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Distance learning courses in engineering in the EU-27

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Introduction and Background

The European Human Resources Observatory in the Nuclear Energy Sector (EHRO-N)[1] provides the European Commission with data regarding the situation of supply and demand of human resources in the nuclear energy field in Europe. A report titled "Mapping of Nuclear Education Possibilities and Nuclear Stakeholders in the EU-27"[2] describing the situation of both supply and demand has been published and is available at the EHRO-N website.

On the supply side, the Observatory monitors the availability of courses in nuclear and nuclear-related fields offered by Universities across the EU-27, but focuses only on traditional classroom teaching methods and does not include on-line and distance learning courses.

In this regard the present report has the aim of complementing the EHRO-N report by presenting a snapshot of the offer of eLearning courses in nuclear and nuclear-related fields across the EU-27.

On-line and distance learning courses, by their own nature, can be tailored to address very specific study cases. It is not uncommon to find courses that have a very short duration (of one or two weeks) and that cover only very specific topics or sub-sets of more comprehensive courses. As a consequence the true value of this report lies in the list of providers of on-line courses more than in the list of specific courses in itself, as the latter changes weekly.

The data presented in Annex 1 is a snapshot of the situation on the 15th of April 2013. A short version of the list, indicating the name of the course and the University offering it, can be found on page 17.

1 http://ehron.jrc.ec.europa.eu/

2 "Mapping of Nuclear Education Possibilities and Nuclear Stakeholders in the EU-27" http://ehron.jrc.ec.europa.eu/ehron/sites/ehron/files/documents/public/ehro-n_reports/mapping_nuclear_stakeholdersonline_2.pdf

It was initially decided that the investigation should have been limited to strictly report the courses programmed by the various Universities in the field of Nuclear Engineering, i.e. for the preparation of professionals with specific knowledge of the nuclear process. Subsequently, the scope of the project was broadened on the assumption that the nuclear activity in its complexity should be considered for inclusion, in all phases from project layout, construction, operation, decommissioning and safety aspects.

As a consequence, the search was expanded to include courses in the domain of Civil Engineering, Mechanical Engineering, Electric and Electronic Engineering, Software Engineering and Physics Engineering.

Why eLearning?

In the context of a comprehensive education path, eLearning can be a valid support tool to complement traditional classroom learning. Even though it cannot completely substitute traditional classroom learning, it can be useful in many cases. For example, for trainings on specific subjects, for complementary activities related to a classroom subject, and in general in every case where the simultaneous physical presence of students and teachers is not essential for a correct learning process.

Methodology

When dealing with a large and distributed population of potential data providers such as universities and training centers, the data collection methods that can be employed are essentially either top-down, bottom-up or a combination of the two.

In the top-down approach the data is collected by means of surveys, Internet searches, requests for information sent by email, fax, etc. The performers of the data collection must actively search and obtain the required information. This approach is usually employed at the beginning of a data collection effort to build

an initial database. After this startup phase, the data can be kept up to date by using the same approach, i.e. by periodically polling the data providers for the availability of any new or updated information, or by gradually shifting to a bottom-up approach.

A bottom-up approach can be employed once the project has gained enough momentum and the data providers see the value in spontaneously providing the data. In this case the data providers will actively send new and updated information as it becomes available.

For the purpose of this survey, a top-down approach was employed.

The first step was to go through the list of universities available on the EHRO-N website to verify whether they had scheduled Nuclear Engineering and the related courses indicated above and, if so, whether a possibility of distance learning was contemplated.

In a parallel approach each university website was searched for the existence of any eLearning platform, and in case such platform existed, for the courses offered which matched the requirements.

In some cases, inquiries according to these methods were unsuccessful, either because information was missing from the sites, or due to language difficulty. In those instances, data were requested by e-mail.

Several of the courses within the scope of our search were found not directly from the Universities concerned, but through web sites such as UNED[3] and Studyportals[4], specialized in collecting this type of information as a service to the prospective students and to Universities.

Furthermore, other courses were found through simple Google searches.

3 http://portal.uned.es/
4 http://www.studyportals.eu/

Analysis of the different types of eLearning

eLearning is a term that describes every situation in which the knowledge is transferred from the teachers to the students through the use of electronic means.

A primitive form of what we know today as eLearning probably started with the use, in schools and Universities, of projectors and slides to help instructors and teachers. Subsequently, with the appearance of affordable portable storing devices, the teaching material could be distributed in floppy discs, CD-ROMS and zip drives. At that stage eLearning was nothing more than a new way of distributing teaching material, but it did not assist in any way in the interaction between students and teachers.

With the diffusion of the Internet and modern server-side technologies, eLearning as it is known today started gaining wider adoption. In fact, today's technology allows a variety of systems for eLearning. From simple TV courses with lectures given at scheduled times by the teacher aided in the presentation by diagrams, tables and slides with no direct interaction with the students, to the computer method, which offers the student a richer program of tools, thus making the study more satisfying: here too, the direct interaction teacher-student is missing.

A step ahead is the Internet method, where teaching material is availed of on the university site and reached by way of a web browser.

All methods commented above allow only individual learning, excluding the benefits that could derive from a collective (class) learning. They are all asynchronous methods, since the students learn in their own time and at their own pace, while a collective method implies that the program be run with all students in attendance at a given time: that is called synchronous method.

In the collective method, the teacher streams through the Internet the lecture, to students in different locations, if necessary with audiovisual materials.

Figure 1 shows a more detailed view of the available types of eLearning.

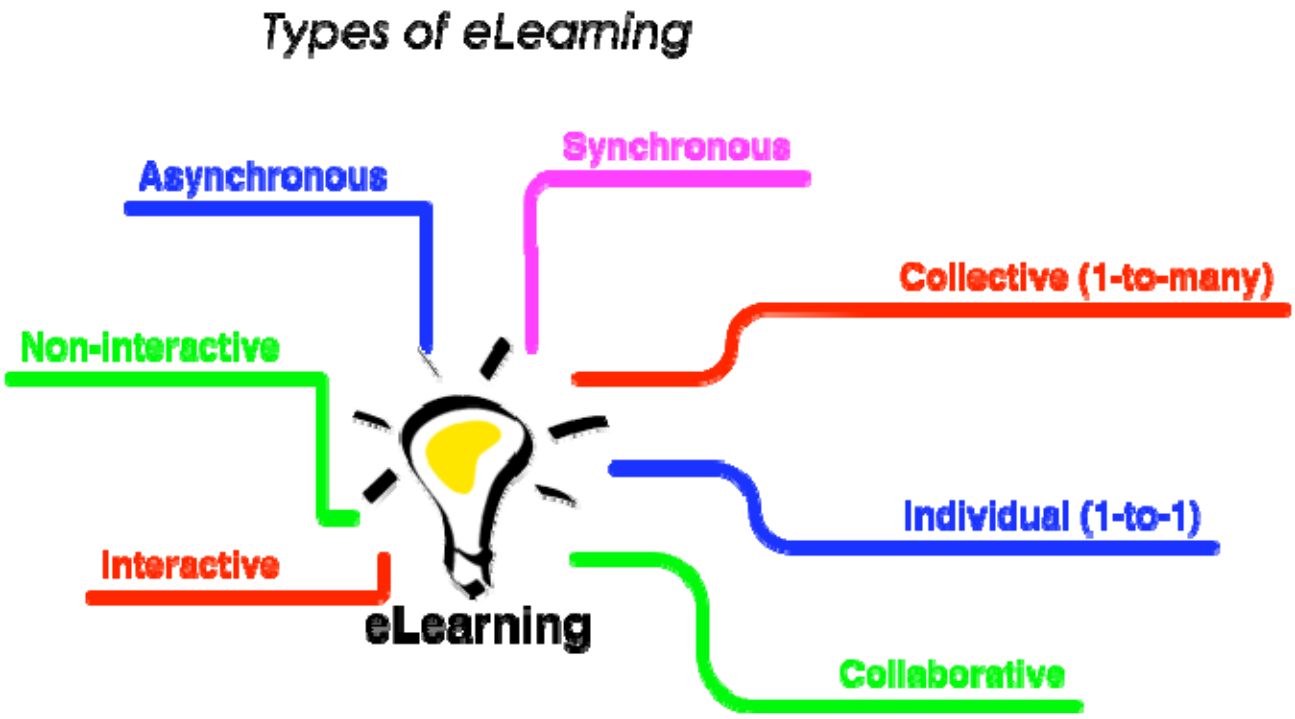

Figure 1: Types of eLearning

What follows is a simple explanation of the types of eLearning mentioned in Figure 1.

Asynchronous

In this type of eLearning the teacher and the students do not have to be present at the same time. The use of persistent hosting facilities such as websites for the contents of the course enable the students to access the contents at their own pace and leave requests for help or clarifications to the teacher on the same site. The teacher will access the site at a different time and respond to the requests. In this case both the questions and the answers remain available on the website for other students to see. This helps lowering the workload for the teachers, in that they usually do not have to answer the same questions more than once.

The website might eventually evolve into a knowledge base, where the need for teacher intervention slowly diminishes with time.

Examples: online forums, blogs with comment sections.

Synchronous

Here the teacher and the students are present at the same time. This resembles closely classic teaching methods such as offline classroom teaching and one-to-one lessons, the main difference being that the students and the teacher might be communicating at a distance.

Examples: web conferences, video chat, text-based chat, virtual classrooms.

Interactive

Interactive eLearning happens when there is a two-way communication between the teacher and the students. The students can ask questions or clarifications and the teacher has the possibility to answer. This communication can take place synchronously or asynchronously.

Examples: virtual classrooms, video chat, text-based chat.

Non-interactive

In this case the communication happens only from the teacher to the students, and there is no possibility for the students to speak directly with the teacher. This method is asynchronous only, but can be individual or collective (see below).

Examples: webinars, streaming.

Individual (1-to-1)

In this case there is only one student per teacher. This kind of eLearning can be synchronous or asynchronous, interactive or non-interactive.

Examples: video chat, text-based chat.

Collective (1-to-many)

In this case there is one teacher for more than one student. This kind of eLearning can be synchronous or asynchronous, interactive or non-interactive.

Examples: webinars, streaming, virtual classrooms.

Collaborative

This kind of eLearning focuses on the interaction between students. The main strength of this approach is that it promotes discussion among students and allows a more in-depth comprehension of the topics being studied, while diminishing the role of the teachers.

Sometimes communities evolve around particular topics where the teacher's role is diluted to the point where the teacher becomes just another member of the community, albeit a knowledgeable one.

The output of a community-based eLearning system is usually persistent, and might be consulted also by people that are not members of that community.

Collaborative eLearning can be synchronous or asynchronous, interactive or non-interactive.

Examples: online discussion forums, wikis, FAQ (Frequently Asked Questions) sections.

Figure 2 shows the connections between available tools and types of eLearning.

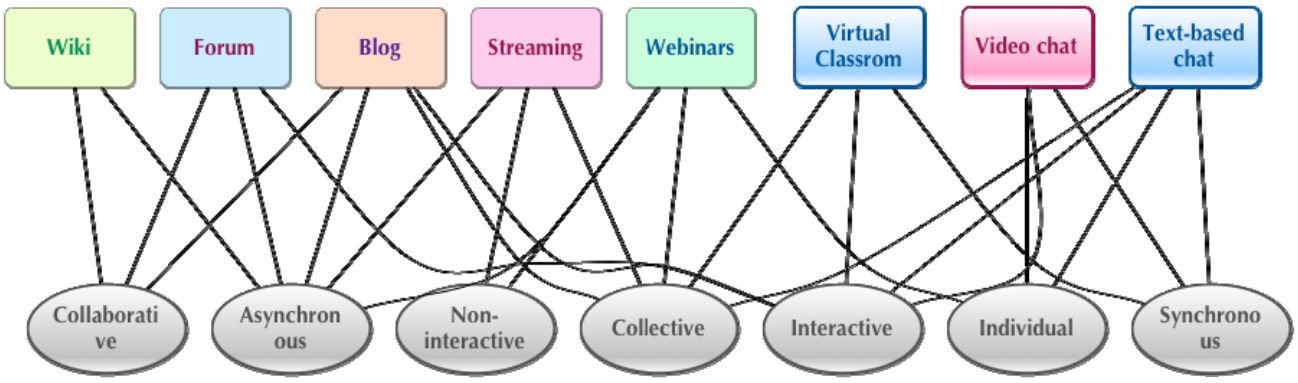

Figure 2: Connections between tools and types of eLearning

When only a part of a course is given by electronic means, while the rest is taught through more traditional offline methods, the course is defined as ***blended***.

Advantages of eLearning

The following is a short list of the main advantages of eLearning:

- It can be an important support to the traditional teaching method, with the availability of technological means to enhance and broaden outreach.
- Once implemented, eLearning could have a positive impact on the economics of the education system, both from the point of view of direct cost of teaching as well as for the additional student population that can be reached through it, with limited need of expanded campus facilities. Additionally, a part of the program material is recorded and therefore can be re-used, provided that the validity of the content is still relevant.
- Accessibility to higher education for a large number of people otherwise impeded for reasons such as physical distance from education centers, limited financial capacity or time restrictions.

The following considerations can be made in relation to the types of eLearning most popular in European universities:

- Of all universities contacted, those that have yet to start eLearning programs are all in the process of doing so, at various stages of advancement.

- Faculties of humanistic nature are generally more advanced into the implementation of eLearning than the scientific ones. This may depend from the different complexity of program preparation.

- In many cases, the organization of the eLearning lectures is left to the responsibility of the teacher, while in other instances audiovisual material for the programs is prepared by a centralized team, specially skilled in providing technical support to different types of courses. This appears to be advantageous both in terms of technical quality of the material package, as well as for giving the teacher more time for the preparation of the actual core work.

- eLearning implemented in the non-scientific area was normally found to be a fully distance learning, in which the whole course of study is offered online and the students need to be at the University physical location only to be submitted to interim or final examination. For the scientific courses, however, cases of full eLearning resulted quite limited. The majority of courses were of the hybrid or blended type, in which a part – in some cases a substantial part – of the course has to be studied at the university premises, where labs, models, experimental plants etc. are available.

- To successfully implement an eLearning system, a solid and flexible software platform is needed. On the market there are different types of them, some more suitable than others for different types of use. An eLearning system well geared for a big multinational company may not fulfill the requirements of a university language faculty, or vice-versa.

eLearning Platforms

An eLearning platform is a software tool designed to facilitate the deployment of an eLearning system.

There are many different platforms available on the market, each one designed to cater to a different user case. All the platforms have some elements in common, such as the fact that they are web-based and customizable to various extents.

The two most popular platforms utilized in Europe are Moodle[5] and Blackboard[6], with Moodle being a very clear first choice.

Moodle

Moodle is open source and free of cost. It is a PHP application developed on a LAMP (Linux, Apache, MySQL, PHP) stack and designed to run on any modern operating system. The most common choices for the deployment of a Moodle system are Linux, Windows and Mac OSX, even though Linux is recommended.

Moodle is not a hosted solution, meaning that universities have to download the Moodle software package from the Moodle website and install it on their own servers. It is customizable and comes with many eLearning tools out of the box (discussion forums, course management, wikis, grading systems, etc.).

Both commercial and community support is available for the Moodle platform.

Blackboard

Blackboard is a commercial, closed-source solution and it is not available for download. It offers its services as a hosted solution, meaning that the company rents a blackboard "instance" on their servers for their clients.

It is a professional tool that offers many options out of the box and is fairly customizable. Commercial support is available.

5 https://moodle.org/
6 http://www.blackboard.com/

It appears that most universities have preferred Moodle to the competition due to reduced costs and increased flexibility, added to the fact that relying on an open-source product avoids the risk of vendor lock-in and forced upgrade paths. Furthermore, Moodle gives more possibilities of adapting it to different user needs.

Recommendations

The present situation of eLearning in Europe is very fragmented and not at the same level as the offerings in other developed areas of the world. European universities and training centers treat eLearning as a second-class citizen, and it seems that there are still some cultural barriers to overcome before it can become mainstream. Most of the universities that offer eLearning courses do not make an effort to publicize the fact on their websites, and sometimes do not mention their availability at all.

While all the universities claimed they are in the process of starting the offering of eLearning courses, the ones that presently do are very few and the offerings are quite sparse. This is especially true for technical and nuclear-related faculties.

There are some interesting initiatives that seem to indicate a shift in the right direction, such as the launch of the first pan-European university MOOCs (Massive Open Online Courses)[7] by the European Commission, and the Lifelong Learning Programme[8] (formerly known as SOCRATES), also by the European Commission.

To give eLearning more visibility in the European scene, it would need clearer quality assurance mechanisms and increased comparability with courses, both online and offline, offered by other universities and in other European countries. eLearning in Europe would gain greater visibility if it were fully integrated in the Bologna process.

7 http://ec.europa.eu/education/news/20130423_en.htm
8 http://ec.europa.eu/education/lifelong-learning-programme/doc78_en.htm

List of Courses

The following is a list of eLearning courses offered in the EU-27 as of the 15th of April 2013. For a complete list, with links to the courses and other detailed information, please refer to Annex 1.

The Course Name column refers to the name of the course as listed on the website of the entity offering it.

In addition to the courses specified in the following list, there exist a rich selection of online courses and literature in the Euratom Fission Training Schemes (EFTS) initiative. For a complete description of the initiative and more information on the courses, refer to the following link:

http://www.enen-assoc.org/en/training/for-nuclear-community/efts-fp7.html

Annex 1

Country	University Name	Course Name
Austria	University of Applied Sciences Technikum Wien	Bsc Electronics and Business (BSc)
Czech Republic	Czech Technical University	Bsc Informatics (BSc)
France	National Politechnic Institute	Industrial Engineering (BSc)
Germany	Akad University Stuttgart	Bachelor informatics engineering (BSc)
Germany	Akad University Stuttgart	Mechatronics
Germany	Akad University Stuttgart	Bachelor mechanical engineering (BSc)
Germany	Leibniz University Hannover	Structural Engineering (MSc)
Germany	Karlsruhe Institute of Technology (KIT)	Mechanical Engineering in Energy Eng. (BSc)
Germany	Rhine-Waal University of Applied Sciences	Industrial Engineering (BSc)
Germany	Beuth University Berlin	M. Eng. Industrial engineering
Germany	Kassel University	Industrial Production Management (MSc)
Greece	National & Kapodistrian University of Athens	Introduction to Atomic Physics (BSc)
Greece	National & Kapodistrian University of Athens	Intro to Nuclear Physics & Elementary Particles (BSc)
Greece	National & Kapodistrian University of Athens	Nuclear Energy and Society (BSc)
Greece	National & Kapodistrian University of Athens	Nuclear Technology (BSc)
Greece	National & Kapodistrian University of Athens	Elementary Particles (BSc)
Italy	Pisa University	Computer engineering (BSc)
Italy	Pisa University	Ingegneria Edile e Costruzioni Civili (BSc)
Italy	Pisa University	Electronic Engineering (BSc)
Italy	Pisa University	Energy Engineering (MSc)
Italy	Uninettuno	B.Eng. Civil and Environmental Engineering
Italy	La Sapienza University Rome	Mechanical Engineering (BSc)

Country	University Name	Course Name
Italy	La Sapienza University Rome	Electrotechnical Engineering (BSc)
Italy	La Sapienza University Rome	Energy Engineering (BSc)
Italy	La Sapienza University Rome	Ingegneria della Sicurezza (BSc)
Italy	La Sapienza University Rome	Civil Engineering (BSc)
Italy	La Sapienza University Rome	Chemical Engineering (BSc)
Ireland	Dublin City University	Electronics Engineering (BSc)
Ireland	Dublin City University	Mechatronic Engineering (BSc)
Ireland	Dublin City University	Electronic Systems (MSc)
Ireland	Dublin City University	Mechatronic Engineering (MSc)
Netherlands	Eindhoven University of Technology	M.Sc. Sustainable Energy Technology (MSc)
Netherlands	Eindhoven University of Technology	M.Sc. Chemical Engineering (MSc)
Netherlands	Eindhoven University of Technology	M.Sc. Electrical Engineering (MSc)
Netherlands	Delft University of technology	M.Sc. Water Management (MSc)
Portugal	University of Lisbon	Particles & Nuclear Physics (MSc)
Portugal	University of Lisbon	Physics and Radiation Technology
Portugal	University of Lisbon	Nuclear Physics (MSc)
Portugal	University of Porto	Phd Doctoral Programme in Sustainable Energy Systems (PhD)
Spain	National Open University	Mechanical Enginnering (BSc)
Spain	National Open University	Electrical Engineering (BSc)
Spain	National Open University	Industrial Technology Engineering
Spain	National Open University	Informatics Engineering (BSc)
Spain	National Open University	Electrical, Electronic & Ind. Control Engineering (MSc)
Spain	Funiber	Master of Engineering and Environmental Technology (MSc)
Sweden	KTH Royal Inst, Technology	Electrical Engineering (MSc)
Sweden	KTH Royal Inst, Technology	Production Engineering & Management (MSc)
Sweden	Linkoping University	Electronics Engineering (MSc)
Sweden	Linkoping University	Mechanical Engineering (MSc)

Country	University Name	Course Name
Sweden	Linkoping University	Energy & Environmental Engineering (MSc)
Sweden	Linkoping University	Industrial Engineering & Management (MSc)
Sweden	Chalmers University of Technology	Electric Power Engineering (MSc)
Sweden	Gavle university	Energy Engineering (MSc)
United Kingdom	Surrey University	Civil Engineering (MSc)
United Kingdom	Surrey University	Structural engineering (MSc, post-graduate)
United Kingdom	University of Lincoln	Engineering Managment (BSc)
United Kingdom	Manchester University	Advanced process for Energy (MSc)
United Kingdom	Manchester University	Nuclear Science and Technology (MSc)
United Kingdom	Manchester University	Radiation and Radiological protection
United Kingdom	Manchester University	Nuclear Safety case Development
United Kingdom	Manchester University	Critical Safety Management
United Kingdom	Manchester University	Reactor Thermal Hydraulics
United Kingdom	University of Central Lancashire	Construction Management (MSc)
United Kingdom	University of Central Lancashire	Governance of Civil UK Nuclear Ind. (Post. Grad.)
United Kingdom	University of Central Lancashire	Engineering Nuclear
United Kingdom	University of Central Lancashire	Decommissioning Technology and Robotics
United Kingdom	University of Portsmouth	B.Eng. Mechanical and Manufacturing Engineering (3 years)
United Kingdom	University of Portsmouth	B.Eng. Mechanical and Manufacturing Engineering (2 years)
United Kingdom	University of Sheffield	Processing, Storage & Disposal Nuclear Waste

Country	University Name	Course Name
United Kingdom	Westlakes Consulting	Decommissioning / Waste / Environmental Management
United Kingdom	Westlakes Consulting	Nuclear Fuel Cycle
United Kingdom	University of Birmingham	Nuclear Decommissioning and Waste Management (MSc)
United Kingdom	Academy of Distance Learning	Fundamentals of Nuclear Power
United Kingdom	University of Northampton	Wastes Management (MSc)
United Kingdom	The Open University	Inside Nuclear Energy
United Kingdom	University of Liverpool	Software Engineering (MSc)
United Kingdom	University of Liverpool	Project Management (MSc)
United Kingdom	Queen Mary University	Energy Systems (PhD)
United Kingdom	Brunel University	Engineering Management (MSc)
United Kingdom	Edinburgh Napier University	Architectural Technology & Building Performance (MSc)
United Kingdom	Edinburgh Napier University	MSc Construction Project Management (MSc)
Other entities		
Austria	International Atomic Energy Agency	E-Learning for nuclear newcomers (different modules)
Netherlands	European Commission	WWER RPV Integrity Assessment

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Abstract

The European Union is facing a scarcity of skilled professionals in the field of nuclear energy, especially at the higher educational levels. This is mainly due to the worldwide reduction in public acceptance of everything nuclear in the aftermath of the Three Mile Island and Chernobyl accidents, occurred in 1979 and 1986 respectively. These accidents have led to a decreased interest in nuclear education and thus to a "generational gap", where the skilled nuclear workforce is on the verge of retirement or has already retired, and the new generation of nuclear workers does not have the numbers to cover the needs of the industry.

The present report, commissioned by the CAPTURE Action of the Joint Research Centre of the European Commission, has the aim of complementing other European initiatives in the field of nuclear Education & Training by analyzing the availability of eLearning courses in nuclear and nuclear-related fields across the EU-27.

This report gives an overview of the eLearning tools and frameworks available on the market and analyzes the main types of eLearning.

A list of the eLearning courses offered by Universities in Europe is presented, along with contact details and websites (situation as of the15th of April 2013).

An electronic version of the list of courses will be published on the CAPTURE website (http://capture.jrc.ec.europa.eu/), and it will be updated every six months.

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