Management (NKM) in line with the proposal presented by Nagra to avoid the loss of knowledge and expertise in the face of retirement of experts.

The IGD-TP Exchange Forum 5 participants were reserved but open also to other approaches like the potential to have mechanisms for mutual recognition and accreditation established. The amended directive 2005/36/EC on recognitions of professional qualifications gives a workable framework for the existing regulated professions and for future professions to be included into the national list of professions under the directive.

In the future the IGD-TP EG could interact with the ENEF initiative EN3S through a Joint Programming initiative. At the same time it is important to maintain the links with the other active ENEF initiative EHRO-N. EHRO-N has produced timely surveys and reports on the demand and supply of workforce in the nuclear sector and complemented the surveys with modelling exercises for validating the survey and study results under various European energy scenarios. The participation to the EHRO-N Senior Advisory Group (SAG) was made under the SecIGD2 project. For the future, it is recommended that the IGD-TP EG nominates a representative into the SAG.

7.3 Recommendations for the Commission and on the European level

Competence maintenance, education and training in Europe and especially in European Union are attributed directly to the national level. Several policy decisions related to education and qualifications are made under the DG Education and Culture (EAC) and the Euratom policies are not necessarily always in the same timeline with the European Union developments that take place in other fields of education and training. The difficulties of using e.g. the Marie Skłodowska-Curie grant funding for nuclear or geological disposal education and studies widens the gap between the educational development trends even further. This can certainly not be of European value added.

The 2011/70/Euratom directive on waste management also requires that education and training programmes exist in the Member States. An assessment on the state-of-the-art is now possible based on the national reporting submitted to the DG-ENER and potential gaps on European level can be identified for future recommendations by the Commission.

Even though it is advantageous to give the basic induction education or training into geological disposal in a national language, E&T is certainly an area where further studies into the topic either on university level or for professional benefit from international cross-fertilisation. Here training modules in English are needed or in another major European language. The strength of competence acquisition and E&T is that it is an area with non-conflicting interested in its aims to provide a solid scientific and technical knowledge base related to the topics taught.

Knowledge sharing and training development would benefit from setting up sector specific learning databases for eLearning courses and other training activities either independently or in collaboration e.g. with the IAEA already in possession of such resources.

The European Commission's role here would be to further bridge and integrate the developments in Education and Training across the different DG's especially in this case between the DG RTD in Fission and Fusion and

the DG EAC for learning faster from the current good European practices. Input is also needed from DG ENER for sharing the good national practices as reported to the Commission in connection with the adaptation of the Directive 2011/70/Euratom. ECVET is one example area to take advantage of. In this way, one can ensure that the community's different stakeholders like universities, research institutes, WMOs, and other industry organizations are aware of European level developments and in alignment with the aspiration to avoid overlapping activities, and to maximise the existing opportunities.

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Appendices

Appendix 1	Members of the CMET working group status end of 2015 and participation to the meetings and forums
Appendix 2	CMET Terms of Reference (2013-2016) v.2
Appendix 3	Last update of Joint Activity no 14 CMET to the IGD-TP's Master Deployment Plan 2015
Appendix 4	Identified areas for CMET cooperation (long list)
Appendix 5	List of Abbreviations Used

CMET WORKING GROUP MEMBERS AND AFFILIATES December 2015 **Meeting participation** **APPENDIX 1**

					April 2013	November 20	March-April 2	Oct. 2014	Nov. 2014	April 2015	April 2015	Dec. 2015
Affiliation	**Organisation**	**Country**	**Surname**	**Name**	**no1**	**no2**	**no3A-B**	**EF no5**	**no4**	**no5**	**Training WS**	**no6**
EG	SURAO	Czech Republic	Dvořáková	Markéta		x	x					x
EF	CTU	Czech Republic	Pacovský	Jaroslav	x	x						
EF	CTU	Czech Republic	Vašíček	Radek	x	x	x	x	x	x	x	x
EG	Posiva	Finland	Palmu	Marjatta	x	x	xx	x	x	x	x	x
EF	Aalto University	Finland	Leveinen	Jussi			x	x				
EG	ANDRA	France	Trentesaux-Hamamdjian	Christine			x	x	x	x		
EF	LU Mines Nancy	France	Bazargan-Sabet	Behrooz	x	x	x		x	x	x	
EF	WEFalck Scientific Consulting Ser	France	Falck	W. Eberhard								
EG	BMWi (KIT)	Germany	Steininger	Walter								
EF	BGR	Germany	Fahland	Sandra	x							
EF	Goethe University	Germany	Wittum	Gabriel								
EF	TU Clausthal	Germany	Röhlig	Klaus	x			x				
EF	JRC-ITU	Germany	Fazio	Concetta			x	participant	x	x	x	
EF	JRC-ITU	Germany	Buckau	Gunnar	x		x	participant				
Other	TU Braunscweig	Germany	Brewitz	Wernt				participant				
EF	REC CO Slovenia	Slovenia/Hungary	Železnik	Nadja			x					
EF	DICI - University of Pisa (CIRTEN)	Italy	Lo Frano	Rosa		x	x	x	x (telecon)	x	x	x
EF	University of Milan	Italy	Cantone	Marie Claire	x		x					
EF	Nidia srl	Italy/France	Vivalda	Claudia	x	x	x	x	x	x	x	
EG	RWM Ltd	Great Britain	Winsley	Robert	x		x					
EG	Nagra	Switzerland	Blechschmidt	Ingo	x							
EG	Nagra	Switzerland	Martin	Andrew		x			x			
EF	TU Delft	The Netherlands	Vardon	Phil	x		xx	x	x	x	x	
EF	IST/ITN	Portugal	Paiva	Isabel	x	x		x	x	x	x	x
EF	IST/ITN	Portugal	(Capucho dos) Reis	Mário			x			x	x	
EF	ARAO	Slovenia	Hertl	Bojan		x	x			x	x	x
EG	SKB	Sweden	Rubio Lind	Lotta								
EF	Stockholm University	Sweden	Pereira	Antonio				participant				
EF	UPM	Spain	**Elorza** Teneiro	Francisco Javier		x	x		x		x	
EG	Enresa	Spain	**Farias** Seifert	Joaquin	x	x		questionnaire				
EF	STUBA	Slovakia	Slugen	Vladimir								x
EG	SURAO	Czech Republic	Hanusová	Irena						x	x	
EF	ENEN association	France	**Dieguez** Porras	Pedro		x			x	x	x	x
EF	Mines Nantes	France	Abdelouas	Abdesselam						x	x	
EG	SÚRAO	Czech Republic	Nikol	Novotná								x
EF	CTU	Czech Republic	Lucie	Hausmannová								x
					14	13	18	18	13	15	15	10

Additional Secretariat contacts

EG	ANDRA	France	Delay	Jacques								
EG	ANDRA	France	Garcia	Marie			x	x	x	x	x	
EG	RWM Ltd	Great Britain	Kowe	Raymond				x				

One time visitors or Retired members of CMET group

EF	BGR	Germany	Mente	Michael	x							
EG	SURAO	Czech Republic	Bělíćková	Lucie				x				
ENEN	ENEN/Univ. of Pisa	Italy	Ambrosini, Walter	Walter				x				

APPENDIX 2

TERMS OF REFERENCE (ToR)

COMPETENCE MAINTENANCE, EDUCATION AND TRAINING WORKING GROUP (CMET) of the IMPLEMENTING GEOLOGICAL DISPOSAL OF RADIOACTIVE WASTE TECHNOLOGY PLATFORM (IGD-TP)

Version 2.0 with updated Appendix
31 December 2015

1 BACKGROUND

The Competence Maintenance, Education and Training group (CMET) is a working group deployed by the Executive Group (EG) of the IGD-TP in June 2011. Its first Terms of Reference (ToR) were discussed during the IGD-TP's second Exchange Forum in November 2011 and sent for comment to the IGD-TP representatives who had volunteered for this Working Group. The first ToR were finalised and sent for the IGD-TP EG approval in May 2012. The ToR were approved by the EG during summer 2012 and included into the Terms of Reference of the IGD-TP in February 2013.

The call for volunteers to the CMET Working Group was issued prior to the third Exchange Forum in Paris in November 2012. By November 2013, representatives from 26 different organisations had volunteered to be members of this Working Group. They represent waste management (WMOs), universities, research institutes and consulting companies from 12 different European Union Member States and from Switzerland.

2 OBJECTIVES, RESPONSIBILITIES AND POWERS

The overall goal of the CMET Working Group is to promote European cooperation in this cross-cutting area in support of the IGD-TP's "Vision 2025" and in support of its commitment to *"facilitate access to expertise and technology and maintain competences in the field of geological disposal for the benefit of Member States."*

The main four objectives of the CMET to promote with regards to co-operation, are:

- Carry out transfer of state of the art strategies and activities for Competence Maintenance, Education and Training related to the implementation of Vision 2025. This includes producing input information on current and future Knowledge, Skills, and Competence (KSC) needs of the geological disposal community and transferring the knowledge base about these needs to CMET providers.

  A specific aim under this objective is effectively to identify the shortfalls and needs in KSC to undertake the planned research, development and demonstration activities and programmes identified in (Strategic Research Agenda (SRA) and its Deployment Plan (DP). This also requires defining the borders of current knowledge (the state of the art) for each of the SRA Topics for their expansion. This activity needs to be carried out in co-operation with all of the relevant Joint Activities in order to identify the KSC gaps across the IGD-TP's Joint Activities on the European level. Communication about the

actions undertaken by the CMET providers to close any KSC gaps is also aimed to be carried out under this transfer activity.

- Develop quality assurance of training aimed at new and experienced professionals in the field of nuclear waste management and especially geological disposal by developing quality assurance procedures and criteria for the voluntary accreditation of training (and education) in geological disposal.
- Develop the content of training i.e. a type of “curricula" for professionals in geological disposal for the development of joint training or alternatively engage educators and trainers into developing Education and Training (E&T) to meet the expertise needed to carry out the IGD-TP's SRA and its Research, Development and Demonstration (RD&D) activities as part of the deployment. The different training needs (different jobs) of the different target groups need to be addressed in the "curricula" development.
- Ensure indirectly that providers for the CMET exist i.e. ensure the sustainability of providers and the necessary infrastructures/facilities for competence maintenance, and that new personnel will be available and developed for the future.

Competence and/or capabilities cover a wide range of activities beyond E&T. However, in the formal competence development E&T activities play a major role. It is also acknowledged that education in Europe is a matter of subsidiary of the Member States and it is decided on a national or regional level, depending on each national legal framework. Its impact is that the initiatives proposed by the CMET are voluntary actions of its members and recommendations to the IGD-TP only. In this spirit, the CMET aims for consensus in its decisions.

As described above, the CMET group is formed on a voluntary and in-kind basis for working together on activities that promote the objectives. The work of the CMET group is steered by its Strategy and Action Plan that is under preparation by the group for the period of 2013-2016. The CMET informs the IGD-TP via the Secretariat of its activities and progress.

Each CMET member acts under the authorisation of its own organisation. In the event CMET receives external support, the contractual requirements need to be taken into account in the CMET responsibilities and activities as stipulated in the contract(s).

A CMET working group can and should, however, cooperate with the existing and new E&T initiatives and provide improved accreditation schemes and consistency in learning outcomes (LO) within the geological disposal community, which already is very multidisciplinary and international in its requirements and activities.

The emphasis of the CMET Working Group in the voluntary accreditation is to focus on the acknowledgement of training activities and their quality assurance, which are not covered by existing European initiatives like the ENEN[1] association, EHRO-N[2] and/or EETI[3]. Another focus of the voluntary accreditation is to look at the accreditation of a professional individual's learning outcomes. The ENEN association has already set up a voluntary accreditation and mutual recognition of the Master's level university education in the nuclear field in Europe.

Note that accreditation means in general recognition of competency[4]. With voluntary accreditation in the IGD-TP and CMET context this is defined as a mutual agreement to recognise learning outcomes. These learning outcomes can be from a training activity or an individual's specific learning outcomes in geological disposal that are produced outside the jurisdiction of a national educational framework and/or independent of the means of acquiring them. The accreditation is always based on mutually agreed preselected and fixed criteria.

To achieve its objectives, the CMET can also submit, with the approval of the Executive Group, proposals for funding of its activities or for joint activities with the EFTS[5]'s or other relevant groups for new developments in Competence Maintenance and E&T. If the proposal is in alignment with the IGD-TP's Vision and SRA or recommended by the IGD-TP's Secretariat, the IGD-TP EG may in response issue it an “approval” or “"label”.

3 GUIDELINES

Achieving the "Vision 2025" of the IGD-TP requires the development of Knowledge, Skills and Competence in the field of geological disposal. This includes meeting the regulatory qualification and competence requirements during the different stages of repository development. Specific competences are needed to carry out the deployment of the "SRA 2011" and to implement the Joint Activities described in the DP for 2011-2016. Thus IGD-TP's three founding documents and the further guidelines of the IGD-TP Executive Group direct the CMET's work. In addition, the interests of the CMET members and their in-kind contributions to the work set the boundary conditions on the scope of the CMET's activities.

[1] ENEN = European Nuclear Education Network association established in France
[2] EHRO-N = European Human Resources Observatory in the Nuclear Energy Sector, an initiative from ENEF run by the JRC's IET in Petten, the Netherlands
[3] EETI = SET-Plan European Energy Education and Training Initiative
[4] as in e.g. STUK A-163 Servomaa, Antti (ed.). Säteilyturvallisuus ja laadunvarmistus röntgendiagnostiikassa 1999. STUK-A163. Helsinki 1999, 158 s. (Radiation safety and Quality Assurance in X-ray diagnostics)
[5] EFTS = European Fission Training Schemes

The Cross-Cutting activity (CC2) of the SRA and DP of the CMET needs and benefits from the maintenance and cooperative development of resources in this field by working jointly on the:

- Maintenance and development of expertise over the long lifetime of the waste management programmes at different stages of repository development.
- Ensuring that capabilities, infrastructures, research and educational facilities are available for the RD&D for implementation of deep geological disposal and waste management programmes.
- Development of new KSC in the field of geological disposal as the waste management programmes shift their activity from RD&D to operating repositories and disposal facilities as defined in the SRA.
- Pooling of expert resources and increasing the mobility of experts in Europe to assist achieving the Vision 2025 and implementing the SRA and to maintain critical human resources needed for these tasks.
- Promoting quality of education and training by educating new experts and new educators and trainers to work in all the aspects of geological disposal e.g. by developing a common basis for accreditation and recognition of KSC.
- Supporting the availability of education and training in geological disposal despite the changing circumstances and changing level of activities in different waste management programmes.

4 ROLES OF CMET AND ITS TASKS

4.1 CMET ORGANISATION

The CMET consists of representatives of the IGD-TP participant organisations and other stakeholders, who have expressed an interest in the CMET Working Group to the IGD-TP's Secretariat. These representatives are willing to commit their time and expertise in the form of in-kind contribution to achieve the CMET objectives by working in the group. The IGD-TP Secretariat works in conjunction with the CMET.

The members of the CMET, who have expressed interest in participating in the Working Group by December 2013 are listed in Appendix 1.

Other interested organisations are encouraged to join the group by contacting the IGD-TP Secretariat. The CMET encourages the participation of a wide range of organisations in its work keeping in mind that the focus of the CMET is to work with the demand side issues of the human resources in waste management and especially in geological disposal.

The organisations are responsible for the use of the results of the work and for providing resources for participating in the CMET work. Secretarial work is provided by the IGD-TP Secretariat.

4.2 DRIVERS OF CMET'S WORK

The mission of the CMET Working Group is to analyse competence and E&T needs related to the IGD-TP's SRA together with the IGD-TP's Joint Activities to support the deployment of the SRA with E&T related activities. In addition, the CMET will seek to voluntarily accredit and quality assure training activities and potentially individual's learning outcomes in geological disposal in Europe of at the request of the training activities or individual asking for this accreditation.

Based on these tasks, the CMET Working Group can either recommend actions on the IGD-TP's Executive Group, or to act itself after the approval of the CMET members and/or the Executive Group and the CMET member organization's authorisation.

Furthermore, the CMET mission is to indirectly ensure that the necessary facilities and providers for Competence Maintenance, Education and Training exist and new personnel will be available for the future by maintaining the CMET network and transfer of knowledge on needs.

4.3 CMET CHAIR AND SECRETARY OF MEETINGS

The CMET selects a chairperson either for a fixed term or the chair can rotate between the members and between meetings according to decisions within those meetings on the means for decision making. The first chair selected by the IGD-TP's EG to initiate the CMET Organisational Working Group is Ms. Marjatta Palmu (Posiva). It is preferable that the chair is selected from one of the EG member organisations in the CMET.

The chairperson is responsible for the planning of the next meeting with support from the IGD-TP's Secretariat. The acting chair is also responsible for following up actions from the previous CMET meeting.

The CMET group selects a secretary for its bi-annual meetings from the group for record keeping if the IGD-TP Secretariat is not available for the task.

4.4 CMET MEETINGS

The CMET meets bi-annually in connection with the IGD-TP's Exchange Forum and meetings of other related European initiatives that include several CMET

members as participants. The CMET meetings not connected to the EF are generally held in a country of one of the CMET members.

4.5 CMET WORKING MODES AND TASKS

The first action of the CMET is to produce a strategy and action plan for its future work to meet its objectives, but primarily to address its second objective: the quality assurance of training and the training related accreditation (feasibility of a voluntary accreditation scheme). The action plan's content follows the relevant parts of the management guidelines (v.1.0) of the IGD-TP's Joint Activities.

In setting up the action plan as a part of the first CMET task, the Working Group meets in person or by virtual means, when required, until the first action plan and first set of agreed CMET actions, including the voluntary accreditation scheme feasibility study, are completed.

The Working Group's modes of working may consist of setting up different task forces for the Working Group's future dissemination activities as per the organisation of the CMET exchange forums or workshops in line with the IGD-TP's "Vision 2025", SRA, DP and the objectives of the CMET working group. This may take place in conjunction with other European initiatives (as defined earlier) in the field of Competence Maintenance, Education and Training.

The tasks that may be included in the CMET action plan(s) include the:

- Promotion to sustain a sufficient critical mass in CMET in geological disposal in Europe to meet the needs of the IGD-TP's vision for all stages of the repository development;
- Identification of the CMET needs and activities for competence development needed to deploy the IGD-TP's Joint Activities and to maintain and update the knowledge base of those needs;
- Development and maintenance of quality guidelines and criteria for the accreditation of the CMET activities, especially training and training programmes in geological disposal in Europe;
- Initiation of the development of joint CMET activities among the IGD-TP participants or with other stakeholder groups to meet the identified needs including proposals for funding of these activities;
- Strengthening of existing E&T activities and initiatives by providing input and information on future needs and trends in education and training in the field of geological disposal; exchange related experiences and include participation of professionals from the member organisations in these activities;

- Assistance in finding industry/end-user representatives to the national "ECVET[6]" assessment boards in geological disposal if they exist. This may include evaluating and issuing accreditation supplements to individuals, who have completed studies, learning outcomes or educational programmes that meet the quality criteria set for them by the IGD-TP (CMET Working group);
- Disseminating information about accreditation and other recognition tools and to assist in the acknowledgement of the Europass[7] in their relevant organisations together with other European initiatives;
- Initiating the organisation of venues or exchange forums, workshops or similar events at least once a year to help achieve the CMET objectives and for disseminating information about CMET related to the IGD-TP.

The CMET Working Group will also contribute information on its objectives and activities to the IGD-TP's extranet and website (including action plans and other documentation intended for public or open access distribution).

5 MANAGEMENT AND APPROVAL OF CMET SPECIFIC DOCUMENTS AND RESULTS

The CMET meetings are recorded in minutes that are sent for comment and approval of the working group members. The CMET group selects a secretary for recording its meetings if the IGD-TP Secretariat is not available.

English shall be used in all documents produced by the CMET and in meetings.

The CMET group documents and stores the outcomes of its past and current work to the IGD-TP extranet's CMET workspace. Access to the IGD-TP's extranet is provided only to the CMET representatives of the IGD-TP participant organisations.

In addition, an e-mail list will be used for notifying the CMET members of meetings and other activities.

Any publications planned to be published on the IGD-TP's public website need to be approved by the EG in advance. Approved outcomes of the work not containing confidential information will be published with the help of the IGD-TP Secretariat.

An annual written assessment of the CMET progress is prepared and submitted to the IGD-TP's Executive Group for information and for guidance after each calendar year.

[6] European Credit Transfer System for Vocational Education and Training
[7] European Skills Passport http://europass.cedefop.europa.eu/fi/home

6 UPDATING OF THE CMET ACTION PLAN

On completion of the first activities (2013-2015) for the CMET or in the event of major changes in the CMET objectives, its action plan will be updated to take into account any changes in the needs of waste management programmes around competence maintenance, education and training.

7 TERM OF CMET

The CMET is a Working Group whose work is intended to have a long lifespan. During 2013-2015, the IGD-TP Secretariat supports of the CMET Working Group's work under the Euratom FP7 project SecIGD2 (GA no 323260).

APPENDIX 1

MEMBERS OF THE CMET WORKING GROUP (STATUS DECEMBER 2015)

JA no 14 CMET WORKING GROUP December 2015

Affiliation	Organisation	Country	Surname	First Name
EG	SURAO	Czech Republic	Dvořáková	Markéta
EF	CTU	Czech Republic	Pacovský	Jaroslav
EF	CTU	Czech Republic	Vašíček	Radek
EG	Posiva	Finland	Palmu	Marjatta
EF	Aalto University	Finland	Leveinen	Jussi
EG	ANDRA	France	Trentesaux-Hamamdjian	Christine
EF	LU Mines Nancy	France	Bazargan-Sabet	Behrooz
EF	WEFalck Scientific Consulting Services	France	Falck	W. Eberhard
EG	BMWi (KIT)	Germany	Steininger	Walter
EF	BGR	Germany	Fahland	Sandra
EF	Goethe University	Germany	Wittum	Gabriel
EF	TU Clausthal	Germany	Röhlig	Klaus
EF	JRC-ITU	Germany	Fazio	Concetta
EF	JRC-ITU	Germany	Buckau	Gunnar
Other	TU Braunscweig	Germany	Brewitz	Wernt
EF	REC CO Slovenia	Slovenia/Hungary	Železnik	Nadja
EF	DICI - University of Pisa (CIRTEN)	Italy	Lo Frano	Rosa
EF	University of Milan	Italy	Cantone	Marie Claire
EF	Nidia srl	Italy/France	Vivalda	Claudia
EG	RWM Ltd	Great Britain	Winsley	Robert
EG	Nagra	Switzerland	Blechschmidt	Ingo
EG	Nagra	Switzerland	Martin	Andrew
EF	TU Delft	The Netherlands	Vardon	Phil
EF	IST/ITN	Portugal	Paiva	Isabel
EF	IST/ITN	Portugal	(Capucho dos) Reis	Mário
EF	ARAO	Slovenia	Hertl	Bojan
EG	SKB	Sweden	Rubio Lind	Lotta
EF	Stockholm University	Sweden	Pereira	Antonio
EF	UPM	Spain	Elorza Teneiro	Francisco Javier
EG	Enresa	Spain	Farias Seifert	Joaquin
EF	STUBA	Slovakia	Slugen	Vladimir

JA no 14 CMET WORKING GROUP December 2015

Affiliation	Organisation	Country	Surname	First Name
EG	SURAO	Czech Republic	Hanusová	Irena
EF	ENEN association	France	Dieguez Porras	Pedro
EF	Mines Nantes	France	Abdelouas	Abdesselam
EG	SÚRAO	Czech Republic	Nikol	Novotná
EF	CTU	Czech Republic	Lucie	Hausmannová

This version of the appendix has been updated on 30 December 2015.

APPENDIX 3

Last update of Joint Activity no 14 CMET to the IGD-TP's

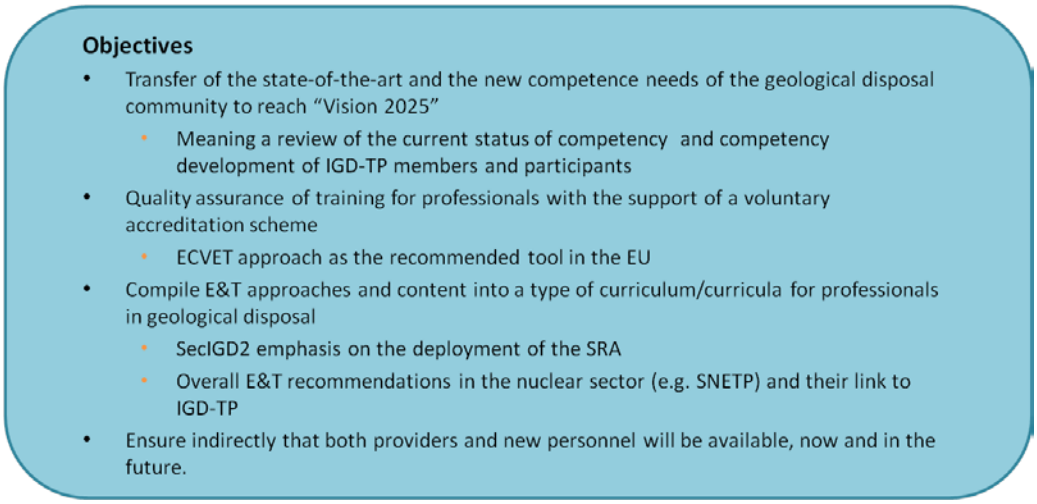
Master Deployment Plan 2015

6.21 JA14: Competence Maintenance, Education and Training

JA14: Competence Maintenance, Education and Training		
SRA Cross-cutting Activity: CC2		**Type of Activity:** IEP
Joint Activity leader:	**Posiva Oy, Finland** Marjatta Palmu (marjatta.palmu@posiva.fi)	
Cross-cutting Activity: Competence Maintenance, Education and Training		

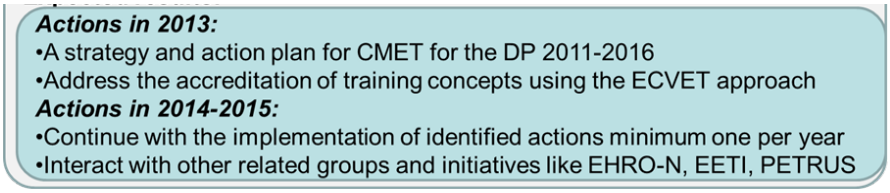
Competence Maintenance, Education and Training Working Group CMET (IEP)

Objectives of CMET working group



The CMET Working Group (CMET) is a permanent Working Group of the IGD-TP formed in 2012. The current actions towards the CMET group's objectives are carried out with the financial support of the EURATOM FP7 and the IGD-TP's EG with the assistance of the SecIGD2 project, that organises work defined in the project's Work Package 3 (2013-2015). This assistance includes organisation of at least two work group meetings of the CMET annually, compiling a strategy and action plan for the group and reporting the feasibility study of an accreditation scheme that could apply the ECVET approach.

Expected results as defined in the SecIGD2 work plan



On-going work in 2015

- The CMET group continues to meet according to its annual meeting plan. Fifth CMET meeting took place in April 2015 in Lisbon, Portugal and it included a special training session by Cheryl Contee from Fission Strategy to the members of the group. One more meeting under the SecIGD2 is to be scheduled in 2015 for the group members and takes place in the Czech Republic in December.

- A StrAP editing workshop was arranged on the 2 June 2014 in Delft Holland and the new content was presented to the EG for comments in the EG no14 meeting in June 2014. The work to produce the CMET Strategy and Action Plan (StrAP) continues with some delays.
- The identification of other actions for the CMET is on-going and as the 2015 action a prioritisation of identified CMET action opportunities took place in the CMET no 5 meeting in Lisbon. This prioritisation identified further the 2016 activity/activities. The plan is to continue the CMET's activity during the first half of 2016 with the cooperation of the Petrus III project.
- Dissemination about the IGD-TP CMET group's activities continues in the relevant venues and cooperation forums and projects like with ENEN, Petrus III and CINCH.
- The StrAP and feasibility study reports are scheduled for completing in 2015.

Major achievements during 2014 and 2015

- A special walkabout session was held to the EF5 participants in Kalmar, Sweden to collect the views and inputs of the IGD-TP on the feasibility of a voluntary accreditation scheme. This session was organised by the CMET members within the SecIGD2 project and with additional support from Petrus3 project and ENEN association.
- Four CMET working group meetings were organised, CMET meeting no 3 was split into two meetings: 3A in Cardiff, United Kingdom and 3B in Delft, Holland, both hosted at the universities. CMET no 4 meeting was held in Paris in November 2014 to collect the outputs from the EF5 walkabout and CMET no 5 meeting was held in Lisbon in April 2015.
- Projectplace folder for the group has been continuously used for material sharing; set-up of a LinkedIn CMET group for discussions was done, but it is not as active; the update of JA14 page of the www.igdtp.eu website for public announcements is in use, too. CMET related announcements of European events have been actively submitted for distribution and published by the Secretariat in the www.igtp.eu calendar for wide outreach.
- IGD-TP and especially CMET continues to be represented in the EHRO-N SAG and its meetings, interactions with the PETRUS III project. The membership of the ENEN association in the CMET working group was agreed in March 2015 at the ENEN General Assembly in Finland. IGD-TP endorsement for the ENEN coordinated H2020 proposal ANNETTE was provided, unfortunately the project proposal remained on the reserve list of the first H2020 call.
- Ecole des Mines de Nantes joined the CMET working group in April 2015.

CMET Competence Maintenance, Education and Training Working Group

Joint Activity participants

9 organisations from 14 European Member States have volunteered for the CMET activity. They represent six different types of organisations active in the geological disposal community. CMET is continuously open for new volunteers into the group. Expressions of interest can be sent directly to the CMET chair with a copy to the Secretary General of the IGD-TP.

EG participants

ANDRA	Christine Trentesaux- Hamamdjian christine.trentesaux-hamamdjian@andra.fr; Marie Garcia, (Secretariat)	**BMWi**	BGR, S. Fahland Sandra.fahland@bgr.de, KIT /Walter Steininger walter.steininger@kit.edu
ENRESA	J.Farias jfas@enresa.es	**Nagra**	Ingo Blechschmidt Ingo.blechschmidt@nagra.ch; Andrew Martin Andrew.Martin@nagra.ch
RWM	Robert Winsley robert.winsley@nda.gov.uk	**Posiva**	**Marjatta Palmu Marjatta.Palmu@Posiva.fi**
SURAO	Marketa Dvorakova / Irena Hanusová dvorakova@surao.cz; hanusova@surao.cz	**SKB**	Lotta Rubio Lind Lotta.Rubio.Lind@skb.se

Posiva, RWM and Andra are also supporting the activity through the SecIGD2 project.

EF participants volunteered for the activity

Czech Technical University, CTU (CZ), Jaroslav Pacovsky and Radek Vasicek
Aalto University (FI), Jussi Leveinen
Université Lorraine- Mines Nancy (FR), Behrooz Bazargan-Sabet
Université de Versailles St. Quentin-en-Yvelines (FR), W. Eberhard Falck
BGR[5] (DE), Sandra Fahland
Steinbeis-Center for Simulation in Technology (DE), Gabriel Wittum
TU Clausthal, IELF (DE), Klaus Röhlig
JRC - ITU (EC), Concetta Fazio and Gunnar Buckau
CIRTEN[6] - University of Pisa (IT), Rosa Lo Frano
University of Milan (IT), Marie Claire Cantone
Nidia srl. (FR/IT), Claudia Vivalda
TU Delft (NL), Phil Vardon
Instituto Superior Técnico/ Nuclear and Technological Center (PT), Isabel Paiva and Mario Reis
ARAO (SI),Bojan Hertl
UPM[7] (ES), Francisco Javier Elorza
STUBA[8] (SK), Vladimir Slugen
REC[9] (SI), Nadja Zeleznik
ENEN Association[10] (FR), Pedro Dieguez Porras

[5] Bundesanstalt für Geowissenschaften und Rohstoffe
[6] Inter-University Consortium for Nuclear Technological Research
[7] Universidad Politechnica de Madrid
[8] Slovak University of Technology in Bratislava
[9] Regional Environmental Centre for Central and Eastern Europe REC Hungary
[10] European Nuclear Education Network Association registered in France (www.enen-assoc.org)

Ecole de Mines Nantes EMN (FR), Abdesselam Abdelouas

Other interested participants

former TU Braunschweig (DE), Wernt Brewitz
former Stockholm University, Department of Physics (SE), Antonio Pereira

Description of the drivers for the activity in 2012 when it was kicked-off::

The CMET activity is supported by the IGD-TP Secretariat via the EURATOM FP7 SecIGD2's **Work Package 3** (WP3) ***"Support for the development, implementation and coordination of Competence Maintenance, Education and Training (CMET) activities in geological disposal in Europe".*** The WP3 and this activity are led by **Posiva Oy**. The background information for the activity is described in the following based on the SecIGD2 project plan and on some recent updates from 2013-2014 activities.

The IGD-TP has identified in its SRA[11] the need for Competence Maintenance, Education and Training (CMET) as one of its Cross-Cutting Activities that supports the Vision 2025[12] of the IGD-TP, especially in facilitating access to expertise and technology and maintaining competence for the benefit of Member States.

The IGD-TP's SRA 2011 identified the state-of-the-art within this Cross-Cutting Activity CMET. It acknowledges that geological disposal community is a fairly small community in its size compared e.g. with the rest of the nuclear sector. In the community a very broad range of qualifications, competence and expertise are needed for a wide range of scientific and technical disciplines and of humanities (especially economics, communication and competence development). The multidisciplinary character of geological disposal forces the waste management community to attract work force in competition with a large variety of industries and research organisations to meet the personnel demands. Working together on this Cross-cutting Topic assists in pooling a mass of potential participants large enough to make the CMET activities happen and to help in pooling human resources also in the future to address the knowledge maintenance challenges created by the retirement of experts.

The recognition of a person's learning outcomes and also gaining a qualification can be achieved independently of the way the learning has been acquired in compliance with the qualification levels defined in the European Qualification Framework (EQF[13]) and by taking advantage of the ECVET approach. Thus the accreditation of the learning outcomes opens opportunities to define and assess the learning outcomes of any training concept or scheme developed within the waste management community. The European wide credit systems in the future not only serve the outcomes of university education but also more informal training activities. The development of such accreditation schemes requires common actions and agreement by the stakeholders in question that is not necessarily self-evident in the Member States, where qualifications are subject to national educational policies and related legal frameworks (subsidiarity).

The European cooperative training concepts (or schemes) feasibility in geological disposal has been studied and tested on various EFTS[14] and national projects. One practical long-term issue is maintaining the sustainability of such concepts after the end of the projects. A mutually accepted accreditation of individual

[11] IGD-TP 2011. Strategic Research Agenda 2011 (SRA 2011) www.igdtp.eu
[12] IGD-TP 2009. Implementing Geological Disposal of Radioactive Waste Technology Platform. Vision Report. EUR 24160 EN or http://www.igdtp.eu
[13] European Qualification Framework (EQF) and European credit system for vocational education and training or VET (ECVET)
[14] European Fission Training Scheme (EFTS)

training concepts for quality assurance, mutual recognition and mutual acknowledgement of learners learning outcomes would help promote the status of such training concepts in the eyes of the end-users and potential students and thus contribute to their sustainability.

Lack of funding instruments for running such concepts and funds for a wider international student communities participation into such concepts at the European level is currently one reason for their limited financial viability. The main mobility funding resources are tied to formal degree programmes at universities and other higher education institutions. In addition, the funding is often allotted on an individual basis and not aimed at groups of students and their tutors.

For training concepts depending on participant fees or other direct funding, there is a need to take into account the demand side views of the end-users in the development of the European competence maintenance, education and training activities in alignment with the IGD-TP's vision, SRA and the Deployment Plan, too.

Achieving the "Vision 2025" and deploying the Joint Activities of the IGD-TP are the specific reasons for carrying out the support activities to the CMET under the SecIGD2 project. The CMET work as such is a voluntary commitment of the CMET group members and their background organisations.

The emphasis of the group is to focus on the development, implementation and coordination of the CMET activities. It will not act as a training provider or a training scheme/concept developer in geological disposal, nor does it plan to become one. Because this provision is the task of training and education providers i.e. training is provided by professional training organisations and universities. The IGD-TP's CMET can provide information from the demand side needs (Figure 1) of competence maintenance, E&T to the providers so that they can develop and maintain ways of producing learning outcomes in geological disposal. Most importantly, the CMET can also work as a channel to bring participants to such schemes and thus contribute to their sustainability.

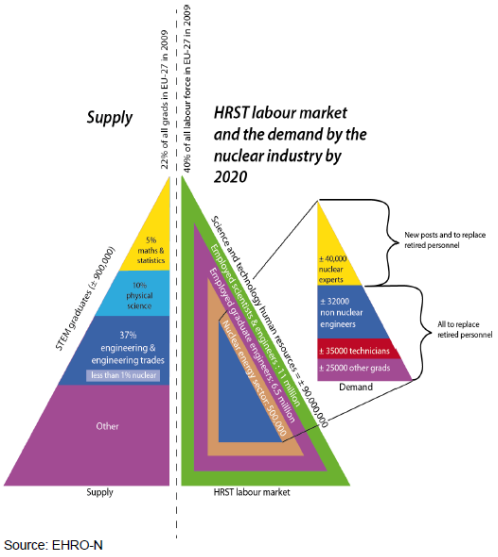


Figure 1: Supply and demand sides of HR resources in nuclear (according to EHRO-N). Supply side is taken care by governments and educational institutes/training providers and the demand side looks at how much HR is needed and in what type of competence areas. The IGD-TP CMET works on the demand side issues in HR but collaborates with the supply side in order for the needs and supply to match. Source of figures: EHRO-N (with permission)

During 2013-2015, the preliminary action plan is that during each of the three years of the SecIGD2 project, the CMET selects (at least) one action from its mandate for implementation with in-kind contributions. The accreditation scheme feasibility study will be the first to be implemented due to its importance. The CMET actions all focus on the development, implementation and coordination of the CMET from the perspective of implementing the IGD-TP's SRA (current and future SRAs). They will be based on a more detailed strategy and action plan of the CMET group.

In Europe, there is very limited specific formal in-depth education leading to a degree in geological disposal. Also the amount of wider educational or training programmes is limited, though their number has increased since the beginning of this century. In geological disposal, learning on the job and in RD&D[15] projects in various ways is the main source of knowledge, skills and competence (KSC[16]) development. In such a setting the use of ECVET approach and mutual recognition of the defined and documented learning outcomes that are acquired by the professionals in such informal ways (e.g. on the job, in projects, on internal or other training courses) are beneficial in HR development and task related knowledge preservation.

In geological disposal, the quality assurance of the learning outcomes currently takes place on the organisational level and for their assessment and recognition by other organisations a very limited scope of mutual recognition applies. New needs for qualification of personnel arise as the implementation of repositories and other related nuclear facilities start operating. The regulators in regard with the licensing of the facilities will also address and require the qualification of personnel, in particular the demonstrated qualification of the operating and other personnel dealing with safety critical tasks,. Quality assurance procedures for mastering the construction and operating procedures (i.e. the learning outcome requirements) need to be developed. The CMET and the IGD-TP with its Secretariat can support the development of suitable procedures. The CMET group's progress in this area will be incorporated into the record documenting the feasibility and the potential development of the accreditation scheme.

The adoption of the new “Waste Directive”[17] in the European Member States was on 23 August 2013. In the Member States closest to licensing, most of the requirements of the directive have already been incorporated into the national legislation and guidelines and a lot of experience dealing with the practical implementation of the requirements exists within the IGD-TP. In addition, the Nuclear Waste Directive (Waste Directive) now states explicitly in its article 8 on "Expertise and skills" that *"Member States shall ensure that the national framework require all parties to make arrangements for education and training for their staff, as well as research and development activities to cover the needs of the national programme for spent fuel and radioactive waste management in order to obtain, maintain and to further develop necessary expertise and skills"*.

The IGD-TP's working group on Competence Maintenance, Education and Training is aware of the various challenges facing competence maintenance, education and training in implementing geological disposal. The CMET is motivated and aims to address these challenges in a coordinated way to the degree, for which resources have and will be provided for the CMET work by the SecIGD2 project and the volunteering organisations. The strategic aim of the work is to ensure that the necessary knowledge, skills and competence in geological disposal are maintained and to further develop opportunities for competence maintenance,

[15] Research, Development and Demonstration
[16] In the ECVET approach, Learning Outcomes (LO) of a unit of learning (i.e. mastery of one task or task component) are verbally defined with Knowledge, Skills and Competence (KSC) components based on a taxonomy that is in a process of development for the nuclear sector
[17] COUNCIL DIRECTIVE 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste.

education and training without becoming an education and training (E&T) provider. Many providers of E&T and EFTS's have already volunteered to participate in the CMET activity and unnecessary overlap with existing activities shall be avoided. The SecIGD2 support for catalysing this Joint Activity (JA14) enables thus support in the form of a European wide a forum of interested voluntary participants.

All organisations working in the nuclear sector work with high safety requirements and with a high awareness of factors influencing safety. This means a need to meet at least a minimum common level of KSC about safety in all of the European Member States despite their national subsidiarity related to educational and other related decisions. The drivers for harmonising the requirements related to the learning outcomes for the personnel working in the field are derived from the implementation of a good safety culture in the organisations.

The ECVET[18] approach is a potential tool for assessing such and other learning outcomes. In the high safety context it has first been piloted in the aeronautics sector. ECVET approach is also complementary to the SAT[19] introduced by the IAEA for HR and training development for nuclear facilities. ECVET piloting is now taking place in the nuclear sector in various European Fission Training Schemes like ENENIII, PETRUS2-3, CINCH1-2, ENETRAP2-3 and in newer schemes. The quality assurance of the learning processes and the validation of the learning outcomes require industry and other end-user involvement. Similar parallel processes are on-going in the nuclear field at e.g. EHRO-N[20] and EETI[21] for the SET-Plan Roadmap on Education and Training[22]. The intention of the CMET is to continue working in an integrated manner with other existing and new initiatives during following years. Key experiences can be transferred and modified to the geological disposal context despite the fact that many of these other initiatives cover the whole nuclear sector. The interaction in CMET can provide future opportunities for piloting such schemes in geological disposal.

Way Forward: See section: On-going work of CMET

Update of Outline Information: Marjatta Palmu April 2015

[18] ECVET = European Credit System for Vocational Education and Training e.g. CEDEFOP. 2013. Monitoring ECVET implementation strategies in Europe. Working paper no 18. http://www.cedefop.europa.eu/EN/Files/6118_en.pdf
[19] SAT = Systematic Approach to Training e.g.in INTERNATIONAL ATOMIC ENERGY AGENCY. 2009. Managing Human Resources in the Field of Nuclear Energy. IAEA Nuclear Energy Series No. NG-G-2.1. Vienna.
[20] European Human Resource Observatory in Nuclear (the operating agency is DG JRC's Institute for Energy and Transport) resulting from ENEF visit: http://ehron.jrc.ec.europa.eu/.
[21] Energy Education and Training Initiative (EETI)
[22] Strategic Energy Technology (SET) Plan Roadmap on Education and Training visit: http://ehron.jrc.ec.europa.eu/news/set-plan-roadmap-education-and-training

APPENDIX 4

IDENTIFIED AREAS (ACTION PROPOSALS) FOR CMET COOPERATION

Long list from CMET working group member and top ranking

CMET Objective 1:	**To carry out transfer of the state of the art of strategies and activities for Competence Maintenance, Education and Training related to the implementation of Vision 2025.**
Rank/Short term (S)	
Top level strategies	
5. (S)	9.12 Produce a strategy that is in alignment or aligns with the European Commission's strategy and potential funding requirements. The purpose is to provide input for where the E&T in geological disposal should focus on in Europe.
(S)	9.1 Prioritize the training needed to move to the IGD-TP vision - first priorities: safety culture and risk acceptance
Cooperation strategies including sharing infrastructures, exchange of personnel/fellows	
(S)	9.5 Measures to strengthen the link between IGD-TP members and CMET
2. (S)	9.9 Use practical training on repository/URL sites or site related work in training (potential Josef, CZ; Grimsel, CH; Bure, FR. Not included in CMET: Tournemire, FR; Mont Terri, CH; Äspö, SE and HADES, BE)
	9.10 Carry out actions in international cooperation and use fellowships and KM tools
7. (S)	9.20 Make a Geological disposal workshop to train people (URF network type). Provide experts for the workshop.
(S)	9.22 Produce a IAEA TecDoc type document as a tool to preserve (KSC)/competences on the area of geological disposal/repositories. Contribution by defining contents and and contacting international organisations.
	9.26 SOMET educational facility in France
	9.27 CP4NET virtual learning platform (IAEA NKM Moodle based platform)
	9.28 VNMU Virtual Nuclear Management University
	9.29 Potential open database for LO and KSC development (EHRO-N initiative?)
	9.30 NUSHARE (FP7 project) on safety culture
Knowledge transfer and related strategies	
4. (S)	9.3 Sharing what has been learned in the countries with more advanced programmes with other countries at earlier stages of repository development
7. (S)	9.20 Make a Geological disposal workshop to train people (URF network type). Provide experts for the workshop.
3. (S)	9.21 E-learning courses (IAEA style) on a specialised topic by an international working group by sharing competences and expertise
	9.23 Look for ways to support exchange of knowledge and competence; Look for ways to sustain KSC in long time period and Lifelong learning to maintain knowledge and expertise and to keep up with new developments in geological disposal
(S)	9.24 Need to address how knowledge can be transfered in practice from experienced staff to new or junior staff - various means like: refresher courses, conference attendance, information exchange meetings with sister organisations (WMOs), structured seminars/workshops/interviews - organised by experienced staff to new staff (alternative; new staff to organize and engage the experts), secondments to other industries

IDENTIFIED AREAS (ACTION PROPOSALS) FOR CMET COOPERATION

Long list from CMET working group member and top ranking

Knowledge management and tools	
6. (S)	9.8 Collect/Refresh [community] memory around the RD&D that has been conducted in geological disposal in the past (state-of-the-art "summary")
4. (S)	9.3 Sharing what has been learned in the countries with more advanced programmes with other countries at earlier stages of repository development
	9.4 Push for having an active tool/database that is updated continuously for use
	9.10 Carry out actions in international cooperation and use fellowships and KM tools
3. (S)	9.21 E-learning courses (IAEA style) on a specialised topic by an international working group by sharing competences and expertise
(S)	9.22 Produce a IAEA TecDoc type document as a tool to preserve (KSC)/competences on the area of geological disposal/repositories. Contribution by defining contents and and contacting international organisations.
	9.27 CP4NET virtual learning platform (IAEA NKM Moodle based platform)
	9.28 VNMU Virtual Nuclear Management University

CMET Objective 2:	**To develop quality assurance of training aimed at new and experienced professionals in the field of geological disposal.** This is done by developing quality assurance procedures and criteria for the voluntary accreditation of training (and education) for the sector.
Learning Outcomes and Accreditation	
(S)	9.13 Promote the implementation of ECVET approach for mutual recognition of learning outcomes from all types of learning activities and for the preservation of knowledge by identifying the KSC leading to specified units of learning.
(S)	9.11 Select one or more examples using KSC identification for those areas that cover specific competences and capabilities that need to be preserved in the geological disposal community
1. (S)	9.15 Define some professionals' profiles (learning outcomes) for civil engineers, geologists
(S)	9.18 Develop an adaptive accreditation system/ Propose a framework for accreditation and organise related workshops
(S)	9.22 Produce a IAEA TecDoc type document as a tool to preserve (KSC)/competences on the area of geological disposal/repositories. Contribution by defining contents and and contacting international organisations.
	9.29 Potential open database for LO and KSC development (EHRO-N initiative?)
	9.32 European Nuclear Sector Education & Training Council
	9.33 Network of National Certification Bodies

IDENTIFIED AREAS (ACTION PROPOSALS) FOR CMET COOPERATION

Long list from CMET working group member and top ranking

CMET Objective 3:	**To compile the content of training i.e. a type of "curriculum or curricula" for professionals in geological disposal** for pooling joint training efforts or alternatively engaging educators and trainers to address the IGD-TP's RD&D work's education and training (E&T) needs.
Identification of curriculum state of the art and development	
(S)	9.31 Identifying the current state of curricula that have already been developed for geological disposal is required. Mapping their content in relation to the generic stages of repository development identified in the SRA 2011
Learning Outcomes and Accreditation	
1. (S)	9.15 Define some professionals' profiles (learning outcomes) for civil engineers, geologists
(S)	9.22 Produce a TecDoc type document as a tool to preserve (KSC)/competences on the area of geological disposal/repositories. Contribution by defining contents and and contacting international organisations.
Knowledge management and tools	
6. (S)	9.8 Collect/Refresh [community] memory around the RD&D that has been conducted in geological disposal in the past (state-of-the-art "summary") 9.27 CP4NET virtual learning platform (IAEA NKM Moodle based platform) 9.28 VNMU Virtual Nuclear Management University
3. (S)	9.21 E-learning courses (IAEA style) on a specialised topic by an international working group by sharing competences and expertise
Cooperation strategies including sharing infrastructures, exchange of personnel/fellows	
2. (S)	9.9 Use practical training on repository/URL sites or site related work in training (potential Josef, CZ; Grimsel, CH; Bure, FR. Not included in CMET: Tournemire, FR; Mont Terri, CH; Äspö, SE and HADES, BE) 9.30 NUSHARE on safety culture

CMET Objective 4:	**To ensure indirectly the sustainability of providers and the necessary infrastructures/facilities for CMET, and the new personnel and their development in the future.**
Sustainability of training and accreditation scheme/s	
(S)	9.2 Have organizations to send (sufficient) applicants to the training programmes existing and offered; 9.16 Create a financing system to motivate new graduates to participate in professional development training schemes/ apply for accreditation by CMET
(S)	9.17 Create a financing system to motivate the training providers
(S)	9.19 Increase the involvement of employers
5. (S)	9.12 Produce a strategy that is in alignment or aligns with the European Commission's
3. (S)	9.21 E-learning courses (IAEA style) on a specialised topic by an international working group by sharing competences and expertise 9.27 CP4NET virtual learning platform (IAEA NKM Moodle based platform) 9.28 VNMU Virtual Nuclear Management University 9.33 Network of National Certification Bodies

IDENTIFIED AREAS (ACTION PROPOSALS) FOR CMET COOPERATION

Long list from CMET working group member and top ranking

POTENTIAL AREAS FOR TEST CASES BASED ON THE PROPOSALS	
	9.14 A potential pilot case area that all organisations need is procurement capabilities. A test case in the field of outsourcing (especially services like design) starting from criteria and requirements for the different stages of repository development as the starting points
	9.25 Special areas: procurement, requirement definition. Learning via a training workshop
1. (S)	9.15 Define some professionals' profiles (learning outcomes) for civil engineers, geologists
(S)	9.22 Produce an IAEA TecDoc type document as a tool to preserve (KSC)/competences on the area of geological disposal/repositories. Contribution by defining contents and and contacting international organisations.
(S)	9.31 Identifying the current state of curricula that have already been developed for geological disposal is required. Mapping their content in relation to the generic stages of repository development identified in the SRA 2011
Practicalities and impacts/assessment of CMET work	
	9.6 List the deliverables, outcomes of CMET group in the StrAP
	9.7 Include an action to assess the impacts from CMET on IGD-TP members or in IGD-TP resulting from the recommendations and proposals made (by CMET)

Some conclusions:

The areas where a majority of the 13 respondents identified a need for short term actions all relate to Objective no 4: Sustainability of CMET.

Only two responses came from the WMOs and their did not see such a short term urgency as the training providers. The short term urgency actions with at least 4 mentions in the replies are marked with **(S)** on the rank column.

Rating Legend:	
Importance	**Urgency:**
H - High	Urgency: S (short term) within the next 3 years
M - Medium	M (medium term) within the next 8 years
L - Low	L (long term) after 8 year

LIST OF ABBREVIATIONS USED **APPENDIX 5**

A

ANNETTE	Advanced Networking for Nuclear Education and Training and Transfer of Expertise (H2020 project)

B

BELBaR	Bentonite Erosion: effects on the Long term performance of the engineered Barrier and Radionuclide Transport (FP7 Project)
BSS	Basic Safety Standard (Directive

C

CC	Cross-Cutting Activity (IGD-TP SRA)
CEA	Commissariat à l'énergie atomique et aux énergies alternatives
CEDEFOP	European centre for the development of vocational training
CINCH	Cooperation in Education and Training in Nuclear Chemistry
CIRTEN	Consorzio Interuniversitario per la Ricerca Tecnologica Nucleare (CIRTEN, Pisa, Italy
CLP4NET	Cyber Learning Platform for Nuclear Education and Training (IAEA NKM section)
CMET	Competence Maintenance, Education and Training

D

DG	Directorate-General (EC)
DOPAS	Full-scale Demonstration Of Plugs And Seals (FP7 Project)
DoW	Description of Work (EC, FP7)
DP	Deployment Plan (IGD-TP)

E

EAC	Education and Culture (DG EAC)
EC	European Commission
EC-GA	EC Grant agreement
ECTS	European Credit Transfer and accumulation System
ECVET	European Credit system for Vocational Training and Education
EF	Exchange Forum (IGD-TP)
EFTS	European Fission Training Scheme
EHEA	European Higher Education Area
EHRO-N	European Human Resources Observatory for the Nuclear Sector
EG	Executive Group (IGD-TP)
ENEF	European Nuclear Energy Forum
ENELA	European Nuclear Leadership Academy
ENEN	European Nuclear Education Network, Association
ENEN II	Consolidation of European Nuclear Education, Training and Knowledge Management (FP6 project, Euratom)
ENEN III	Training scheme on nuclear engineering (FP7 Project)
ENER	Energy (DG ENER)
ENS	European Nuclear Society
ENSTTI	European Nuclear Safety. Training & Tutoring Institute

	EN3S	European Nuclear Safety and Security School
	EQAVET	European quality assurance in vocational training and education
	EQF	European Qualification Framework
	ESCO	European Skills/Competences, qualifications and Occupations (EC)
	E&T	Education and Training
	ETKM	Education,Training and Knowledge Management
	Euratom	European Atomic Energy Community
F		
	FP7	Seventh Framework Programme (EU and Euratom)
H		
	HRL	Hard Rock Laboratory
	H2020	Horizon 2020 Programme
I		
	IAEA	International Atomic Energy Agency
	IGD-TP	Implementing Geological Disposal of Radioactive Waste Technology Platform
	IGSC	Integration Group for Safety Case (OECD/NEA)
	IET	Institute for Energy and Transport in Petten (JRC, EC)
	ITU	Institute for Transuranium Elements in Karlsruhe (JRC, EC)
	IRCP	International Commission on Radiological Protection
	IRSN	Institut de Radioprotection et Sûreté Nucléaire
	ISCED	International Standard Classification on Education (Unesco)
	ISO	International Organization for Standardization
	IST	Instituto Superior Técnico (TU in Portugal)
J		
	JA	Joint Activity (of IGD-TP)
	JOPRAD	European Joint Programming Project in Radioactive Waste Disposal (H2020 project)
	JRC	Joint Research Center (EC)
K		
	KIC	Knowledge & Innovation Community
	KSC	Knowledge, Skills and Competence (ECVET)
L		
	LO	Learning Outcome (ECVET)
M		
	MOOC	Massive Online Open Courses
	MoU	Memorandum of Understanding

N

NEA	Nuclear Energy Agency (OECD)
NEFW	Division of Nuclear Fuel Cycle and Waste Technology (IAEA)
NFIL	Non-formal and Informal Learning
NKM	Nuclear Knowledge Management
NUSHARE	FP7 Project for sharing & growing nuclear safety culture competence

P

PETRUS	Programme for Education, Training and Research on Underground Storage (network)
PETRUS II	Towards an European training market and professional qualification in Geological Disposal
PETRUS III	Implementing sustainable E&T programmes in the field of Radioactive Wastes Disposal
PIAAC	OECD Survey of Adult Skills

R

RD&D	Research, Development and Demonstration
RK&M	Records, Knowledge and Memory (OECD/NEA initiative)
RTD	Research & Innovation (DG, EC)
RWMC	Radioactive Waste Management Committee (OECD/NEA)

S

SAG	Senior Advisory Group (of EHRO-N)
SCK•CEN	Belgian Nuclear Research Centre
SecIGD2	Secretariat of the Implementing Geological Disposal of Radioactive Waste - Technology Platform - Phase 2 (Euratom FP7 project)
SET-Plan	European Strategic Energy Technology Plan (EC)
SNETP	Sustainable Nuclear Energy Technology Platform
SRA	Strategic Research Agenda (IGD-TP, SNETP)
STEM	Science, Technology, Engineering and Mathematics
StrAP	CMET's Strategy and Action Plan for 2013-2016
SWOT	Strengths, Weaknesses, Opportunities and Threats

T

TC	Technical Committee (ISO)
TEP	Technical Project (IGD-TP)
ToR	Terms of Reference
TU	Technical University

U

URC	Underground Research Center
URF	Underground Research Facility
URL	Underground Research Laboratory

W

WMO	Waste Management Organisation
WP	Work Package

3

3D	Three dimensional