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Report on analysing and benchmarking existing E&T programs

Lead Beneficiary: SCK CEN

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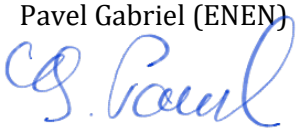
Luyten Jakob (SCK CEN) 	Pesznyák Csilla (BME) 	Pavel Gabriel (ENEN) 

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PU	Public	**x**
RE	Restricted	
SEN	Sensitive	

Version control table

Version number	Date of issue	Author(s)	Brief description of changes made
0.1	04/10/2023	Luyten Jakob (SCK CEN)	First draft
0.2	31/10/2023	Ambrosini Walter, Čerba Štefan, Chantho Creze, Clarijs Tom, Jimenez Javier, Luyten Jakob, Paulo António, Pavel Gabriel, Safa Henri & Stelczer Gábor	Input review data and feedback from QC members
0.3	17/11/2023	Ambrosini Walter, Caruso Gianfranco, Čerba Štefan, Cruz Dario, Deja Kararzyna, Epskamp Kirsten, Eriksen Brian, Ferrucci Barbara, Ionascu Corina, Lo Frano Rosa, Luyten Jakob, Michailidou Eirini, Němec Mojmir, Paiva Isabel, Paulo António, Rossetti Veronica & Safa Henri	Review task partners
1.0	23/11/2023	Pavel Gabriel (ENEN) & Pesznyák Csilla (BME)	Review WP leader& project coordinator

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EXECUTIVE SUMMARY

It is expected that the nuclear sector will grow in the coming years due to new builds, decommissioning projects, advancements in non-power applications, etc. This will result in an increased demand of highly skilled and trained people. It is therefore important to have education and training opportunities complementary to and building on general and academic education.

In this report, education and training opportunities organised by a variety of providers resulting from current and past European projects, sometimes with direct support by the European Commission, are analysed and benchmarked. Academic training, vocational education and training, and other training opportunities that are not organised within the framework of a European project are out of scope of this work. Several data was collected by different means to be able to analyse the existing opportunities and allow the quality committee, consisting of task partners, to review the courses based on the proposed working method. The results are presented in this report but will also be available in the educational HUB developed in this ENEN2plus project. This HUB will be a database for educational courses and many other offers. The analysis of the existing courses was mainly done on practical information such as topic, amount of training hours, modality, etc. The review was done based on eight questions compiled using the IAEA Systematic Approach to Training, the European Qualifications Framework and experience from previous European projects.

The analysis of the data shows that the organisation of courses is well distributed within Europe except for some countries. The distribution over the different nuclear topics in decreasing order is: Nuclear engineering and safety (29%), Waste management and disposal (27%), Radiochemistry (13%), Radiation protection (9%), Decommissioning (8%), Other (7%), Nuclear materials, nuclear fuels and fuel cycle (5%) and Medical applications (2%). Most courses (87%) range from a couple of days to two weeks of training and most nuclear courses are organized face-to-face. Other modalities such as online training, blended learning and e-learning represent each about 5% of the opportunities. Only in 13% of the training courses, the trainees aren't rewarded with a certificate or another form of qualification (micro credential, diploma, etc.).

At this moment, only 19% of the courses presented in this report score positive on all eight quality criteria. If only considering the courses where all requested information was available this numbers increases to 92%.

The above results described only the collected data and should be evaluated in that way. As new training opportunities keep being created, data for older training opportunities is not complete and our list of training opportunities is not exhaustive, it is important to keep analysing and reviewing new data presented in the educational HUB to keep end-users informed.

Besides the work done in this report, also the work done in work package 4 of this ENEN2plus project resulting in D4.1 'Gap analysis of VET offers for the European nuclear domain' is of important value. This work describes the vocational education and training (VET) opportunities. Each part, general & academic education, VET, and educational courses plays its own role in providing skilled and trained people for the nuclear sector in the future.

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INTRODUCTION

In the coming years the workforce in the nuclear sector in Europe will continue to grow, as some European countries like Bulgaria, Czech Republic, France, Hungary, Lithuania, the Netherlands, Poland, Romania, Slovakia, Slovenia, Sweden, the UK and possibly others are investing in the building of new nuclear power plants. In other countries, decommissioning becomes an important industrial topic requiring skilled people. Combined with these two topics also the workforce in nuclear R&D, regulations and non-power applications is expected to grow (1; 2). As nuclear power plants and research reactors, but in general all nuclear facilities, require a highly skilled and trained workforce, educating and training the future employees is essential for the nuclear industry.

Attracting people to nuclear starts at young age by enthusing primary and secondary school pupils for STEM (Science, Technology, Engineering and Mathematics) and familiarising them with nuclear concepts and the advantages and disadvantages of nuclear applications. Before these pupils move on to academic education, they should be made aware that there are job opportunities in the broad nuclear industry and that a broad variety of studies will get them involved. Besides (nuclear) engineering and (nuclear) physics that can lead to a job in nuclear, many other educational backgrounds are useful in the sector. To name a few: chemistry, geology, environmental science, medical physics, computer science, electrical, civil and structure engineering and many others.

Considering that these students will represent the future workforce targeted by the nuclear sector, various education and training institutions, and other interested companies created educational courses on various nuclear topics, sometimes with direct support by the European Commission, especially in past European projects. Most of the relevant projects are funded by the Euratom Research and Training Programme. Older projects are not excluded, but for the work done for this report it is concluded that little to no information is easily available for educational courses older than roughly 10 years.

This report describes the analysing and benchmarking of existing educational courses provided by other European projects related to nuclear science and technology. The methodology of collecting the data will be described first, followed by the results of the analysis. The retrieved data is collected in a way in which it can be a direct input for the HUB developed in work package 2 of this project. This database will be the single point of entry for educational (courses, internships, thesis work), job and other opportunities (e.g. available infrastructure) in the nuclear sector (industry, healthcare, research and governmental) targeting students, from secondary school level up to PhD level, teachers and nuclear professionals. A plan will be put in place to keep this educational HUB up to date and provide a sustainable solution beyond this ENEN2plus project. The development, creation and operation of this HUB will be presented in D2.1 ‘Report on the development and functioning of the HUB’ of this project.

The review of the data is done by a quality committee composed of task partners. The composition is based on the different nuclear topics that were selected in this task. Additional to the data needed for the analysis of the courses, review data is requested at the same time to perform the quality control of the existing courses. Eight questions, presented in Table 2 under the heading ‘benchmarking information’ were compiled based on the IAEA Systematic Approach to Training (SAT), the European Qualifications Framework (EQF) and experience from previous European projects to be able to report on the quality of the courses. A working method is set up to perform the review.

The main focus of this task is to inform the end-user of the HUB of the availability but mostly on the quality of existing courses. This report is intended as a baseline and continuous and iterative review needs to be done during this project and preferably afterwards, as educational courses will continue to be created.

As previously described, the data collected for the analysis part of this task will be directly put in the HUB once it becomes available. The data collected for the review part will also be available in the HUB but in a summarized way.

The European projects on which data on training opportunities is collected are listed in the table below in alphabetical order.

Table 1 Overview of the European projects related to nuclear E&T

European project and platforms			
A-C	**D-H**	**I-P**	**Q-Z**
A-CINCH	DELISA-LTO	INSIDER	REDUPP
ADVANCE	DOPAS	MADEIRA	SAMOFAR
ANNETTE	DoReMi	MATTER	SEAKNOT
ANSELMUS	ELINDER	MEET-CINCH	SITEX-II
ARCHER	ENEEP	MIND	TALISMAN
ASGARD	ENEN	Modern2020	THERAMIN
Beacon	ENEN+	MYRTE	THINS
CAST	ENEN2plus	NECTAR	TRANSAT
CHANCE	EURAD	PEBS	VINCO
CINCH I	EUROTRANS	PETRUS II	
CINCH II	F-Bridge	PIANOFORTE	
CONCERT	FREDMANS	PRISMAP	
CP-ESFR	Gre@t-PIONEeR		

For the ANNETTE project (Advanced Networking for Nuclear Education and Training and Transfer of Expertise), it should be noted that for this report data is collected on almost 20 courses developed or coordinated within the ANNETTE project, which contributed intensely to nuclear education and training for students and professional learners. Although all work packages of the project were relevant to education and training opportunities, the second work package 'design and implementation of coordinated E&T and VET offers' is the most relevant for this work. Besides the courses processed in this work, additional information on the courses compiled and coordinated by ANNETTE can be found in the reports delivered by the project. More information on the work done can be found in D2.1 'Specific needs for an advanced European Programme for CPD in the nuclear areas'. This report can be found on the ANNETTE website (https://www.annette.eu/public-deliverables-available-for-download/). An outcome of this project is the pilot course program. Information on the pilot course program compiled and coordinated by the ANNETTE consortium is still available on the website (https://www.annette.eu/et-opportunities/).

1 METHODOLOGY

1.1 Introduction

A variety of educational courses was created in the framework of several past European projects. Vocational education and training (VET) and academic programs (BSC and MSc programs) are out of scope of this task. However, VET is discussed in work package 4 of this project.

In order to analyse these courses data was collected. Most of the data was collected by one the following methods:

- Through direct data collection via a MS Forms survey that was distributed between the project partners. The survey had no restrictions concerning availability so project partners could share this link freely with others to expand the target group. The survey that is still active until this day can be found via this link: https://forms.office.com/e/X49eFm3Fsb.

- By data collection via the VET template. This Excel file is developed in cooperation with WP4 of this project to optimise and align the data collection for educational courses and courses for professionals. This VET template will also serve as the temporary database until the HUB is fully developed. More information on development and use of this template is available in D4.1 'Gap analysis of VET offer for the European nuclear domain' of this project.

- By data collection via secondary data sources. In this case, data was collected from the information pages of different courses and different projects that were available on the internet or in other databases such as the current and old ENEN database.

- By data collection via national organisations.

With these four methods a total of 171 existing E&T opportunities originating from past European projects were gathered. It should be noted that not all requested information was available in all cases. This is presented further in the text by indicating the number (n) of available data.

The collected data will be available in the VET template on the ENEN2plus project website (https://www.enen2plus.eu/documents) as a temporary database until the HUB is fully developed.

1.2 Analysis and benchmarking data

Based on the work performed in previous projects and on a discussion within this working group a list of data for analysing and benchmarking was compiled (3; 4; 5). The requested data was divided in two major parts. The first part contains data necessary for the analysing of the offers. This data will be available to the public in the HUB which is to be created in task 2.1 'Develop and implement a database to promote existing E&T programmes' of this project. The second part contains the information needed for the review by the quality committee. This data will not be publicly available as such but will be presented as a summary after review by the quality committee.

A summary of the requested data is presented in the Table 2 below. The complete overview of the requested data is presented in ANNEX I 'Survey on existing nuclear E&T opportunities'.

Table 2 Summary of requested data

Data	Sort of data
Database information	
Title of course	Free text field
Nuclear domain	Dropdown list
Provider (organisation)	Free text field
Country	Dropdown list
Language(s)	Multiple choice
Start & end date	Date field
Duration (hours)	Free text field
Frequency	Free text field
Schedule	Dropdown list
Number of participants (min-max)	Free text field
Venue	Free text field
Target audience	Multiple choice
Learning objectives	Free text field
Learning outcomes	Free text field
Modality	Dropdown list
Type of program	Dropdown list
Level of content	Dropdown list
Evaluation	Dropdown list
(inter)national recognition of certificate/diploma	Free text field
Credit points	Free text field
Registration (website)	Free text field
Deadline for application	Free text field
Application requirements	Free text field
Contact person **Contact email** **Contact phone**	Free text field
Benchmarking information	
Are there selection criteria and/or prerequisites for the trainees?	Yes/no question
Are these criteria available for trainees in advance?	Yes/no question
Learning outcomes are expressed in terms of knowledge, skills, and responsibility and autonomy or equivalent?	Yes/no question
The institution provides supporting material?	Yes/no question
How does the training institution officially recognize the achievement of the learning outcomes?	Dropdown list
Does the institution have any QA processes in place regarding E&T?	Yes/no question
How is the training staff in charge qualified according to expertise and didactic/pedagogic experience?	Free text field
How does the institution obtain, process and implement feedback from the trainees?	Free text field

2 ANALYSING OF EXISTING E&T OPPORTUNITIES

In total, information on 171 courses was collected. In the following graphs, the available data is analysed.

The map below shows the number of E&T opportunities that are organised per country.

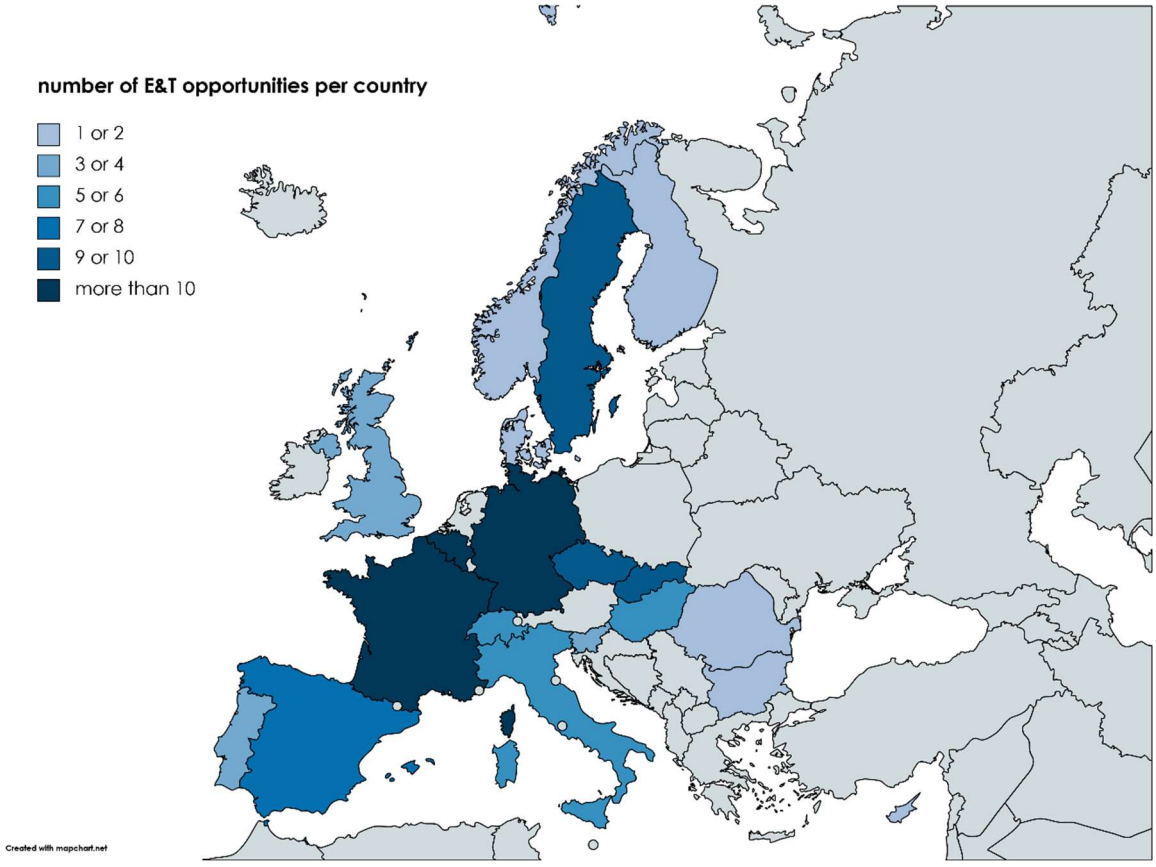

Figure 1 Number of E&T opportunities per country (n = 112), one course organised in Japan isn't visible on this map. 19 courses were only offered online, some courses were organised in different locations and for other older courses no information was readily available and are therefore also not included in this map.

Figure 1 shows that the educational courses organised in previous European projects are well distributed across Europe except for (south) eastern regions. However, it should be noted that this figure only accounts for 65% of the collected offers. Furthermore, this figure does not reflect the effort put in by different European institutions and companies as only the country of the venue of a course is displayed. In various European projects, multiple project partners from multiple countries cooperate in the organisation of courses.

The following graph below displays the distribution of courses between the nuclear domains. The selection of nuclear domains is kept to a limited number of possibilities. The same domains as used for work package 5 'Mobility schemes for nuclear talents' in the mobility manual are chosen with the addition of one extra domain namely decommissioning. The domains are aligned to keep things clear and concise for end-users of the HUB and to make it easier to compare the collected data in this work package with information from work package 5.

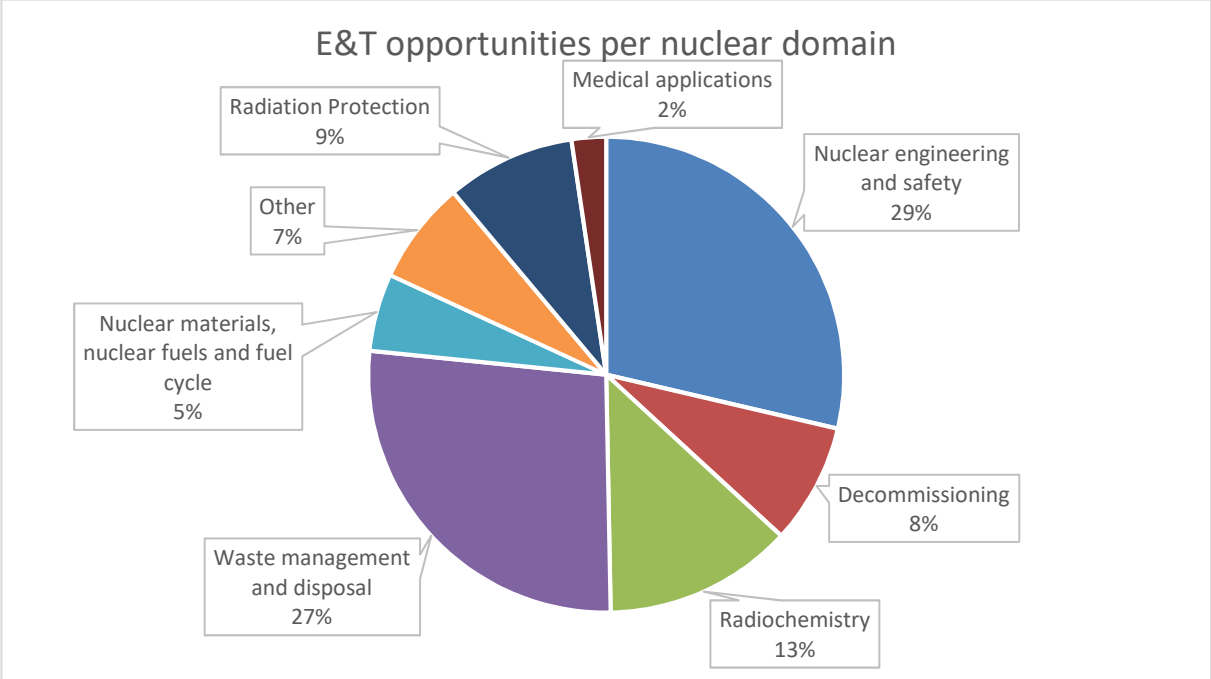

Figure 2 Percentage of E&T opportunities per nuclear domain (n = 171).

Within the collected data, it is clear that both 'Nuclear engineering and safety' and 'Waste management and disposal' are the two topics accounting for half of the courses. 'Decommissioning' and 'Medical applications' together only account for about 10% of courses. This graph supports the statement of the description of work of this project where a shortage of training offers regarding new and innovative nuclear topics such as decommissioning, space research, medical applications, food, and environmental applications is mentioned. The 'Other' category with 7% accounts for training courses with topics such as, space research, radioecology, tritium management as well as introductory courses containing a variety of nuclear domains.

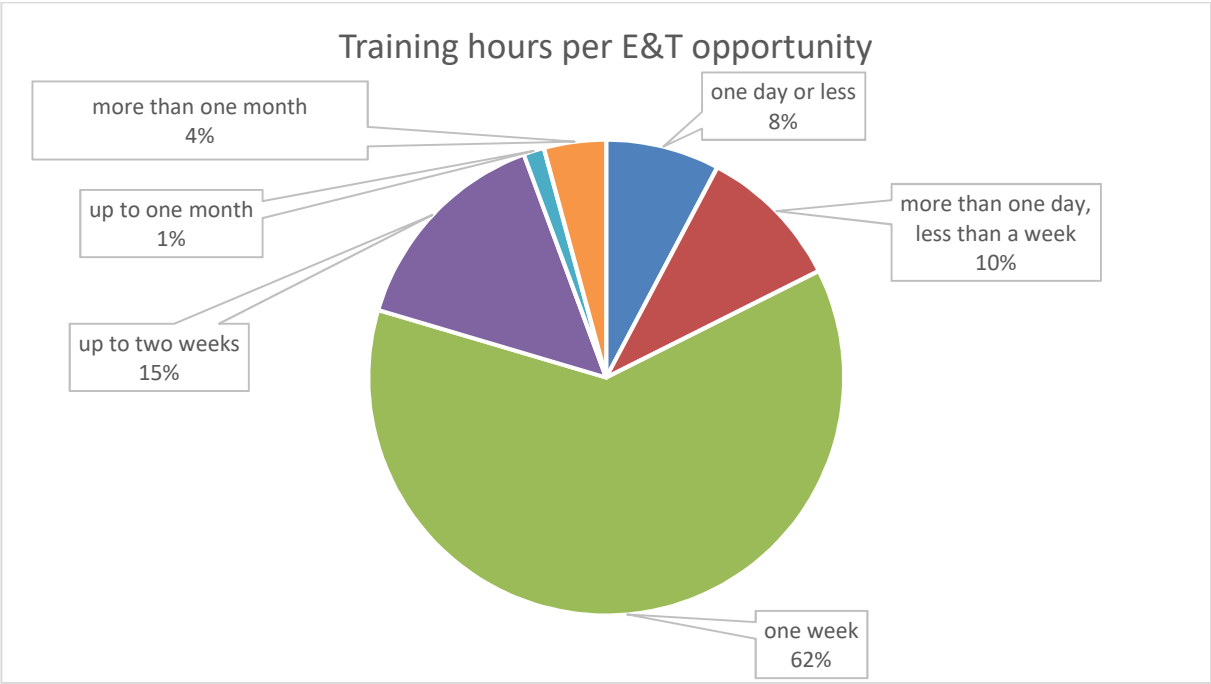

Figure 3 Training hours per course (n = 142).

Figure 3 above shows the approximate number of training hours that go into a training course. More than half of the collected training courses have a duration of one week. With 15% of the training courses lasting up to two weeks, almost 77% of all courses are one- or two-week courses. The training courses 'one day or less' are mostly e-learning modules or online webinars.

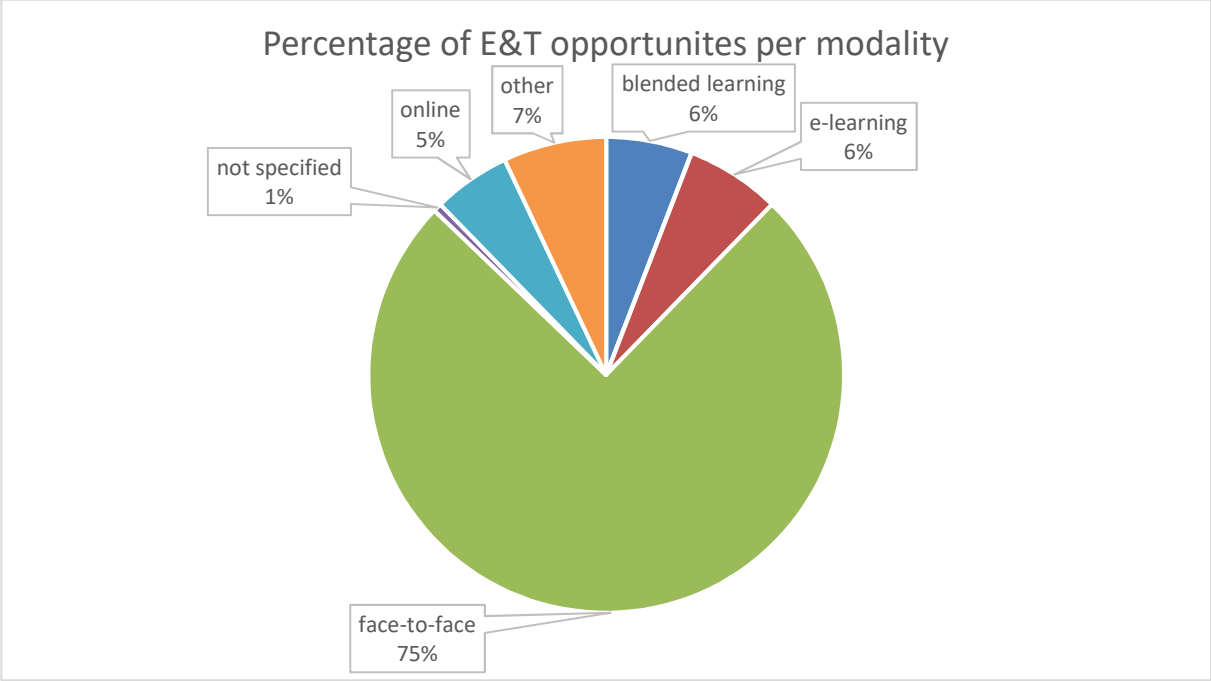

Figure 4 Modality of the different training courses (n = 171).

Figure 4 shows the modalities for the different training courses. It is clear that 75% of courses is organised face-to-face. Other modalities such as e-learning (online self-paced learning), online (online live training), blended-learning (combination of some online form and face-to-face) are also available. In the 'other' category, there are mostly courses which are organised in a hybrid way whether or not with some self-paced training as a preparation.

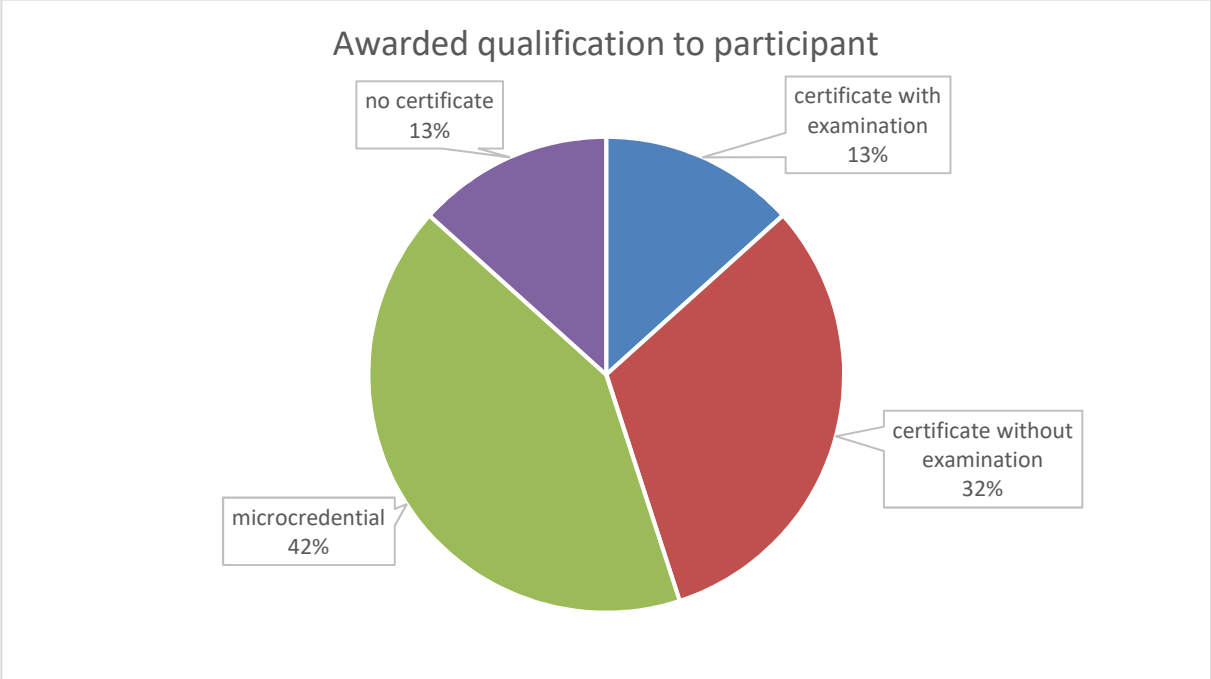

Figure 5 Awarded qualification of training courses (n = 60)

The available data on the qualification awarded for training courses is scarce. Information is available for only about 35% of all gathered training courses. This conclusion is presented in Figure 5 above. About half of the training courses provide a certificate with or without an examination. Only a few training courses are awarded with micro credentials which are mostly ECTS points. On average 3.4 ECTS points are awarded for a course. The range is between 2 and 10, with 3 as the mode.

Most courses (98%) are organised in English (n = 171) and are on graduate and post graduate level, equal to EQF levels 7 (MSc) and 8 (PhD) (n = 64). Only a few courses are on bachelor (EQF 6) or high school level (EQF 3-4). This is also reflected in the type of program, as approximately 90% are classified as a specialisation courses (n = 112).

3 REVIEW OF EXISTING E&T OPPORTUNITIES

3.1 Introduction

The existing E&T opportunities will be reviewed to inform end-users of the ENEN2plus HUB about the quality of the courses. A first review on the currently collected data was done as input for this report. Additional reviews will be performed once the HUB is active, and more courses are collected in this database.

Both the Systematic Approach to Training (SAT) described by the IAEA and the European Qualification Framework (EQF) serve as a source for this review (3; 6; 7; 8). As the end-user is the focal point of the outcome of this review, the selected review questions should provide data relevant to this end-user.

In short, the SAT consists out of five phases namely analysis (A), design (D), development (D), implementation (I) and evaluation (E) (3; 6; 8). Within each of these phases information relevant for the end-user is collected or determined when organising a course.

During the analysis and design phase, the target audience and the pre-requisites of the course are determined (3; 8). This information is necessary to design an effective and suitable training from the course provider side, but it is also important for the end-user in finding appropriate and relevant courses. Therefore, the presence of prerequisites/selection criteria and the availability of these prerequisites to end-users in advance are the first two quality criteria used in this review (see Table 4 below or Annex I).

In the design phase, also the learning outcomes are established (3). Together with the prerequisites, this information is crucial for the end-user in deciding whether a course is relevant and able to improve the knowledge, skills, and responsibility and autonomy of the learner. The availability of the learning outcomes expressed in terms of knowledge, skills, and responsibility and autonomy, is the third review question. The IAEA recommends the expression of learning outcomes in terms of knowledge, skills and attitudes (8). For the purpose of this work, both the EC recommendation and the IAEA recommendation are considered equivalent.

In an effective training course, a learner should be actively involved and ideally, differentiation based on the learner's background should be possible. Therefore, the availability of supporting material is requested. Supporting material are materials (slides, reference work, audio-visual materials a.o.) that help learners to achieve the learning outcomes of the course. Another aspect for an effective training is the qualification of the trainers. Trainers (teacher, professor, educator from industry, …) should be qualified both on the technical aspect and on the didactic/pedagogic aspect (3; 8). A trainer should be an expert who is specialised in the content of the course but is also familiar with the context of this content (8). Additionally, a trainer should be able to transfer the course content in a proper way, such as adapted to the course level, the training methodology, the audience and be able to manage the class group. Both the availability of supporting material and the qualification of the trainers are reviewed.

The last phase described in the SAT is the evaluation phase (8). Collecting feedback is a first step on improving a training course. More important is to discuss the provided feedback and implement changes in future or other training courses. The Kirkpatrick evaluation model is commonly used for evaluating training programs. This model consists out of four levels. Each level corresponds to a different subject that relates to the delivered training. The first level covers the reaction of the participants to the training. In most cases, this

evaluation is done with a survey. It is necessary to evaluate at least on Kirkpatrick level 1 to measure how the trainee experienced the training course. An evaluation on Kirkpatrick level 1 surveys the reaction of a participant to several aspects of the course for example the training material, the trainer, and the practical organisation.

The second level is the assessment of the participants where the improvement in terms of knowledge, skills and attitudes is checked. This can be done by a knowledge test such as an exam, a practical test or a combination of both. An evaluation on Kirkpatrick level 2 is advisable, as it should show how the training course actually improved the trainees' knowledge, skills, responsibilities and attitudes. In other words, an evaluation on Kirkpatrick level 2 polls whether the learning outcomes of the course are met by the participants and how well they have performed. This can be done informally by trainers at the end of a module or formally by an exam. Based on this information the last two review questions were determined.

The third and fourth level of the Kirkpatrick model are evaluating the desired change in behaviour of the participants after following the course and the impact of the training course with regard to the learning objectives of the course.

3.2 Quality committee and working method

In order to process the review data, a quality committee is established. This quality committee will periodically review the available data. The current proposal is to review additional data twice a year to keep the HUB up to date. Based on the amount of incoming training offers in the HUB, this periodicity can be altered in order to keep the HUB up to date and perform the review work efficiently.

The quality committee members were selected during a task meeting. The following people are involved on the following topics.

Table 3 Composition of the quality committee

Nuclear topic	Committee Members
Nuclear engineering and safety	Walter Ambrosini (UNIPI, CIRTEN)
Waste management and geological disposal & Decommissioning	Chantho Creze (WEF)
Radiation protection	Tom Clarijs (SCK CEN) & Jakob Luyten (QC secretary, SCK CEN)
Medical applications	Gábor Stelczer (BME)
Radio chemistry	António Paulo (IST)
Nuclear materials, nuclear fuels and fuel cycle	Henri Safa (CEA)
Other nuclear topics (i.e., safeguards)	Gabriel Pavel (ENEN)
Link with work package 4 (VET)	Štefan Čerba (STU)

As described in Chapter 'Methodology' eight questions were in the survey to gain information on the quality of the courses.

Six of these questions are directly answered by the provider when gathering data (yes/no question or dropdown list). The other two questions need to be reviewed by the members of the quality committee. To keep things straightforward and clear for the end-users of the HUB the review of the two open questions is limited to three categories namely a checkbox if the answer to the related question proves to be in alignment with a course of good quality,

a X symbol if the answer is not aligned and a question mark in case the requested information is not available.

Initially, the collected data was gathered and divided in the different nuclear topics by the quality committee secretary. Each of the quality committee representatives got distributed the courses of its own expertise. The review was done offline, and the data was brought back together in one file by the quality committee secretary. The collected data provided by the review of the quality committee is then processed and will be made public via this report and will be in the HUB once it will be available. A similar process will be carried out for the following reviews. The main difference with the first review, presented in this report, will be that in the next ones the information should mainly come from data provided by course organisers through the HUB.

The current review results in the following conclusion. 46 courses were excluded from the review as too little to no information was available. The result is presented in Table 4.

Table 4 Quality criteria used for review of existing E&T opportunities and the results of the initial review.

n = 125	√	X	?
Are there selection criteria and/or prerequisites for the trainees?	74%	18%	8%
Are these criteria available for trainees in advance?	89%	3%	8%
Learning outcomes are expressed in terms of knowledge, skills, and responsibility and autonomy or equivalent?	22%	70%	8%
The institution provides supporting material?	40%	-	60%
How does the training institution officially recognize the achievement of the learning outcomes?	See Figure 5		
Does the institution have any QA processes in place regarding E&T?	25%	-	75%
How is the training staff in charge qualified according to expertise and didactic/pedagogic experience?	36%	-	64%
How does the institution obtain, process, and implement feedback from the trainees?	28%	-	72%

The current round of reviewed data (n = 125) shows that in 74% of training cases there are selection criteria and/or pre-requisites available for trainees and that in 89% of these cases these criteria are available in advance. In 22% of training cases, the learning outcomes are expressed in terms of knowledge, skills, and responsibility and autonomy or an equivalent system. However, for most training courses the learning objectives and/or learning outcomes are available but not described in detail. For 40% of all training courses supporting material is certainly available. Only 25% of training courses appears to have QA processes behind it to obtain, process and implement feedback. In about 36% of all training courses, the training staff is qualified according to didactic experience and expertise. It should however be noted that for these three criteria a low number of data was available, as indicated in the table. This is further discussed in the next chapter.

Only 24 of the courses score positive on all eight questions which corresponds to 19%.

4 CONCLUSIONS AND RECOMMENDATIONS

The analysis of the data shows that the organisation of courses is well distributed within Europe. For Ireland, The Netherlands, Poland, Estonia, Latvia, Greece, Croatia, Austria, Luxemburg and Lithuania no courses were collected. This does not necessarily reflect an absence of training opportunities in those countries as this report only considers educational opportunities provided by European funded projects. Academic Bachelor and Master programs as well as vocational training and other training opportunities might exist in those countries. VET offers are discussed in D4.1 'Gap analysis of VET offers for the European nuclear domain' resulting from this project.

The distribution over the different nuclear topics in decreasing order is: 'Nuclear engineering and safety' (29%), 'Waste management and disposal' (27%), 'Radiochemistry' (13%), 'Radiation protection' (9%), 'Decommissioning' (8%), 'Other' (7%), 'Nuclear materials, nuclear fuels and fuel cycle' (5%) and 'Medical applications' (2%).

87% of all registered courses are ranging from a couple of days to two weeks of training. 8% are training courses of only a few hours until one day.

Most of the nuclear educational courses are organized face-to-face. Other modalities (online, blended learning & e-learning) represent each about 5% of the opportunities.

Only in 13% of the training courses (n = 60) the trainees are not rewarded with a certificate or another form of qualification (micro credential, diploma, etc.).

As stated before, the analysis of the data can only discuss the collected data in this project. It is without doubt that other courses were organized within European projects that are not represented in this report. On the other hand, the details for training opportunities older than about 10 years presented in this work were not only hard to find but also not always complete.

It is therefore of paramount importance to keep collecting information on nuclear education and training courses both from the past and the present. In this view, collaboration between past and present project partners is crucial and the development of the HUB is necessary. The HUB, intended to be the single point of entry, could provide a lot of useful information to continue this analysing and reviewing task.

A quality committee has been established containing at least one responsible for each of the nuclear topics considered. The quality committee will review the available data from the HUB periodically. The initial proposal is to have a continuous collection of data in the HUB and process and review this available data twice a year to distribute the workload but still keep the reviewed data up to date for the end-users. This periodicity can be altered by the quality committee in function of the available data.

The current reviewed data shows that only 19% of courses score positive on all eight quality criteria. It should be noted that this number should be considered a rough estimate as not always all review information was available. It is most likely that more courses score positive on all eight or even most quality criteria in practice (For example: for the opportunities where all information was available, 92% scored positive on all eight criteria). This – again - stresses the importance of collecting further data through the HUB and continuing the review process.

As reported within task 1.2 'HR needs of research centres, waste management and safety operators' of this project, it is estimated that the workforce in the nuclear sector (R&D, regulation, decommissioning and waste management) in the EU including the UK is around 52.000 direct jobs with a need for 30.000 direct jobs to compensate for retirements alone

by 2036 (1). This does not consider indirect jobs, and jobs in the nuclear industry and non-power applications. (1) The total amount of jobs in the nuclear sector is expected to grow due to commissioning of new reactors, decommissioning of old facilities, the use nuclear technology in various applications such as medical, food and space to name a few.

More information on these domains will be available in D1.1 'Report on HR needs of the European nuclear industry' and D4.1 'Gap analysis of VET offers for the European nuclear domain' resulting from this project.

It is therefore clear that many new talents are needed in this sector. A first hurdle to take in finding these talents is attracting them to a technical and/or academic degree that can lead to the nuclear sector. In a second instance, it is also necessary to further educate both students and professionals in their respective fields to ensure a highly competent staff. For students this is done with the education and training opportunities described in this report. For professionals this topic is handled in work package 4 of this project. Although some overlap in activities is expected. Besides classic education (secondary and academic education), educational courses and vocational education apprenticeships on the shop floor could be considered a way of training.

For both nuclear engineering, decommissioning and waste management there are a lot of existing courses available in the data, although this number doesn't necessarily reflect the current offer on available training. It signifies that a lot of knowledge is present in Europe and was shared within European projects or can be shared with further students and professionals. Furthermore, it should be noted that there is no direct link between the described disciplines and the type of education needed for the jobs included in those disciplines. Training opportunities on academic level, E&T courses and vocational training (VET) remain relevant.

For medical applications, the reported data shows the opposite. Only 2% of the gathered data is described as courses in medical applications. This shows that there is either a shortage of training offers in this field or that these training offers are difficult to find or that training was not offered in one of the projects investigated within the scope of this deliverable but is rather covered by VET courses considered in WP4. It is recommended to present the HUB to the organizations involved in the medical field such as EFOMP, ESR, EANM, ESTRO and others to achieve more data on medical application training courses that were (and will be) provided but might not have been organized in the framework of EC projects.

For radiation protection, a higher percentage compared to medical applications of training offers is available in this dataset. In reality, radiation protection as a topic is also a part of some training offers in the 'Other' category and most likely partially covered in other courses in other categories. The same recommendation as for medical applications could be interesting to have a clearer view on the radiation protection educational courses.

'Nuclear materials, nuclear fuels and fuel cycle' is a clear missing gap in our portfolio, even though this is a domain of the utmost importance for operation and maintenance of nuclear installations, as has been painfully demonstrated recently by undesired and forced shutdowns on European reactors. One strong recommendation is therefore to better identify and widely open the number of trainings in that highly technical and specific issue. That will even be more and more required in the near future given the fact that our reactors are ageing, the present European nuclear power plants being over 36 years old on average.

The topic of (nuclear) physics is not a separate nuclear domain selected in this survey therefore it is not possible to draw any conclusion on this topic.

Regarding space applications and environmental applications it is stated that these applications are rather niche applications (2). Although the need for further education and training beyond academia is expressed, it is proposed as specialised postgraduate studies or research exchanges with appropriate institutes (2). The combination of limited workforce and the need for academic and vocational training can explain the lack of educational courses avaible for students.

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ANNEX I SURVEY ON EXISTING NUCLEAR E&T OPPORTUNITIES

1. Database information

Title of course		
Nuclear domain	Choose an item.	If other specify:
Provider (organisation)		
Country	Choose an item.	If other specify:
Language(s)	Choose an item.	Choose an item.
Start & end date	Click or tap to enter a date.	Click or tap to enter a date.
Duration (hours)		
Frequency		
Schedule	Choose an item.	
Number of participants (min-max)		
Venue		
Target audience*	☐ Students ☐ Scientists and Researchers ☐ Engineers ☐ Regulators ☐ Trainers ☐ Teachers ☐ Managers ☐ Support staff ☐ Technicians ☐ Other, specify	
Learning objectives		
Learning outcomes		
Modality	Choose an item.	If other specify:
Type of program	Choose an item.	If other specify:
Level of content	Choose an item.	If other specify:
Evaluation	Choose an item.	If other specify:

(inter)national recognition of certificate/diploma	
Credit points**	
Registration (website)	
Deadline for application	Click or tap to enter a date.
Application requirements	
Contact person	
Contact email	
Contact phone	

*

Students	People studying at a university or other place of higher education.
Scientists & Researchers	People trained and expert in one or more areas of science, and performs experiments to conduct research in a scientific manner.
Engineers	People responsible for designing, developing and maintaining products and services.
Regulators	People working for organisations responsible for the control of specific activities or industries.
Trainers	People responsible for training of others in or for an organisation.
Teachers	People responsible for education in schools.
Managers	People responsible for an organization or for a group of staff.
Support staff	People who work to support the main activities of an organisation but are not directly involved in these activities.
Technicians	People employed to look after technical equipment or do practical work in a laboratory.

****more info on ECTS: https://education.ec.europa.eu/education-levels/higher-education/inclusive-and-connected-higher-education/european-credit-transfer-and-accumulation-system.**

2. Benchmarking information

Admission policy		
Are there selection criteria and/or prerequisites for the trainees?	Choose an item.	
Are these criteria available for trainees in advance?	Choose an item.	
Learning outcomes		
Learning outcomes are expressed in terms of knowledge, skills, and responsibility and autonomy or equivalent?	Choose an item.	If other specify:
Supporting material		
The institution provides supporting material?	Choose an item.	If other specify:
Personal transcripts		
How does the training institution officially recognize the achievement of the learning outcomes?	Choose an item.	If other specify:
Quality Assurance		
Does the institution have any QA processes in place regarding E&T?	Choose an item.	If other specify:
How is the training staff in charge qualified according to expertise and didactic/pedagogic experience?		
How does the institution obtain, process and implement feedback from the trainees?		