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PUTTING INTO PERSPECTIVE THE SUPPLY OF AND DEMAND FOR NUCLEAR EXPERTS BY 2020 WITHIN THE EU-27 NUCLEAR ENERGY SECTOR

An EHRO-N report

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FOREWORD

The Council of the EU faced the rising scarcity of adequate skilled professionals for the nuclear energy sector on the policy level by:

- concluding on 1st December 2008 that it is "essential to maintain in the EU-27 a high level of training in the nuclear field" [1] and preserve the skills that we already have;
- adopting on 25th June 2009 a directive stating in its article 7, on "Expertise and skills in nuclear safety", that national arrangements for education and training should be made so as to allow for maintenance and further development of the existing expertise and skills related to the safety of nuclear installations [2];
- adopting on 19th July 2011 a directive on the safe management of spent fuel and radioactive waste where in its article 8, on "Expertise and skills", refers especially to the need to obtain, maintain and further develop the expertise and skills in this area [3].

At the same time, the nuclear knowledge management landscape in the EU-27 grew in variety and numbers of instruments and initiatives. The European Commission (EC), more precisely the Directorate-General (DG) for Research and Innovation (DG RTD) with its initiatives: 1) Sustainable Nuclear Energy Technology Platform (SNE-TP), 2) Implementing Geological Disposal of Radioactive Waste Technology Platform (IGD-TP), 3) Multidisciplinary European Low-Dose Initiative (MELODI), and the 4) European Nuclear Education Network (ENEN) and DG ENER with its initiative: the European Nuclear Energy Forum (ENEF), are at the forefront of these efforts.

On 22nd October 2008, at the fourth meeting of the ENEF working group on "Risks", the need to set-up a permanent entity to observe and monitor the nuclear human resource in the EU-27 was finally endorsed [4]. This was the initiation of the European human resource observatory or EHRO-N, which was to add the missing instrument to the above mentioned nuclear knowledge management landscape in the EU-27.

EHRO-N was given the task to explore the link between supply and demand for nuclear human resource in the EU-27 by creating a database of nuclear skills needed in the short- (1 year), medium- (5 years), and long-term (10 years) perspective and by identifying gaps and deficiencies in the nuclear educational and training infrastructure in the EU-27. Of course, co-operation with other relevant actors in the area, mentioned above, is necessary if the task is to be achieved properly. This co-operation is fulfilled through the so called EHRO-N Senior Advisory Group (SAG) [5] (see Annex 3) where sit representatives of research organisations, industry, international organisations, etc. and oversee the activities of EHRO-N, and also through other available formal or informal channels.

In order to arrive to a comprehensive picture for the EU-27 as a whole, national data on the supply and demand of nuclear human resource is of utmost importance. On the national levels, some EU Member States have already monitored their nuclear workforce supply and demand through comprehensive national surveys (e.g. France and UK, and most recently Finland). In the other EU Member States, the data is either not complete or missing altogether. Some, but not complete, data is obtainable from reports of international organisations like IAEA and OECD/NEA but this is in no way replacing the need for comprehensive national reports on the nuclear human resource situation.

This is the first EHRO-N report on the supply and demand for nuclear experts in the EU-27. Its concrete purpose is to present, in global terms, how the supply of experts for the nuclear industry in the EU-27 responds to the needs for the same experts for the present and future nuclear projects in the region by 2020. For more refined and accurate data that can determine policy, the most effective way is to envisage regular nuclear human resource monitoring in the future.
Nuclear experts were for the purpose of this report defined as the core experts, mainly nuclear scientists and nuclear engineers, needed to adequately and successfully perform nuclear projects in a nuclear organisation.

Because the analysis was done on data received from spring 2010 to spring 2011, the effects of the Fukushima-Daiichi accident on the workforce situation were not taken into account in the results. The main changes that affect the supply of/demand for nuclear experts at least at a national level occurred in Germany, where 8 nuclear power reactors were taken off the grid and the rest will be closed by 2022, and in Italy, where in June 2011 a referendum imposed a ban on the reintroduction of a nuclear power program. In some countries new-build and replacement of nuclear reactors might be slowed down, whereas significant changes are not expected in other countries. The overall picture is changeable and a clear judgment of the consequences is considerably challenging at this moment. It is however clear that there is still the need for highly competent experts on nuclear safety in the EU-27 which should provide a drive for existence of good job-opportunities in the region for the next decades to come.

After this first report, it is our hope that the messages of the "First situation report on education and training in the nuclear energy in the European Union" [6] of the European Commission will be heard: namely, that

1) The need to keep a constant eye on the availability of nuclear experts in the EU Member States is recognized by endorsing EHRO-N as the central information source for all stakeholders in the EU-27. EHRO-N would serve to all nuclear stakeholders interested in the optimization and rounding up of their initiatives relating to the nuclear human resources monitoring, planning, education and training, and that
2) the EU Member States as well as relevant public and private organisations are going to fully support the European Commission in developing such an instrument.

ACKNOWLEDGEMENTS

EHRO-N team is deeply grateful to the higher education institutions and nuclear stakeholders that responded to the EHRO-N questionnaire(s).
We would like to thank as well the EHRO-N Senior Advisor Group (SAG) members who provided us with direction, ideas and support without which this report would either be impossible to prepare or would lack the sufficient quality.

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1 Listed in the order as they appear in the text.

LIST OF ABBREVIATIONS

CEDEFOP	European Centre for the Development of Vocational Training
DG ENER	Directorate-General for Energy
DG RTD	Directorate-General for Research and Innovation
DG TREN	Directorate-General for Transport
E&T	Education and Training
EC	European Commission
ECVET	European Credit System for Vocational Education and Training
EHRO-N	European Human Resource Observatory for Nuclear
ENEF	European Nuclear Energy Forum
ENEN	European Nuclear Education Network
ENS	European Nuclear Society
EQF	European Qualifications Framework
EU-27	European Union
EURATOM	European Atomic Energy Community
Eurostat	Statistical Office of the European Union
Foratom	The European Atomic Forum is the Brussels-based trade association for the nuclear energy industry in Europe
HRST	Human Resource in Science and Technology
HRSTE	Human Resource in Science and Technology in terms of Education
HRSTO	Human Resource in Science and Technology in terms of occupation
IAEA	International Atomic Energy Agency
IGD -TP	Implementing Geological Disposal of Radioactive waste Technology Platform
ISCED	International Standard Classification of Education
MELODI	Multidisciplinary European Low-Dose Initiative

OECD/NEA	Organisation for Economic Cooperation and Development/Nuclear Energy Agency
RWM	Radioactive waste management
S&T	Science and Technology
SAG	Senior Advisory Group
SNE - TP	Sustainable Nuclear Energy Technology Platform
SET	Science, Engineering and Technology
STEM	Science, Technology, Engineering and Mathematics
TSOs	Technical Safety Organisations
WMOs	Waste Management Organisations

SUMMARY

CHAPTER I: TOWARDS THE FIRST EHRO-N REPORT

EHRO-N or the European Human Resource Observatory for the Nuclear Energy Sector is the initiative of the European Nuclear Energy Forum (ENEF), with the task to build a system for monitoring the supply of and demand for experts needed for the nuclear energy sector in the EU-27 for the years to come until 2020.

This is the first EHRO-N report on the supply and demand for nuclear experts in the EU-27. Its objective is to assess how the supply of experts for the nuclear industry in the EU-27 responds to the needs for the same experts for the present and future nuclear projects in the region.

The report is based on an analysis of responses to two surveys that were sent throughout 2010 and in the first half of 2011 to:

1. Higher education institutions in EU-27 that offer nuclear-related degrees, and
2. Nuclear stakeholders, who are active on the EU-27 nuclear energy labour market.

The quantitative data received was quality checked against a quality assurance procedure set within the Senior Advisory Group (SAG) of EHRO-N. It was also assessed against data available from other sources (e.g. IAEA data, national nuclear human resource reports, if available).

The relevant statistical information from OECD, IAEA, World Nuclear Association, and Eurostat (especially on the numbers of science, engineering and technology (SET) graduates and HRST (Human Resource in Science and Technology) employees supplied and/or demanded in EU-27) was used, so that the quantitative data gathered via EHRO-N questionnaire was put into the wider context of supply of and demand for highly skilled personnel in EU-27.

The methodology according to which the data was gathered and analyzed followed these steps:

1. Desk research of the higher education institutions in EU-27 offering nuclear-related degrees (for the supply side of the report);
2. Desk research of the nuclear organisations active in the EU-27 nuclear energy industry (for the demand side of the report) complemented with the information available from the existing EURATOM national contact points (source: DG Research and Innovation);
3. Design of the questions and sending out the questionnaires to the institutions from the points 1 and 2 above;
4. Analysis of the responses received;
5. Estimation of the missing data (where the nuclear employers in EU-27 did not provide us directly with it) as well as benchmarking of the supply data received;
6. Putting the EHRO-N data into wider context using statistical data available from OECD/NEA, IAEA, World Nuclear Association, and Eurostat.

The definitions used in the report were set either by the EQF (European Qualifications Framework) (this goes for the definition of "knowledge" and "skill"), ECVET (European Credit System for Vocational Education and Training) (this goes for the definition of “competence” and “learning outcomes”), CEDEFOP (European Centre for the Development of Vocational Training) (this goes for the definition of “mobility”) or Eurostat (this goes for the definition of “scientists and engineers”, “technicians and associate professionals”), or EHRO-N (this goes for the definition of “nuclear expert”, “nuclearised”, “supply/demand for nuclear experts”, “nuclear stakeholders”).

CHAPTER II: NUCLEAR ENERGY IN THE EU-27 TODAY AND TOMORROW

On 10th March 2011 there were 143[2] nuclear power reactors in the EU-27 with the net capacity of almost 131 000 MWe. The biggest share of these reactors was located in France, which had also the highest share of nuclear electricity production within their total national electricity production: around 74%. The share of electricity generated by the 143 nuclear power reactors in the total electricity generated in the EU-27 in 2010 was some 28%. The nuclear electricity generation by the 143 nuclear reactors in EU-27 represents roughly one third of the total nuclear electricity generation in the world.

Between 2020 and 2025 the licenses of at least some 50 nuclear power reactors are due to expire, but life time extensions are being considered for many of them, located in Bulgaria, Czech Republic, France, Hungary, Slovakia, Slovenia, and Spain. Some 53 new nuclear power reactors, more of them in eastern Europe, and with the total gross capacity of somewhat less than 68 000 MWe, are being built/are planned to be built /are considered to be built in the future in Bulgaria, Czech Republic, Finland, France, Hungary, Lithuania, the Netherlands, Poland, Romania, Slovakia, Slovenia, Sweden and the United Kingdom.

CHAPTER III: SUPPLY OF AND DEMAND FOR NUCLEAR EXPERTS IN EU-27

SUPPLY SIDE

Somewhat less than 190 higher education institutions received a questionnaire asking them about the:

1. Number of nuclear engineering students that graduated in year 2009;
2. Number of students following nuclear subjects that graduated in 2009;
3. Number of nuclear engineering students that started with their studies in the school year of 2009/2010; and
4. Number of students following nuclear subjects that started with their studies in the school year of 2009/2010.

These are some examples of nuclear – related studies covered with the above data: Nuclear engineering, Nuclear physics, Nuclear chemistry, Nuclear energy.

The initial results showed that:

1. Slightly less than 1800 nuclear engineering students and students following nuclear energy – related subjects graduated in the year 2009 on BSc, MSc, or PhD levels in the higher education institutions in EU-27, and

2 Today, April 2012, there are 8 nuclear power reactors less within the EU-27 (all of the 8 nuclear power reactors closed were situated in Germany).

2. Around 2300 students started their nuclear engineering and nuclear energy – related studies in the year 2009/2010.

The response rate of the higher education institutions contacted was above 90 %.

Some of the higher education institutions did not respond to the questionnaire. Furthermore, some of the received data needed to be benchmarked according to the quality-assured procedure defined by EHRO-N SAG. This means that some data needed to be re-assessed against: 1) the existing national data and/or 2) the knowledge of relevant experts, some of which are also members of the EHRO-N SAG.

After the benchmarking exercise the total number of nuclear engineering students/students following nuclear energy – related subjects that graduated in the year 2009 on BSc, MSc, or PhD levels was somewhat above 2800.

DEMAND SIDE

Of the 358 nuclear stakeholders contacted, 242 or nearly 70% responded to the EHRO-N questionnaire.

The information requested covered these data:

1. The total number of nuclear experts employed in 2010;
2. The division of the total number of nuclear experts employed in 2010 into 4 age groups:

- below 35
- between 35 and 45
- between 45 and 55, and
- above 55

3. The need for new nuclear experts within 1, 5, and 10 years (without making distinction whether these were needed in order to fill a position because of retirement or because of a creation of a completely new post).

The 242 organisations that responded to the questionnaire had together 62 958 nuclear experts employed in 2010, the biggest share of which fell into the age group "between 45 and 55". At the same time the sum of the age group "below 35" and the age group "between 35 and 45" was slightly smaller than the sum of the remaining two age groups, suggesting that there is indeed a need to replace the nuclear experts that will retire in the next 10 to 20 years. The need for nuclear experts by 2020 reported by these 242 organisations was 30 664.

For the remaining 32% of the nuclear stakeholders, that did not respond to the EHRO-N questionnaire, the estimated figure of nuclear experts employed in 2010 was 14 647 and their estimated need for nuclear experts by 2020 was 8 236.

Thus, the total number of nuclear experts in the 358 nuclear organisations employed in the 358 nuclear organisations in the EU-27 in 2010 was 77 605:

Received data (RD) + Estimated data (ED) = 62 958 +14 647 = 77 605

The highest share of nuclear experts employed in EU-27 was located in France, followed by the United Kingdom. The distribution per age group of these experts stayed similar as stated above (the biggest share of experts fell into the age group "between 45 and 55").

The total need for nuclear experts by 2020 of the 358 nuclear organisations active in the EU-27 in 2010 was 38 900:

Received data (RD) + Estimated data (ED) = 30 664 + 8 236 = 38 900

The highest share of nuclear experts needed by 2020 was again in France, followed by the United Kingdom.

CHAPTER IV: PUTTING THE SUPPLY AND DEMAND DATA FOR NUCLEAR EXPERTS INTO PERSPECTIVE

SUPPLY OF RELEVANT GRADUATES IN EU-27 FOR THE NUCLEAR ENERGY LABOUR MARKET

The numerical data available from EHRO-N analysis of 2011 was supplemented with the statistical data, mainly from Eurostat, on the numbers of graduates in science, technology, engineering and math, in the EU-27 (so called STEM students).

The objective was to get a wider view on the supply of relevant graduates for the nuclear specific jobs available in the EU-27 in the future.

The number of all graduates in all fields in the EU-27 in 2009 was 4 127 039. The share of STEM graduates within the above graduates in the EU-27 was 22% in 2009 or, in absolute terms, 907 949 students. The highest share of STEM graduates among the members of the EU-27 was in Austria, followed by Finland, Portugal, France, Spain, Germany, Czech Republic, Sweden and Italy, all of which had their shares above the EU-27 average.

In the EU-27 in 2009, the numbers of STEM students graduating from specific fields was as follows:

- 339 414 graduates from engineering/engineering trades[3] or 37.4% of all STEM graduates

The highest share of graduates in engineering/engineering trades was in France, followed by Germany, Romania, Spain, the United Kingdom, Poland and Italy.

The share of graduates of nuclear engineering within the amount of all engineering/ engineering trades' graduates was in EU-27 in 2009 less than 1%.

3 This is a terminology used by Eurostat. Eurostat counts within "Engineering and engineering trades" students of 1) the study of engineering and engineering trades without specialising in any of the detailed fields, 2) the study of planning, designing, developing, producing, maintaining and monitoring machines, mechanical plants and systems and metal products (or Mechanics and metal work), 3) the study of installing, maintaining, repairing and diagnosing faults in electrical wiring and related equipment in domestic, commercial and industrial establishments (or Electricity), 4) the study of planning, designing, developing maintaining and monitoring electronic equipment, machinery and systems (or Electronics and automation), 5) the study of planning, designing, and developing products and processes where chemical and physical changes occur (or Chemical and process). Source: Fields of Education and Training, Eurostat Manual [7].

- 96 422 graduates from physical science or 10.6% of all STEM graduates

  The highest share of graduates from physical science was in the United Kingdom, followed by Germany, France, Poland, Spain, Romania and Italy, and

- 45 712 graduates from mathematics and statistics or 5% of all STEM graduates

The highest share of graduates from mathematics and statistics was in Germany, followed by the United Kingdom, France, Poland and Italy.

The number of PhD/Doctorates awarded within the fields mentioned above in 2009 in the EU-27 was 9 581 (for engineering/engineering trades), 10 876 (for physical science), and 2 002 (for mathematics and statistics).

THE EU-27 HRST LABOUR MARKET

The numerical data about nuclear experts needed in the EU-27 in the future available from EHRO-N analysis was supplemented with the statistical data available on the numbers of employees belonging to the group of science and technology human resource (HRST).

The objective was to get a wider view on the demand for relevant graduates/professionals for the nuclear specific jobs available in the EU-27 in the future.

40% of the labour force in the EU-27 in 2009 belonged to the HRST group. 3% of these worked in one EU-27 member state but were citizens or another EU-27 member state, and 3% worked in an EU-27 member state but were citizens of a country outside the EU-27.

The number of scientists and engineers within the HRST group was some 11 million in 2009. Most of them were employed in Germany, the United Kingdom, France, Spain, Poland and Italy. Of these the number of graduated engineers was somewhat less than 6.5 million based on the data available from 2007.

There will be a need for at least some 1 200 000 engineers for the EU-27 labour marker by 2020 just to replace the retired engineers by that same year. The least need for engineers per year in the EU-27 as a whole is thus some 120 000 engineers. That means that around one third of all engineering/engineering trades' graduates in the EU-27 (assuming that their numbers stay at the level of some 340 000 every year as in 2009) are needed every year by the employers just to replace the retired personnel.

A point of concern is the estimation that some 25% of the graduated engineers might not get employed in engineering professions after their graduation. There is a need for further exploration of the reasons why engineers, and in particular nuclear engineers, would choose not to search for an employment within the engineering sector.

BREAKDOWN PER PROFILES OF EMPLOYEES IN THE EU-27 NUCLEAR ENERGY SECTOR

The French nuclear energy sector employs the biggest share of all nuclear experts in the EU-27.

The need for specific profiles of employees for the French nuclear energy sector (a study done for up to 2012) was taken as the basis for a hypothetical breakdown by main profiles of employees in the nuclear energy sector for the EU-27 as a whole.

Thus, in the EU-27, the workforce in the nuclear energy sector, which in total is estimated at some 500 000, is hypothetically divided like this:

1. 16% are nuclear experts,
2. 74% are nuclearised engineers, other graduates, and technicians, and
3. 10% are support and other employees (so called nuclear-aware employees).

A similar breakdown is proposed in the so called competence pyramid mentioned in the most recent OECD report on Nuclear Education and Training: From Concern to Capability.[4]

Additionally, in the nuclearised part of the workforce (point 2 above), there are some 38% technicians, 35% non-nuclear engineers, and 27% other graduates

The nuclear experts (point 1 above) and engineers and technicians (point 2 above) fall, according to the OECD Canberra Manual[5] definition, into the group of so called human resource in science and technology (HRST). [6]

DOES SUPPLY OF NUCLEAR EXPERTS RESPOND QUANTITATIVELY TO THE DEMAND FOR THE SAME EXPERTS BY THE NUCLEAR ENERGY SECTOR IN THE EU-27?

22% of all graduates from all fields in the EU-27 in 2009 were STEM graduates. Of these graduates some:

- 37% were graduates from engineering and engineering trades
- 11% were graduates from physical science, and
- 5% were graduates from mathematics and statistics.

On the labour force side, 40% of all actively employed in the EU-27 in 2009, were science and technology employees. Of these, 11 million were scientists and engineers, of which, 6.5 million were graduated engineers.

According to some estimates, some 500 000 people work in the nuclear energy sector in the EU-27.

4 Issued in April 2012. See also point 9 in the List of references.

5 This is a manual on the measurement of human resources devoted to S&T. See Reference 45 in the List of References.

6 According to the OECD Manual, the HRST group is divided into two parts:

1) Individuals having successfully completed tertiary level education in a science and technology field (HRSTE or HRST in terms of education), and

2. Individuals working in a science and technology occupation as professionals and technicians (HRSTO or HRST in terms of occupation).

On the basis of the statistical data available from the Eurostat and on the basis of the results of the EHRO-N questionnaire coupled with the hypothetical breakdown by main profiles of employees in the nuclear energy sector for the EU-27 as a whole, the future demand of this sector up to 2020 is estimated to be as follows (these numbers are related in the most part to the needs of the employers to replace the retired personnel):

- Somewhat less than 40 000 nuclear experts (for new posts and in order to replace retired personnel)
- Around 35 000 technicians (due to retirements)
- Around 32 000 non-nuclear engineers (due to retirements), and
- Somewhat less than 25 000 other graduates (due to retirements).

The supply of nuclear engineering students and students having had a nuclear energy-related subject in their studies (between 1800 and 2800 in the EU-27 graduated in 2009) cover some 45%-70% of the demand for nuclear experts by the nuclear energy sector in the EU-27 (on average 4000 per year by 2020). This is true if one assumes that all the relevant graduates mentioned are looking for an employment in the nuclear energy sector. A worrying observation is that by 2020 nearly 50% of nuclear experts employed today will retire (the retirement rate for other engineers is much lower).

The demand for nuclear experts which is not fulfilled by the supply from the higher university institutions in the EU-27 is directed towards the other STEM graduates (e.g. non-nuclear engineers, physical scientists, etc.). On top of the rising demands for STEM graduates, because of the retirement of the "baby boomers", the numbers of STEM students and graduates have been reported to be inadequate in the EU-27 in general.

The nuclear energy sector needs to be aware of the demand for the STEM graduates by the other (energy) sectors in the EU economy as well as of the demand for these graduates by the newly emerging industries associated with renewable energies and energy efficiency (so called "green jobs").

CHAPTER V: LESSONS LEARNT

Chapter V lists several lessons learnt deriving from the activities of EHRO-N, the most important being the surveys conducted of which the results are being presented in this report. As SAG is the "heart" of EHRO-N, some of the lessons learnt, and even more so, some of the recommendations (see Chapter VI), are directly linked to the deliberations held within the five SAG meetings held to this moment (April 2012).

Table 1: EHRO-N lessons learnt

SUPPLY SIDE	DEMAND SIDE	GENERAL
Further refine methodology and database of nuclear education and training possibilities in EU-27; refine benchmarking methodology; there is also a need for national nuclear contact points to monitor	Further refine methodology and database of nuclear energy stakeholders; refine definitions used in report, especially as concern terms: nuclear expert, nuclearised, nuclear-aware; expand	Regular monitoring of the supply/demand situation of nuclear human resource needed in EU-27 in order to have more accurate data and for trends analysis (better data could better influence policies on

the nuclear human resource supply/demand situation in their respective countries;	and refine questionnaire used; there is also a need for national nuclear contact points to monitor the nuclear human resource supply/demand situation in their respective countries;	different levels);
Need for more and/or more efficient cooperation between organisations providing nuclear education; Acknowledgment that there were some positive developments in the last decade;	Nuclear energy stakeholders need be aware of the wider context in which they operate: significant competition comes from outside the nuclear energy sector (e.g. so called (other) green industries);	There is a need for further studies: e.g. to check the mobility of nuclear experts vs. the mobility of technically qualified personnel; to examine ECVET and its application to the nuclear energy sector of EU-27;
Different degree of development of the relevant higher education institutions offering nuclear energy education. This depends on the country where the institution in question has its seat: more governmental support means better education possibilities (but there are some exceptions);	Different degree of openness of the nuclear energy stakeholders as to sharing their nuclear human resource data. Reasons: 1) type of stakeholder, 2) country(ies) of operation, 3) sensibility to competiveness matters, 4) (in)clarity of future business plans;	There is a need for strong interaction between nuclear energy stakeholders in the EU-27 as far as questions of nuclear human resource monitoring is concerned;
The share of graduates of nuclear engineering within the amount of all engineering graduates is less than 1%;	There is a yearly need for some 4 000 nuclear experts by the nuclear energy stakeholders in EU-27 by 2020 (the need for professors and trainers is not included here)	
ECVET: a new approach to the transfer and recognition of learning outcomes – possible application in the nuclear energy sector that can facilitate a mobile and competent workforce on the technical and craft level;	The supply of nuclear experts does not correspond to the demand for nuclear experts by 2020; The provision of nuclear experts to the nuclear energy sector in EU-27 by the higher education institutions is somewhere between 45% to 70%; By 2020 nearly 50% of nuclear experts employed today will retire (the	

	retirement rate for other engineers is much lower);	

Source: EHRO-N

CHAPTER VI: RECOMMENDATIONS

The EHRO-N's recommendations, deriving from the lessons learnt (see Chapter V) and generally from the EHRO-N SAG, to the nuclear energy sector in the EU-27 are that:

- EHRO-N's operation should be actively supported by the national governments, nuclear safety authorities, nuclear industry and the E&T organisations within the EU-27 and thus should be long-term secured:
    - to provide the authoritative and comprehensive platform for strong interaction between nuclear energy stakeholders in the EU-27 as far as questions of nuclear human resource monitoring is concerned; concretely this could mean devising a commonly agreed methodology and database on the demand/supply situation of nuclear human resource;
    - so that the workforce situation for the nuclear energy sector in the EU-27 is regularly monitored in order to forecast trends and provide information on the demand/supply situation;
    - to provide a roadmap for human resource development across the various sectors according to its mandate;
    - to communicate reliable information by conventional and electronic means to the Member States' governmental, higher education, and private organisations involved in nuclear E&T that could be used to report to the European Parliament and the Council of the EU and thus influence policy developments;
- EU-27 Member States/Nuclear Stakeholders should contribute actively to EHRO-N surveys e.g. use the existing Euratom National Contact Points or create new ones to coordinate and organize national information;
- A feasibility study should be carried out with the main objective to consider ways to support the mutual recognition of knowledge, skills and competences relevant for the nuclear energy sector;
- The application of the ECVET approach should be promoted to continuously improve the quality of the nuclear workforce at professional, technical and craft level by facilitating borderless mobility and lifelong learning;
- There is a need for further assessment of the effectiveness of the coordination between industry and universities in nuclear education and training and in the provision of related opportunities to students and the industry workforce;

The above EHRO-N recommendations are in line with the recommendations outlined by the SNETP [8] and by OECD/NEA [9].

1. TOWARDS THE FIRST EHRO-N REPORT

1.1. GENERAL OBJECTIVES OF EHRO-N

EHRO-N or the European Human Resource Observatory for the Nuclear Energy Sector is the initiative of the European Nuclear Energy Forum (ENEF), with the task to build a system for monitoring the supply of and demand for relevant experts needed for the nuclear energy sector in the EU-27 for the years to come.

EHRO-N's general objectives are to:

1. Produce and regularly update a quality-assured database on the short-, medium-, and long-term needs for human resources for the different stakeholders in the nuclear energy and nuclear safety;
2. Identify gaps and deficiencies in the European nuclear education and training (E&T) infrastructure and elaborate recommendations for remedial actions and optimization;
3. Play an active role in the development of a European scheme of nuclear qualifications and mutual recognition;
4. Regularly communicate by conventional and electronic means relevant data to the Member States' governmental, higher education, and private organisations involved in nuclear E&T;
5. Provide information and recommendations to the EC that could be used to report to the European Parliament and the Council.

The management of EHRO-N consists of mainly two bodies:

1. The Operating Agent which is the Institute for Energy and Transport[7], one of the seven research institutes of the Joint Research Centre of the European Commission, and
2. The Senior Advisory Group (SAG).

While the first is providing the necessary infrastructure, networking and long-term stability, the SAG, which is composed of highly-qualified experts active in the nuclear energy either in academia, industry or international regulatory setting, meets twice per year and focuses on providing general guidance on conceptual issues (e.g. type of data to be gathered, the analysis to be performed, the endorsement of major human resource-related reports and the preparation/execution of major communication campaigns).

1.2. HOW DID EHRO-N COME ABOUT?

The timeline since the initiation of EHRO-N is the following:

- 4th March 2008: At the second meeting of the ENEF working group (WG) on "Risks", an overview of the areas of increased need for a human resource in the nuclear field was presented [10];

7 http://iet.jrc.ec.europa.eu/

- 22nd September 2008: At the third meeting of the ENEF WG on “Risks”, a need for a study on the demand for nuclear human resource in the EU-27 was mentioned [11];
- 22nd October 2008: At the forth meeting of the ENEF WG on “Risks”, the need for a study on the need for nuclear human resource in the EU-27 was replaced by the need for an European human resource observatory thus verbally expressing the necessity for a longer-term solution rather than a one-time study [4];
- 22nd June 2009: At the sixth meeting of the ENEF WG on “Risks”, the EC Joint Research Centre-Institute for Energy (JRC-IE) at Petten expressed its preparedness to host the European human resource observatory in cooperation with ENEF, DG ENER and DG RTD [12];
- 28th October 2009: At the seventh meeting of the ENEF WG on “Risks”, member organisation of the WG were asked to evaluate in their countries, whether organisations/institutions are in place, which could provide the EHRO-N with national data from the Member States on the need/offer situation in the field of nuclear energy human resource. The Observatory was set to start its operation in May 2010 [13];
- Throughout the second half of 2010 and beginning of 2011 the Senior Advisory Group of EHRO-N was being set up;
- From April 2010 until April 2012, 5 SAG meetings took place: on 14th/15th April 2010 in Petten, the Netherlands, on 7th/8th October 2010 in Amsterdam, the Netherlands, on 12th/13th April 2011 in Amsterdam, the Netherlands, on 26th/27th September 2011 (together with the Enlargement and Integration workshop for the (potential) candidate countries in Dubrovnik, Croatia, and on16th/17th April 2012 in Amsterdam, the Netherlands.

1.3. EHRO-N REPORT: METHODOLOGY AND LIMITATIONS

The methodology according to which the data was gathered and analyzed followed these steps:

1. Desk research of the higher education institutions in the EU-27 that offer nuclear energy - related degrees (for the supply side of the report). Here various sources were used including the databases of ENEN [14] and ENS [15].

2. Desk research of the nuclear organisations that are active in the EU-27 nuclear energy industry (for the demand side of the report) (this information was checked against the information available from the existing EURATOM national contact points (source: DG Research and Innovation) and also through direct telephone calls;

The challenge (and potential limitation) here was setting up a complete list of higher education institutions in the EU-27 that offer nuclear energy - related degrees and a list of nuclear energy stakeholders active in the nuclear energy sector in the EU-27. What is the kind of list that one could say that it encompasses (preferably almost) 100% of the above mentioned organisations?

3. Design of the questions and sending out the questionnaires to the institutions from the points 1 and 2 above;

After the identification of higher education institutions offering nuclear energy - related degrees on bachelor, master and PhD levels, and after the identification of nuclear stakeholders active in the nuclear energy area in the EU-27[8], two sets of surveys were designed for the two sets of databases: the first for the higher education institutions (see Annex 1), and the second for the nuclear stakeholders (see Annex 2).

While the first questionnaire was designed with the objective to find out the numbers of students at bachelor, master and PhD level that graduated from/enrolled in an EU-27 academic institution in a given year, the second questionnaire aimed at revealing the 1) numbers of employed nuclear experts in the EU-27 in 2010 according to age groups and 2) numbers of experts needed in the short- (1 year), medium- (5 years), and long-term future (10 years).

4. Analysis of the responses received;

The analysis of the responses received was done on a case-by-case basis:

- If a country sent data about its nuclear energy sector supply and/or demand, this data was taken as the most accurate one and no further enquiries on our part were done directly with the companies;
- Some support was provided through the already existing EURATOM national contact points. Nevertheless, it was inevitable to directly contact the nuclear stakeholders themselves in each country separately and stakeholder by stakeholder. in these cases the organisations were contacted directly
- Some stakeholders, because of their subsidiary status, were reached through another channel, usually through their mother companies; in these cases the data received was listed under the country where the seat of the mother company was;
- Where no data was received either through a national contact point or from a mother company, stakeholders were contacted directly; in these cases the data received was listed under the country where the seat of the contacted stakeholder was;

5. Estimation of the missing data (where the nuclear employers in the EU-27 did not provide us directly with it) as well as benchmarking of the supply data received;

The quantitative data received was quality checked against a quality assurance procedure set within the Senior Advisory Group (SAG) of EHRO-N. It was also assessed against data available from other sources (e.g. IAEA data, national nuclear human resource reports, if available).

6. Putting the complete EHRO-N data into wider context using statistical data available from OECD, IAEA, World Nuclear Association, and Eurostat.

The relevant statistical information from OECD, IAEA, World Nuclear Association, and Eurostat (especially on the numbers of science, engineering and technology (SET) graduates and HRST employees supplied and/or demanded in the EU-27) was used, so that the quantitative data gathered via EHRO-N questionnaire was put into the wider context of supply and demand of highly skilled personnel in the EU-27.

8 A map of higher education institutions offering nuclear energy - related degrees on bachelor, master and PhD levels, and a map of nuclear stakeholders active in the nuclear energy area in the EU-27 were placed on the EHRO-N website: http://ehron.jrc.ec.europa.eu. See also point 16 in the list of References.

1.3.1. CONTACTING HIGHER EDUCATION INSTITUTIONS - SUPPLY SIDE

A study was performed to map all education providers in Europe regarding nuclear energy. There are somewhat less than 190 higher education institutions in the EU-27 (see Annex 1) [16] that offer nuclear engineering subjects on BSc, MSc and PhD levels and/or other subjects aimed at educating students on different aspects of the nuclear cycle (e.g. Nuclear Plant design, Nuclear Physics, Radiation Protection, Fuel Cycle, Decommissioning and Waste Management)

These two questions were relevant when contacting the higher education institutions, offering nuclear engineering studies/nuclear energy - related subjects in the EU-27:

1. Number of nuclear engineering students/students following nuclear energy - related subjects that graduated in year 2009
2. Number of nuclear engineering students/students following nuclear energy - related subjects that started their studies in year 2009-2010

The timeline was the following:

- June 2010: first round of e-mails were sent to pre-determined higher education institutions;
- September 2010: second round of e-mails were sent to pre-determined higher education institutions;
- November 2010: first round of calls were done to pre-determined higher education institutions;
- In parallel analysis of results was conducted;
- Final analysis of results was done In April 2011;
- Benchmarking of the data received was conducted throughout the second half of 2011.

1.3.2. CONTACTING NUCLEAR STAKEHOLDERS - DEMAND SIDE

On the EU-27 level, no comprehensive study has been undertaken concerning the demand for and supply of nuclear experts by the nuclear industry. There have been some comprehensive studies on national level, like the ones in UK [17], France [18], and more recently in Finland [19] and some more partial ones like for example in Germany [20]. Furthermore, there are also some more specialized studies, on the level of one organisation (usually a company for internal purposes).

Thus, the possibility and need for more research in the area of nuclear human resource in the EU-27 prompted ENEF to initiate EHRO-N as the EU-27 nuclear human resource observatory to explore the issue more in detail.

The table below represents the questionnaire, which was used for the demand side of this report; more precisely it was used to assess

1. the present situation within the EU-27 nuclear energy sector as far as the numbers of nuclear experts are concerned (please see the first two columns, where the second one is subdivided in 4 columns), and

2. the future needs for these experts within the same sector (please see the third column, subdivided in 3 columns).

Table 2: EHRO-N Questionnaire 2010 (for the demand side of the report)

	Total number of nuclear experts* employed in 2010	**Approximate age span of nuclear experts employed in 2010 (can be expressed in %)**				**Need for new (to replace the retired experts + for new nuclear projects) nuclear experts within:**		
Name of organisation/Country		Below 35:	Between 35-45:	Between 45-55	Above 55	1 year	5 years	10 years

***Definition of nuclear experts: nuclear engineers, nuclear physicists, nuclear chemists, etc. – employed staff with *nuclear* education background (bachelor, master, PhD), and those with *non-nuclear* education background (bachelor, master, PhD) but with *competences/skills* in the nuclear field (for e.g. acquired through in-house/other training).**

The reasoning behind this questionnaire was that the stakeholders themselves knew what they needed as far as nuclear experts were concerned. The assumption was that the understanding of the definition below the table was more or less uniform.

Limiting ourselves to specific profiles of nuclear experts, we could encounter the problem of different understanding of the terminology and thus different counting dilemmas. Moreover, in 2010, when EHRO-N started its activities, there was still no common nuclear job taxonomy within the EU-27.

The above questionnaire was sent out following these steps:

- June 2010: first round of EHRO-N questionnaire was sent to pre-determined stakeholders, around 600, believed to be active in the nuclear energy area in the EU-27;
- September 2010: second round of EHRO-N was sent to pre-determined stakeholders, around 600, believed to be active in the nuclear energy area in the EU-27;
- November 2010 – February 2011: Telephone calls to the nuclear stakeholders that have not responded to the sent EHRO-N questionnaire;
- November 2010 – February 2011: the initially established list of 600 stakeholders was, after the telephone calls previously conducted, narrowed down to 358 stakeholders (see Annex 1), which actually have a need for nuclear experts in the future;
- In parallel, analysis of results was conducted;
- Final analysis was done in October 2011.

1.3.3. LIMITATIONS OF THE METHODOLOGY

The limitations related to the above methodology were these:

1. The lists of higher education institutions in the EU-27 that offer nuclear energy - related degrees and that of nuclear energy stakeholders active in the nuclear energy sector in the EU-27 might not encompass 100% of all organisations actually involved in the nuclear energy area in the EU-27. This

is especially true as far as the significant number of subcontracting companies that operate in the nuclear energy sector is concerned.

2. There seems to be a certain understanding of what a “nuclear expert” is, but when it gets down to numerically defining the term, the definition looses clarity (organisations may also understand, and consequentially also count, the term differently). Thus, the definition and interpretation of a “nuclear expert” is limited to this report;
3. The definition of a “nuclear stakeholder”, especially the division per types of stakeholders, is limited to this report; Some organisations may fall in one or two groups of different stakeholders but this was not taken into consideration for the division per types of stakeholders used in this report;
4. Not all organisations that were contacted were prepared to reveal their data on students/needs for nuclear experts. This made the estimation of the missing data unavoidable;
5. The benchmarking of the supply data proved to be challenging because of a lack of a central source of information on national level against which we could check the data received. Thus, best possible estimates from on the basis of other available reports and figures were made;
6. The assumptions upon which were based the estimations mentioned in Section 3.2.2. of this report were based, might be themselves limited. This made some under-, or overestimating of the data unavoidable;
7. The division of nuclear experts per type of stakeholder in this report is estimated. The reason for this is that significant portion of the data was received in a way that it was not divided by type of stakeholder (e.g. the data was received for a country in total without dividing it per nuclear stakeholders active in that same country);
8. The figures of nuclear subcontractor companies like consultants and engineering companies might be to some extent biased in the sense that the figures received were to some extent unreliable because 1) significant engineering suppliers were missing from the list (in Annex 2), and/or 2) the list contained suppliers active in more than one country of the EU-27, thus raising the question of double-counting. This limits to some extent the accuracy of data on a country level, but not the overall data.

1.3.4. DEFINITIONS

For the purpose of this report, we define the terms *in italics* below as follows:

Knowledge corresponds to “the facts, feelings or experiences known by a person or a group of people” [21].

Skill is “the knowledge and experience needed to perform a specific task or job” [21].

According to ECVET ***competence*** includes [22]:

1) cognitive competence involving the use of theory and concepts, as well as informal tacit knowledge gained experientially;
2) functional competence (skills or knowhow), those things that a person should be able to do when they are functioning in a given area of work, learning or social activity;
3) personal competence involving knowing how to conduct oneself in a specific situation; and
4) ethical competence involving the possession of certain personal and professional values.

Learning outcomes are “statements of what a learner is expected to know, understand and/or be able to do, or is able to demonstrate, after completion of any learning process or at the end of a period of learning” [22].

Mobility is “the ability of an individual to move and adapt to a new occupational environment” [23].

Nuclear experts are the core experts, mainly nuclear scientists and nuclear engineers, needed to adequately and successfully perform nuclear projects in a nuclear organisation. For the purpose of this report we define nuclear experts as those nuclear engineers, nuclear physicists, nuclear chemists, etc. that have a formal nuclear education background (bachelor, master, PhD). Some ***Technicians*** (see the definition below) have acquired the appropriate ***competences*** through thorough nuclear training and professional experience and fall under this category but are, strictly speaking, part of another category with its own specificities.

Nuclear experts fall into the wider group of ***Scientists and Engineers*** which “refer to persons who, working in those capacities, use or create scientific knowledge and engineering and technological principles, i.e. persons with scientific or technological training who are engaged in professional work on S&T activities, high-level administrators and personnel who direct the execution of S&T activities. (In the case of R&D activities, "scientists" are synonymous with researchers and assistant researchers engaged both in the natural sciences and in social sciences and humanities).”[24]

STEM students/graduates are those students/graduates in the field of science, technology, engineering or mathematics.

Because a part of the statistics shown in this report derives from the Statistical Office of the EU (Eurostat) we needed to look at how Eurostat itself defines some of the concepts used. Thus, according to the Eurostat ***Technicians and associate professionals*** is a group that “includes occupations whose main tasks require technical knowledge and experience in one or more fields of physical and life sciences, or social sciences and humanities. The main tasks consist of carrying out technical work connected with the application of concepts and operational methods in the above-mentioned fields, and in teaching at certain education levels (…)[25] For the purpose of this report *Technicians* were regarded simply as those that have a technical, non-university degree.

*“**Nuclearised**”* nuclear experts are those experts that have a non-nuclear higher education background (e.g. physicist, chemists, mechanical, civil, electrical and other engineers) but have acquired some nuclear competences through additional education/training.

Supply of nuclear experts*:* Nuclear engineers on offer/available on the market, either going out from the EU-27 E&T institutions or those who are already active on the labor market and/or are in between employments.

Demand for nuclear experts*:* needs for nuclear experts as defined in the organisation’s human resource reports and plans and/or annual reports.

Nuclear Stakeholders: we define as nuclear stakeholders those organisations that are active on the nuclear energy field in the EU-27. We differentiate among these types:

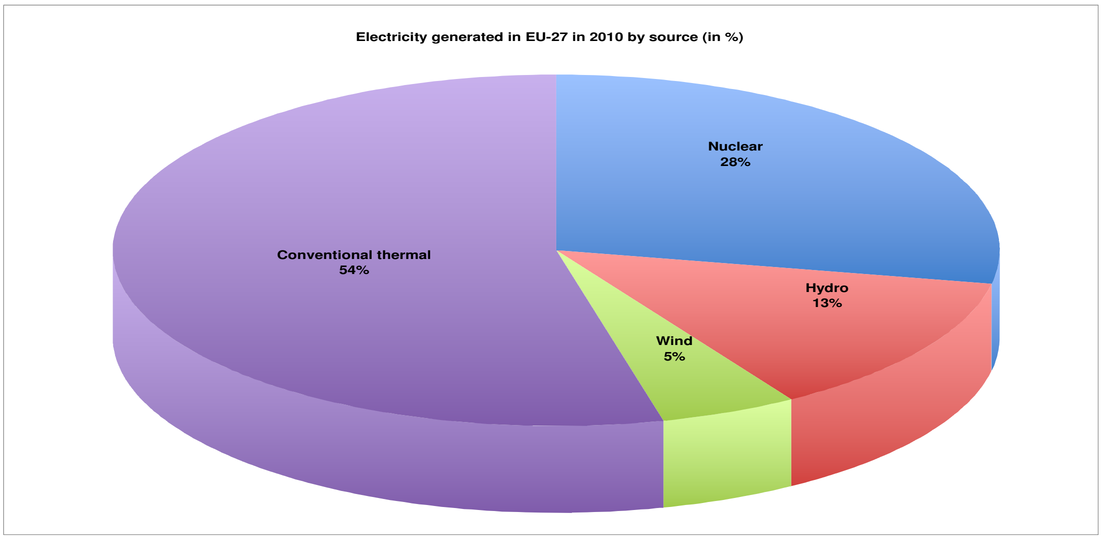
1. Utilities (i.e.) NPPs
2. Nuclear Facility vendors and other big suppliers
3. Fuel Fabrication, Enrichment, Supply organisations
4. Waste management organisations (WMOs)/Radioactive waste management (RWM) and decommissioning organisations
5. Design, Engineering, Manufacturing, Maintenance organisations
6. Consultancy (including project management and training)
7. Regulatory Authorities and TSOs
8. R&D institutes
9. Universities and training organisations

2. NUCLEAR ENERGY IN THE EU-27 TODAY AND TOMORROW

2.1. NUCLEAR ELECTRICITY AND NUCLEAR POWER PLANTS IN THE EU-27

The share of nuclear energy within the total electricity production in the EU-27 is approximately one third.

Figure 1: Share of electricity generated in the EU-27 in 2010 from nuclear



Source: Eurostat [26]

Between 2009 and 2010 the electricity generated by the 143 nuclear power reactors in the EU-27 increased by 2.6 %, but its share within the total electricity generated in the EU-27 decreased slightly [26].

The largest share of electricity generated from nuclear power in the 14 EU-27 Member States that operate nuclear facilities, is in France, followed by Slovakia, Belgium, Hungary, and Sweden. The table below shows the situation in the EU-27 as a whole.

Table 3: Total number of nuclear power reactors in the EU-27 (as of 10 March 2011) by country and the approximate share of nuclear energy generation within the total electricity generation in the respective country and in the EU-27 as a whole

	TOTAL NUMBER OF OPERATING	NUCLEAR ELECTRICITY	TOTAL NET ELECTRICITY	APPROXIMATE SHARE OF

COUNTRY	NUCLEAR POWER REACTORS	GENERATION (TWh)	GENERATION (TWh) (LATEST DATA AVAILABLE FOR 2010)	NUCLEAR ELECTRICITY GENERATION WITHIN TOTAL NATIONAL ELECTRICITY GENERATION (%)
Belgium	7	45.7	89.4	51
Bulgaria	2	14.2	41.6	34
Czech Rep.	6	26.4	79.5	33
Finland	4	21.9	77	28
France	58	410	544	75
Germany	17	133	580	23
Hungary	4	14.7	34.8	42
Netherlands	1	3.7	111	3
Romania	2	10.7	54.6	19
Slovakia	4	13.5	25.8	51
Slovenia	1	5.4	15.3	35
Spain	8	59.2	289.6	20
Sweden	10	55.7	144.5	38
UK	19	62.9	364.2	17
TOTAL EU-27	**143**	**877**	**3155.8**	**28**

Source: IAEA for the Total number of reactors operable and for the Nuclear electricity generation [27] and Eurostat for the total net electricity generation [26]

The average NPP in the EU-27 is made up of two nuclear power units and has net capacity of 915.7 MWe (see Table 4).

Table 4: Nuclear power reactors in the EU-27 (as of 10 March 2011) by country, its capacity and its operator(s)

COUNTRY	OPERATIONAL NUCLEAR POWER REACTORS*	TOTAL CAPACITY (MWe)*	OPERATOR
Belgium	Doel 1-4 Tihange 1-3	5 926	Electrabel GDF Suez
Bulgaria	Kozloduy 5-6	1 906	National Electric Company (NEK EAD)
Czech Republic	Dukovany 1-4 Temelin 1-2	3 678	ČEZ, a. s.
Finland	Loviisa 1-2	2 716	Fortum Power and Heat Ltd.
	Olkiluoto 1-2		Teollisuuden Voima Oyj (TVO)

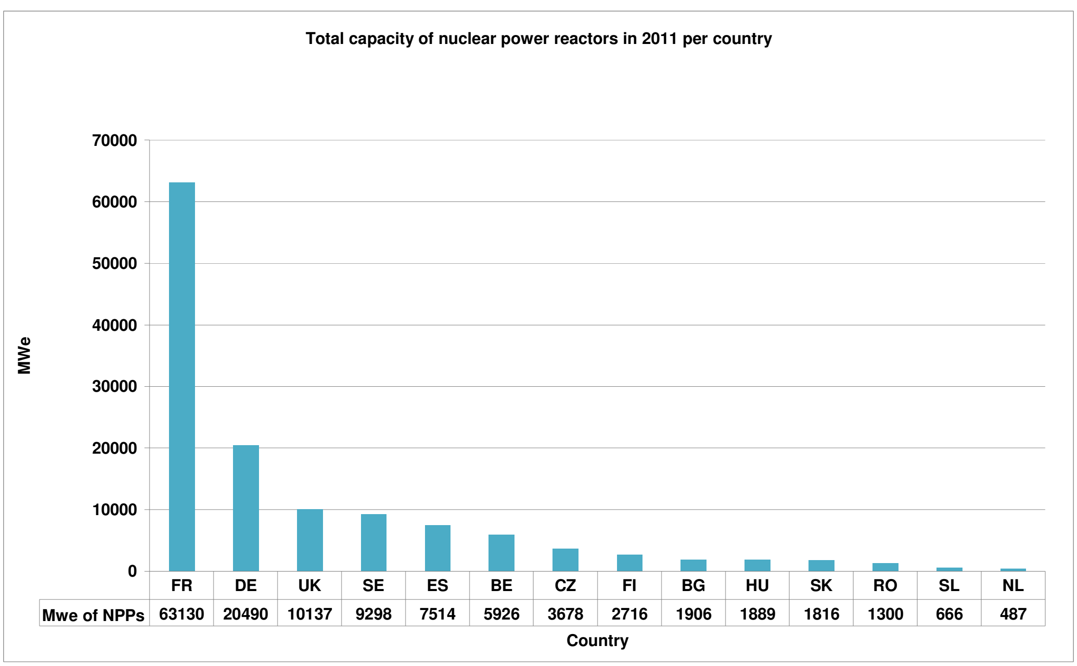
France	Belleville 1-2 Blayais 1-4 Bugey 2-5 Cattenom 1-4 Chinon B1-B4 Chooz B1-B2 Civaux 1-2 Cruas 1-4 Dampierre 1-4 Fessenheim 1-2 Flamanville 1-2 Golfech 1-2 Gravelines 1-6 Nogent-sur-Seine 1-2 Paluel 1-4 Penly 1-2 Saint-Alban 1-2 Saint-Laurent-des-Eaux B1-B2 Tricastin 1-4	63 130	EDF
Germany	Biblis A-B	20 490	RWE Power AG
	Brokdorf		E.ON Energie AG 80%; Vattenfall Europe Nuclear Energy GmbH 20%
	Brunsbuttel		Vattenfall Europe Nuclear Energy GmbH 66,7% and E.ON Energie AG 33,3% / Kernkraftwerk Brunsbuettel GmbH (KKB)
	Emsland		RWE Power AG 87,5%, E.ON Energie AG 12,5% / Kernkraftwerke Lippe-EMS GmbH
	Grafenrheinfeld KKG		E.ON Energie AG
	Grohnde		E.ON Energie AG
	Gundremmingen B-C		RWE Power AG
	Isar 1-2		E.ON Energie AG
	Krummel		Vattenfall Europe Nuclear Energy GmbH 50% and E.ON Energie 50% / Kernkraftwerke Lippe-EMS GmbH
	Neckarwestheim 1-2		EnBW Kraftwerk AG
	Philippsburg 1-2		EnBW Kraftwerk AG
	Unterveser		E.ON Energie AG
Hungary	Paks 1-4	1 889	Magyar Villamos Művek Zrt.(MVM Zrt.) (Hungarian Power Companies Ltd.)
Netherlands	Borssele 1	487	EPZ (50% ERH; 50% Delta Energy)
Romania	Cernavoda 1-2	1 300	Nucleaelectrica S.A.
Slovakia	Bohunice 3 -4 Mochovce 1-2	1 816	Slovénske elektrárne as. (66% ENEL SpA)
Slovenia	Krsko NPP (NEK)	666	GEN Energija
Spain	Almaraz 1-2	7 514	CNAT (Iberdrola Generación 53%, ENDESA Generación 36% and Unión Fenosa 11%)
	Asco 1-2		Asociacion Nuclear Asco-Vandellos A.I.E. ANAV (Endesa (85%); Iberdrola (15%)
	Cofrentes		IBERDROLA Generación
	Santa Maria de		NUCLENOR, S.A

	Garona		
	Trillo 1		CNAT
	Vandellos 2		ANAV
Sweden	Forsmark 1-3	9 298	Forsmark Kraftgrupp AB (Vattenfall owns it 66%, the Swedish Power Group 25.5% and E.ON Sverige 8.5%).
	Oskarshamn 1-3		Oskarshamnsverkets Kraftgrupp OKG (E.ON Sverige owns it 54.5% and Fortum owns 45.5%)
	Ringhals 1-4		Vattenfall AB
UK	Dungeness B1-B2	10 137	EDF Energy
	Hartlepool 1-2		EDF Energy
	Heysham A1-A2		EDF Energy
	Heysham B1-B2		EDF Energy
	Hinkley Point B1-B2		EDF Energy
	Hunterston B1-B2		EDF Energy
	Oldbury 1		Magnox North Sites (the Magnox North and Magnox South sites are now all managed by Magnox Limited)
	Sizewell B		EDF Energy
	Torness 1-2		EDF Energy
	Wylfa 1-2		Manox North Sites (the Magnox North and Magnox South sites are now all managed by Magnox Limited)

* Source: IAEA [27]

The total net MWe capacity of the 143 nuclear power reactors in the EU-27 is 130 953 MWe. Figure 2 shows the same capacity, only divided per country.

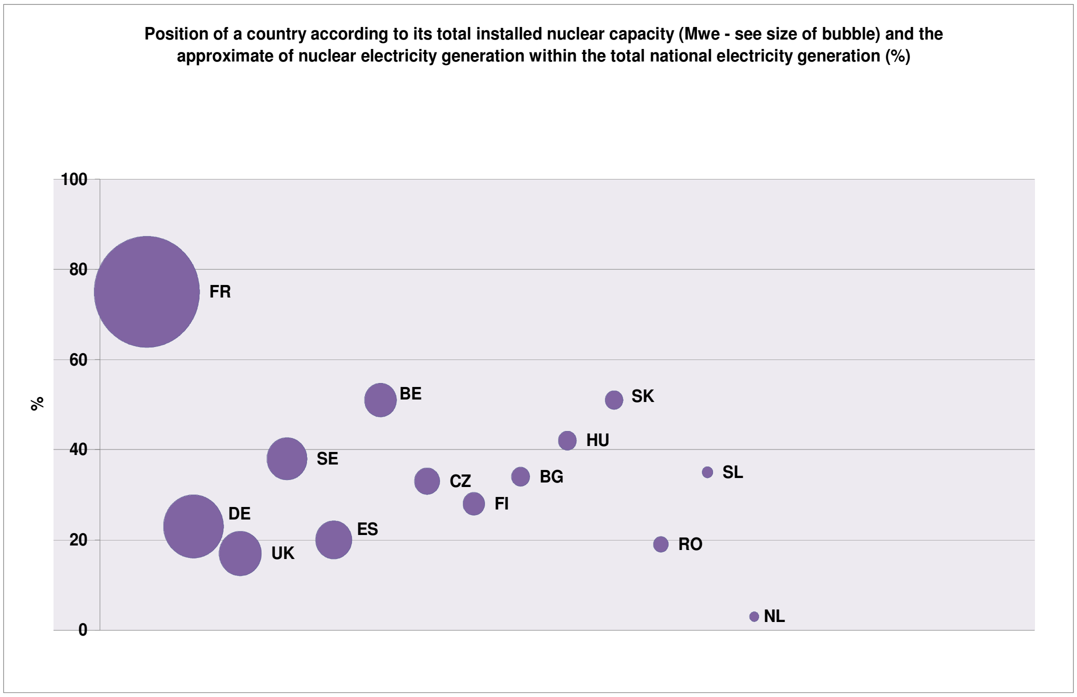
Figure 2: Total capacity of nuclear power reactors per EU-27 MS in 2011 in descending order



Source: IAEA [27]

According to the installed capacity and the share of nuclear generation within the total electricity generation, one could present the situation in the EU-27 like this:

Figure 3: Position of a country according to its total installed nuclear capacity (Mwe - see size of bubble) and the approximate of nuclear electricity generation within the total national electricity generation (%)

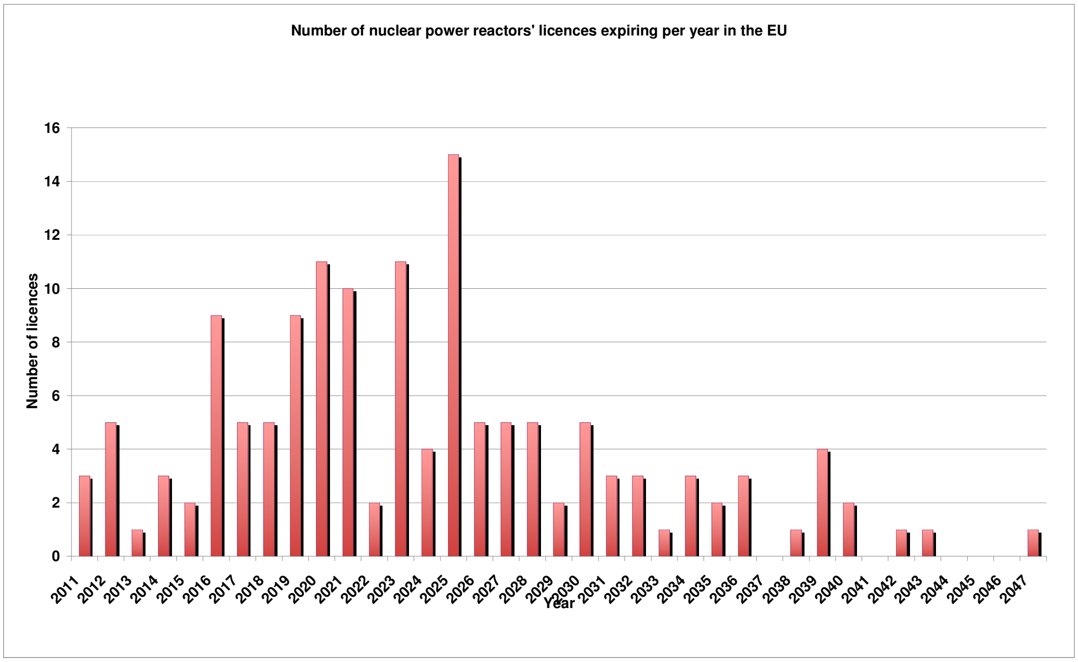


Source: IAEA for Nuclear electricity generation [27] and Eurostat for the total net electricity generation [26]

2.2. CHANGES IN THE NUCLEAR LANDSCAPE IN THE EU-27 IN THE FUTURE

The operating licences of some 95 nuclear power reactors in the EU-27 are due to expire in the period up to 2025, the bigger part of these, some 53, in the period between 2020 and 2025. In this calculation are not taken into account the possible life extensions that are under consideration in some of the nuclear power countries. Namely, the life of some 79 nuclear reactors, including all French ones, might be prolonged in the same period by 10 or 20 years.

Figure 4: Number of licences of nuclear power reactors in the EU-27 that will expire until 2047



Source: World Nuclear Association [28]

Besides considering the extension of the life-span of some NPPs in the EU-27 (with the exception of Germany[9]) like for example in Belgium [29] [30], Bulgaria [31], Czech Republic [32], France [33], Hungary [34], Slovakia [34], Slovenia [35], Spain [36] [37], there are also plans for building new NPPs in the EU-27, for e.g.in Poland [38], while some are already under construction (in France, Finland and Slovakia).

At the moment, 6 new reactors with the total capacity of 5 888 MWe are being built in EU-27. There are plans/proposals for some 47 new reactors more in the long-term future with the total capacity of 62 065 MWe.

Table 5: Nuclear reactors under construction or planned/proposed in the EU-27 (as of 10 March 2011) by country, their capacity and by their operator(s)

COUNTRY	NUCLEAR REACTOR S UNDER	NUCLEAR REACTORS PLANNED/PROPOSED	TYPE	CAPA	OPERATOR

9 Between 11 March and May 2011 it was decided that 8 nuclear reactors will be shut down in Germany, the remaining 9 reactors will be shut down earlier than expected: by 2022. The plan to build 10 new nuclear reactors in Italy was dropped after the referendum held in June 2011. This changes significantly the data in the Table 5.

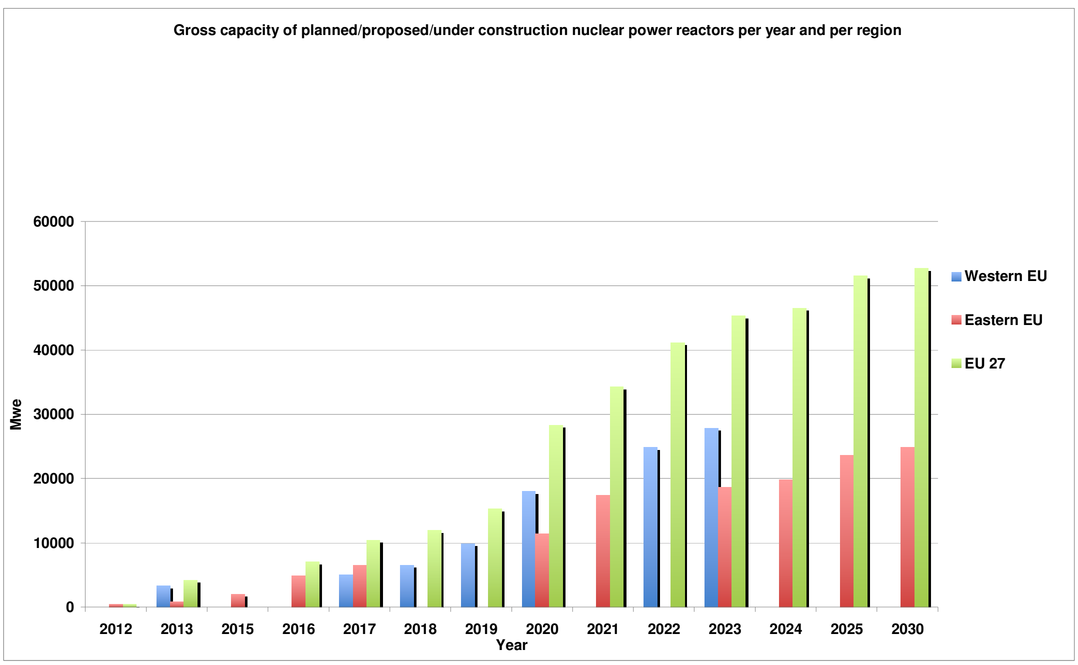
	CONSTRUCTION			CITY (MWe)	
Bulgaria	2		VVER-1000 (AES-92)	1 906	National Electric Company (NEK EAD)
		2	AP1000?	1 900	
Czech Republic		3	unknown	3 600	ČEZ, a. s.
Finland	1		EPR	1600	Teollisuuden Voima Oyj (TVO)
		2	EPR, ABWR, or APR-1400	3 000	Fennovoima Oy Teollisuuden Voima Oyj (TVO)
France	1		EPR	1 750	EDF, ENEL (12,5%)
		2	EPR	2 820	EDF, ENEL (12, 5%)
Hungary		2	unknown	2 200	Magyar Villamos Művek Zrt.(MVM Zrt.) (Hungarian Power Companies Ltd.)
Italy		10		17 000	
Lithuania		1	unknown	1 700	Visaginas Nuclear Energy (Visagino Atominė Elektrinė, VAE) company
Netherlands		1	PWR	1 000	EPZ (50% ERH; 50% Delta Energy)
Poland		6	unknown	6 000	PGE
Romania		3	CANDU 6	1 965	Nucleaelectric a S.A.
Slovakia	2		V-213	880	Slovenske elektrarne as.
		1	unknown	1 200	JESS (Slovak Nuclear Energy Company)
Slovenia		1	unknown	1 000	GEN Energija

UK		13	EPR or AP1000	18 680	EDF Horizon (RWE + E.ON) NuGeneration (Iberdrola, GDF Suez, Scottish & Southern)
TOTAL	**6 (total 5 888 MWe)**	**47 (total 62 065 MWe)**			

Source: IAEA for Reactors under construction [27] and World Nuclear Association for Reactors Planned and Reactors Proposed [28]

From the figure 5 below it seems that the new build is starting earlier in western EU countries than in eastern EU countries, but it seems that these will catch up soon.

Figure 5: Capacity of nuclear power reactors under construction or planned/proposed and divided by region



Source: World Nuclear Association [28]

The construction of new NPPs in the EU-27, the operation of existent as well as new NPPs and the decommissioning of the same will all require a significant number of nuclear experts and technicians to be employed in the following years. The same goes for the EU-27 nuclear research and development (R&D), regulatory and the E&T infrastructure. The objective of these new employments is the efficient and, most importantly, safe operation of present and future nuclear power reactors in the EU-27.

3. SUPPLY OF AND DEMAND FOR NUCLEAR EXPERTS IN THE EU-27

3.1. SUPPLY SIDE

3.1.1. HIGHER EDUCATION INSTITUTIONS' SUPPLY OF NUCLEAR EXPERTS IN THE EU-27– ACCORDING TO THE DATA RECEIVED

The response rate of the higher education institutions contacted was above 90 %.

The data received from the contacted institutions covered the:

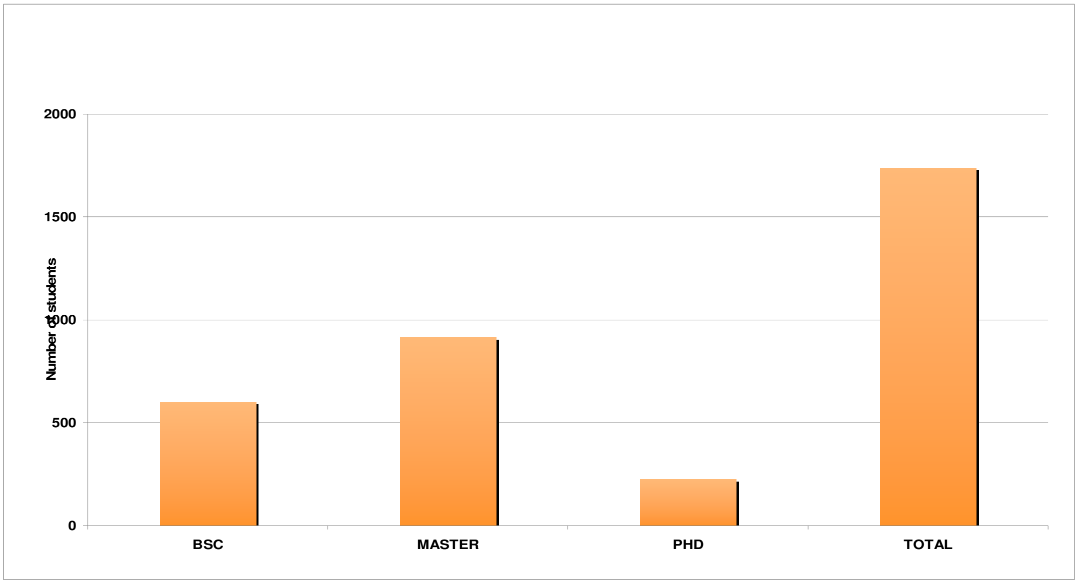
1. Number of nuclear engineering students that graduated in year 2009;
2. Number of students following nuclear energy – related subjects that graduated in 2009;
3. Number of nuclear engineering students that started with their studies in the school year of 2009/2010; and
4. Number of students following nuclear energy - related subjects that started with their studies in the school year of 2009/2010.

Some examples of studies/subjects covered with the above data: Nuclear engineering, Nuclear physics, Nuclear chemistry, Nuclear energy.

The initial results showed that:

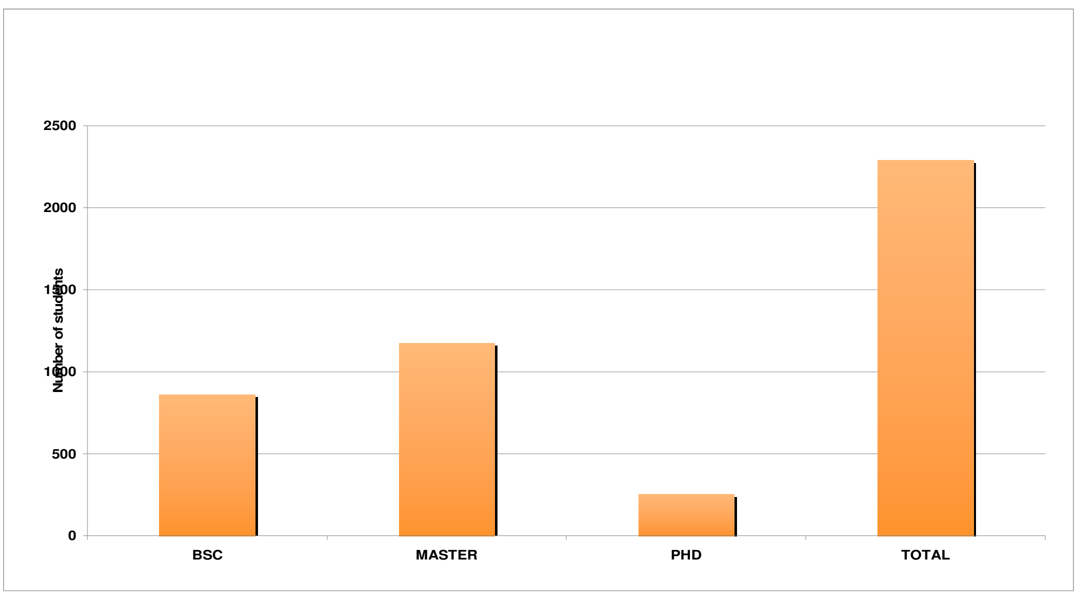
1. Slightly less than 1800 nuclear engineering students and students following nuclear energy – related subjects graduated in the year 2009 on BSc, MSc, or PhD levels in the higher education institutions in the EU-27, and
2. Around 2300 students started their nuclear engineering and nuclear energy – related studies in the year 2009/2010.

Figure 6: Number of nuclear engineering students/students following nuclear energy – related subjects that graduated in 2009 on BSc, MSc, PhD level in the EU-27 (received data)



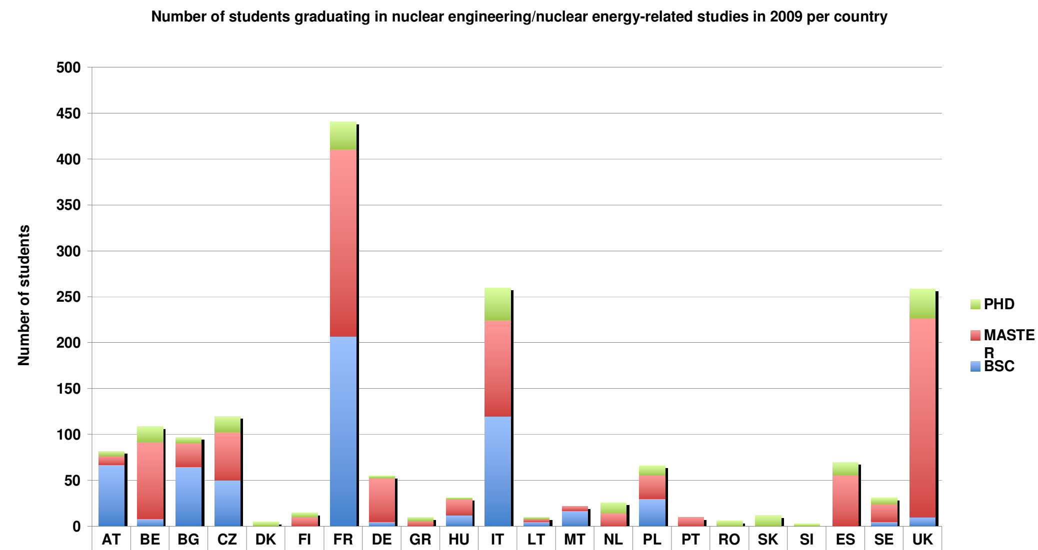
Source: EHRO-N

Figure 7: Number of nuclear engineering students/students following nuclear energy – related subjects that started their studies in year 2009/2010 in the EU-27 (received data)



Source: EHRO-N

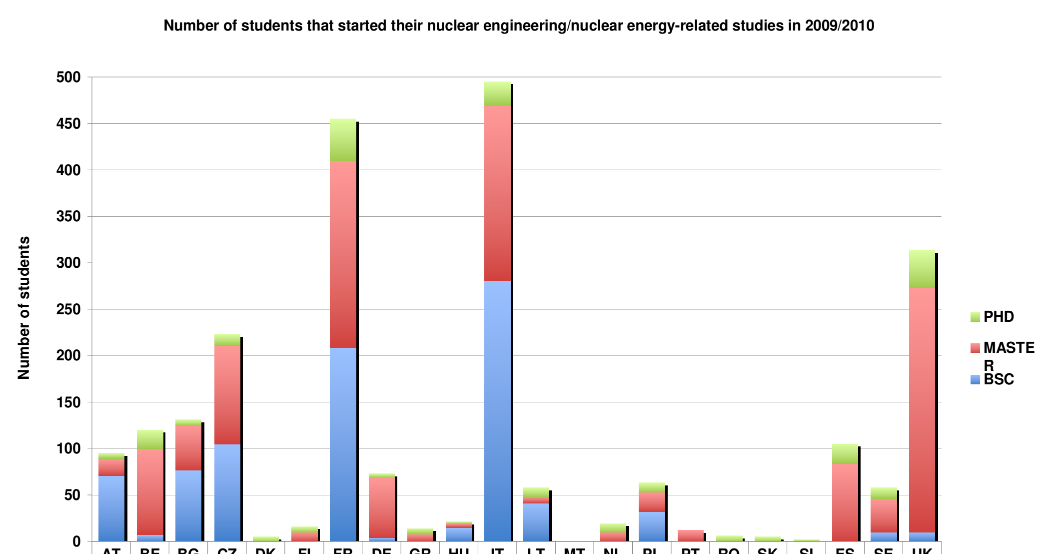
Figure 8: Number of nuclear engineering students/students following nuclear energy – related subjects that graduated in 2009 on BSc, MSc, PhD level (per country) (received data)



	AT	BE	BG	CZ	DK	FI	FR	DE	GR	HU	IT	LT	MT	NL	PL	PT	RO	SK	SI	ES	SE	UK
PHD	5	17	6	17	5	5	30	2	4	1	35	2		12	10		6	12	3	14	6	32
MASTER	10	84	26	53		10	204	48	6	18	105	3	5	14	26	10				56	20	217
BSC	67	8	65	50			207	5		12	120	5	17		30						5	10

Source: EHRO-N

Figure 9: Number of nuclear engineering students/students following nuclear energy - related subjects that started their studies in year 2009/2010 (per country) (received data)



	AT	BE	BG	CZ	DK	FI	FR	DE	GR	HU	IT	LT	MT	NL	PL	PT	RO	SK	SI	ES	SE	UK
PHD	6	20	6	12	5	6	45	4	6	2	25	10		9	10		6	5	2	21	12	40
MASTER	18	93	48	106		10	201	65	8	4	189	7		10	21	12				84	36	263
BSC	71	7	77	105			209	4	0	15	281	41			32						10	10

Source: EHRO-N

3.1.2. BENCHMARKING OF THE DATA ON THE HIGHER EDUCATION INSTITUTIONS' SUPPLY OF NUCLEAR EXPERTS IN THE EU-27

Some of the higher education institutions did not respond to the questionnaire and thus, the received data needed to be benchmarked against existing national data.

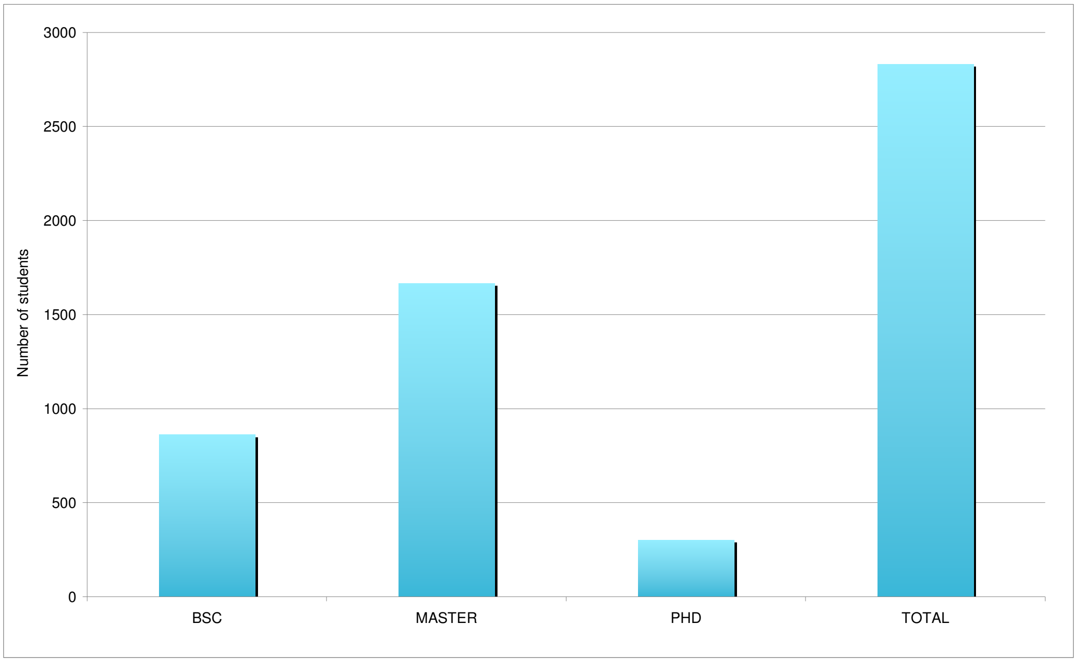
When the data that was received from the universities, this was also benchmarked against the data existing on a national level and/or against the knowledge of experts some of which are also members of the EHRO-N SAG.

The data about the number of nuclear engineering students/students following nuclear energy – related subjects that **graduated** in year 2009 was benchmarked for Belgium, Finland, France, Germany, Slovakia, Spain and the UK. The data per country changed as follows:

- Belgium: the number of BSc level students increased to a minor extent
- Finland: the data was confirmed to be in the range received
- France: the data was adapted according to CFEN figures [39]
- Germany: the number of PhD level students increased to a minor extent
- Slovakia: the numbers for BSc, MSc and PhD level students changed slightly, and
- Spain: the numbers for BSc, MSc and PhD level students matched the data received
- UK: the data for MSc and PhD level students was changed slightly following data from Cogent [17].

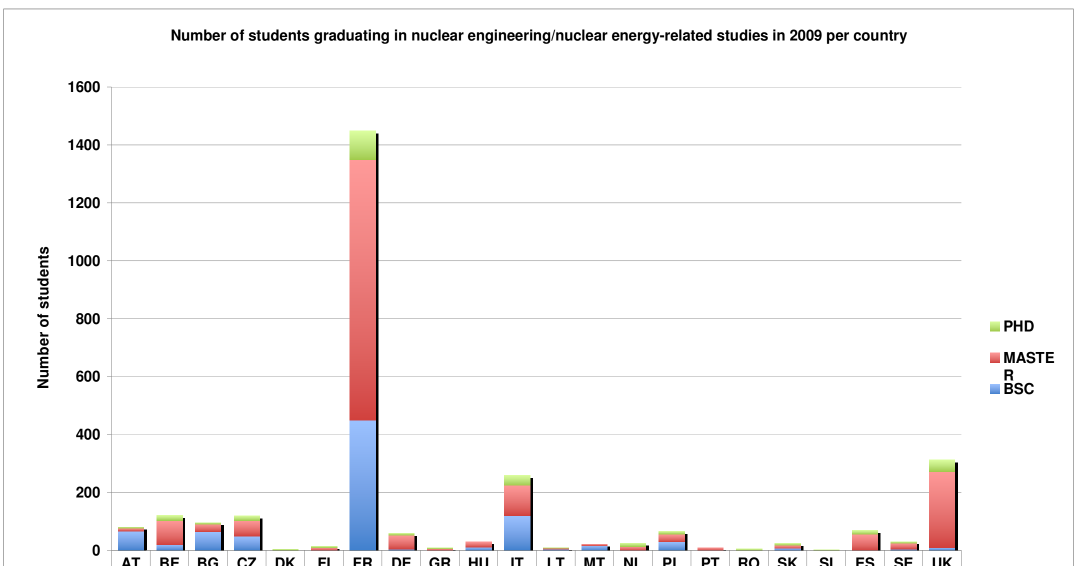
After the benchmarking exercise the total number of nuclear engineering students/students following nuclear subjects that **graduated** in year 2009 on BSc, MSc, or PhD levels raised to above 2800.

Figure 10: Number of nuclear engineering students/students following nuclear energy - related subjects that graduated in 2009 on BSc, MSc, PhD level in the EU-27 (benchmarked data)



Source: EHRO-N

Figure 11: Number of nuclear engineering students/students following nuclear energy – related subjects that graduated in 2009 on BSc, MSc, PhD level (per country) (benchmarked data)



	AT	BE	BG	CZ	DK	FI	FR	DE	GR	HU	IT	LT	MT	NL	PL	PT	RO	SK	SI	ES	SE	UK
PHD	5	17	6	17	5	5	100	7	4	1	35	2		12	10		6	7	3	14	6	40
MASTER	10	84	26	53		10	900	48	6	18	105	3	5	14	26	10		11		56	20	263
BSC	67	20	65	50			450	5		12	120	5	17		30			7			5	10

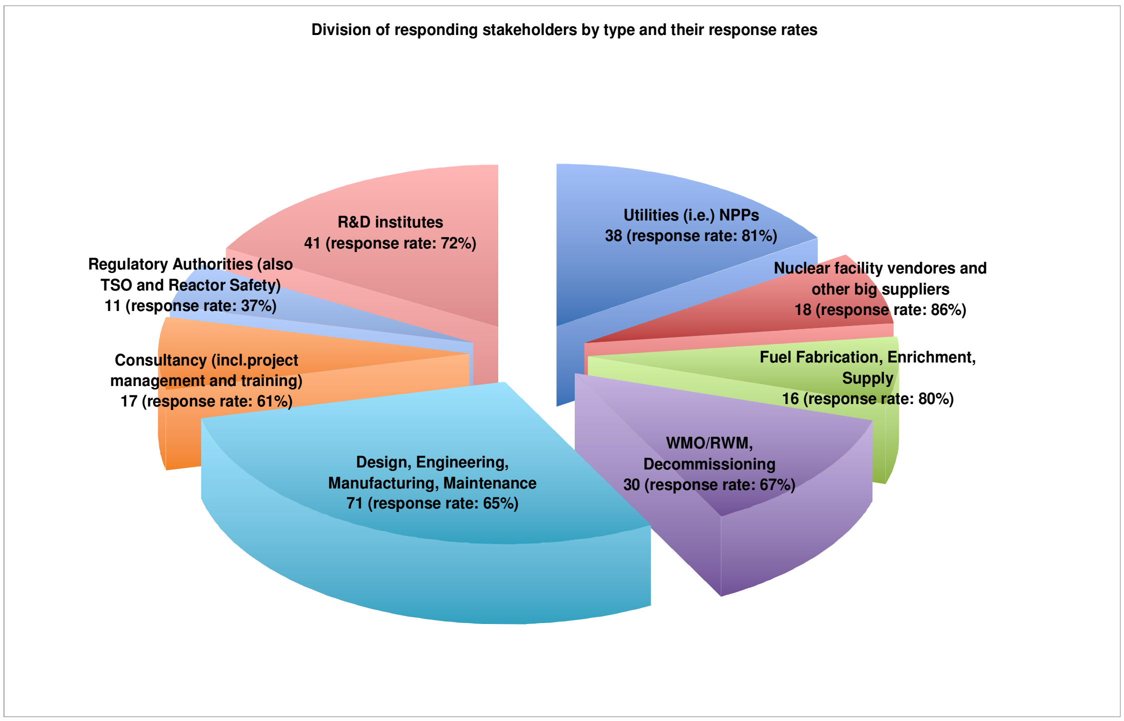
Source: EHRO-N

3.2. DEMAND SIDE

3.2.1. RESULTS ON THE BASIS OF THE DATA RECEIVED

The response rate to the questionnaire was relatively high with 242 organisations, or nearly 70 %, providing the requested data. Below is a chart that shows the division of the stakeholders by their type that answered to the questionnaire and their response rates.

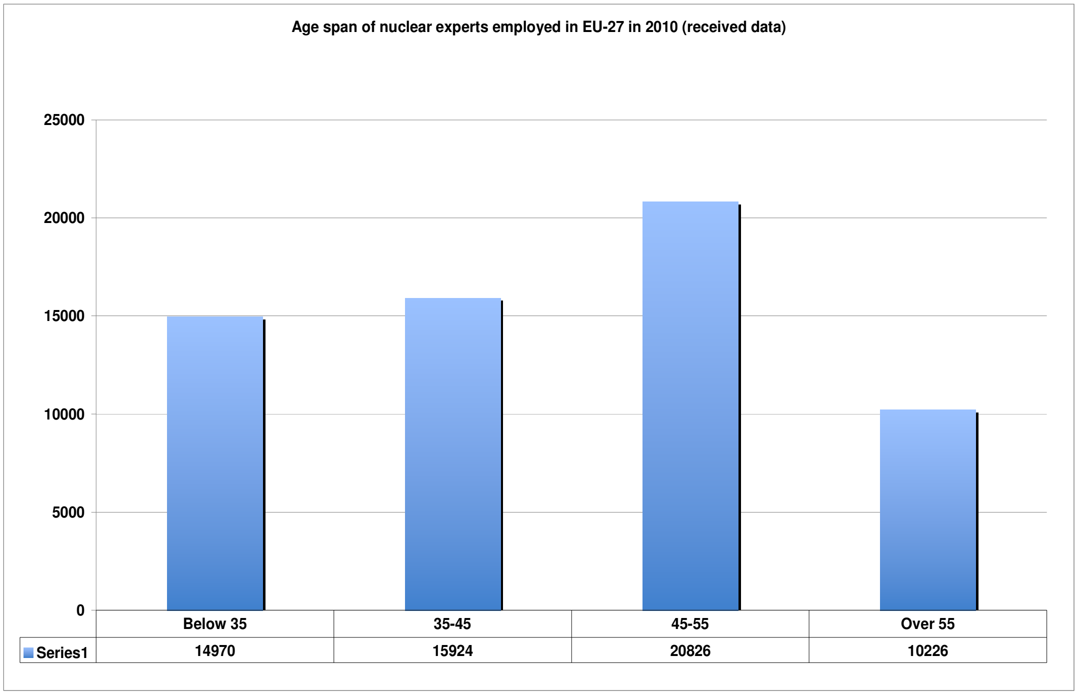
Figure 12: Division of responding stakeholders by type and their response rates



Source: EHRO-N

The total number of nuclear experts employed in 2010 in the 68% of the responding nuclear stakeholders was 62 958. The nuclear experts employed in the main EU-27 nuclear stakeholders are included in this figure. The distribution per age groups of these nuclear experts is shown in figure 13. The age group “45-55” is the most numerous one; it is worth noting that the sum of age groups “below 35” (14 970) and “35-45” (15 924) is smaller than the sum of age groups “45-55” (20 826) and “above 55” (10 226) suggesting that there is indeed a strong need in EU-27 for recruitment of nuclear experts in the next 10 to 20 years to just replace the aging workforce.

Figure 13: Number of nuclear experts employed in the EU-27 in 2010 divided by age group (received data)

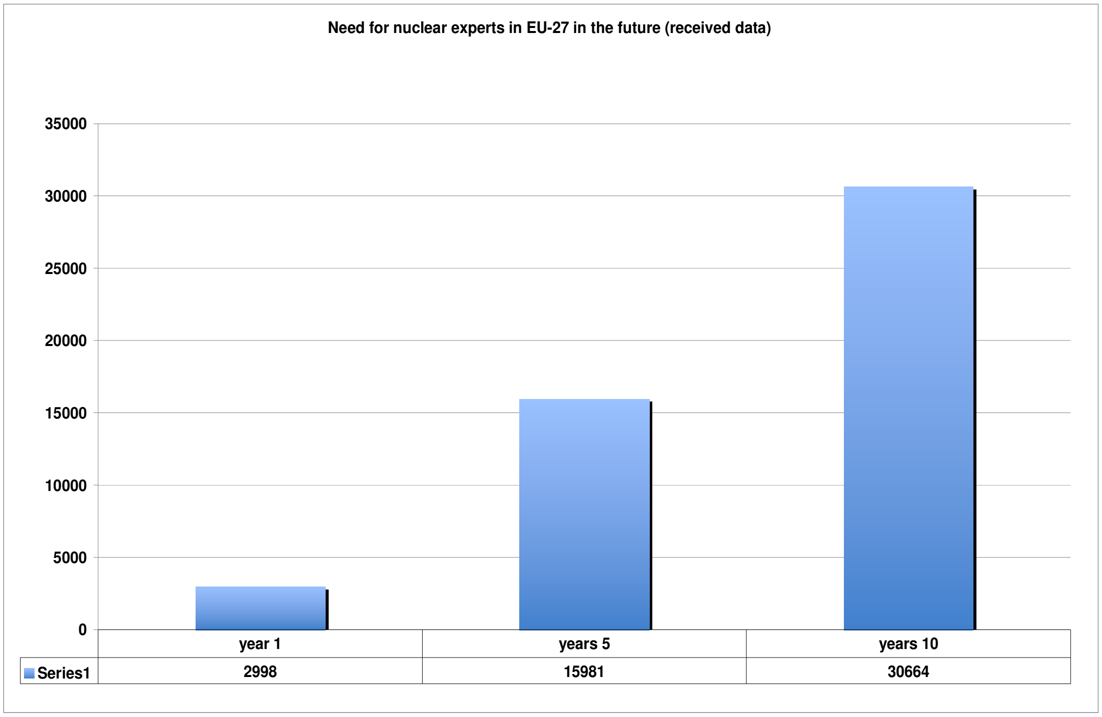


Source: EHRO-N

Figure 14 shows cumulatively the need for nuclear experts in the EU-27 in the short-(1 year), medium-(5 years), and long-term (10 years) period. This figure is only representing the situation for the 68% of the stakeholders contacted, which actually responded to the EHRO-N questionnaire.

The need for nuclear experts by 2020 by the nearly 70% nuclear stakeholders that responded to the questionnaire is 30 664.

Figure 14: Need for nuclear experts in the EU-27 in the short-, medium-, and long-term future (received data)



Source: EHRO-N

3.2.2. ESTIMATIONS OF THE REMAINING DATA

Estimations for the stakeholders, which did not respond to the EHRO-N questionnaire, were necessary in order to have a more comprehensive picture of the need for nuclear experts in the EU-27. But, in order to be able most accurately possible assess the data for those circa 30% of the stakeholders in the EU-27, this methodology was followed:

1. Where no data was received through the most reliable source (the person responsible for human resource from the contacted organisations themselves), data was extracted from IAEA report on the Status and Trends in Nuclear Education [40];
2. Where no data could be extracted from the above mentioned IAEA report, data was estimated according to information available on the website of the organisation in question;
3. If there was no data available on the website of the organisation in question, the data was simply not estimated as no pointers were available.

The data was estimated according to the above methodology for 32% organisations active in the nuclear industry in the EU-27, which means that was estimated was actually the:

1. *Total number of nuclear experts in 2010*, and the
2. *Need for new nuclear experts in the next 10 years*: the assumption was that this number represents 40%[10] of the total (replacing retired nuclear experts +

10 According to the data received, the need for nuclear experts up to 2020 represented 49% of the total number of nuclear experts employed in the nuclear energy sector in 2010.

employing new experts), except in cases where here was an explicit mentioning, either on the website of the stakeholder in question in the above mentioned IAEA report on Status and Trends in Nuclear Education, of the retirement percentage and needs in the future.

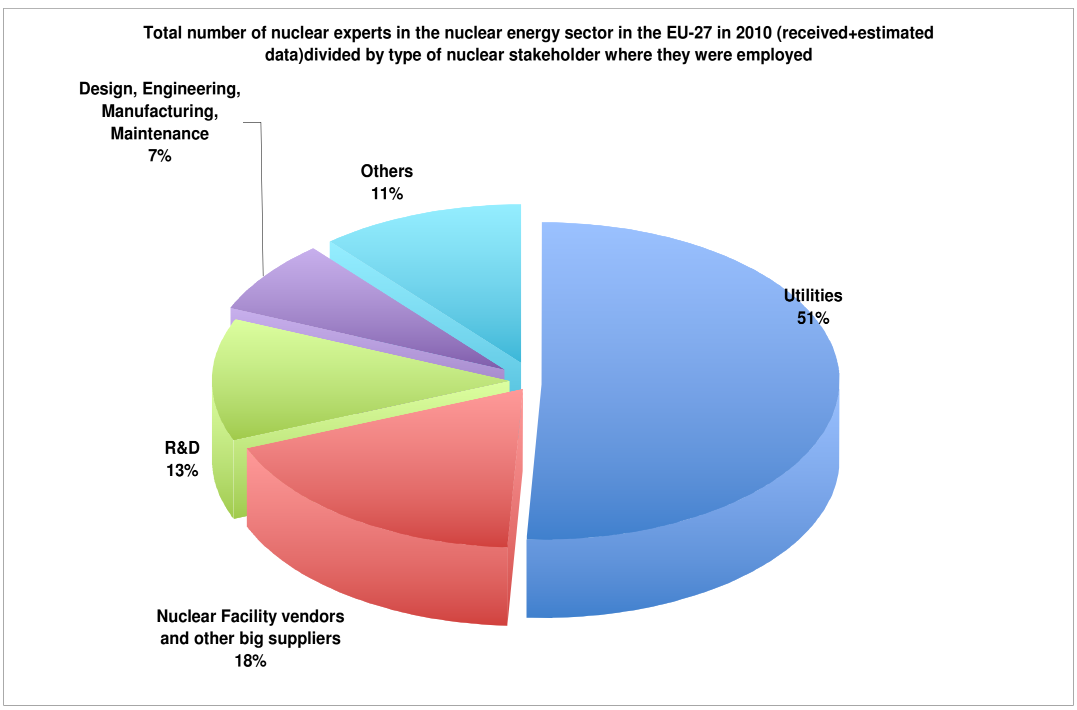
3.2.3. DEMAND FOR NUCLEAR EXERTS – SUM OF RECEIVED DATA AND ESTIMATED DATA

The sum of both, data received (RD) and data estimated (ED), gives the final picture as to the total number of employed nuclear experts in 2010 and the need for nuclear experts in the EU-27 in the future.

The total number of nuclear experts employed in the nuclear energy sector in the EU-27 in 2010 was thus 77 605 (RD+ ED = 62958 +14647).

These 77 605 nuclear experts were estimated to be employed as shown in figure 15.

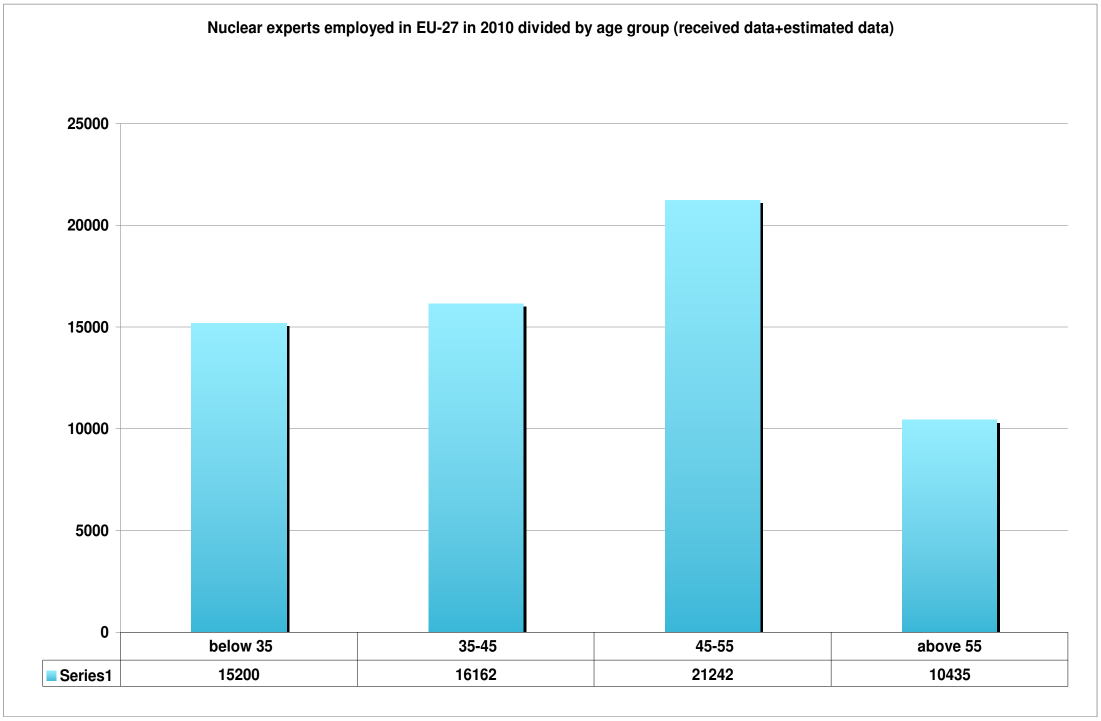
Figure 15: Total number of nuclear experts in the nuclear energy sector in the EU-27 in 2010 (received data+estimated data) divided by type of nuclear stakeholder where they were employed



Source: EHRO-N

The distribution per age groups changed only slightly from the one shown in figure 13 above.

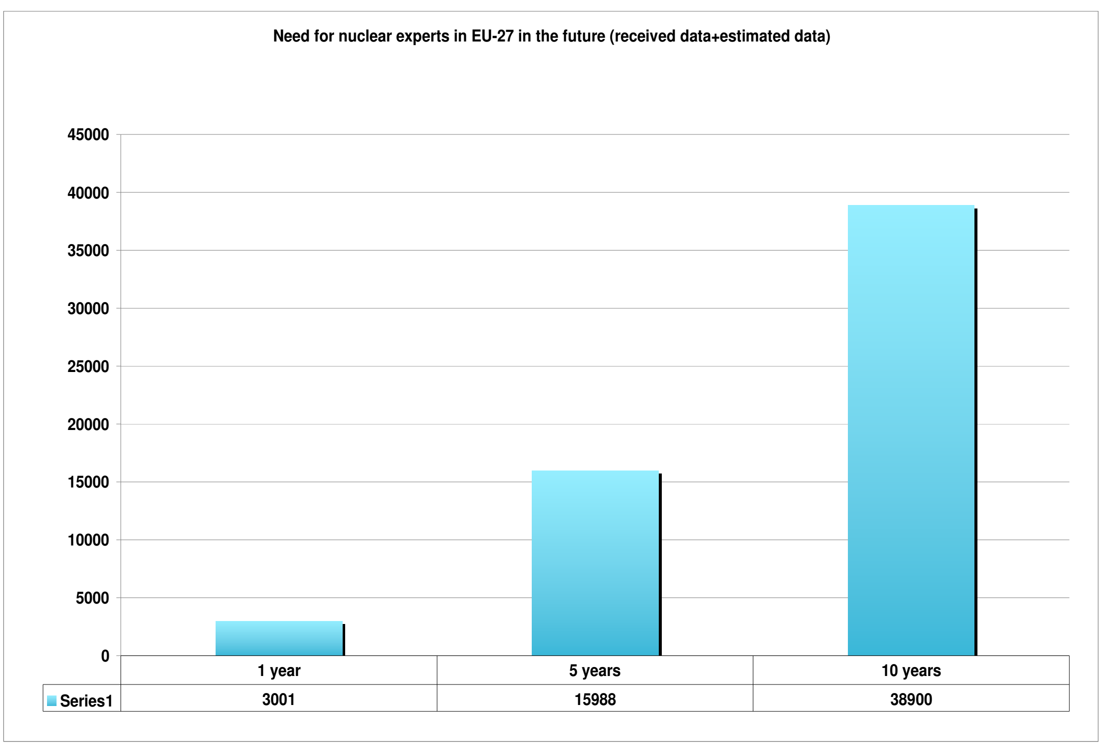
Figure 16: Total number of nuclear experts employed in the EU-27 in 2010 divided by age group (received data+estimated data)



Source: EHRO-N

In the next 10 years **38 900** nuclear experts will be needed by the EU-27 nuclear energy sector.

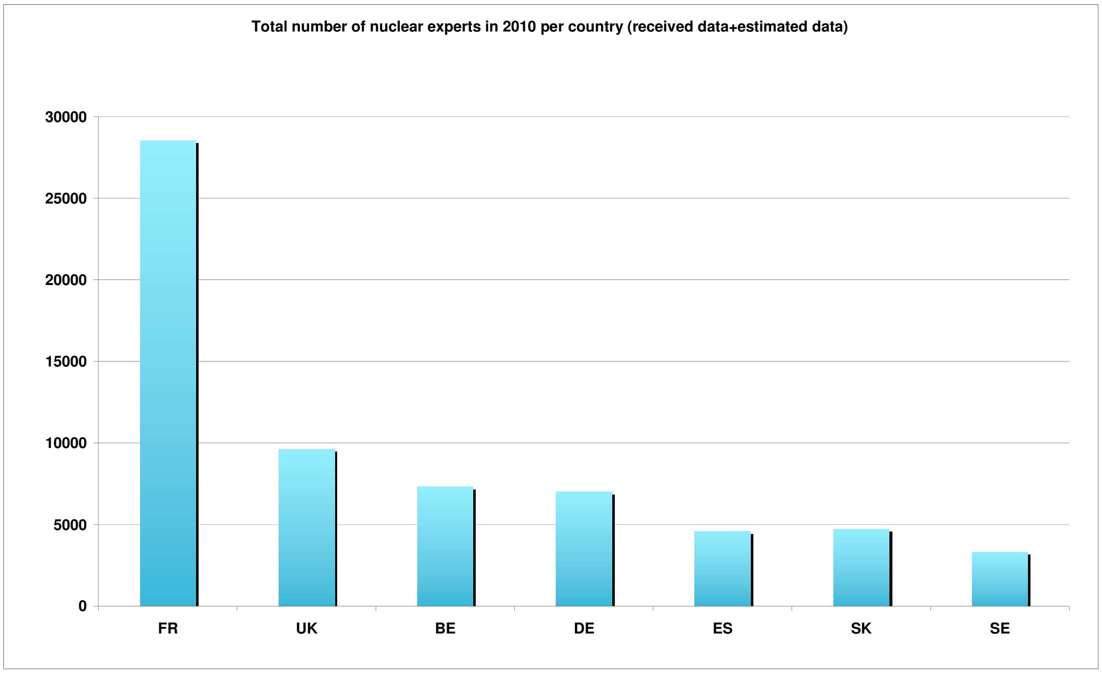
Figure 17: Need for nuclear experts in the EU-27 in the short-, medium-, and long-term future (received data+estimated data)



Source: EHRO-N

As for the data per country, figure 18 shows that the number of nuclear experts employed in 2010 in the EU-27 was the biggest in France, followed by the United Kingdom, Belgium, Germany, Spain, Slovakia and Sweden.

Figure 18: Total number of nuclear experts in 2010 per country (received data+estimated data):

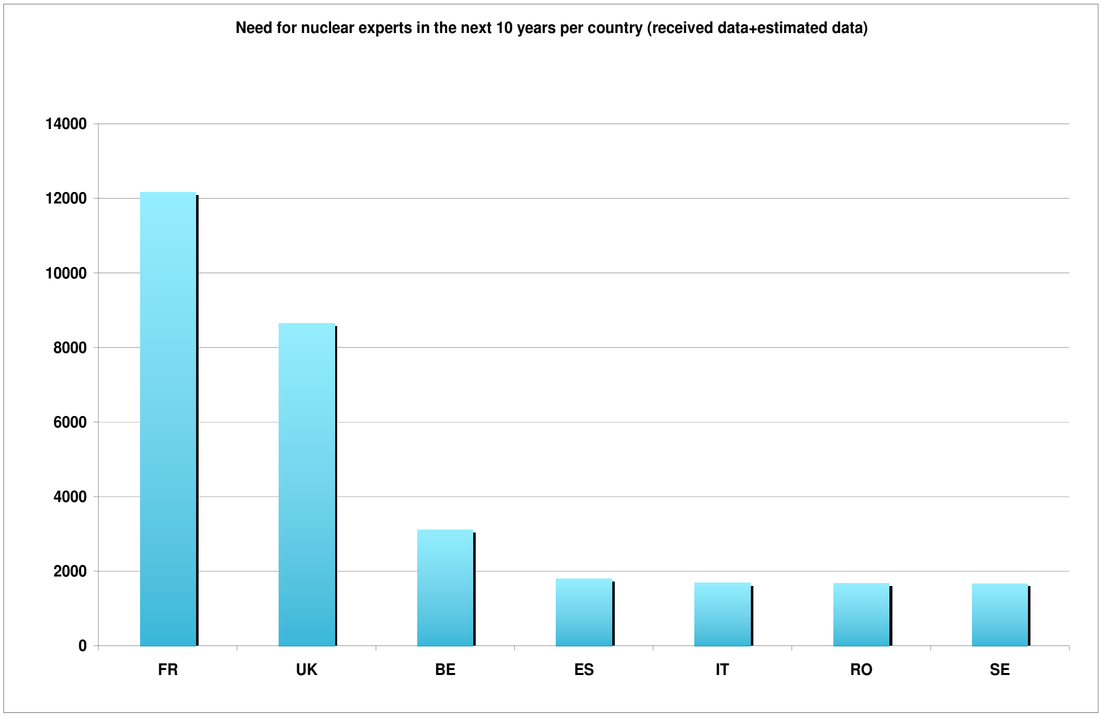


Source: EHRO-N

The need for nuclear experts in the next 10 years will be, according to the data received and estimated, biggest in France, followed by the United Kingdom, Belgium, Spain, Italy, Romania and Sweden. It is worth noting that the graph below may not adequately reflect the situation as of today since there was a significant change as regard the Italian nuclear program: namely, following a referendum in June 2011 a permanent ban was imposed on the reintroduction of a nuclear power program in this country.[11]

Figure 19: Need for nuclear experts in the next 10 years per country (received data+estimated data)

11 The Fukushima-Daiichi nuclear accident, which happened in Japan in March 2011, might have also contributed to the decision to hold the referendum in Italy.



Source: EHRO-N

4. PUTTING SUPPLY OF AND DEMAND FOR NUCLEAR EXPERTS IN THE EU-27 INTO PERSPECTIVE

4.1. SUPPLY OF RELEVANT GRADUATES IN THE EU-27 FOR THE NUCLEAR ENERGY LABOUR MARKET

For the purpose of this report we used the relevant statistical data available from Eurostat on the supply of graduates in EU-27 for the nuclear energy labour market. The statistical data available from Eurostat refers to ISCED 1997. ISCED is the International Standard classification of Education and it was developed by was designed by Unesco in the early 1970's to serve "as an instrument suitable for assembling, compiling and presenting statistics of education both within individual countries and internationally"[12]. For the purpose of the report we used the data available about levels 5 (Bachelor and Master level) and 6 (PhD level)

The ISCED 1997 was revised in 2011 and envisages 8 levels of education, where the levels 6, 7 and 8 correspond to the levels 6, 7 and 8 of the European Qualifications Framework (EQF).[13]

EQF and ISCED 1997 do differ but are not contradictory. While the EQF envisages three levels of tertiary education (Bachelor (EQF 6), Master (EQF 7) and PhD and above (EQF 8), the ISCED 1997 distinguishes between two levels only where the levels of Bachelor and Master are gathered into one level (ISCED 5).

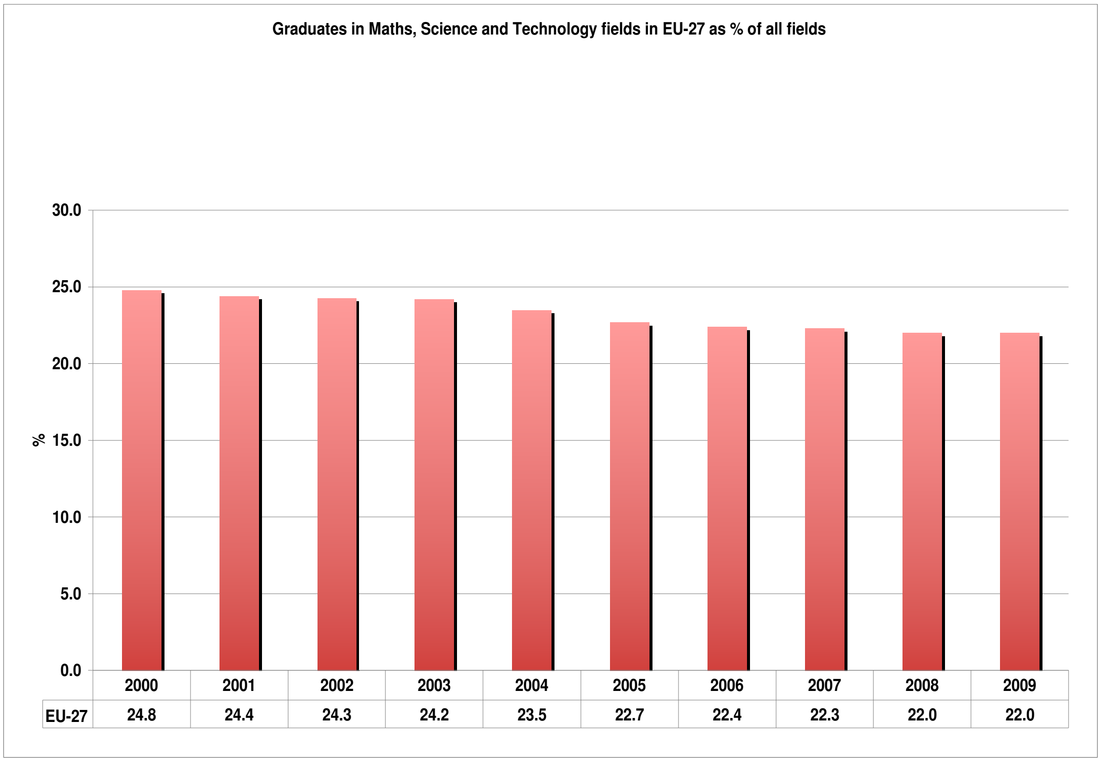
The number of all students that graduated in 2009 in all fields was 4,127,039. The share of graduates of math, science and technology (STEM) fields within graduates of all fields in the EU-27 was 22% [41].

Figure 20: Graduates levels 5-6 (ISCED 1997) in Mathematics, Science and Technology fields - as % of all fields in the EU-27

12 International Standard Classification of Education ISCED 1997,

http://www.unesco.org/education/information/nfsunesco/doc/isced_1997.htm

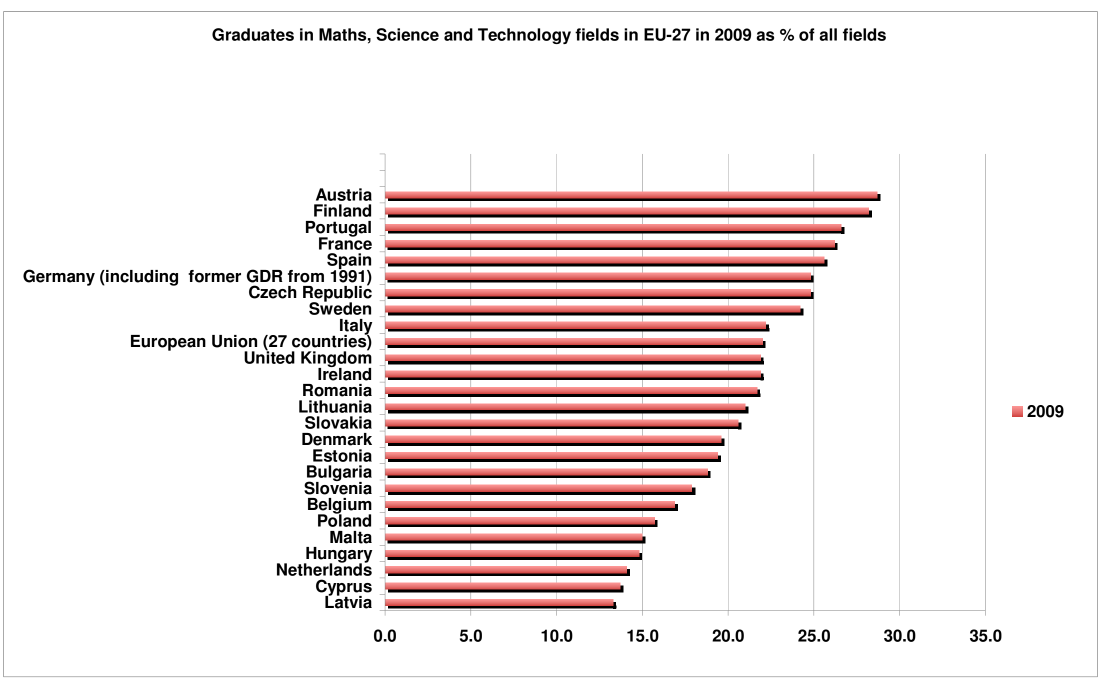
13 European Qualifications Framework, http://ec.europa.eu/eqf/about_en.htm



Source: Eurostat [41]

Austria, Finland, Portugal, France, Spain, Germany, Czech Republic, Sweden and Italy had a number of graduates in Mathematics, Science and Technology in 2009, which was above the EU-27 average.

Figure 21: Graduates levels 5-6 (ISCED 1997) in Mathematics, Science and Technology fields in 2009 as % of all fields per country

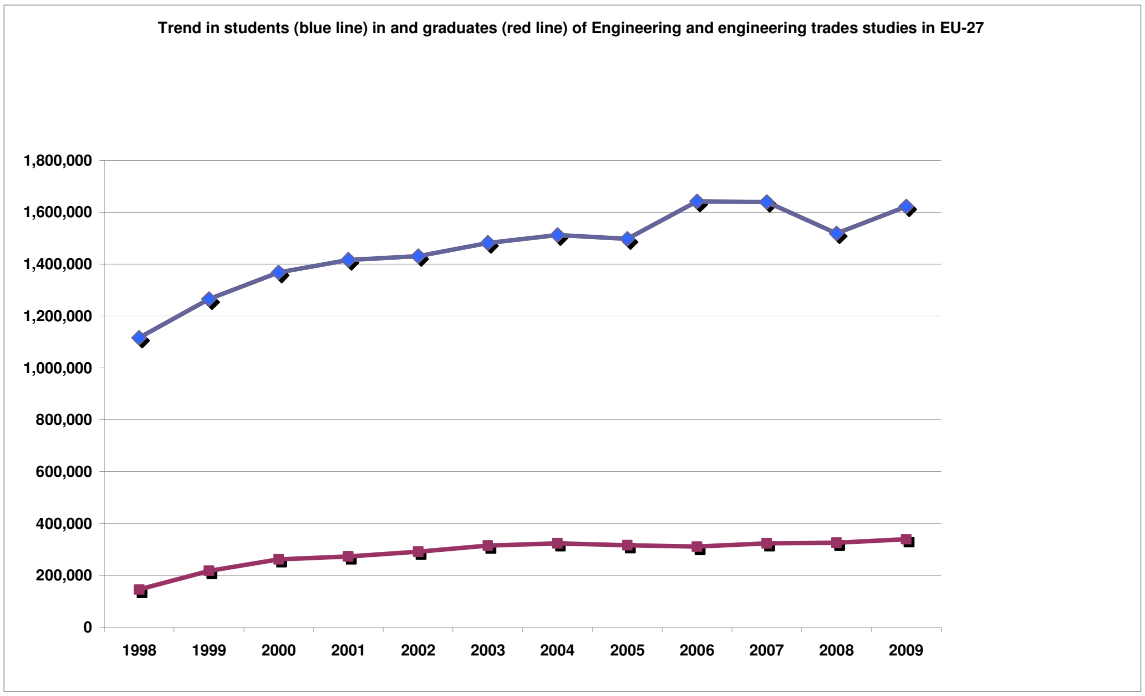


Source: Eurostat (data for Greece and Luxembourg was missing) [41]

Those employees that are of particular importance for the nuclear energy sector and that are at the same time more likely to be involved in leading-edge technology professions also outside the nuclear energy sector are the **physical, mathematical and engineering** occupations [42].

According to the Eurostat data [41], the supply of engineers graduating in 2009 throughout the European universities was estimated at 339 414 or **37.4%** of all STEM graduates in 2009.

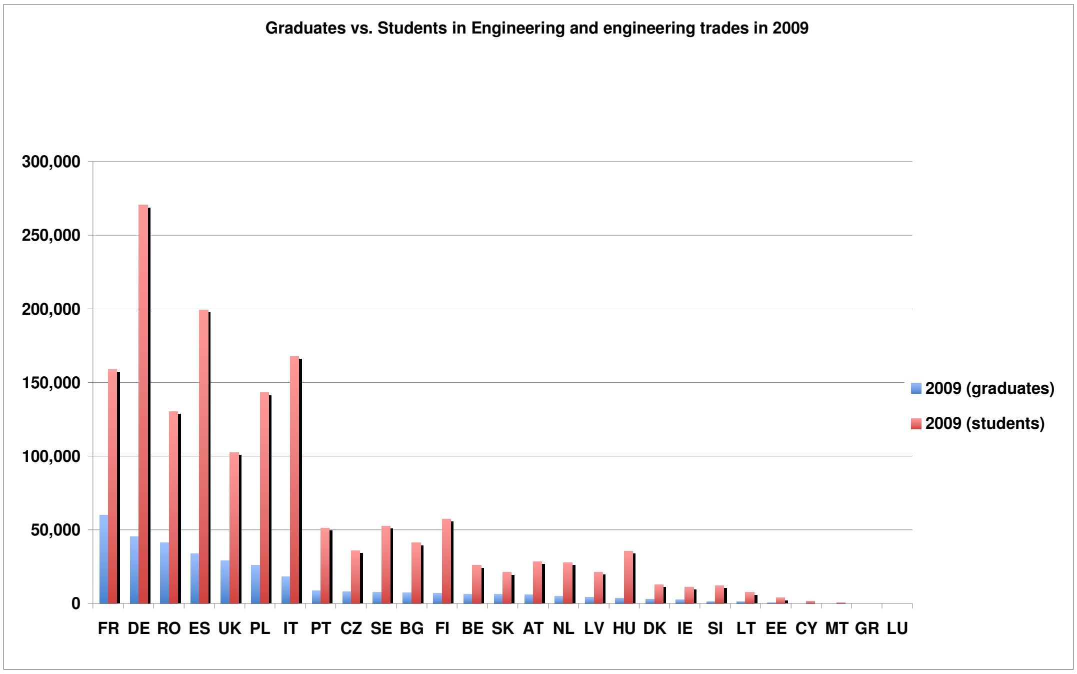
Figure 22: Trend in students entering in/graduates of Engineering and engineering trades studies (Tertiary education - levels 5-6 (ISCED 1997)) in the EU-27



Source: Eurostat [41]

Per EU-27 Member State, the situation in 2009 was as follows (starting from the one with biggest number of graduates of Engineering and engineering trades):

Figure 23: Number of students entering in/graduates of engineering and engineering trades (Tertiary education - levels 5-6 (ISCED 1997)) per country



Source: Eurostat [41]

In 2009 the amount of students graduating in engineering/engineering trades was **339 414**. One has to note though that a minimum of more than a quarter of these graduate engineers in the EU-27 will go to work in a non-engineering sector,[14] lowering the total of available engineering graduates for engineering professions to **254 560** per year.

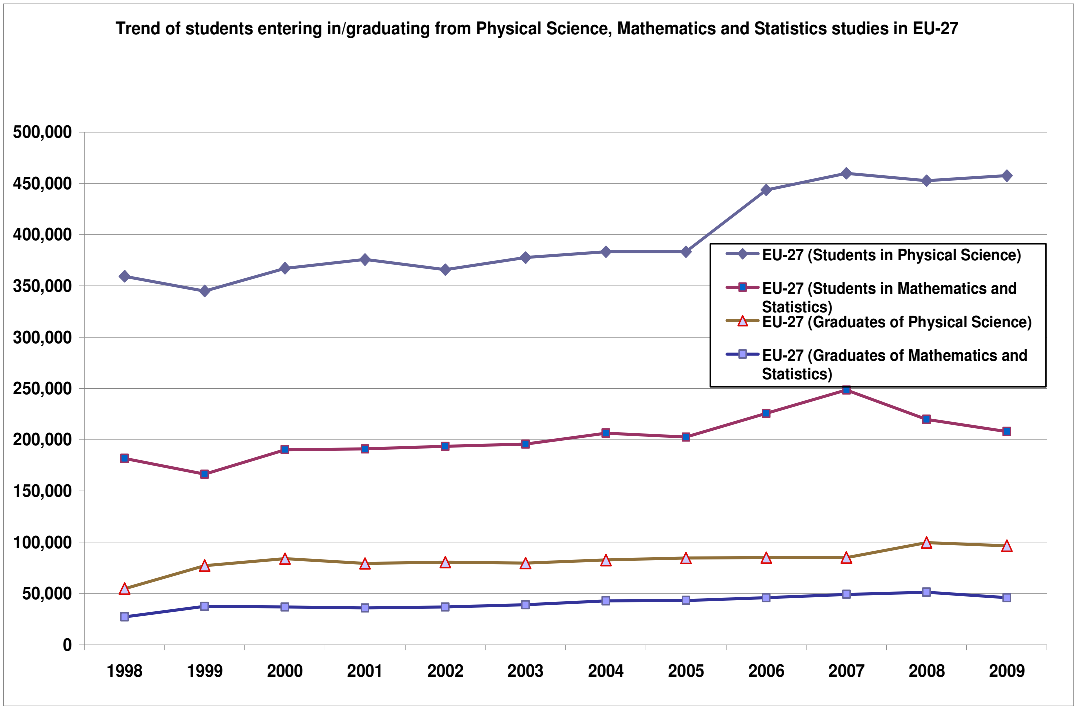
The share of students graduating in nuclear engineering within the total amount of students graduating in engineering/engineering trades in the EU-27 every year is less than **1%** (2800/339 414*100).

The number of PhD/Doctorates in engineering and engineering trades in the EU-27 in 2009 was **9 581**.

The nuclear energy sector employs as well physical scientists and mathematicians. In 2009 the amount of students graduating in physical science, mathematics and statistics was **142 134**. Figure 24 shows the trend of students graduating from these fields.

Figure 24: Trend of students entering in/graduating from Physical Science, Mathematics and Statistics (Tertiary education - levels 5-6 (ISCED 1997)) in the EU-27

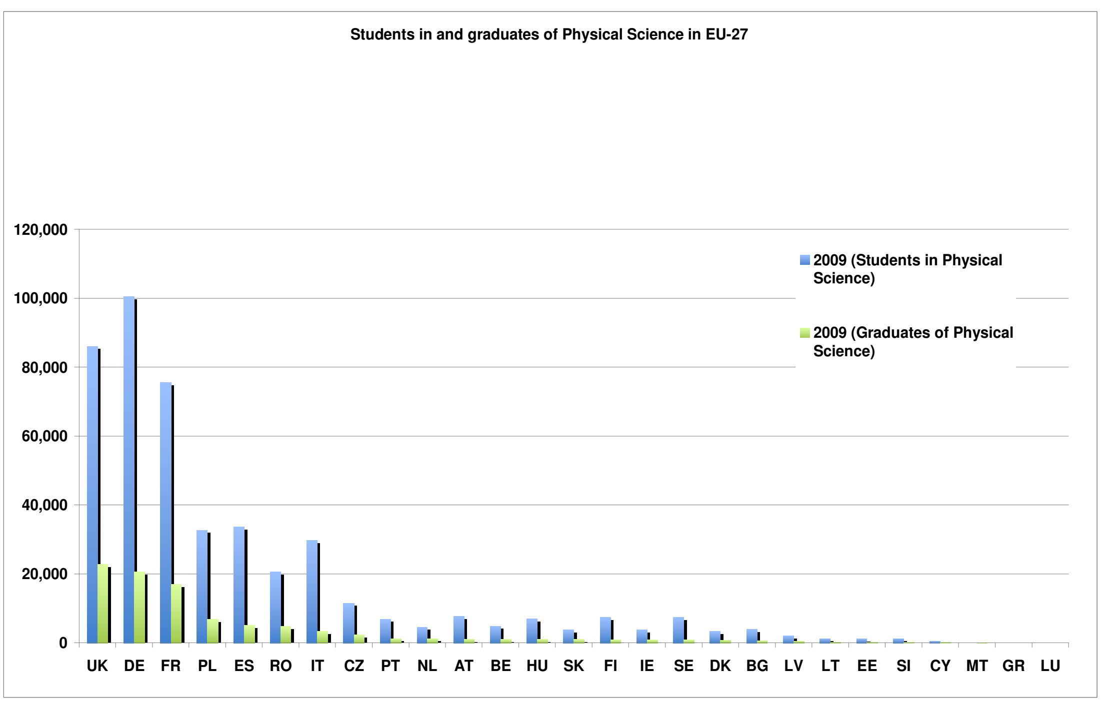
14 Eurostat estimated that in 2007 the share of graduates in engineering/engineering trades having an employment in a non-engineering sector was 28%.



Source: Eurostat [41]

Per EU-27 Member State, the situation, starting from the one with the biggest number of graduates of Physical science in 2009, was as follows:

Figure 25: Number of students entering in/graduates of Physical science (Tertiary education - levels 5-6 (ISCED 1997)) per country

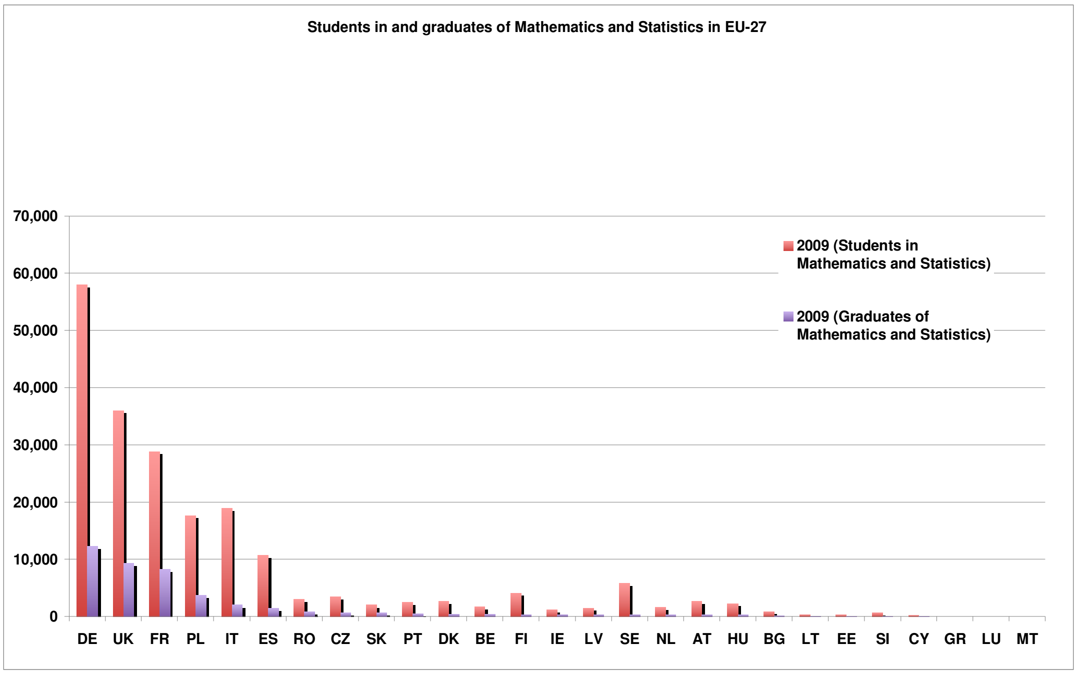


Source: Eurostat [41]

In 2009, **96 422** physical scientists graduated in the EU-27. In relative terms, that is **10.6%** of all STEM graduates in the same year.

Per EU-27 Member State, the situation, starting from the one with biggest number of graduates of Mathematics and statistics in 2009, was as follows:

Figure 26: Number of students entering in/graduates of Mathematics and Statistics (Tertiary education - levels 5-6 (ISCED 1997)) per country

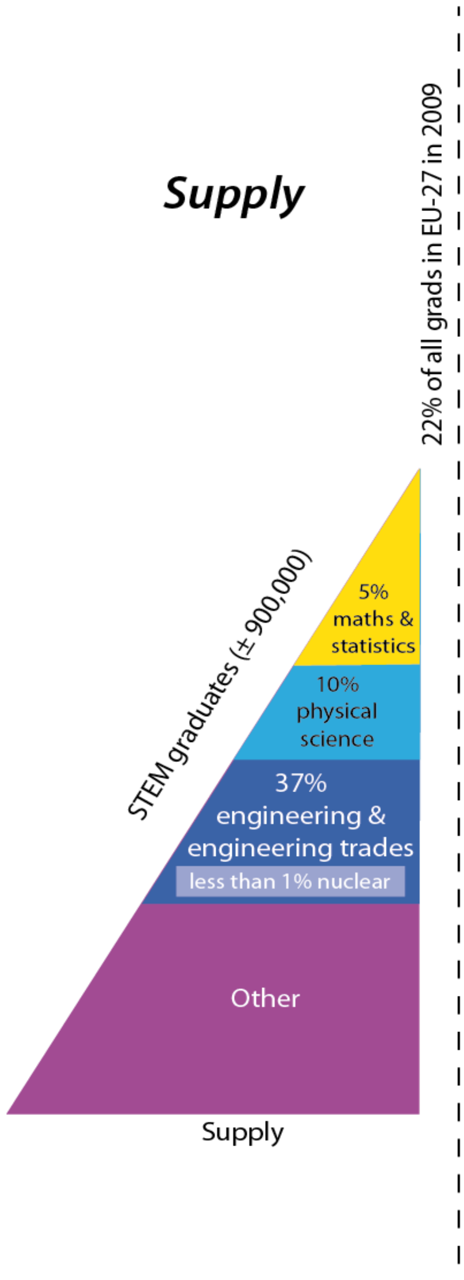


Source: Eurostat [41]

In 2009, **45 712** mathematicians and statisticians graduated in the EU-27. In relative terms, that is **5%** of all STEM graduates in the same year.

The number of PhD/Doctorates in Physical Science, and Mathematics and Statistics in the EU-27 in 2009 was **10 876** and **2 002** respectively.

Figure 27: Graphical representation of the supply of STEM graduates in the EU-27 in 2009



Source: EHRO-N

4.2. THE EU-27 HRST LABOUR MARKET

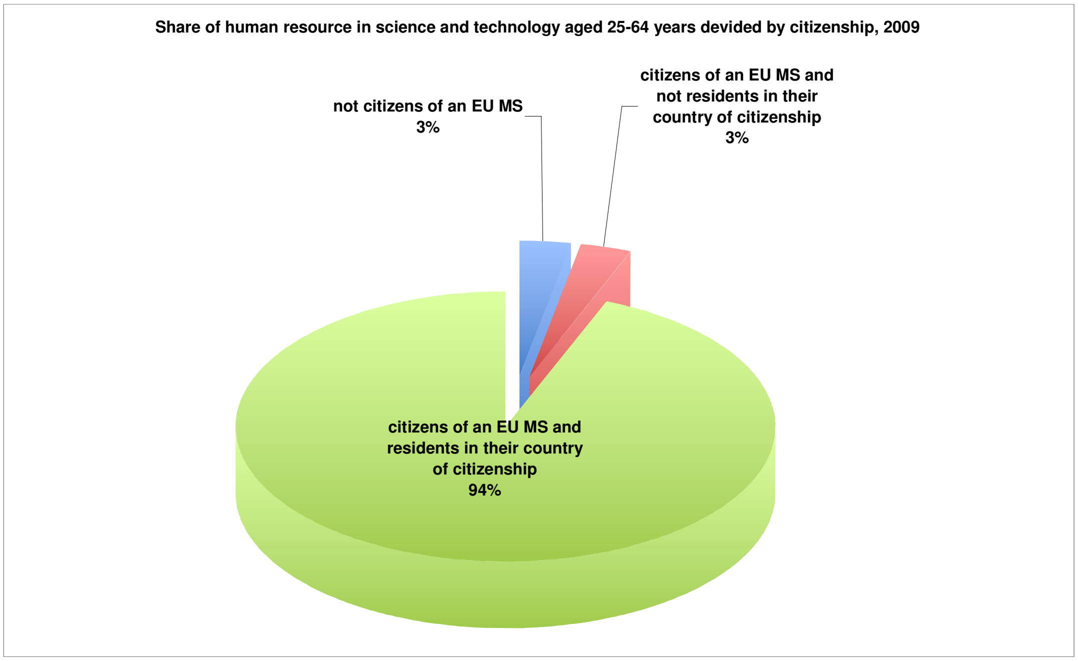
According to the OECD Canberra Manual [43] Human Resource in Science and Technology (S&T) – HRST - are defined as persons fulfilling at least one of the following conditions:

1. Human resource in S&T in terms of education — HRSTE: individuals having successfully completed tertiary level education in an S&T field of study — ISCED 97 version levels 5a, 5b or 6, and/or
2. Human resource in S&T in terms of occupation — HRSTO: individuals working in an S&T occupation as professionals and technicians.

The share of S&T human resource within the total labour force in the EU-27 in 2009 (217 827 000) was 40% in 2009 [44] [45].

Figure 28 shows the international mobility of the human resource in science and technology in the EU-27.

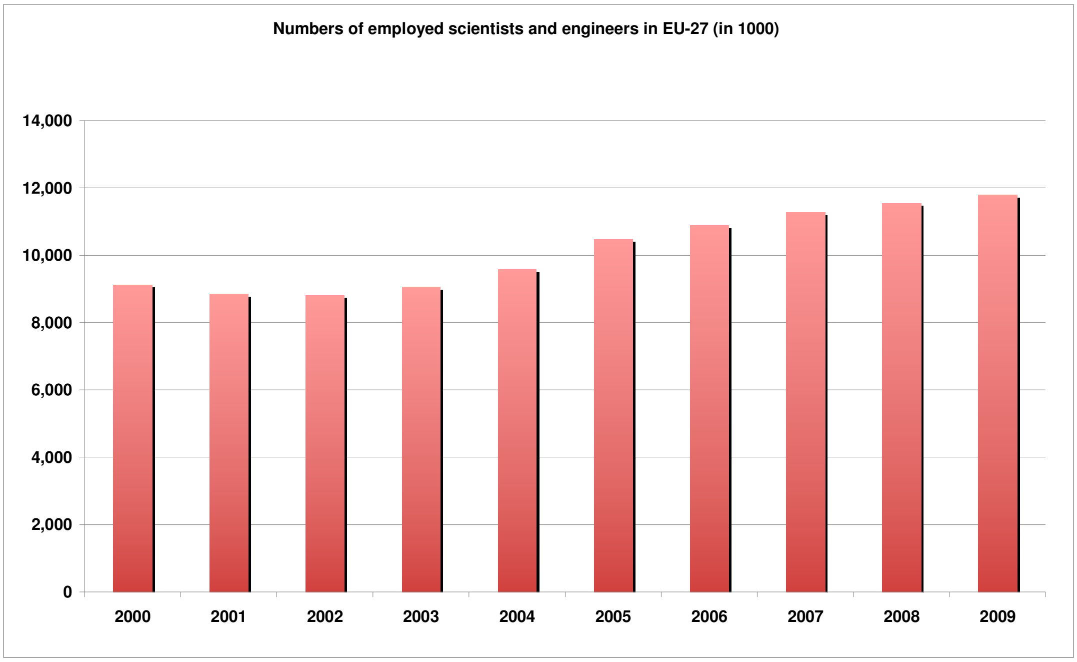
Figure 28: Share of the human resource in science and technology aged 25-64 years in the EU-27 in 2009 divided by citizenship



Source: Eurostat [46]

As for science and engineering employees specifically, the EU-27 has in recent years seen a rise in their numbers [46].

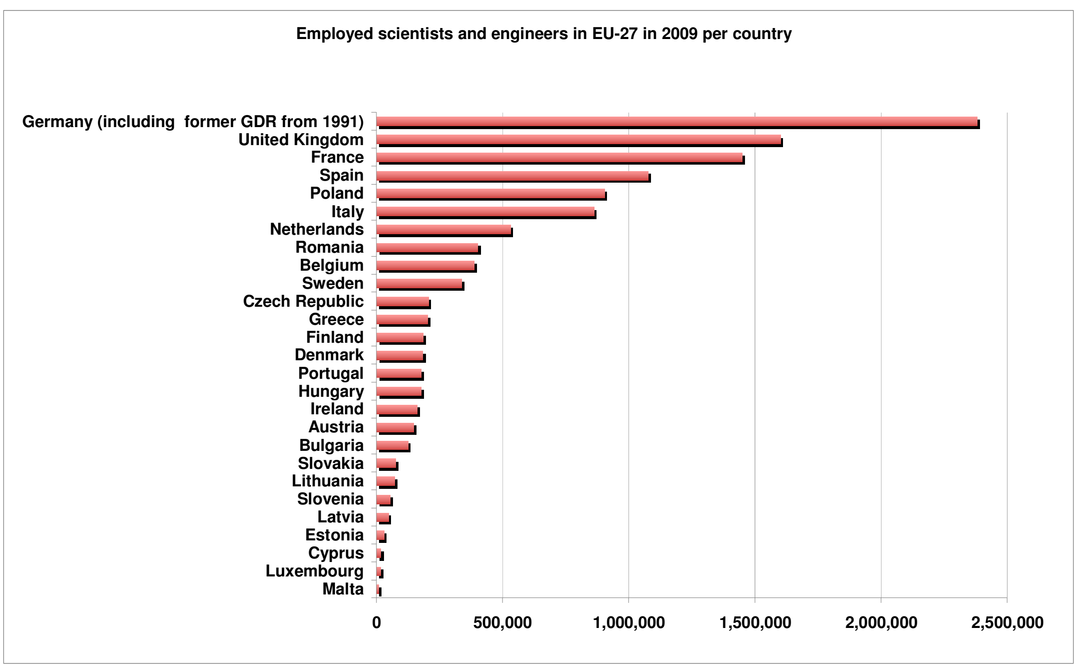
Figure 29: Total scientists and engineers in the EU-27



Source: Eurostat [48]

Germany, United Kingdom, France, Spain, Poland and Italy had the highest number of scientists and engineers employed in 2009.

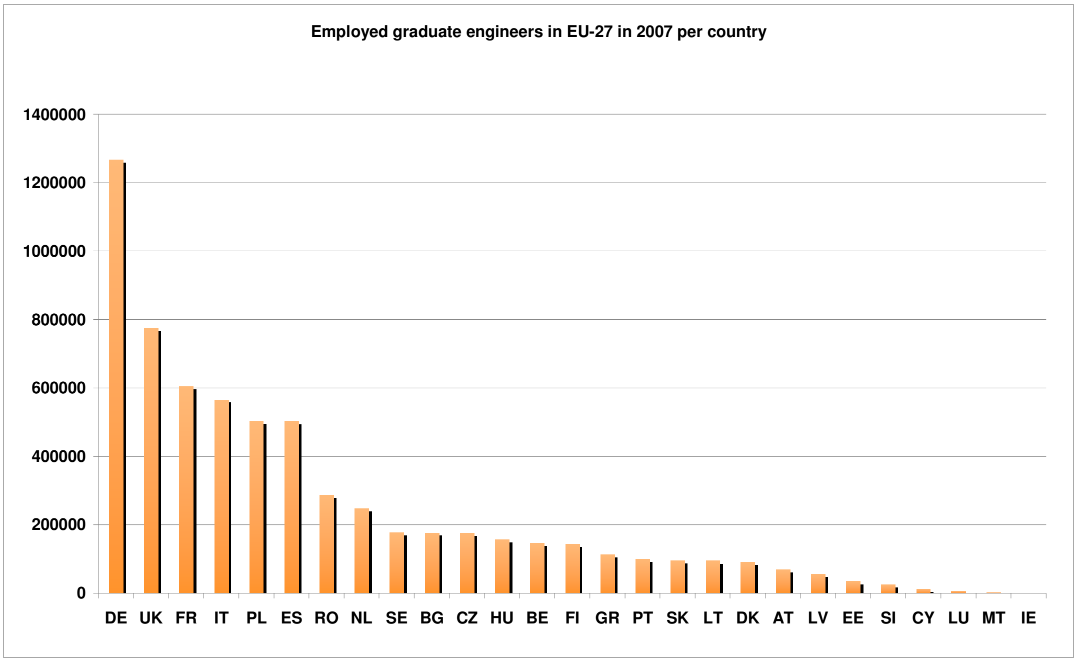
Figure 30: Total scientists and engineers by country



Source: Eurostat [48]

Of the roughly **11 million** scientists and engineers employed in the EU-27 in 2009, **6 421 800** are graduate engineers. In 2007, Germany, France and United Kingdom had the highest number of employed graduate engineers.

Figure 31: Employed graduate engineers in the EU-27 in 2007



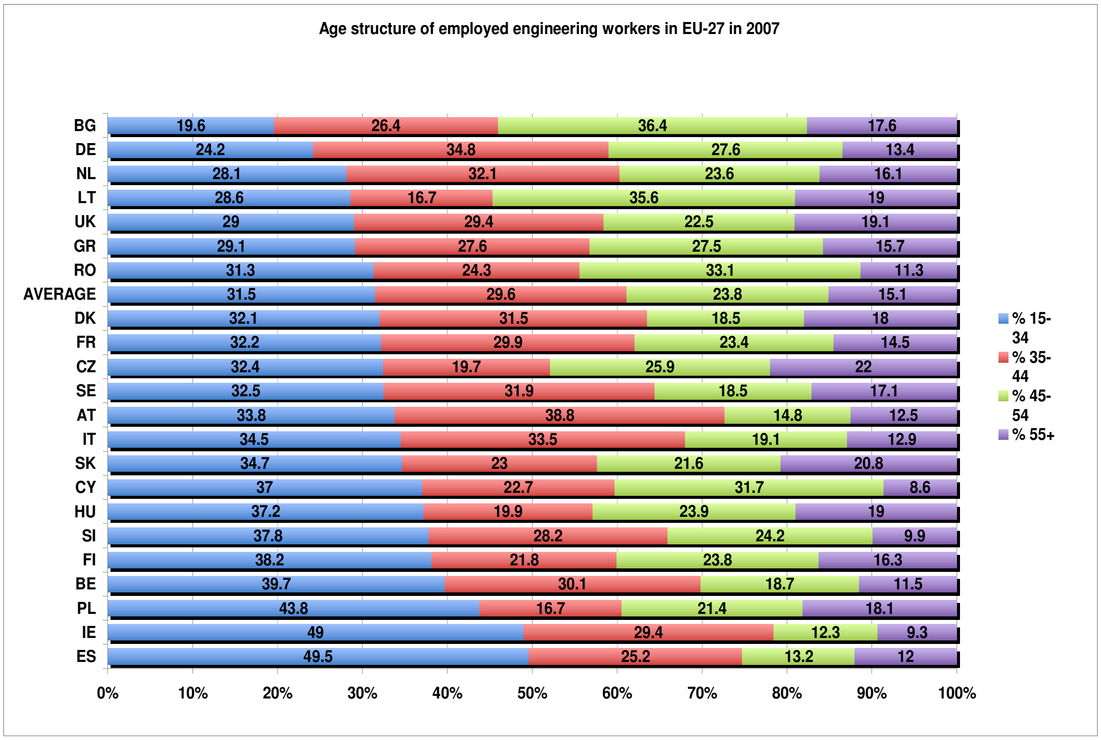
Source: European Engineering Report [49]

Approximately **25%** of the engineers from figure 31 work outside the engineering professions, lowering the number of graduate engineers working in engineering professions in the EU-27 to **4 816 350**.

The average age structure of the employed engineering workers[15] in the EU-27 is 31.5% for those aged 15-34 years, 29.6% for those aged 35-44 years, 23.8 for those aged 45-54 years and 15.1% for those aged above 55 years of age.

Figure 32: Age structure of employed engineering workers in the EU-27

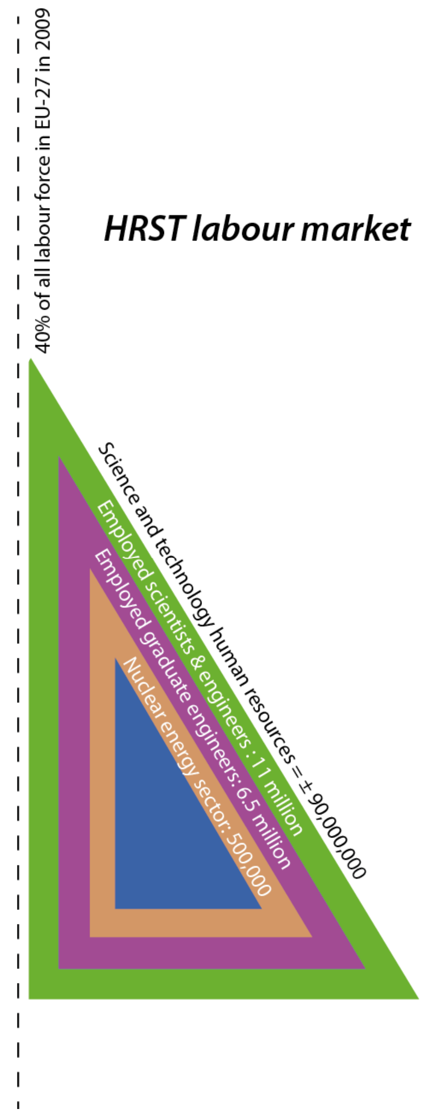
15 The European Labour Force Survey defines employed engineering workers as employees who work in engineering profession, regardless of the degree they hold.



Source: European Engineering Report [49]

Taking into account that some **25%** of the employed engineering workers will retire by 2020, there will be a **need for 1 204 088 engineers in the EU-27 by 2020**, that is, on average, **120 409** per year.

Figure 33: Graphical representation of the HRST workforce in EU-27 in 2009 in comparison with the total workforce in the nuclear energy sector in the same region



Source: EHRO-N

4.3. BREAKDOWN PER PROFILES OF EMPLOYEES IN THE EU-27 NUCLEAR ENERGY SECTOR

According to the OPIIEC study on the evolution of the nuclear industry in France [18] and according to the needs for specific profiles for the French nuclear industry by 2012, one can estimate the share of each profile within a nuclear industry.

Table 6: Need for engineers and technicians for the French nuclear industry up to 2012:

Ventilation par domaines de compétences du besoin global annuel en recrutements *(France)* d'ingénieurs et techniciens pour l'ingénierie nucléaire jusqu'en 2012 : (*)

	En % des besoins de recrutements annuels en ing. et tech.	En nombre d'ingénieurs à recruter par an jusqu'en 2012	*Dont :* chez les ss-traitants des grands donneurs d'ordre	En nombre de techniciens à recruter par an jusqu'en 2012	*Dont :* chez les ss-traitants des grands donneurs d'ordre
- Automatisme, électronique, informatique industrielle **	~ 15%	~ 200 (/ an)	~ 70 (/ an)	~ 130 (/ an)	~ 80 (/ an)
- Sûreté, combustible, neutronique	~ 14%	~ 180	~ 30	~ 130	~ 40
- Métallurgie, physique des matériaux, CND	~ 11%	~ 140	~ 40	~ 100	~ 70
- Génie civil **	~ 6%	~ 80	~ 50	~ 50	~ 40
- Electro-mécanique	~ 10%	~ 140	~ 60	~ 100	~ 70
- Conception et process	~ 25%	~ 360	~ 40	~ 200	~ 60
- Installation générale	~ 8%	~ 80	~ 80	~ 100	~ 100
- Radioprotection	~ 2%	~ 30	~ 10	~ 30	~ 20
- Chimie et environnement	~ 4%	~ 60	~ 20	~ 40	~ 30
- Codes de calcul et traitement du signal	~ 2%	~ 30	~ 10	~ 20	~ 20
- Métiers supports *(achats, qualité, ...)*	~ 3%	~ 50	~ 50	~ 30	~ 30
	Σ = 100%	Σ ~ 1300 / an	Σ ~ 400 à 500 / an	Σ ~ 900 / an	Σ ~ 500 à 600 / an

(ventilation déduite des entretiens auprès des experts) / (** recrutements perçus comme particulièrement difficiles)*

Source: OPIIEC study [18]

In the French nuclear energy sector up to 2012 there is an annual need for some:

- 23% of nuclear experts (safety, fuel, neutron calculations) (14%), nuclear physicists (5%),[16] nuclear chemists (2%)[17], radioprotection specialists (2%),
- 26% of non-nuclear engineers (civil (6%), electrical and mechanical (5%),[18] design (13%),[19] Instrumentation & Control (2%)),
- 20% of other graduates (metallurgy and CND (6%) [20], chemists and environment (2%)[21], concept and process (12%)[22])
- 28% of technicians (general installations (8%), industrial informatics (15%), electrical and mechanical technicians (5%)[23]) is, and
- 3% of support profiles.

The profiles from table 6 were taken as a possible division per profiles of the workforce employed today in the nuclear energy sector in the EU-27.

16 The need of 11% for "Mettalurgie, physique des materiaux, CND" was hypothetically divided into 5% nuclear physicists and 6% of other graduates with similar profile.

17 The need of 4% for "Chimie et environnement" was hypothetically divided into 2% of nuclear chemists and 2% of other graduates with similar profile.

18 The need of 10% for "Electro-mechanique" was hypothetically divided into 5% of electrical and mechanical engineers and 5% of electrical and mechanical technicians.

19 The 25% need for "Conception et process" experts was hypothetically divided into 13% of design engineers and 12% of other graduates with similar profile.

20 See Footnote 16.

21 See Footnote 17.

22 See Footnote 19.

23 See Footnote 18.

However, the part that needed to be changed was the share of nuclear experts in the EU-27 as a whole, which in 2010 was **77 605** or **16%** of the whole workforce of 500 000 [50] employed in the nuclear energy sector in the EU-27 (results of the EHRO-N survey), and the share of support and other profiles which instead of 3% became 10%.

Thus, in the EU-27, the workforce in the nuclear energy sector is divided like this: profiles:

- 16% of nuclear engineers, nuclear physicists, nuclear chemists, radioprotection specialists (or, in short, nuclear experts),
- 26% of non-nuclear engineers,
- 20% of other graduates,
- 28% of technicians, and
- 10% of support and other profiles.

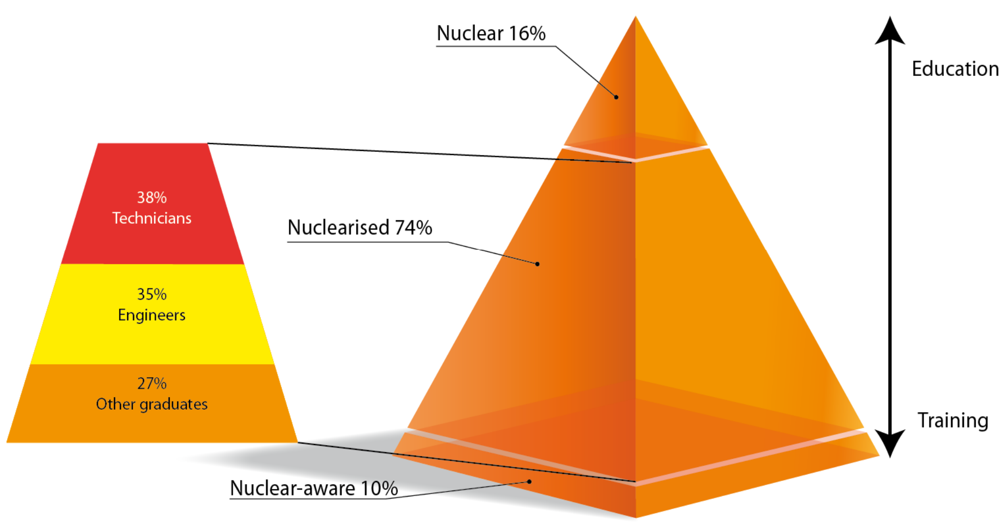
The family of 74% or 370 000 (500 000*74%) of nuclearised engineers, other graduates and technicians is made up of:

- 38% or 190 000 technicians,
- 35% or 175 000 engineers, and
- 27% or 135 000 are other graduates.

The remaining 10% are employees that perform support and other activities (e.g. commercial, etc.) and are only nuclear-aware.

Both, the nuclearised and nuclear-aware employees need to be trained in order to acquire the competences and skills necessary to perform their activities in the nuclear energy industry.

Figure 34: Hypothetical graphical representation of the nuclear energy sector in the EU-27 by type of employees



Source: EHRO-N

4.4. DOES SUPPLY OF NUCLEAR EXPERTS RESPOND QUANTITATIVELY TO THE DEMAND FOR THE SAME EXPERTS BY THE NUCLEAR ENERGY SECTOR IN THE EU-27?

Looking at the supply side, in 2009, 22% of all the graduates in the EU-27 graduated from Science, Technology and Mathematics. More specifically, in that same year, 339 414 students graduated from Engineering and engineering trades; furthermore, there were 96 422 graduates from Physical science and 45 712 graduates from Mathematics and Statistics. All these graduates are potentially employable also by the nuclear energy sector in the EU-27.

Looking at the demand side, in 2009, 40% of the labour force in the EU-27 worked in science and technology field. More specifically, 11 million employees were employed scientists and engineers, of which 6.5 million were employed graduate engineers.

In the nuclear energy sector in the EU-27 work approximately 500 000 employees, of which

- 16% are nuclear engineers, nuclear physicists, nuclear chemists, radioprotection specialists (or, in short, nuclear experts),
- 26% are non-nuclear engineers,
- 20% are other graduates,
- 28% are technicians, and
- 10% are support and other profiles.

Looking only at the share of nuclearised employees or 370 000 in the nuclear energy sector in the EU-27, the situation is as follows:

- 38% are technicians
- 35% are non-nuclear engineers,
- 27% are other graduates.

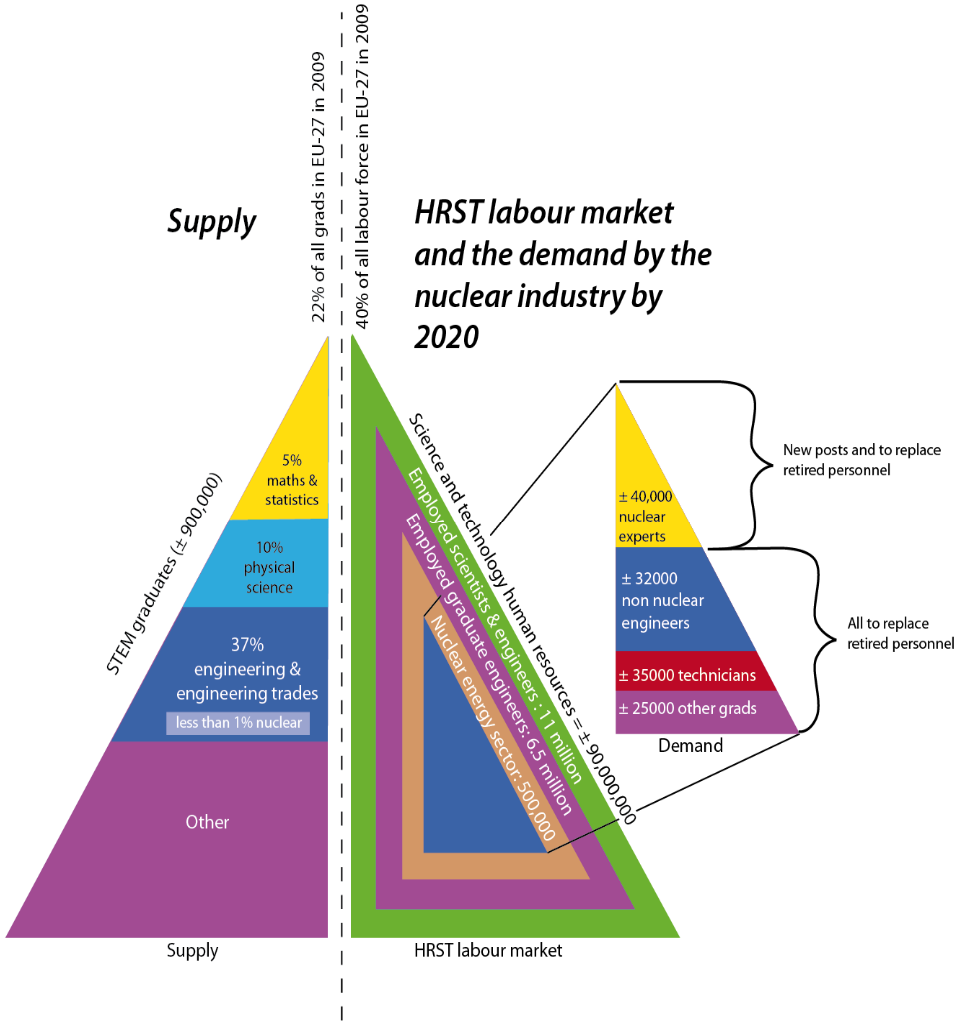
As concerns the future demand, there will be a need for 38 900 nuclear experts by 2020 in the EU-27 by the nuclear energy sector, as shown by the EHRO-N survey results.

In order to estimate the lowest future need for the nuclearised engineers, other graduates, and technicians by the nuclear energy sector in the EU-27, we assumed that the retirement rate is at least 25% (see age distribution for engineers in figure 32).
Thus, the demand by 2020, in order to replace the retired nuclearised workforce, will be:

- 35 150 technicians or (370 000*38%)*25%,
- 32 375 non-nuclear engineers or (370 000*35%)*25%, which represents ca. 3% (32 375*100/1 204 088) of all engineers needed to be employed because of retirement of engineers in the EU-27 labour force as a whole (see page 49 above), and
- 24 975 other graduates or (370 000*27%)*25%.

Figure 35: Graphical representation of the supply of STEM graduates in the EU-27 in 2009, the HRST workforce in the EU-27 in 2009, and the lowest

hypothetical demand for nuclear experts, non - nuclear engineers, technicians and other graduates by the nuclear energy sector in the EU-27 by 2020



Source: EHRO-N

The supply of nuclear engineering students and students having had a nuclear energy-related subject in their studies (some 2800 in the EU-27 graduated in 2009) cover some 70% of the demand for nuclear experts by the nuclear energy sector in the EU-27 (on average 4000 per year by 2020). This is true if one assumes that all the graduates mentioned (will) search an employment in the nuclear energy sector.

The demand for nuclear experts which is not fulfilled by the supply from the higher university institutions in the EU-27 is directed towards the other STEM graduates (e.g. non-nuclear engineers, physical scientists, etc.). On first sight it seems that the number of STEM graduates could fulfil the need of the nuclear energy sector, considering that these are nuclearised to a desired degree of expertise. But in order to make a more accurate judgment on this question, one has to take into account that these same STEM graduates are also needed by other (energy) sectors.

On top of the rising demands for STEM graduates, because of the retirement of the “baby boomers”, the numbers of STEM graduates have been reported to be inadequate in the EU-27 in general and the future does not seems brighter either. There are three main challenges that the EU is facing:

1) Attracting more students to undertake STEM studies;
2) Large-scale retirements in the not-so-distant future, and
3) Low attractiveness to foreign talent.

Due to insufficient supply of STEM graduates, the economic practices might change as well [24][51].

Furthermore, the emerging market for greener products and services is itself driving change in skill needs. The renewable energy sector is one of those with the highest potential for employment and for the creation of new employment posts. The estimated employment potential in the renewable energy sector in the EU-27 is some 1.3 million new jobs by 2020 [52]. As a comparison, nowadays there are some 108 000 jobs across the EU-27 only in the wind energy sector [53]. The job profiles needed for the renewable energy sector are renewable energy engineers, consultants, auditors, quality controllers and installation and maintenance technicians. In Spain, for example, 76% of the new green jobs created in the renewable energy sector are in construction, installation, manufacturing and maintenance; the other 24% are in management, commercialization or engineering occupations [52].

A high level of educational attainment has proven not to be a sufficient response to the needs of the renewable energy sector and the greening economy in general. Training in vocational and technical skills is also of great importance. The nuclear energy sector can learn from the renewable energy sector and possibly maybe use some of these innovative training solutions [52]:

- Joint initiatives by social partners at sectoral or regional level;
- Collaboration between companies and training providers or universities;
- Research institutes undertaking community-level training;
- Proactive approaches by international professional associations and NGOs involving training of trainers and projects out of reach of formal training provision.

One could conclude that today's supply of nuclear engineering graduates does not sufficiently respond to the demand of the same graduates by the nuclear energy sector, and thus is the demand directed towards the STEM graduates. As there is a (growing) demand for STEM graduates from various sectors across the European economy, the nuclear energy stakeholders need to be aware of the wider context in which they operate. It becomes clear that only the joining of forces rather than competition could help in adequately responding to the human resource and skills challenges of the nuclear energy sector.

24 Recently a decision was taken by Airbus, the world's biggest aeroplane maker, to carry out a greater proportion of its engineering work in India. This is a direct result of the lack of qualified engineers in the UK, Germany and France. Analysis performed by Deutsche Bank shows that off shoring of R&D often follows as a consequence of a lack of skilled employees [51].

5. LESSONS LEARNT

While this first EHRO-N report is a valuable contribution to the issue of supply and demand of nuclear human resource, we are aware that only regular human resource monitoring is the most effective way to have accurate data that can determine policy. Moreover, as EHRO-N started collecting the data, there was not yet agreement on what the methodology for this monitoring should be like. Furthermore, the nuclear community in the EU was not yet familiar with EHRO-N.

The first lesson learnt is thus that a process for regular monitoring of nuclear human resource should be established in the EU. This process, together with a ***commonly agreed methodology,*** should regularly be followed so that the next EHRO-N report offers a more insightful and up-to-date review of the situation.

The second lesson learnt is related to the methodology used when trying to assess the gap between the supply and demand for nuclear experts.

On the supply side some of the questions were:

- What is a nuclear-energy related study?
- Do we count here only the nuclear engineers or also the nuclear physicists and nuclear chemists?
- What about those students that have only a nuclear energy – related subject within their otherwise non-nuclear studies?
- And also, how do we count the supply of technically qualified personnel that seems to be in most serious lack now and into the future [48]?
- Is the data received reliable? What quality assurance procedure do we follow in order to double-check (benchmark) the received data? (the difficulty being that often there is no central organisation on national level that has this kind of data).

Our belief was that for this first report the data on the supply of graduates in nuclear related studies like Nuclear engineering, Nuclear physics, Nuclear chemistry, Nuclear energy was most easily available data in the EU-27 today. It was for this reason that the employers approached were asked how many nuclear experts they needed. We defined a “nuclear expert” as a nuclear engineer, nuclear physicist or chemist or any other professional trained to the level of proficiency of these experts.

There was a gap between the data received from the French higher education institutions and the data which is publicly available from the *French Council for Education and training in Nuclear energy (CFEN)*. For the purpose of the report we chose to use the CFEN data which in turn does not correspond with the fact that 90% of the higher education institutions responded to the supply questionnaire. This could either mean that: 1) some very important (in numbers of graduates “supplied’) French higher education institutions did not respond/responded inadequately to our questionnaire, or that 2) our list of higher education institutions does not contain certain higher education institutions.

On the other side the responses from the nuclear energy sector showed that their demand for employees goes far beyond the aforementioned fields. Namely, it is not only nuclear experts that are needed in the future but also, for example, non-nuclear engineers and technicians. Moreover, their perspective is also different: their focus is much wider and it includes also a need for certain skills and competences that are often obtained through dedicated (in-house) training programs. One other important need for nuclear experts, which was not taken into account in this study, was that for professors and researchers by the universities and for trainers by the nuclear training organisations.

In order to make the comparison between the two data sets easier, we tried using the data available mainly from Eurostat. We used the Eurostat numbers about the graduates from other relevant fields for the nuclear energy and tried to match this supply with a hypothetical demand for these same fields by the EU-27 nuclear energy sector. The French nuclear energy sector demand was here used as the basis for extrapolation. We realize that this might still not be sufficient or even fair in order to adequately address the question of the gap that is looming between the supply and demand of competent professionals for the nuclear energy sector in the EU-27.

Thus, ***the second lesson learnt*** is

- **that the methodology used in gathering the supply data needs to be reviewed, especially the benchmarking process**, and that
- **those *fields that are specific for the nuclear energy sector in the EU-27 need to be 1) more clearly defined and categorized within the 3 fields proposed (nuclear experts, nuclearised, or nuclear-aware), and 2) incorporated into the EHRO-N demand questionnaire thus expanding the scope of the survey (see proposal in Annex 4), which is the vital part of the EHRO-N methodology***,
- ***there is a need for a more reliable network of national nuclear contact points to share/benchmark gathered data with.***

Due to the general lack of STEM graduates for various (energy) sectors across the European economy, the ***nuclear energy sector needs to be more open and aware of the environment in which it operates***. Only the joining of forces rather than competition could help in adequately responding to its human resource and skills challenges ***(third lesson).***

As far as the SUPPLY side of this report is concerned, the first observation is that ***there is a lack of sufficient cooperation in the field of nuclear energy education in Europe in responding to the challenge of the supply of enough and adequately skilled graduates for the nuclear energy sector***; however the European Nuclear Education Network (ENEN) had been established to support the cooperation between the academia. In addition, it is recognised that the existence of institutions like the European Nuclear Society (ENS), and the Academies of Sciences (or similar educational institutions) are providing a major contribution in the field of nuclear education in ensuring that the general public and future students are aware of the issues relating to nuclear energy ***(forth lesson).***

In those countries ***where nuclear energy plays an essential role in the energy sector, education in the nuclear field is widely supported both by government and by the different educational institutions***.

It is noted that ***when assessing the nuclear energy – related educational possibilities around the 27 EU countries, there is a clear division between those countries that support nuclear energy and those countries that do not.*** In the countries that do not have a nuclear power program, it is usually the case that the higher educational institutions do not offer many courses in the nuclear field. However, in some of these countries, there is ongoing research and educational activities in the nuclear field that are continuously being maintained and updated.

In general terms, it is noted that ***increasing supply possibilities for a human resource development for the nuclear industry are being created in the EU-27 and that this is beginning to repair the deficit that has arisen during the last***

decades in which the acceptance of nuclear energy has shown a downturn ***(fifth lesson).***

As far as the DEMAND side of this report is concerned, the observation is that ***there was a different degree of openness to the sharing of numerical data on nuclear experts employed and nuclear experts needed in the future. This depends on the type of stakeholder, on the country where it operates, competitiveness considerations and/or on the degree of (in) clarity of future plans (sixth lesson).*** Some stakeholders were more open to give away this data (e.g. R&D institutes), than others (some utilities, regulatory authorities). It is clear that some countries have a more systematic approach to the assessment of human resource needs for their nuclear energy sector (e.g. UK, France, recently also Finland) than others. Some countries are at the beginning of the creation of a nuclear energy sector all together and thus are only starting to assess their possible future needs for nuclear experts (e.g. Poland). Some countries/companies although being very advanced as far as their nuclear energy – related activities are concerned, were not as open to sharing their data as some other countries/companies. It seems that the competitiveness considerations played a certain part in the decision to share data on needs for nuclear experts. Moreover, for many of the stakeholders it seems that the lack of clarity of the future plans also made difficult the assessment for future needs of nuclear experts.

As for the concrete results, they show that an urgent action is needed on the side of the "suppliers" of nuclear human resource for the nuclear energy sector in the EU-27***(seventh lesson)*** because:

- The supply of nuclear experts coming from the relevant higher education institutions (some 2 800 graduates) is not sufficient to cover the yearly need for nuclear experts by the responding 358 nuclear organisations (some 4 000 nuclear experts);
- Considering the most optimistic case, some ***70% of the demand for nuclear experts by the nuclear energy stakeholders is covered by the supply of the relevant higher institutions in the EU-27; if we consider only the data received on the supply side, without the adjustments done in the benchmarking exercise, this share is only 45%***
- ***nearly half of the nuclear experts employed today in the NPPs in the EU-27 will need to be replaced by 2020***
- ***aging problems*** seem much more important for nuclear (nearly 50% of workforce to be replaced by 2020) than for other relevant fields like engineering (around 25%).

A country specific analysis was not the objective of the report and presumably impossible due to the limited response and other relevant data. Nevertheless, in the future studies it might be valuable to address the specific situation in various countries and the differences between them.
The picture in the EU-27 as far the countries' attitudes toward nuclear energy is varied. There are in the EU-27:

- Countries without nuclear energy (e.g. Austria, Denmark)
- Countries lunching and/or restarting nuclear programs (e.g. Poland)
- Countries with small nuclear programs (e.g. Slovenia, The Netherlands)
- Countries with medium size nuclear programs (e.g. Sweden, Finland)
- Countries with cancelled nuclear programs (e.g. Italy, Germany,)
- Countries with large nuclear programs (e.g. France, UK)

Presumably each of these groups faces different kind of problems in ensuring the availability of a necessary human resource for safe operation and/or dismantling and disposal of their nuclear installations ***(eighth lesson).***

Recently, the European Commission launched the ***ECVET initiative*** (European Credit System for Vocational Education and Training), offering ***a new approach to the transfer and mutual recognition of learning outcomes*** that can be implemented in whatever sector. The system aims to facilitate the validation, recognition and accumulation of work-related of transferable learning outcomes acquired in various ways and places e.g. during a stay in another country or by working in different industry sectors. It should ensure that these experiences contribute to vocational qualifications. ECVET aims for better compatibility between the different vocational education and training (VET) systems in place across Europe and their qualifications. ***This is especially relevant in the context of borderless mobility and life-long learning, two main characteristics of the free movement of professionals***. The implementation of the ECVET system within the nuclear energy sector is only at its beginnings. If ECVET is to be implemented into the nuclear energy sector, having a clearer idea on the competences and skills of the employees needed for the nuclear energy sector is of vital importance for its well-functioning in practice. ***EHRO-N and ECVET are complementing each other*** **and can reinforce each other**. The fact that ECVET is working on the definition of the taxonomy of skills and competences needed for the nuclear energy sector in the EU-27 could, on the other side, help EHRO-N to fine-tune its surveys following the principle: If you ask the employer a general question, you get a general answer, but if you ask them concretely about the competences and skills they require from their employees, you get concrete answers. And these answers can be well used by ECVET and the nuclear education and training infrastructure in the EU-27 so that their educational and training programs are ameliorated ***(ninth lesson).***

Mobility of the S&T human in resource within the EU-27 seems to be low in general: only 6% of the S&T human resource is mobile. It would be valuable to ***further investigate what the situation is regarding mobility of nuclear human resource, making at the same time a clear distinction between mobility of nuclear experts and the technically qualified personnel*** that seems to be in most serious lack now and into the future [53] ***(tenth lesson).***

Much of the work to produce the report was carried out before the accidents at the Fukushima-Daiichi nuclear power plant occurred in March 2011. Its impact on the public opinion related to the future of nuclear power in the EU-27 is still difficult to foresee. However, ***the factual information in this report, together with the newly created EHRO-N website, http://ehron.jrc.ec.europa.eu/, that together present the situation relating to nuclear power in each of the countries, the higher education opportunities available and the companies involved in the nuclear industry, and their needs for nuclear experts in the future, will still be valid.*** From the EU Member States only Germany and Italy changed up to this moment their view on nuclear power and consequently their future plans and needs for nuclear experts. Some other Member States are reviewing and modifying their plans for developing nuclear energy as well (e.g. Bulgaria, Poland, France). Hence, the report in its current form will still provide a source of information that can be used by young people considering working in the nuclear industry, the higher educational institutions and companies involved in the nuclear energy sector.

6. RECOMMENDATIONS

The EHRO-N's recommendations, deriving from the lessons learnt (see Chapter 5) and generally from the EHRO-N SAG, to the nuclear energy sector in the EU-27 are that:

- EHRO-N's operation should be actively supported by the national governments, nuclear safety authorities, nuclear industry and the E&T organisations within the EU-27 and thus should be long-term secured:
  - to provide the authoritative and comprehensive platform for strong interaction between nuclear energy stakeholders in the EU-27 as far as questions of nuclear human resource monitoring is concerned; concretely this could mean devising a commonly agreed methodology and database on the demand/supply situation of nuclear human resource;
  - so that the workforce situation for the nuclear energy sector in the EU-27 is regularly monitored in order to forecast trends and provide information on the demand/supply situation; this information would be regularly communicated by conventional and electronic means to the Member States' governmental, higher education, and private organisations involved in nuclear E&T and used to report to the European Parliament and the Council of the EU thus influencing policy developments;
  - to provide a roadmap for a human resource development across the various sectors according to its mandate;
  - to communicate reliable information by conventional and electronic means to the Member States' governmental, higher education, and private organisations involved in nuclear E&T that could be used to report to the European Parliament and the Council of the EU and thus influence policy developments;
- EU-27 Member States/Nuclear Stakeholders should contribute actively to EHRO-N surveys e.g. use the existing Euratom National Contact Points or create new ones to coordinate and organize national information;
- A feasibility study should be carried out with the main objective to consider ways to support the mutual recognition of knowledge, skills and competences relevant for the nuclear energy sector;
- The application of the ECVET approach should be promoted to continuously improve the quality of the nuclear workforce at professional, technical and craft level by facilitating borderless mobility and lifelong learning;
- There is a need for further assessment of the effectiveness of the coordination between industry and universities in nuclear education and training and in the provision of related opportunities to students and the industry workforce;

The above EHRO-N recommendations are in line with the recommendations outlined by the SNETP [8] and by OECD/NEA [9].

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ANNEX 1 – HIGHER LEVEL EDUCATION POSSIBILITIES AND R&D ORGANISATIONS IN EU-27

AUSTRIA	**Atomic Institute of the Austrian Universities/Atominstitut (Research)**
	Upper Austria University of Applied Sciences/FH Oberösterreich (Course)
	University of Applied Sciences, FH Campus Wien/Fachhochschule FH Campus Wien (Bachelor, Master)
	University of Applied Sciences Technikum Wien/Fachhoschule Technikum Wien (Course)
	University of Applied Sciences Wiener Neustadt/Fachhochschule Wiener Neustad (Bachelor, Course)
	Upper Austria University of Applied Sciences/FH Oberösterreich (Course)
	Vienna University of Technology/Technische Universität Wien (Course)
BELGIUM	**Antwerpen University/Universiteit Antwerpen (Course, Research)**
	BNEN (Master)
	Catholic University Leuven/ Katholieke Universiteit Leuven (Course, Research)
	Catholic University of Louvain/ Université Catholique de Louvain (Course, Research)
	Free University of Brussels/ Université Libre de Bruxelles (ULB) (Master)
	Free University of Brussels/Vrije Universiteit Brussel (VRIJ) (Course)
	Ghent University/Universiteit Ghent (Master, PhD)
	JRC-Institute for Reference Materials and Measurements (Research)
	SCK-CEN (PhD, Research)
	University of Liege/Université de Liège (Master, Course, Research)
	Xios Hogeschool Limburg (Bachelor, Master, Course)
BULGARIA	**Institute for Nuclear Research and Nuclear Energy (INRNE) (Course, Research)**
	Plodiv University Paisii Hilendarski (Course)
	Ruse University Angel Kanchev/ Русенски университет Ангел Кънчев (Course)
	Sofia University St. Kliment Ohridski (Bachelor, Master, PhD, Research)
	Technical University of Sofia (Bachelor, Master, PhD, Research)
CYPRUS	**University of Cyprus (Course, Research)**
CZECH REPUBLIC	**Academy of Sciences of the Czech Republic/Akademie věd ČR (PhD)**
	Brno University of Technology/ Vysoké Uceni Technické v Brne (Master)
	Charles University in Prague/ Univerzita Karlova v Praze (Bachelor, Course, Research)
	Czech Technical University in Prague/Ceské Vysoké Ucení Technicke (Bachelor, Master, PhD, Course, Research)
	Institute of Chemical Technology Prague/Vysolá Skola Chemicko-Technologická v Praze (Research)
	Nuclear Research Institute Rez plc (Research)
	UJP Praha (Research)
	University of West Bohemia/Západoceska Univerzita v Plzni (Research)
ESTONIA	**Tallinn University of Technology/ Tallinna Tehnikaûlikool (Research)**
	University of Tartu/Tartu Ülikool (Research)
FINLAND	**Aalto University School of Science and Technology/ Aalto-Yliopiston Teknillinen Korkeakoulu (Course, Research)**

Helsinki University/Helsinki Institute of Physics/ Fysiikan tutkimuslaitos

	(HIP) (Research)
	Lappeenranta University of Technology/ Lappeenrannan Teknillinen Yliopisto (Course)
	Tampere University of Technology/ Tampereen Teknikkinen Yliopisto (PhD, Course, Research)
	Technical Research Centre of Finland (VTT) (Research)
	University of Jyväskylä/ Jyväskylän Yliopisto (Course, Research)
	University of Oulu/Oulun Yliopsito
	University of Turku/Turun Yliopisto (Research)
FRANCE	Armines (Grandes Écoles) (Research)
	Blaise Pascal University Clermont Ferrand/Université Blaise Pascal Clermont-Ferrand (Course)
	Central School Paris/École Centrale Paris (Bachelor)
	Chemistry Paris Tech/Chimie Paris Tech (Bachelor)
	Consortium: Paris Tech, the University Paris-Sud 11/Université Paris-Sud11, the École Central Paris (ECP), the National Institute for Nuclear Science and Technology/Institut National des Sciences & Techniques Nucléaires (INSTN) and EDF (Master)
	Engineering National High School of Caen/École Nationale Supérieure d'Ingénieurs de Caen (ENSICAEN) (Bachelor)
	ENSTA Paris Tech/École Nationale Supérieure de Techniques Avancées (Bachelor)
	ESPCI Paris Tech/École de Physique et de Chimie Industrielles de Paris (Research)
	French Atomic Energy Commission/ Commissariat à l'énergie atomique (Research)
	Grenoble Institute of Technology/ Institute Polytechnique de Grenoble (Bachelor, Master)
	High School of Arts and Crafts/École National Supériure d'Arts et Métiers (Bachelor)
	Mines Paris Graduate School/ École des Mines Paris (ENSMP) (Bachelor)
	Mines School of Alés/École des Mines d'Alés (Bachelor)
	Mines School of Nantes/École des Mines de Nantes (Bachelor)
	National Academy of Arts and Crafts/ Conservatoire National des Arts et Métiers (CNAM) (PhD)
	National Chemistry High School of Montpellier/École Nationale Supérieure de Chimie de Montepellier (Bachelor)
	National Institute for Nuclear Science and Technology/Institut National des Sciences & Tecniques Nucléaires (INSTN) (Bachelor, Eur.Master, PhD, Course)
	National Mines High School of Saint-Étienne/École Nationale Supérieure des Mines de Saint-Étienne (Bachelor)
	Radioprotection and nuclear Safety Institute/Institut de Radioprotection et de Sûreté Nucléaire (Research)
	University Joseph Fourier/Université Joseph Fourier (Master)
	University of Nancy I Henri Poincaré /Université Henri Poincaré-Nancy I (Eur. Master)
	University of Paris VII/Université Paris Diderot (Course)
	University Pierre and Marie Curie - Paris VI/Université Pierre et Marie Curie - Paris VI (Master)
GERMANY	Aachen University of Applied Sciences/Hochschule Aachen (Eur.Master, Course)
	Clausthal University of Technology/ Technische Universität Clausthal (Master)
	European Nuclear Energy Leadership Academy (ENELA) (Master)

Federal Institute for Geosciences and Natural Resources/Bundesanstalt

	für Geowissenschaften und Rohstoffe (Research)
	Federal Office for Radiation Protection/ Bundesamt für Strahlenschutz (Research)
	German Research Foundation/ Deutsche Forschungsgemeinschaft (Research)
	Heidelberg University/ Universität Heidelberg (Research)
	Institutes of the Dresden-Rossendorf Research Center/Institute des Forschungszentrums Dresden-Rossendorf (Research)
	JRC-Institute of Transuranium Elements (Research)
	Jülich Research Centre/ Forschungszentrum Jülich (Research)
	Karlsruhe Institute of Technology/ Forschungszentrum Karlsruhe (Research)
	Karlsruhe University/ Universität Karlsruhe (Research)
	RWTH Aachen University/Rheinisch-Westfaelische Technische Hochschule Aachen (Master)
	Technical University of Dresden/ Technische Universität Dresden (Research)
	Technical University of Munich/ Technische Universität München (Bachelor, Master)
	University of Stuttgart/Universität Stuttgart (Course)
GREECE	**Aristotle University of Thessaloniki/ Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης (Research)**
	Greek Atomic Energy Commission/ Ελληνική Επιτροπή Ατομικής Ενέργειας (GAEC) (Master)
	National Centre of Scientific Research Demokritos/Εθνικό Κέντρο Έρευνας Φυσικών Επιστημών Δημοκριτοσ (Master, PhD, Research)
	National & Kapodistrian University of Athens/Εθνικού και Καποδιστριακού Πανεπιστημίου Αθηνών (Research)
	National Technical University of Athens (NTUA)/Εθνικό Μετσόβιο Πολυτεχνείο (ΕΜΠ) (Course)
	University of Ioannina/ Πανεπιστήμιο Ιωαννίνων (Course, Research)
HUNGARY	**Budapest University of Technology and Economics/Budapesti Műszaki és Gazdaságtudományi Egyetem (BUTE) (Bachelor, Master)**
	Eötvös Loránd University/Eötvos Loránd Tudományegyetem (Course)
	Frédéric Joliot Curie National Research Institute for Radiobiology and Radiohygiene/Országos Frédéroc Joliot-Curie Sugáregészségügyi Kutató Intézet (Research)
	Institute for Electric Power Research (Research)
	Institute for Isotopes/Izotóp Intézet (Research)
	University of Debrecen/Debreceni Egyetem (PhD)
	University of Pannonia Veszprém/ Pannon Egyetem (Course)
IRELAND	**Dublin City University (Course)**
	Dublin Institute for Advanced Studies (Research)
	National University of Ireland (Maynooth) (Course)
	University of Dublin/Trinity College Dublin (Research)
ITALY	**Milan Polytechnic/Politecnico di Milano (Bachelor, Master, PhD, Research)**
	National Institute of Nuclear Physics/Istituto Nazionale di Fisica Nucleare (INFN) (Research)
	Technical University of Turin/ Politecnico di Torino (Bachelor, Master, PhD, Research)
	Turin University/Università di Torino (Master, Course, Research)
	University of Bologna/Università di Bologna (Bachelor, Master, PhD, Course, Research)
	University of Palermo/Università degli Studi di Palermo (Bachelor, Master, PhD, Course, Research)

	University of Pisa/Università di Pisa (Bachelor, Master, PhD, Course, Research)
	University of Roma/Sapienza Università di Roma (Bachelor, Master, PhD)
LATVIA	**Riga Technical University/Rigas Tehniska Universitate (Course)**
	University of Latvia/Latvijas Universitate (Research)
LITHUANIA	**Kaunas University of Technology/ Kauno Technologijos Universitetas (Bachelor, Master, PhD, Research)**
	Lithuanian Energy Institute/Lietuvos Energetikos Institutas (Research)
	Radiation Protection Center/Radiacines Saugos Centras (Research)
	Vilnius University/Vilniaus Universitetas (Bachelor, Research)
	Vytautas Magnus University/Vytauto Didijojo Univerzitetas (Course)
LUXEMBOURG	**University of Luxembourg/ Université de Luxembourg (Course, Research)**
MALTA	**Malta Institute for Medical Education (M.I.M.E.) (Course)**
	University of Malta/L-Universita`ta' Malta (Bachelor, Course, Research
The NETHERLANDS	**Delft University of Technology/ Technische Universiteit Delft (Master, PhD, Research)**
	Eindhoven University of Techonology/ Technische Universiteit Eindhoven (Master, Course)
	Energy Research Center of the Netherlands (ECN) (Research)
	Foundation for Fundamental Research on Matter (FOM) (Research)
	JRC-Institute for Energy and Transport (Research)
	Nuclear Research and Consultancy Group (NRG) (Research)
	University of Groningen/ Rijksuniversiteit Groningen (PhD, Course)
POLAND	**AGH University of Science and Technology/Akademia Górniczo-Hutnicza Im. Stanislawa Staszica w Krakowie (Bachelor, Master, PhD, Research)**
	Central Laboratory for Radiological Protection/Centralne Laboratorium Ochrony Radiologicznej (Research)
	Institute for Atomic Energy POLATOM/Instytut Energii Atomowej POLATOM (Research)
	Institute of Plasma Physics and Laser Microfusion (Research)
	Jagiellonian University/Univwersytet Jagiellonski w Krakowie (Research)
	Jan Kochanowski University/ Uniwersytet Humanistyczno-Przyrodniczego Jana Kochanowskiego w Kielcach (Research)
	Maria Curie-Sklodowska University/Uniwersytet Marii Curie Sklodowskiej (Course)
	University of Gandsk/Uniwersytet Gdański (PhD)
	University of Silesia in Katowice/ Uniwersytet Slaski w Katowicach (Research)
	University of Szczecin/Uniwersytet Szczeciński (Research)
	University of Wroclaw/ Uniwersytet Wroclaski (Research)
	Warsaw University of Technology/ Politechnika Warszawska (Research)
PORTUGAL	**High Technical Institute/Instituto Superior Técnico (Research)**
	National Institute of Technological Engineering and Innovation/Instituto Nacional de Engenheria Tecnologia e Inovaçao (Research)
	Porto University/Universidade de Porto (Course)
	Technological and Nuclear Institute/ Instituto Tecnológico é Nuclear (Research)
	Technical University of Lisbon/ Universidade Técnica de Lisboa (Course, Research)
	University of Coimbra/Universidade de Coimbra (Master, Course)
	University of Lisbon/Universidade de Lisboa (Course, Research)

ROMANIA	Horia Hulubei National Institute of Physics and Nuclear Engineering (PhD, Course, Research)
	Institute for Nuclear Research – Pitesti/Sucursala Cercetari Nucleare-Pitesti (Research)
	Ovidius University of Constanta/ Universitatea Ovidius Constanta (Bachelor)
	Polytechnical University of Bucharest/ Universitatea Politehnica din Bucurest (Bachelor, Master, Research)
	University Babes-Bolyai Cluj/ Universitatea Babeş-Bolyai (Research)
	University of Bucharest/Universitatea din Bucuresti (Master, PhD, Course, Research)
SLOVAKIA	Comenius University in Bratislava/ Univerzita Komenského v Bratislave (Research)
	Nuclear Power Plant Research Institute (VUJE) (Course)
	Slovak University of Technology in Bratislava/Slovenska Technická Univerzita v Bratislave (STU) (PhD, Research)
SLOVENIA	Institut Josef Stefan/Institut Jozef Stefan (Research)
	University of Ljubljana/Univerza v Ljubljani (Master, PhD, Course)
SPAIN	Autonoma University of Barcelona/ Universidad Autónoma de Barcelona (Master)
	Autonoma University of Madrid/ Universidad Autónoma de Madrid and Energetic, Environmental and Technologic Research Center/Centro de Investigaciones Energéticas Medio Ambientales y Tecnológicas (CIEMAT)(Master)
	Basque Country University/ Universidad del País Vasco (Course, Research)
	Carlos III University of Madrid/ Universidad Carlos III de Madrid (PhD, Research)
	Carlos III University of Madrid/ Universidad Carlos III de Madrid , Complutense University of Madrid/ Universidad Complutense de Madrid and the Polytechnical University of Madrid/ Universidad Politécnica de Madrid (Eur.Master)
	Energy, Environmental and Technology Research Center/Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (Reseach)
	Complutense University of Madrid/ Universidad Complutense de Madrid (Course, Research)
	Components Techonology Center of Cantabria/Centro Tecnológico de Componentes Cantabria (Research)
	Granada University/Universidad de Granada (Course)
	Huelva University/Universidad de Huelva (Master)
	Madrid Institute for Advanced Studies of Materials/Instituto Madrileño de Estudios Avanzados de Materiales (IMDEA) (Research)
	National Open University/ Universidad Nacional de Educación a Distancia (Course, Research)
	Polytechnical University of Catalonia/ Universidad Politécnica de Cataluña(Master, Course, Research)
	Polytechnical University of Madrid/ Universidad Politécnica de Madrid (Master, PhD, Course, Research)
	Tecnatom (Master)
	University of Alcalá/Universidad de Alcalá (Course, Research)
	University of Castilla La Mancha/ Universidad de Castilla La Mancha (PhD)
	University of Cantabria/ Universidad de Cantabria (Research)
	University of Zaragoza/ Universidad de Zaragoza (Research)
SWEDEN	Chalmers University (Master, Research)

	KTH Royal Institute of Technology/ Kungliga Tekniska Högskolan Universitet (Master, PhD, Research)
	Lund University/Lunds Universitet (Course, Research)
	Stockholm University/Stockhoms Universitet (Course)
	Swedish Radiation Safety Authority/Stral Säkerhets Myndigheten (Research)
	Uppsala University/Uppsala Universitet (PhD, Research)
UK	City University London (Master)
	Defence Academy of the UK (Course)
	Imperial College London (Bachelor, Course, Research)
	Lancaster University (Bachelor, Course, Research)
	Nuclear Institute (Research)
	Nuclear Technology Education Consortium (Master)
	University of Birmingham (Master, Course)
	University of Leeds (Bachelor, Master)
	University of Liverpool (Bachelor, Master, PhD, Course, Research)
	University of Manchester (PhD, Course, Research)
	University of Sheffield (Master, PhD)
	Westlakes Scientific Coonsulting (Course)

ANNEX 2 – NUCLEAR STAKEHOLDERS IN EU-27

COUNTRY	STAKEHOLDERS	TYPE
Belgium	**GDF Suez**	Utilities (i.e.) NPPs
Belgium	**Electrabel (GDF Suez Group)**	Utilities (i.e.) NPPs
Bulgaria	**National Electric Company (NEK EAD)**	Utilities (i.e.) NPPs
Czech Republic	**ČEZ, a. s.**	Utilities (i.e.) NPPs
Estonia	**Eesti Energia AS**	Utilities (i.e.) NPPs
Finland	**Fennovoima Oy**	Utilities (i.e.) NPPs
Finland	**Fortum Corporation**	Utilities (i.e.) NPPs
Finland	**TVO Teollisuuden Voima Oyj**	Utilities (i.e.) NPPs
France	**EDF**	Utilities (i.e.) NPPs
Germany	**E.ON Energie AG**	Utilities (i.e.) NPPs
Germany	**EnBW (Neckarwestheim I+II, Phillipsburg 1+2, Obrigheim)**	Utilities (i.e.) NPPs
Germany	**RWE Power Aktiengesellschaft**	Utilities (i.e.) NPPs
Germany	**Vattenfall Europe AG**	Utilities (i.e.) NPPs
Germany	**VGB PowerTech e. V., Nuclear Power Plant Department**	Utilities (i.e.) NPPs
Hungary	**Magyar Villamos Művek Zrt.(MVM Zrt.)/PAKS NPP**	Utilities (i.e.) NPPs
Italy	**ENEL**	Utilities (i.e.) NPPs
Latvia	**Latvenergo**	Utilities (i.e.) NPPs
Lithuania	**Lietuvos Energija AB**	Utilities (i.e.) NPPs
Lithuania	**Visagino atominė elektrinė**	Utilities (i.e.) NPPs
Netherlands	**Delta**	Utilities (i.e.) NPPs
Netherlands	**Energy Resources Holding B.V. - ERH**	Utilities (i.e.) NPPs
Netherlands	**N.V. Elektriciteits-Produktiemaatschappij Zuid-Nederland (EPZ)**	Utilities (i.e.) NPPs
Poland	**Polska Grupa Energetyczna SA (PGE)**	Utilities (i.e.) NPPs
Romania	**Nucleaelectrica S.A./CNE Cernavoda**	Utilities (i.e.) NPPs
Slovakia	**Slovenské elektrárne, a. s. - Enel**	Utilities (i.e.) NPPs
Slovenia	**GEN Energija d.o.o.**	Utilities (i.e.) NPPs
Slovenia	**Krško Nuclear Power Plant (NEK)**	Utilities (i.e.) NPPs
Spain	**ANAV - Asociacion Nuclear Asco-Vandellos A.I.E.**	Utilities (i.e.) NPPs
Spain	**CNAT - Centrales Nucleares Almaraz-Trillo**	Utilities (i.e.) NPPs
Spain	**ENDESA Generación**	Utilities (i.e.) NPPs
Spain	**IBERDROLA Generación**	Utilities (i.e.) NPPs
Spain	**NUCLENOR, S.A**	Utilities (i.e.) NPPs
Spain	**Unión Fenosa**	Utilities (i.e.) NPPs
Sweden	**E. ON Sverige**	Utilities (i.e.) NPPs
Sweden	**Vattenfall AB**	Utilities (i.e.) NPPs
UK	**EDF Energy**	Utilities (i.e.) NPPs
UK	**E. ON UK**	Utilities (i.e.) NPPs
UK	**Magnox North Ltd (Magnox Limited) - Chapelcross**	Utilities (i.e.) NPPs

	site	
UK	**Magnox North Ltd (Magnox Limited) - Hunterston A Site**	Utilities (i.e.) NPPs
UK	**Magnox North Ltd (Magnox Limited) - Oldbury Site**	Utilities (i.e.) NPPs
UK	**Magnox North Ltd (Magnox Limited) - Trawsfynydd Site**	Utilities (i.e.) NPPs
UK	**Magnox North Ltd (Magnox Limited) - Wylfa Site**	Utilities (i.e.) NPPs
UK	**Magnox South Ltd. (Magnox Limited) - Berkeley Site**	Utilities (i.e.) NPPs
UK	**Magnox South Ltd. (Magnox Limited) - Bradwell Site**	Utilities (i.e.) NPPs
UK	**Magnox South Ltd. (Magnox Limited) - Dungeness A Site**	Utilities (i.e.) NPPs
UK	**Magnox South Ltd. (Magnox Limited) - Hinkley Point A Site**	Utilities (i.e.) NPPs
UK	**Magnox South Ltd. (Magnox Limited) - Sizewell A Site**	Utilities (i.e.) NPPs
Belgium	**Alstom Power**	Nuclear facility vendors and other big suppliers
Czech Republic	**ŠKODA JS**	Nuclear facility vendors and other big suppliers
Czech Republic	**Škoda Praha a.s. (ČEZ Group)**	Nuclear facility vendors and other big suppliers
France	**Alstom Power**	Nuclear facility vendors and other big suppliers
France	**Chalon/Saint-Marcel plant (AREVA)**	Nuclear facility vendors and other big suppliers
Germany	**Siemens AG (AREVA NP)**	Nuclear facility vendors and other big suppliers
Slovakia	**Skoda Slovakia a.s.**	Nuclear facility vendors and other big suppliers
Slovakia	**VUJE, a.s.**	Nuclear facility vendors and other big suppliers
Spain	**ENSA - Equipos Nucleares SA**	Nuclear facility vendors and other big suppliers
UK	**Alstom PLC**	Nuclear facility vendors and other big suppliers
UK	**BAE Systems PLC**	Nuclear facility vendors and other big suppliers
UK	**Doosan Babcock**	Nuclear facility vendors and other big suppliers
UK	**Rolce Royce**	Nuclear facility vendors and other big suppliers
Belgium	**Westinghouse Electric Belgium**	Nuclear facility vendors and other big suppliers

France	**AREVA HQ**	Nuclear facility vendors and other big suppliers
France	**Westinghouse France**	Nuclear facility vendors and other big suppliers
Germany	**Westinghouse Electric Germany GmbH**	Nuclear facility vendors and other big suppliers
Spain	**Westinghouse Electric Spain**	Nuclear facility vendors and other big suppliers
Sweden	**Westinghouse Electric Sweden**	Nuclear facility vendors and other big suppliers
UK	**Mitsubishi Heavy Industries Europe Ltd.**	Nuclear facility vendors and other big suppliers
UK	**Westinghouse Electric Company LLC (Springfields Site)**	Nuclear facility vendors and other big suppliers
Belgium	**Belgonucleaire**	Fuel Fabrication, Enrichment, Supply
Belgium	**FBFC International (AREVA)**	Fuel Fabrication, Enrichment, Supply
Belgium	**SYNATOM (GDF Suez Group)**	Fuel Fabrication, Enrichment, Supply
France	**CEZUS (AREVA)**	Fuel Fabrication, Enrichment, Supply
France	**FBFC Lyon (AREVA)**	Fuel Fabrication, Enrichment, Supply
France	**FBFC Pierrelatte (AREVA)**	Fuel Fabrication, Enrichment, Supply
France	**FBFC Romans (AREVA)**	Fuel Fabrication, Enrichment, Supply
France	**MELOX (AREVA)**	Fuel Fabrication, Enrichment, Supply
France	**Réel**	Fuel Fabrication, Enrichment, Supply
France	**SPIE Nucleaire**	Fuel Fabrication, Enrichment, Supply
Germany	**ANF Duisburg (AREVA)**	Fuel Fabrication, Enrichment, Supply
Germany	**ANF Lingen (AREVA)**	Fuel Fabrication, Enrichment, Supply
Germany	**Nuclear Services Erlangen (AREVA)**	Fuel Fabrication, Enrichment, Supply
Germany	**NUKEM Technologies GmbH**	Fuel Fabrication, Enrichment, Supply
Germany	**URENCO Deutschland (Gronau)**	Fuel Fabrication, Enrichment, Supply
Netherlands	**URENCO Nederland BV**	Fuel Fabrication, Enrichment, Supply
Romania	**FCN Pitesti (ENEL and EDF Joint Venture Company)**	Fuel Fabrication, Enrichment, Supply
Romania	**TITAN ECHIPAMENTE NUCLEARE S.A**	Fuel Fabrication, Enrichment, Supply
Spain	**ENUSA Industrias Avanzadas**	Fuel Fabrication,

		Enrichment, Supply
UK	**URENCO UK Limited**	Fuel Fabrication, Enrichment, Supply
Belgium	**Belgoprocess**	WMOs/RWM and Decommissioning
Belgium	**TECNUBEL (GDF Suez Group)**	WMOs/RWM and Decommissioning
Belgium	**TRANSNUBEL (GDF Suez Group)**	WMOs/RWM and Decommissioning
Bulgaria	**DPRAO**	WMOs/RWM and Decommissioning
Czech Republic	**SURAO**	WMOs/RWM and Decommissioning
Czech Republic	**VF**	WMOs/RWM and Decommissioning
Finland	**Posiva**	WMOs/RWM and Decommissioning
France	**ANDRA**	WMOs/RWM and Decommissioning
France	**La Hague (AREVA)**	WMOs/RWM and Decommissioning
France	**Salvarem**	WMOs/RWM and Decommissioning
France	**STMI (AREVA)**	WMOs/RWM and Decommissioning
Germany	**DBE TECHNOLOGY GmbH**	WMOs/RWM and Decommissioning
Germany	**Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe mbH (DBE)**	WMOs/RWM and Decommissioning
Germany	**Eckhert & Ziegler Nuclitec**	WMOs/RWM and Decommissioning
Germany	**EWN Gruppe - Energie Werke Nord**	WMOs/RWM and Decommissioning
Germany	**Studsvik GmbH & Co. KG**	WMOs/RWM and Decommissioning
Hungary	**Public Limited Company for Radioactive Waste management, Decommissioning**	WMOs/RWM and Decommissioning
Italy	**Gruppo Sogin**	WMOs/RWM and Decommissioning
Italy	**Nucleco Società per l'Ecoingegneria Nucleare**	WMOs/RWM and Decommissioning
Lithuania	**State Enterprise Ignalina NPP**	WMOs/RWM and Decommissioning
Lithuania	**RATA - Radioaktyviųjų atliekų tvarkymo agentūra**	WMOs/RWM and Decommissioning
Netherlands	**COVRA N.V**	WMOs/RWM and Decommissioning
Romania	**ANDRAD - Agentia Nucleara Si Pentru Deseuri Radioactive**	WMOs/RWM and Decommissioning
Slovakia	**JAVYS a.s.- Jadrová a vyraďovacia spoločnosť a.s.**	WMOs/RWM and Decommissioning
Slovenia	**ARAO**	WMOs/RWM and Decommissioning
Spain	**ENRESA**	WMOs/RWM and Decommissioning
Sweden	**Barseback Kraft AB**	WMOs/RWM and Decommissioning

Sweden	**SANDVIK AB**	WMOs/RWM and Decommissioning
Sweden	**SKB - Svensk Kärnbränslehantering AB**[25]	WMOs/RWM and Decommissioning
Sweden	**Studsvik Nuclear AB**	WMOs/RWM and Decommissioning
UK	**Aker Kvaerner E & C Ltd**	WMOs/RWM and Decommissioning
UK	**Amec PLC Kent**	WMOs/RWM and Decommissioning
UK	**Amec PLC Gloucester**	WMOs/RWM and Decommissioning
UK	**Amec PLC Bristol**	WMOs/RWM and Decommissioning
UK	**Amec PLC Thatcham**	WMOs/RWM and Decommissioning
UK	**Carillion**	WMOs/RWM and Decommissioning
UK	**Dounreay Site Restoration Ltd**	WMOs/RWM and Decommissioning
UK	**Environmental Agency**	WMOs/RWM and Decommissioning
UK	**Jacobs Babtie Ltd**	WMOs/RWM and Decommissioning
UK	**LLW Repository Ltd.**	WMOs/RWM and Decommissioning
UK	**NDA Nuclear Decommissioning Authority**	WMOs/RWM and Decommissioning
UK	**Nuvia Ltd**	WMOs/RWM and Decommissioning
UK	**Sallafield Ltd.**	WMOs/RWM and Decommissioning
UK	**Studsvik UK Ltd**	WMOs/RWM and Decommissioning
UK	**UKAEA**	WMOs/RWM and Decommissioning
Belgium	**Assystem**	Design, Engineering, Manufacturing, Maintenance
Belgium	**Ateliers de la Meuse - Division Sclessin**	Design, Engineering, Manufacturing, Maintenance
Belgium	**Ateliers de la Meuse - Division Seraing**	Design, Engineering, Manufacturing, Maintenance
Belgium	**Belgatom (GDF Suez Group)**	Design, Engineering, Manufacturing, Maintenance
Belgium	**Cockeril Maintenance and Ingenierie**	Design, Engineering, Manufacturing, Maintenance
Belgium	**Tractabel Engineering (GDF Suez Group)**	Design, Engineering,

25 After the data was gathered and sorted according to the different types of stakeholders it was found out that this organisation is rather a machine manufacture organisation and not a decommissioning organisation. This implies changes in the database of EHRO-N on nuclear energy stakeholders. See link on http://ehron.jrc.ec.europa.eu/index.php?option=com_jumi&fileid=13&Itemid=66

		Manufacturing, Maintenance
Bulgaria	**Astro Engineering**	Design, Engineering, Manufacturing, Maintenance
Bulgaria	**Atomenergoproekt**	Design, Engineering, Manufacturing, Maintenance
Bulgaria	**Atomenergoremont Plc.**	Design, Engineering, Manufacturing, Maintenance
Bulgaria	**Enemona S.A.**	Design, Engineering, Manufacturing, Maintenance
Bulgaria	**Energoremont Holding**	Design, Engineering, Manufacturing, Maintenance
Bulgaria	**EnergoService**	Design, Engineering, Manufacturing, Maintenance
Bulgaria	**ENERGOSTROYMONTAJ-ENGINEERING**	Design, Engineering, Manufacturing, Maintenance
Bulgaria	**Eqe Bulgaria**	Design, Engineering, Manufacturing, Maintenance
Bulgaria	**Montagi EAD**	Design, Engineering, Manufacturing, Maintenance
Bulgaria	**Quantum engineering**	Design, Engineering, Manufacturing, Maintenance
Bulgaria	**RISK ENGINEERING LTD**	Design, Engineering, Manufacturing, Maintenance
Czech Republic	**EGP INVEST, spol. s r.o. (UJV Rez)**	Design, Engineering, Manufacturing, Maintenance
Czech Republic	**I & C Energo (Supplier to CEZ)**	Design, Engineering, Manufacturing, Maintenance
Czech Republic	**Orgrez SC**	Design, Engineering, Manufacturing, Maintenance
Czech Republic	**Pro Engineering s.r.o.**	Design, Engineering, Manufacturing, Maintenance
Czech Republic	**UJP Praha a.s.**	Design, Engineering, Manufacturing, Maintenance
Czech Republic	**Vitkovice Machinery Group**	Design, Engineering, Manufacturing,

		Maintenance
Finland	**Assystem**[26]	Design, Engineering, Manufacturing, Maintenance
France	**AREVA TA - Aix-en-Provence**	Design, Engineering, Manufacturing, Maintenance
France	**AREVA TA - St-Paul-Lez-Durance**	Design, Engineering, Manufacturing, Maintenance
France	**Assystem**	Design, Engineering, Manufacturing, Maintenance
France	**Atos Origin**	Design, Engineering, Manufacturing, Maintenance
France	**CANBERRA France (AREVA)**	Design, Engineering, Manufacturing, Maintenance
France	**CANBERRA Lingolsheim (AREVA)**	Design, Engineering, Manufacturing, Maintenance
France	**CANBERRA Usine de Loches (AREVA)**	Design, Engineering, Manufacturing, Maintenance
France	**CEDOS (AREVA)**	Design, Engineering, Manufacturing, Maintenance
France	**Creusot Forge (AREVA)**	Design, Engineering, Manufacturing, Maintenance
France	**Creusot Mécanique (AREVA)**	Design, Engineering, Manufacturing, Maintenance
France	**ENDEL (GDF Suez Group)**	Design, Engineering, Manufacturing, Maintenance
France	**INEO ANC (GDF Suez Group)**	Design, Engineering, Manufacturing, Maintenance
France	**Intercontrole (AREVA)**	Design, Engineering, Manufacturing, Maintenance
France	**JSPM - EQUIPEMENT (AREVA)**	Design, Engineering, Manufacturing, Maintenance
France	**Lisega**	Design, Engineering, Manufacturing, Maintenance
France	**Oakridge**	Design, Engineering, Manufacturing, Maintenance
France	**OMEGA CONCEPT (GDF Suez Group)**	Design, Engineering, Manufacturing, Maintenance

26 This is an example of a French subcontractor company active also in Finland. This company is not a regular Finnish subcontractor in the field [14]

France	**Onet Technologies**	Design, Engineering, Manufacturing, Maintenance
France	**Technical Centre (AREVA)**	Design, Engineering, Manufacturing, Maintenance
France	**Technoplus Industries (AREVA)**	Design, Engineering, Manufacturing, Maintenance
France	**TRIHOM (AREVA)**	Design, Engineering, Manufacturing, Maintenance
Germany	**AREVA NP GmbH (AREVA and Siemens company)**	Design, Engineering, Manufacturing, Maintenance
Germany	**Assystem**	Design, Engineering, Manufacturing, Maintenance
Germany	**Babcock Noell GmbH**	Design, Engineering, Manufacturing, Maintenance
Germany	**Barlage GmbH**	Design, Engineering, Manufacturing, Maintenance
Germany	**Evonik Energy Services GmbH**	Design, Engineering, Manufacturing, Maintenance
Germany	**IntelligeNDT (AREVA)**	Design, Engineering, Manufacturing, Maintenance
Germany	**Lisega AG**	Design, Engineering, Manufacturing, Maintenance
Germany	**Siempelkamp Nukleartechnik GmbH**	Design, Engineering, Manufacturing, Maintenance
Hungary	**ETV-ERŐTERV Power Engineering and Contracting Co.**	Design, Engineering, Manufacturing, Maintenance
Italy	**Ansaldo Energia S.p.A.**	Design, Engineering, Manufacturing, Maintenance
Romania	**CITON**	Design, Engineering, Manufacturing, Maintenance
Romania	**Nuclearmontaj**	Design, Engineering, Manufacturing, Maintenance
Slovakia	**AREVA NP Controls, s.r.o.**	Design, Engineering, Manufacturing, Maintenance
Slovakia	**REAKTORTEST s.r.o.**	Design, Engineering, Manufacturing, Maintenance
Slovakia	**Relko**	Design, Engineering, Manufacturing, Maintenance
Slovakia	**SES Tlmače, a.s (SLOVENSKÉ ENERGETICKÉ STROJÁRNE, a.s)**	Design, Engineering, Manufacturing,

		Maintenance
Slovenia	**NUMIP Engineering, Construction, Maintenance and Production Ltd and Q Techna**	Design, Engineering, Manufacturing, Maintenance
Spain	**Analisis-DIC**	Design, Engineering, Manufacturing, Maintenance
Spain	**AREVA NP Services Spain SLU.**	Design, Engineering, Manufacturing, Maintenance
Spain	**COAPSA**	Design, Engineering, Manufacturing, Maintenance
Spain	**Empresarios Agrupados**	Design, Engineering, Manufacturing, Maintenance
Spain	**ENWESA Operaciones**	Design, Engineering, Manufacturing, Maintenance
Spain	**GES SIEMSA SPAIN, SIEMSA INDUSTRIA**	Design, Engineering, Manufacturing, Maintenance
Spain	**GHESA**	Design, Engineering, Manufacturing, Maintenance
Spain	**Iberdrola Ingeniería y Construcción**	Design, Engineering, Manufacturing, Maintenance
Spain	**IDOM Bilbao**	Design, Engineering, Manufacturing, Maintenance
Spain	**IDOM Barcelona**	Design, Engineering, Manufacturing, Maintenance
Spain	**IDOM Madrid**	Design, Engineering, Manufacturing, Maintenance
Spain	**INITEC Energia (part of ACS Grupo - Industrual Services)**	Design, Engineering, Manufacturing, Maintenance
Spain	**Instalaciones Inabensa S.A.**	Design, Engineering, Manufacturing, Maintenance
Spain	**INYPSA Informes y Proyectos S.A.**	Design, Engineering, Manufacturing, Maintenance
Spain	**Ingenieria, Estudios y Proyectos NIP S.A.**	Design, Engineering, Manufacturing, Maintenance
Spain	**Ringo Valvulas (RV)**	Design, Engineering, Manufacturing, Maintenance
Spain	**SOCOIN (subsidiary of the Gas Natural GROUP)**	Design, Engineering, Manufacturing, Maintenance
Spain	**Tamoin Grupo**	Design, Engineering, Manufacturing, Maintenance

Spain	**Tecnatom s.a**	Design, Engineering, Manufacturing, Maintenance
Spain	**Técnicas REU-27nidas, S.A.**	Design, Engineering, Manufacturing, Maintenance
Spain	**THUNDER ESPAÑA SIMULACIÓN S.L.U.**	Design, Engineering, Manufacturing, Maintenance
Spain	**Vector & Wellheads Engineering, S.L.**	Design, Engineering, Manufacturing, Maintenance
Sweden	**AREVA NP Uddcomb AB**	Design, Engineering, Manufacturing, Maintenance
UK	**AREVA PLC**	Design, Engineering, Manufacturing, Maintenance
UK	**Atkins PLC**	Design, Engineering, Manufacturing, Maintenance
UK	**Balfour Beatty PLC**	Design, Engineering, Manufacturing, Maintenance
UK	**Balfour Kilpatrick Ltd.**	Design, Engineering, Manufacturing, Maintenance
UK	**BAM Nuttall**	Design, Engineering, Manufacturing, Maintenance
UK	**BARTEC Ltd.**	Design, Engineering, Manufacturing, Maintenance
UK	**Bechtel Ltd**	Design, Engineering, Manufacturing, Maintenance
UK	**Bendalls Engineering Ltd**	Design, Engineering, Manufacturing, Maintenance
UK	**BNS Nuclear Services Ltd**	Design, Engineering, Manufacturing, Maintenance
UK	**Canberra UK LTD. (AREVA)**	Design, Engineering, Manufacturing, Maintenance
UK	**Costain Group PLC**	Design, Engineering, Manufacturing, Maintenance
UK	**DBD Nuclear**	Design, Engineering, Manufacturing, Maintenance
UK	**Fluor Ltd**	Design, Engineering, Manufacturing, Maintenance
UK	**Halcrow Ltd**	Design, Engineering, Manufacturing, Maintenance
UK	**JGC Ltd**	Design, Engineering, Manufacturing,

		Maintenance
UK	**Jordan Engineering Services Ltd**	Design, Engineering, Manufacturing, Maintenance
UK	**Laing O'Rourke PLC**	Design, Engineering, Manufacturing, Maintenance
UK	**NG Bailey**	Design, Engineering, Manufacturing, Maintenance
UK	**NIS Integrated Engineering**	Design, Engineering, Manufacturing, Maintenance
UK	**Parsons Brickerhoff**	Design, Engineering, Manufacturing, Maintenance
UK	**Sheffield Forgemasters International Ltd.**	Design, Engineering, Manufacturing, Maintenance
UK	**Shepherd Engineering Services**	Design, Engineering, Manufacturing, Maintenance
UK	**URS Europe and Middle East HQ**	Design, Engineering, Manufacturing, Maintenance
UK	**Weir Services**	Design, Engineering, Manufacturing, Maintenance
UK	**Wyman Gordon**	Design, Engineering, Manufacturing, Maintenance
Austria	**ENCONET Consulting Ges.m.b.H.**	Consultancy (incl. project management and training)
Bulgaria	**Enpro Consult**	Consultancy (incl. project management and training)
Bulgaria	**Sakar**	Consultancy (incl. project management and training)
Bulgaria	**Theta Consult**	Consultancy (incl. project management and training)
Finland	**Poyry Plc.**	Consultancy (incl. project management and training)
France	**Altran Energy Industry and Life Sciences**	Consultancy (incl. project management and training)
France	**AREVA Risk Management Consulting SAS**	Consultancy (incl. project management and training)
France	**AREVA TA - Saclay**	Consultancy (incl. project management and training)
France	**CETIC (AREVA)**	Consultancy (incl. project management and training)

France	**CORYS T.E.S.S.(AREVA)**	Consultancy (incl. project management and training)
France	**Oxand**	Consultancy (incl. project management and training)
France	**RISKAUDIT IRSN/GRS International**	Consultancy (incl. project management and training)
France	**SOM (Groupe Ortec)**	Consultancy (incl. project management and training)
Italy	**SNI - Sviluppo Nucleare Italia (ENEL and EDF Joint Venture Company)**	Consultancy (incl. project management and training)
Slovakia	**JESS a.s. - Jadrova energeticka spolocnost Slovenska a.s. (Nuclear Power Corporation of Slovakia)**	Consultancy (incl. project management and training)
Slovenia	**IBE d.d., (engineering and consulting company)**	Consultancy (incl. project management and training)
Spain	**Iberinsa**	Consultancy (incl. project management and training)
Sweden	**ÅF-Engineering s.r.o**	Consultancy (incl. project management and training)
Sweden	**ES Konsult**	Consultancy (incl. project management and training)
Sweden	**Fagerström Industrikonsult**	Consultancy (incl. project management and training)
Sweden	**FS Dynamics Sweden AB**	Consultancy (incl. project management and training)
Sweden	**KSU Kärnkraftsäkerhet och Utbildning AB**	Consultancy (incl. project management and training)
UK	**AREVA Risk Management Consulting Ltd**	Consultancy (incl. project management and training)
UK	**ARUP**	Consultancy (incl. project management and training)
UK	**Lloyds Register Group Ltd**	Consultancy (incl. project management and training)
UK	**Morgan Est PLC**	Consultancy (incl. project management and training)
UK	**Mott Macdonald Group Ltd.**	Consultancy (incl. project management and training)
UK	**Serco Assurance Ltd**	Consultancy (incl. project management and training)
Belgium	**BEL V.**	Regulatory Authorities (also TSO and

		Reactor Safety)
Belgium	**FANC**	Regulatory Authorities (also TSO and Reactor Safety)
Belgium	**ONDRAF/NIRAS**	Regulatory Authorities (also TSO and Reactor Safety)
Belgium	**VNS Vinçotte (ex AVN)**	Regulatory Authorities (also TSO and Reactor Safety)
Bulgaria	**NRA**	Regulatory Authorities (also TSO and Reactor Safety)
Czech Republic	**SUJB**	Regulatory Authorities (also TSO and Reactor Safety)
Estonia	**Estonian Radiation Protection Centre**	Regulatory Authorities (also TSO and Reactor Safety)
Finland	**STUK**	Regulatory Authorities (also TSO and Reactor Safety)
France	**ASN**	Regulatory Authorities (also TSO and Reactor Safety)
Germany	**BFS Bundesamt für Strahlenschutz**	Regulatory Authorities (also TSO and Reactor Safety)
Germany	**Federal Ministry for the Environment, Nature Conservation and Nuclear Safety**	Regulatory Authorities (also TSO and Reactor Safety)
Germany	**GRS Cologne**	Regulatory Authorities (also TSO and Reactor Safety)
Germany	**GRS Braunschweig**	Regulatory Authorities (also TSO and Reactor Safety)
Germany	**GRS Berlin**	Regulatory Authorities (also TSO and Reactor Safety)
Hungary	**Hungarian Atomic Energy Authority**	Regulatory Authorities (also TSO and Reactor Safety)
Italy	**ISPRA**	Regulatory Authorities (also TSO and Reactor Safety)
Latvia	**Ministry of environmental protection and regional development**	Regulatory Authorities (also TSO and Reactor Safety)
Latvia	**Radiation Safety Centre of the State Environmental Service**	Regulatory Authorities (also TSO and Reactor Safety)
Lithuania	**VATESI**	Regulatory Authorities (also TSO and Reactor Safety)
Netherlands	**VROM-KFD Ministry of Housing, Spatial Planning and the Environment (now Ministry for Infrastructure and Environment)**	Regulatory Authorities (also TSO and Reactor Safety)

Poland	**PAA Państwowej Agencji Atomistyki**	Regulatory Authorities (also TSO and Reactor Safety)
Romania	**ANRE - Autoritatea Nationala de Reglementare in domeniul Energiei**	Regulatory Authorities (also TSO and Reactor Safety)
Romania	**CNCAN - Comisii Nationale pentru Controlul Activitatilor Nucleare**	Regulatory Authorities (also TSO and Reactor Safety)
Romania	**RAAN - Regia Autonoma Pentru Activitati Nucleare Romania**	Regulatory Authorities (also TSO and Reactor Safety)
Slovakia	**UJDSR**	Regulatory Authorities (also TSO and Reactor Safety)
Slovenia	**SNSA**	Regulatory Authorities (also TSO and Reactor Safety)
Slovenia	**SRPA Slovenian Radiation Protection Administration**	Regulatory Authorities (also TSO and Reactor Safety)
Spain	**CSN - Consejo de Seguridad Nuclear**	Regulatory Authorities (also TSO and Reactor Safety)
Sweden	**SSM**	Regulatory Authorities (also TSO and Reactor Safety)
UK	**Nuclear Directorate (ND)**	Regulatory Authorities (also TSO and Reactor Safety)
Austria	**Atomic Institute of the Austrian Universities (ATI)**	R&D institutes
Belgium	**LABORELEC (GDF Suez Group)**	R&D institutes
Belgium	**SCK CEN**	R&D institutes
Bulgaria	**Energy Institute JSC**	R&D institutes
Bulgaria	**INRNE Institute of Nuclear Research and Nuclear Energy**	R&D institutes
Czech Republic	**Ústav jaderného výzkumu Řež, a. s.**	R&D institutes
Denmark	**Risø DTU Technical University of Denmark Risø National Laboratory for Sustainable Energy**	R&D institutes
Finland	**Aalto University School of Science and Technology/ Aalto-Yliopiston Teknillinen Korkeakoulu (Course, Research)**	R&D institutes
Finland	**Lappeenranta University of Technology**	R&D institutes
Finland	**VTT Technical Research Center**	R&D institutes
France	**AREVA Marcoule**	R&D institutes
France	**CEA / Marcoule**	R&D institutes
France	**CEA / Saclay**	R&D institutes
France	**CEA/Cadarache**	R&D institutes
France	**CEA/Fontenay-aux-Roses**	R&D institutes
France	**Grenoble INP**	R&D institutes
France	**INSTN Institut National des Science et Techniques Nucleaires**	R&D institutes
France	**IRSN Institut de Radioprotection et de Surete**	R&D institutes

	Nucleaire	
Germany	**Helmholtz-Zentrum Berlin fur Materialen und Energie GmbH**	R&D institutes
Germany	**Helmholtz-Zentrum Dresden-Rossendorf (HZDR)**	R&D institutes
Germany	**IKP Forschungszentrum Jülich**	R&D institutes
Germany	**Joint Research Centre - Institute for Transuranium Elements**	R&D institutes
Germany	**KIT**	R&D institutes
Greece	**Aristotle University of Thessaloniki, Department of Physics, Nuclear Physics Laboratory**	R&D institutes
Greece	**Greek Atomic Energy Commission**	R&D institutes
Greece	**National Technical University of Athens**	R&D institutes
Greece	**NCSR Demokritos, Institute of Nuclear Physics and Institute of Nuclear Technology & Radiation Protection**	R&D institutes
Hungary	**BME NTI Institute of Nuclear Techniques**	R&D institutes
Hungary	**KFKI AEKI Atomic Energy Research Institute**	R&D institutes
Italy	**ENEA Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile**	R&D institutes
Italy	**GRNSPG University of Pisa**	R&D institutes
Italy	**INFN National Institute of Nuclear Physics**	R&D institutes
Lithuania	**Lietuvos Energetikos Institutas**	R&D institutes
Netherlands	**JRC - Institute for Energy and Transport**	R&D institutes
Netherlands	**KINT Foundation Stichting Kennis Infrastructuur Nucleaire Technologie**	R&D institutes
Netherlands	**LABORELEC (GDF Suez Group)**	R&D institutes
Netherlands	**NRG Nuclear Research & Consultancy, Project Management, Training Group**	R&D institutes
Poland	**IFJ PAN Instytut Fizyki Jądrowej**	R&D institutes
Poland	**INCT Instytutu Chemii i Techniki Jądrowej**	R&D institutes
Poland	**IPJ Instytut Problemów Jądrowych Andrzeja Soltana**	R&D institutes
Poland	**POLATOM Instytut Energii Atomowej**	R&D institutes
Portugal	**ITN (INSTITUTO TECNOLÓGICO E NUCLEAR)**	R&D institutes
Romania	**ICN Pitesti**	R&D institutes
Romania	**ICPMRR National Institute for Metals and Radioactive Resources**	R&D institutes
Romania	**IFA Institul De Fizica Atomica**	R&D institutes
Romania	**IFIN HH Horia Hulubei National Institute of Physics and Nuclear Engineering**	R&D institutes
Romania	**ROMAG-PROD**	R&D institutes
Slovenia	**IJS Institut Josef Stefan**	R&D institutes
Slovenia	**IMK Institute for metal constructions**	R&D institutes
Slovenia	**IMT Institute of metals and technology**	R&D institutes
Slovenia	**Welding Institute**	R&D institutes
Spain	**CIEMAT Centro de Investigaciones Energéticas Medioambientales y Tecnológicas**	R&D institutes
Spain	**TECNALIA-INASMET**	R&D institutes
Sweden	**KTH - Royal Institute of Technology**	R&D institutes
UK	**Nuclear Institute**	R&D institutes

UK	**Research Sites Restoration Limited**	R&D institutes
UK	**t3**|**UK**	R&D institutes

ANNEX 3 – LIST OF EHRO-N SENIOR ADVISORY GROUP (SAG) MEMBERS

	NAME	ORGANISATION	COUNTRY	CHANGES (AS OF MARCH 2012)
1	**Dr. Brian P. Murphy**	Director, Science & Research Cogent Sector Skills Council	UK	Due to change of post, his membership will be replaced (**tbc**)
2	**Dr.-Ing. Ludger Mohrbach**	VGB Power Tech e.V.	DE	Is represented by **Mr. Hans Werner Otte**
3	**Mr. Luc van Hoenacker**	Tractebel Engineering (GDF Suez)	BE	
4	**Dr. Anselm Schaefer**	IsaR, European Nuclear Education Network (ENEN)	DE/EU	
5	**Dr. Eckhard Nithack**	EON Kernkraft GmbH	DE	
6	**Mrs. Simonne Henrard**	Director for Human Resources - Westinghouse	BE	
7	**Dr. Andreas Hamann**	Vice President for Human Resources, Plant Sector - Areva	FR	Due to change of post, his membership will be replaced (**tbc**)
8	**Mr. David Gilchrist**	ENEL	IT	
9	**Dr.-Ing. Joachim U. Knebel**	Karlsruher Institut für Technology	DE	Is represented by **Mr. Victor Sanchez-Espinoza**
10	**Prof. Vladimir Slugen**	Slovak University of Technology, European Nuclear Society (ENS)	SK	
11	**Dr. Laurent Turpin**	CEA/INSTN	FR	
12	**Mrs. Marie-Francoise Debreuille**	I2EN	FR	Is represented by **Mr. Hubert Flocard**
13	**Dr. Jürgen**	DBE Technology GmbH	DE	

	Krone			
14	**Dr. Yanko Yanev**	Head of Nuclear Knowledge Management Unit, IAEA	World	
15	**Dr. Georges van Goethem**	European Commission, DG RTD	EU	
16	**Mrs. Niina Yliknuussi**	European Commission, DG ENER	EU	
17	**Mrs. Ute Blohm-Hieber**	European Commission, DG ENER	EU	
18	**Mr. Ferry Roelofs**	NRG	NL	
19	**Mr. Jorma Aurela**	MEE [27], Department of Energy (TEM Energiaosasto)	FI	
20	**Mrs. Marjatta Palmu**	Posiva Oy	FI	
21	**Mr. Francisco Jose Sanchez Alvarez**	Tecnatom	ES	
22	**Mrs. Emilia Janisz**	ENS	EU/World	
23	**Mr. Guy Parker**	Foratom	EU/World	
24	**Mr. Ron Cameron**	OECD/NEA	World	

27 Finnish Ministry of Employment and Economy.

ANNEX 4: POSSIBLE FUTURE QUESTIONNAIRE FOR THE NUCLEAR ENERGY SECTOR IN THE EU-27

EUROPEAN COMMISSION
DIRECTORATE-GENERAL JRC
JOINT RESEARCH CENTRE
Institute for Energy and Transport

Petten, 2012

QUESTIONNAIRE

ON THE

QUANTITATIVE AND QUALITATIVE NEEDS OF THE NUCLEAR ENERGY SECTOR IN THE EU IN THE SHORT/MEDIUM AND LONG-TERM

1. Your organisation is a (please choose the appropriate answer):

Type of stakeholder

Utilitiy (i.e.) NPP ☐

Waste Management Organisation/Radwaste management and decommissioning organisation ☐

Fuel fabrication, enrichment and supply organisation ☐

Regulatory authority ☐

RD&D institute ☐

University ☐

Design, Engineering, Manufacturing, Maintenance Organisation ☐

Nuclear Facility Vendor and other big supplier ☐

Consultancy (including project management and training) ☐

Other? (specify) ☐

*** In case you are providing the data for a certain country as a whole, please divide it according to the above groups of stakeholders. This footnote is valid for the below questions as well, of course if applicable.**

2. Your organisation has its HQ in this country (please choose the appropriate answer):

Country

Austria ☐

Belgium ☐

Bulgaria ☐

Cyprus ☐

Czech Republic ☐

Denmark ☐

Estonia ☐

Finland ☐

France ☐

Germany ☐

Greece ☐

Hungary ☐

Ireland ☐

Italy ☐

Latvia ☐

Lithuania ☐

Luxembourg ☐

Malta ☐

Netherlands ☐

Poland ☐

Portugal ☐

Romania ☐

Slovakia ☐

Slovenia ☐

Spain ☐

Sweden ☐

United Kingdom ☐

3. The total number of personnel within each of the below profiles in our organisation is at the moment (please write the numerical value in the spaces provided):

Job profile	**1.** **Total number of employees with this profile**	**2.** **Of those in column 1, there are this many employees with university degree (Msc or above)**	**3.** **Of those in column 1, there are this many employees with technical (non-university) degree**
Nuclear specific			
Nuclear Engineering			

Probabilistic risk analysis (PRA)				
Reactor physics and dynamics				
Nuclear/ particle physics				
Thermohydraulics				
Serious accidents				
Human factors				
Safeguards (incl. inspection)				
Nuclear fuel				
Radiochemistry				
Nuclear waste management related RD&D incl. safety case				
University Professors (specify field)				
Trainers (specify field)				
General technical and engineering fields				
Material technology & science, engineering				
Radiation protection				
Automation and control				
Mechanical engineering				
Electrical engineering				
Project management				
Process technology				
Systems engineering				
(Nuclear) Water chemistry				
QA and inspection				
Security				
University Professors (specify field)				
Trainers (specify field)				
Construction, operation and maintenance (specific)				
Construction (Civil engineering)				

Industrial mechanics (for construction)			
Instrumentation and control			
Operations (supervisors, operators)			
Maintenance (technicians)			
University Professors (specify field)			
Trainers (specify field)			
Other (specify)			

4. The age structure of personnel within each of the below profiles in our organisation is at the moment (please write the numerical value in the spaces provided):

Job profile	The % of personnel below 35	The % of personnel between 35 and 45	The % of personnel between 45 and 55	The % of personnel above 55
Nuclear specific				
Nuclear Engineering				
Probabilistic risk analysis (PRA)				
Reactor physics and dynamics				
Nuclear/ particle physics				
Thermohydraulics				
Serious accidents				
Human factors				
Safeguards (incl. inspection)				
Nuclear fuel				
Radiochemistry				
Nuclear waste management related				

RD&D incl. safety case				
University Professors (specify field)				
Trainers (specify field)				
General technical and engineering fields				
Material technology & science, engineering				
Radiation protection				
Automation and control				
Mechanical engineering				
Electrical engineering				
Project management				
Process technology				
Systems engineering				
(Nuclear) Water chemistry				
QA and inspection				
Security				
University Professors (specify field)				
Trainers (specify field)				
Construction, operation and maintenance (specific)				
Construction (Civil engineering)				
Industrial mechanics (for construction)				
Instrumentation and control				
Operations (supervisors, operators)				
Maintenance (technicians)				
University Professors (specify field)				

Trainers (specify field)				
Other (specify)				

5. In the period 0-2 years (in the short-term) our organisation will need personnel with the following profile (please write the numerical value in the spaces provided):

Job profile	**1.** **Total number of employees with this profile needed in the next 0-2 years**	**2.** **Of those in column 1, there are this many employees with university degree (Msc or above)**	**3.** **Of those in column 1, there are this many employees with technical (non-university) degree**	**4.** **Of those in column 1, there are this many employees needed in order to fill a post because of a retirement of a previous employee**	**5.** **Of those in column 1, there are this many employees needed in order to fill a newly created post**
Nuclear specific					
Nuclear Engineering					
Probabilistic risk analysis (PRA)					
Reactor physics and dynamics					
Nuclear/ particle physics					
Thermohydraulics					
Serious accidents					
Human factors					
Safeguards (incl. inspection)					
Nuclear fuel					
Radiochemistry					
Nuclear waste management related RD&D incl. safety case					
University					

Professors (specify field)					
Trainers (specify field)					
General technical and engineering fields					
Material technology & science, engineering					
Radiation protection					
Automation and control					
Mechanical engineering					
Electrical engineering					
Project management					
Process technology					
Systems engineering					
(Nuclear) Water chemistry					
QA and inspection					
Security					
University Professors (specify field)					
Trainers (specify field)					
Construction, operation and maintenance (specific)					
Construction (Civil engineering)					
Industrial mechanics (for construction)					
Instrumentation and control					
Operations (supervisors,					

operators)					
Maintenance (technicians)					
University Professors (specify field)					
Trainers (specify field)					
Other (specify)					

6. In the period 3-5 years (in the medium-term) our organisation will need personnel with the following profile (please write the numerical value in the spaces provided):

Job profile	**1.** **Total number of employees with this profile needed in the next 3-5 years**	**2.** **Of those in column 1, there are this many employees with university degree (Msc or above)**	**3.** **Of those in column 1, there are this many employees with technical (non-university) degree**	**4.** **Of those in column 1, there are this many employees needed in order to fill a post because of a retirement of a previous employee**	**5.** **Of those in column 1, there are this many employees needed in order to fill a newly created post**
Nuclear specific					
Nuclear Engineering					
Probabilistic risk analysis (PRA)					
Reactor physics and dynamics					
Nuclear/ particle physics					
Thermohydraulics					
Serious accidents					
Human factors					
Safeguards (incl. inspection)					

Nuclear fuel					
Radiochemistry					
Nuclear waste management related RD&D incl. safety case					
University Professors (specify field)					
Trainers (specify field)					
General technical and engineering fields					
Material technology & science, engineering					
Radiation protection					
Automation and control					
Mechanical engineering					
Electrical engineering					
Project management					
Process technology					
Systems engineering					
(Nuclear) Water chemistry					
QA and inspection					
Security					
University Professors (specify field)					
Trainers (specify field)					
Construction, operation and maintenance (specific)					
Construction (Civil					

engineering)					
Industrial mechanics (for construction)					
Instrumentation and control					
Operations (supervisors, operators)					
Maintenance (technicians)					
University Professors (specify field)					
Trainers (specify field)					
Other (specify)					

7. In the period 8-10 years (in the long-term) our organisation will need personnel with the following profile: (please write the numerical value in the spaces provided):

Job profile	**1.** **Total number of employees with this profile needed in the next 8-10 years**	**2.** **Of those in column 1, there are this many employees with university degree (Msc or above)**	**3.** **Of those in column 1, there are this many employees with technical (non-university) degree**	**4.** **Of those in column 1, there are this many employees needed in order to fill a post because of a retirement of a previous employee**	**5.** **Of those in column 1, there are this many employees needed in order to fill a newly created**
Nuclear specific					
Nuclear Engineering					
Probabilistic risk analysis (PRA)					
Reactor physics and dynamics					

Nuclear/ particle physics					
Thermohydraulics					
Serious accidents					
Human factors					
Safeguards (incl. inspection)					
Nuclear fuel					
Radiochemistry					
Nuclear waste management related RD&D incl. safety case					
University Professors (specify field)					
Trainers (specify field)					
General technical and engineering fields					
Material technology & science, engineering					
Radiation protection					
Automation and control					
Mechanical engineering					
Electrical engineering					
Project management					
Process technology					
Systems engineering					
(Nuclear) Water chemistry					
QA and inspection					
Security					
University					

Professors (specify field)						
Trainers (specify field)						
Construction, operation and maintenance (specific)						
Construction (Civil engineering)						
Industrial mechanics (for construction)						
Instrumentation and control						
Operations (supervisors, operators)						
Maintenance (technicians)						
University Professors (specify field)						
Trainers (specify field)						
Other (specify)						

Please write down any comment/additional information you may have:

European Commission
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Title: PUTTING INTO PERSPECTIVE THE SUPPLY OF AND DEMAND FOR NUCLEAR EXPERTS BY 2020 WITHIN THE EU-27 NUCLEAR ENERGY SECTOR

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Abstract

EHRO-N, the European human resource observatory for the nuclear energy sector, was given the task to explore the link between supply and demand for nuclear human resources in the EU-27 in the short-, medium-, and long-term future. This task was achieved through EHRO-N's own research activities and through co-operating with other relevant actors from the nuclear energy area in EU-27. Formally the co-operation between EHRO-N and the nuclear energy sector in the EU-27 is being conducted through the so called EHRO-N Senior Advisory Group (SAG), where sit the representatives of research organisations, industry, international organisations, etc. and oversee the activities of EHRO-N.

At the moment of the start of EHRO-N's activities, there was no comprehensive picture for the EU-27 as a whole as far as the supply and demand for relevant nuclear human resource is concerned. National data on this kind of supply and demand is of utmost importance but countries in the EU-27 vary among them as for the level of available information. Some EU Member States have already monitored their nuclear workforce supply and demand through comprehensive national surveys (e.g. France and UK, and most recently Finland). In the other EU Member States, the data is either not complete or missing altogether. Some, but not complete, data is obtainable from reports of international organisations like IAEA and OECD/NEA but this is in no way replacing the need for comprehensive national reports in EU-27 on the nuclear human resource situation.

The purpose of this report was to

1. See if the supply for relevant nuclear human resource (we focused in this first EHRO-N report on the highly skilled workforce, or on the so called nuclear experts) is sufficient for the demand for these personnel in EU-27 by 2020.
2. Put the supply of/demand for nuclear experts in EU-27 by 2020 in wider perspective, learn from the activities already conducted and set the way forward.

While this first EHRO-N report is a valuable contribution to the issue of supply and demand of nuclear human resource in EU-27, we are aware that for more refined and accurate data that can determine policy, the most effective way is to envisage regular nuclear human resource monitoring in the future based on a strong interaction between all relevant nuclear energy stakeholders in the EU-27.

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