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Report on the nuclear human resources and education and training situation in the European enlargement and integration countries

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FOREWORD

The Energy Policy for Europe[1], covering the full range of energy sources from fossil fuels to nuclear energy and renewables, aims to assure secure energy supply, to promote climate-friendly energy sources and aspires to save energy. Considering the energy mix, nuclear represents a source of energy with low carbon levels and relatively stable costs. Therefore, nuclear energy definitely contributes to secure the energy supply for the EU-27 and to fight global climate change.

It is a fact that nuclear power plants currently produce 28.4% of the total energy consumed in the EU-27[2] and it is obvious that this production will necessitate the long-term availability of highly qualified human resources. Recognizing these needs, the Council of the EU concluded on 1 December 2008 that "it is essential to maintain in the European Union a high level of training in the nuclear field" and emphasized that "training in the nuclear field does not solely involve those Member States which have chosen the nuclear option for energy production; all the Member States, since they have research installations or make use of radioactive materials (particularly for medical purposes), need to maintain expertise in the nuclear field" [3]. The Council's Nuclear Safety Directive, adopted on 25 June 2009, equally promotes the importance of education and training as guarantors for sustainable expertise and skills in nuclear safety.

In 2009, the European Human Resources Observatory for the Nuclear Energy Sector (EHRO-N)[4], an initiative of the European Nuclear Energy Forum (ENEF)[5], was established with the overall objective to monitor the nuclear human resource situation in the EU-27 and to provide qualified data and analyses on the short- and long-term trends in supply and demands of personnel in the nuclear field.

This EHRO-N report focuses on the "Nuclear Human Resources and Education and Training Situation in the European Enlargement and Integration Countries (E&I Countries)"[6] and aims at providing a solid overview of the nuclear education, training and research opportunities as well as the situation of nuclear stakeholders in the E&I Countries. It is addressed to decision makers, young people considering entering the nuclear field, universities, training and research institutions and companies involved in the nuclear industry.

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[1] EU Energy Policy http://europa.eu/legislation_summaries/energy/european_energy_policy/index_en.htm

[2] Eurostat. Keyfigures on Europe 2012. [Online] Available from: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-EI-12-001/EN/KS-EI-12-001-EN.PDF

[3] Council of the European Union. Conclusions on the need for skills in the nuclear field. 2008. [Online] Available from: http://ec.europa.eu/energy/nuclear/forum/risks/doc/2010_06_16/annex_8_-_council_conclusion_nuclear_training_2008.pdf

[4] EHRO-N http://ehron.jrc.ec.europa.eu

[5] ENEF http://ec.europa.eu/energy/nuclear/forum/forum_en.htm In 2007, the European Nuclear Energy Forum (ENEF) was created to organize a broad discussion among all relevant stakeholders on the opportunities and risks of nuclear energy. ENEF is an initiative of the European Commission endorsed by all leaders of the 27 EU Member States.

[6] Enlargement countries: Albania, Bosnia, Croatia, FYROM, Montenegro, Serbia; Integration countries: Iceland, Israel, Liechtenstein, Norway, Switzerland, Turkey;

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LIST OF ACRONYMS AND ABBREVIATIONS

E&I Countries	Enlargement and Integration Countries
E&T	Education and Training
EC	European Commission
EHRO-N	European Human Resources Observatory for the Nuclear Energy Sector
ENEF	European Nuclear Energy Forum
ENEN	European Nuclear Education Network
ENS	European Nuclear Society
EU/EU-27	European Union
Eurostat	Statistical Office of the European Union
NGO	Non-Governmental Organization
IAEA	International Atomic Energy Agency
OECD/NEA	Organisation for Economic Cooperation and Development / Nuclear Energy Agency
SET	Science, Engineering and Technology

EXECUTIVE SUMMARY

The Fukushima Daiichi accident in March 2011 has definitely slowed down the expansion or development of nuclear power programs. However, a number of countries still decided to embark on nuclear power or to expand their existing programmes in the coming years. This development will be characterized by the continuous need for a skilled and knowledgeable workforce able to meet the international requirements for handling nuclear energy.

The Council of the EU recognized on several occasions that training and education are the back-bone of a sustainable development of highly qualified experts in the nuclear field. The European Human Resources Observatory for the Nuclear Energy Sector (EHRO-N)[7] is at the forefront of European efforts to monitor and analyze short- and long-term trends in supply of and demands for personnel in the nuclear field to support the systematic and continuous capacity building in this area in the EU-27 and beyond its borders.

This EHRO-N report examines the current situation of the nuclear human resource SUPPLY – the availability of nuclear education and training programmes, including research opportunities – as well as the DEMAND situation for such experts – companies involved e.g. in consultancy, manufacturing, engineering, provision of technical services, mining, decommissioning and waste management representing direct employment opportunities – in the Enlargement and Integration Countries[8]. In addition, the report provides a brief overview of the nuclear infrastructure of each of the E&I Countries, if applicable.

The objective of the report is to create awareness for existing academic and other programmes focusing on the development of nuclear knowledge and skills as well as for nuclear stakeholders currently present in the E&I Countries. Further, the report hopes to encourage nuclear stakeholders to liaise with education and training (E&T) institutions and vice versa to jointly improve nuclear curricula and attract the next generation for a nuclear career. The closer cooperation and collaboration among academia and nuclear stakeholders might significantly contribute to the enhancement and optimization of the SUPPLY and DEMAND situation, and to the minimization of the expected shortfall of nuclear personnel.

In summary, the report indicates that none of the six Enlargement Countries has a nuclear power programme in place. Two out of the six countries, Croatia and the Former Republic of Macedonia, are currently in the progress of deciding if they will embark on nuclear power in the future. One country, Albania, has decided to postpone its intention to start a nuclear power programme. This decision might have been influenced by the Fukushima Daiichi accident. Serbia is the only country among the Enlargement Countries that operates research reactors and offers a wide range of research opportunities in the nuclear field. Moreover, Serbia is the only Enlargement Country that provides nuclear educational programmes and has necessary laboratories available to carry out nuclear related research

[7] EHRO-N http://ehron.jrc.ec.europa.eu

[8] Enlargement and Integration Countries are defined in the Foreword of this report.

projects. Among the remainder five Enlargement Countries, Croatia is the only one that offers a variety of training programmes aiming at building-up nuclear skills and competences. In addition, Croatia provides a number of research opportunities in the nuclear field. In summary, Serbia and Croatia are the two Enlargement Countries that promote nuclear energy and technology and give access to programmes focusing on the development and maintenance of nuclear competences through E&T as well as research activities.

When it comes to the Integration Countries, it can be said that apart from Switzerland, none of the six countries has a nuclear power programme in place. However, after the events in Fukushima Daiichi, the Swiss government has decided to phase out nuclear power. Turkey is the only of the remainder five Integration Countries that is currently in the process of developing its national infrastructure for the country's new nuclear power programme.

Except Iceland and Liechtenstein, all other Integration Countries offer a wide range of nuclear educational and training opportunities and likewise offer a variety of research activities. This clearly indicates that nuclear science and technology play an important role also in countries with no intentions or plans to start a nuclear power programme. In summary, Israel, Norway, Switzerland and Turkey have programmes in place to develop and maintain nuclear skills and competences at the national level and equally contribute to European and international efforts in developing human resources and carrying out research projects in the nuclear field.

The report also determines that in Switzerland, Turkey, Norway and Croatia there are significantly more nuclear stakeholder companies present than in the other E&I Countries. The reason for this situation in the four countries might be the combination of existing business opportunities and the availability of highly qualified nuclear workforce.

It can also be summarized that all 12 examined countries are part of the Bologna Process and therefore, higher education in each of the E&I Countries is divided into three levels: Bachelor, Master and PhD degrees. This facilitates the recognition of academic degrees and fosters the mobility of graduates within the E&I Countries and the EU-27.

Overall it can be said that most of the E&I Countries have programmes in place to support the development of skilled and knowledgeable nuclear personnel in line with their energy policy. However, this raises the question whether these programmes are effective and if they are sufficient to fully cover the DEMAND for nuclear personnel. For answering this question, deeper analysis on the nuclear workforce SUPPLY and DEMAND situation in the E&I Countries would be needed.

1. INTRODUCTION

The European Human Resources Observatory for the Nuclear Energy Sector (EHRO-N)[9] produces and regularly updates a quality-assured database on the short-, medium-, and long-term needs for human resources for the different stakeholders in nuclear energy and nuclear safety. Since its establishment in 2009, EHRO-N has released the following two reports focusing on the supply and demand of nuclear experts in the EU.

- In 2011, EHRO-N published the report "Mapping of Nuclear Education Possibilities and Nuclear Stakeholders in the EU-27"[10]. The report provides an overview and inventory of currently existing higher educational opportunities in the EU including companies involved in the nuclear arena which could be potential future employers offering a career for highly qualified nuclear staff.
- In 2012, EHRO-N released the report "Putting into Perspective the supply of and the demand for nuclear experts by 2020 within the EU-27 Nuclear Energy Sector" [11]. This report analyzes how the supply of experts for the nuclear industry in the EU-27 responds to the demand for the same experts in the region by 2020.

To date, the EU-27 has seen five enlargements. The fifth enlargement occurred in two successive waves in 2004 and 2007 and welcomed twelve new Member States. Since 2007, a number of new countries have expressed interest in and/or have already applied for EU membership. In order to better understand the supply of and the demand for nuclear experts in potential EU candidate countries, EHRO-N has developed this report to support and complement the EHRO-N EU-27 nuclear educational institutions mapping report mentioned beforehand.

The report focuses on the "Nuclear Human Resources and Education and Training Situation in the European Enlargement and Integration Countries (E&I Countries)[12]" following a similar structure as the report on "Mapping of Nuclear Education Possibilities and Nuclear Stakeholders in the EU-27"[13]. It includes a country section for each of the E&I Countries providing factual information of the situation with respect to nuclear power, education and

[9] EHRO-N http://ehron.jrc.ec.europa.eu

[10] EHRO-N (European Human Resources Observatory for the Nuclear Energy Sector). 2011. Mapping of Nuclear Education Possibilities and Nuclear Stakeholders in the EU-27. [Online] Available from: http://ehron.jrc.ec.europa.eu/ehron/sites/ehron/files/documents/public/ehro-n_reports/mapping_nuclear_stakeholdersonline_2.pdf

[11] EHRO-N (European Human Resources Observatory for the Nuclear Energy Sector). 2012. Putting into Perspective the supply of and the demand for nuclear experts by 2020 within the EU-27 Nuclear Energy Sector. [Online] Available from: http://ehron.jrc.ec.europa.eu/ehron/sites/ehron/files/documents/public/ehro-n_reports/ehro-n_putting_into_perspective_report_2012_05_25.pdf

[12] Enlargement countries: Albania, Bosnia, Croatia, FYROM, Montenegro, Serbia;
Integration countries: Iceland, Israel, Liechtenstein, Norway, Switzerland, Turkey.

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

training as well as research available in the nuclear field (situation of the SUPPLY side) as well as nuclear human resources/stakeholders[14] (situation of the DEMAND side).

The report is based on desk research. Experience has shown that in public domain literature, including the Internet, much general information on training providers, academic and research institutions as well as nuclear stakeholders can be found. However, in many cases detailed information, like number of graduates or human resources employed at nuclear stakeholders cannot be extracted from these sources. For obtaining this information the development of a tailored questionnaire would be required that could be used in interviews or in online surveys which is beyond the scope of this report. Therefore, this report is limited to the enumeration of academic, training, research institutions and nuclear stakeholders without providing any specific numbers of human resources following the report on "Mapping of Nuclear Education Possibilities and Nuclear Stakeholders in the EU-27" mentioned above.

This report, as well as other studies, will feed into continuous EHRO-N analyses assessing the adequacy of nuclear human resources SUPPLY in Europe and will contribute this way to the systematic and sustainable development and maintenance of nuclear competences in the EU-27 and beyond.

[14] In this document the term 'nuclear stakeholders' is taken to mean national and international companies as well as research institutions involved in the nuclear field, as used in the report on "Mapping of Nuclear Education Possibilities and Nuclear Stakeholders in the EU-27".

2. DEVELOPMENT OF THE COUNTRY PROFILES

The methodology according to which the data was gathered for the *Country Profiles* followed the steps set out below:

- Desk research of the current situation related to nuclear power*;*
- Desk research of the training providers and academic institutions providing nuclear related programmes/courses, including related research institutions, networks, associations, societies, NGOs, etc;
- Desk research of nuclear energy stakeholders;
- Compilation of all data related to each individual country including figures, if appropriate;

The sources of information used for the analysis of existing data are mainly European Commission (EC) documents, including relevant EC publications[15], documents of the International Atomic Energy Agency (IAEA)[16], publications of the Organisation for Economic Cooperation and Development/Nuclear Energy Agency (OECD/NEA)[17] and official websites of other relevant organizations/institutions[18], national nuclear competent authorities[19], other nuclear security stakeholders[20], universities, training providers or other institutions providing academic or training programs subject of this study.

The research for each of the Enlargement and Integration (E&I Countries) has been carried out independently and the individual *Country Profiles* are structured as follows:

- **Introduction**
  This part provides an overall overview of the national nuclear power programme, including information on the national nuclear competent authorities, if applicable, and a brief overview of the role of national training providers and academic institutions[21] in building-up nuclear knowledge, skills and attitudes among professionals and students;

- **Higher Education and Training**
  This part is dedicated to available higher education and training opportunities in the nuclear field, including the role of national nuclear networks, associations or other institutions involved in the development of nuclear competencies, including links to the website of each of the institutions, if available. Since all E&I Countries are full

[15] Such as Progress Reports;
[16] Such as IAEA General Conference Delegates' Statements;
[17] Such as Publication on the Nuclear Legislation in OECD Countries Regulatory and Institutional Framework for Nuclear Activities;
[18] Such as World Nuclear Association, European Nuclear Society, etc;
[19] Such as Regulatory Bodies;
[20] Such as companies involved in the nuclear field;
[21] In this document, the term 'academic institution' is taken to mean all higher education establishments, including universities, colleges, polytechnics, academies or other institutions providing academic programmes/courses;

members of the Bologna Declaration, the analysis of educational opportunities focuses on available nuclear Bachelor, Master and Doctorate programmes in the nuclear field. The number of nuclear curricula in each of the E&I Country is summarized and illustrated by figures, if applicable, in the individual *Country Profiles*. In addition, chapter three of this report provides an overall analysis of the higher education situation in the E&I Countries. Relevant courses which are offered under other academic programmes, but do not lead to a nuclear degree, are also indicated, but they are not part of the overall analysis of this report.

Since the report is in English, many of the educational institutions are identified by their English names. The academic programmes or courses are likewise indicated in English. However, this does not mean that the enumerated programmes or courses are taught in English. The details of the instruction language can be obtained by accessing the provided website links.

- **Research**
  This part provides an overview of institutions carrying out nuclear related research activities including their main research projects as well as links to their websites, if available. The website links provide access to more detailed information about the individual research activities.

- **Nuclear Energy Stakeholders**
  This part enumerates national and international companies involved in the nuclear field, including links to the website of each of the stakeholders, if available. The number and types of companies present in each of the E&I Countries is summarized and illustrated by figures in the individual *Country Profiles*. In addition, chapter three of this report provides an overall analysis of the nuclear stakeholder situation in the E&I Countries.

While every attempt has been made to provide a comprehensive overview of the main nuclear academic and training programmes, relevant research institutions and the main nuclear stakeholders in the E&I Countries, the report makes no claim to be exhaustive.

3. RESULTS

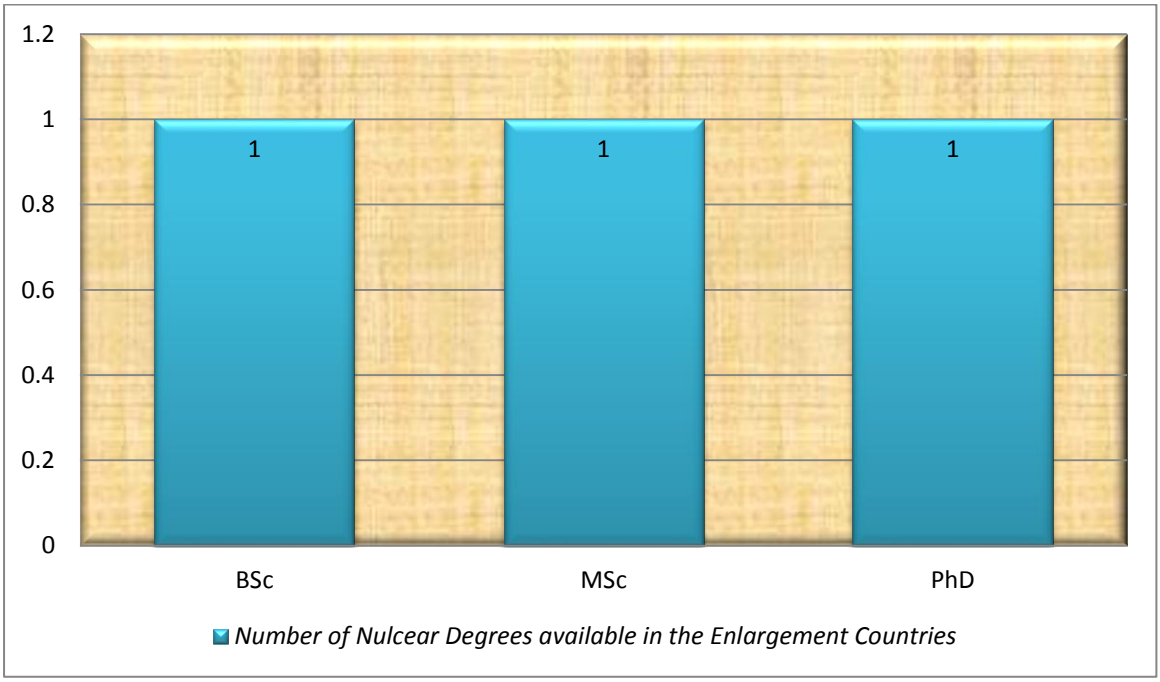
This chapter provides a detailed overview of the study results supported by figures illustrating the situation of nuclear curricula and nuclear stakeholders in the E&I Countries.

3.1 Nuclear Curricula in the E&I Countries

3.1.1 Enlargement Countries

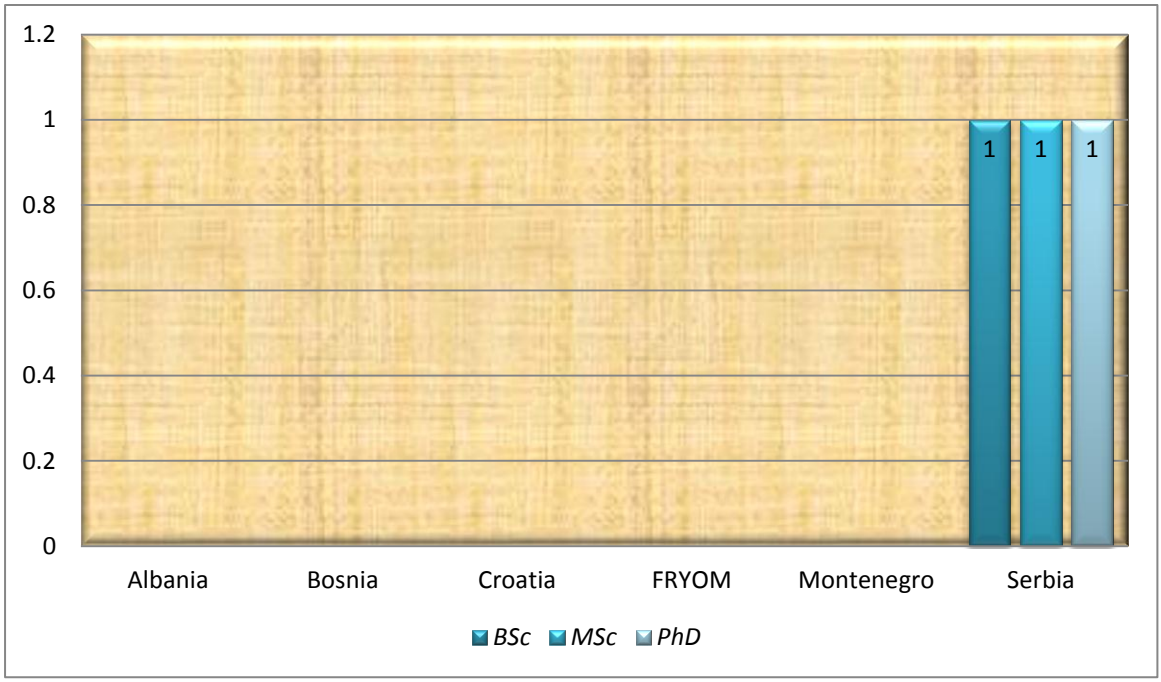
Figure 1 below indicates that currently only three nuclear degree programmes are available in the six Enlargement Countries, one Bachelor, one Master and one PhD programme. The reason for this might be that none of the six countries has a nuclear power programme in place.

Figure 1: Nuclear Curricula in the Enlargement Countries



The access to a nuclear degree programme is only given in one of the six Enlargement Countries, namely in Serbia, which is abstracted in Figure 2 below.

Figure 2: Nuclear Degrees per Enlargement Country



3.1.2 Integration Countries

Figure 3 determines that currently there are three Bachelors, 18 Masters and 14 PhDs programmes available in the Integration Countries which comes up to a total of 35 nuclear degree programmes. This might be a result of the interest in and importance of nuclear energy and technology in four of the six Integration Countries namely Israel, Norway, Switzerland and Turkey even though only Switzerland has currently a nuclear power programme in place.

Figure 3: Nuclear Curricula in the Integration Countries

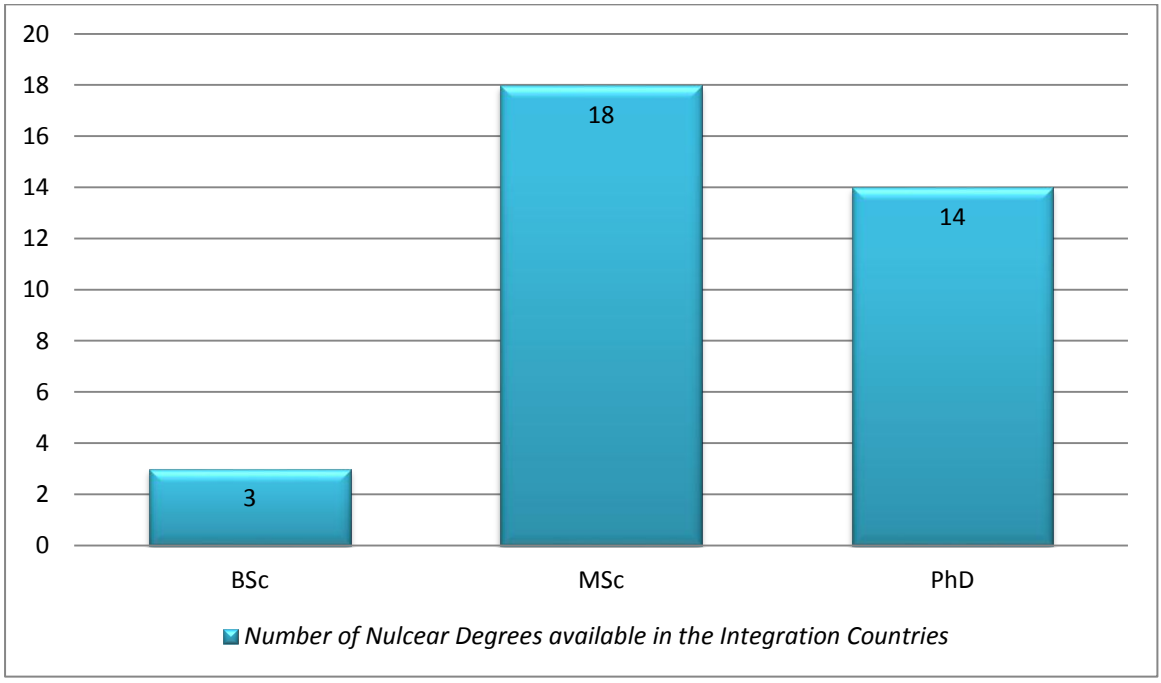
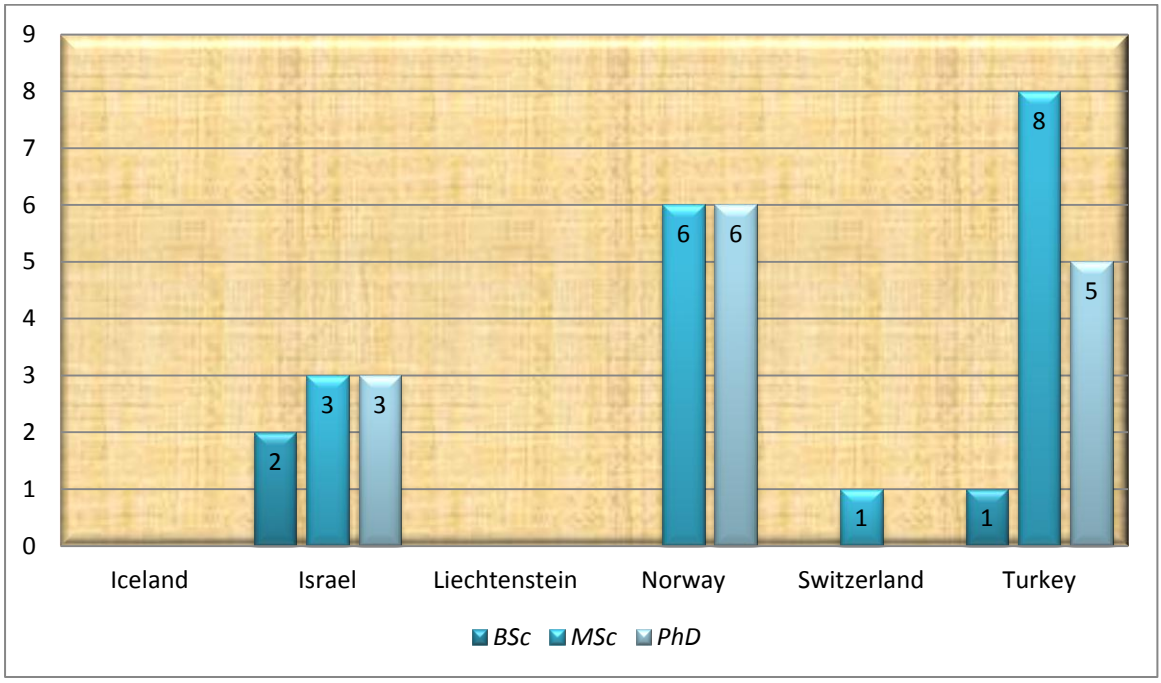


Figure 4 indicates that Israel and Turkey offer graduate and postgraduate academic programmes in the nuclear field, while Norway focuses on Master and PhD programmes only. Figure 4 also determines that, Switzerland, as the only country among the six Integration Countries that has a well-developed nuclear power programme, provides just one nuclear related Master of Science Programme. Iceland and Liechtenstein not promoting nuclear energy do also not offer any academic programme in this area.

Figure 4: Nuclear Degrees per Integration Countries



3.1.3 E&I Countries

Figure 5 indicates the number of Bachelor, Master and PhD programmes currently available in the E&I Countries. The total of 38 nuclear degree programmes are open for students in the 12 E&I countries whereupon the majority of the provided programmes are at the Master level, succeeded by degree programmes at the PhD level.

Figure 5: Number of Nuclear Curricula in the E&I Countries

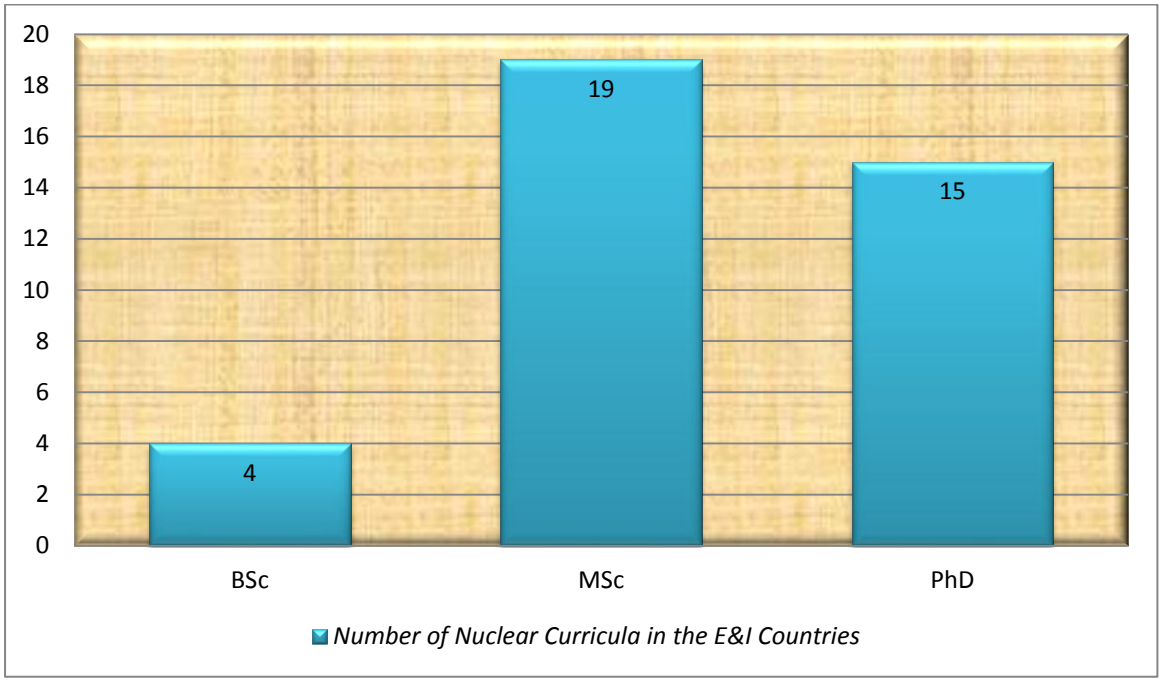
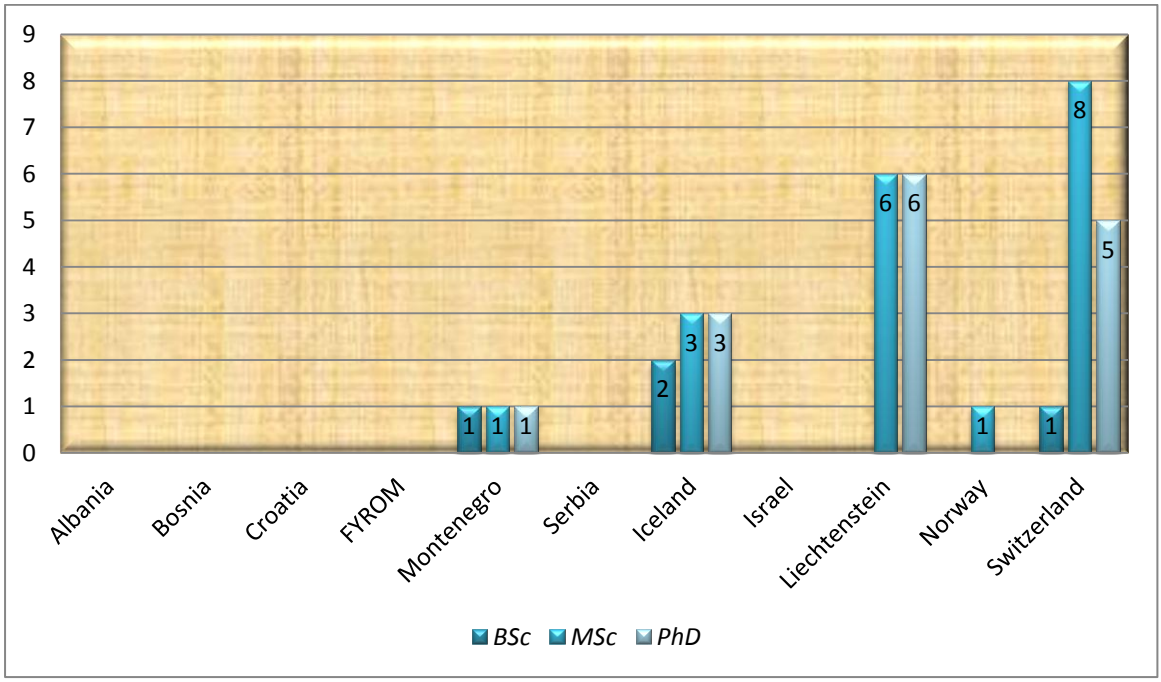


Figure 6 shows the current number of nuclear BSc, MSc and PhD programmes in the E&I countries. The figure indicates that Serbia, part of the Enlargement countries, Israel and Turkey, both part of the Integration Countries, provide all three cycles determined in the Bologna Declaration. The remainder two countries, offering academic nuclear programmes, provide merely MSc and PhD programmes.

Figure 6: Number of Nuclear Degrees per E&I Country



3.2 Nuclear Stakeholders in the E&I Countries

3.2.1 Enlargement Countries

Figure 7 and 8 indicate that most of the companies involved in the nuclear field in the Enlargement Countries are technical services, followed by engineering, manufacturing and consultancy companies. There are a total of 96 companies involved in the nuclear field located in the Enlargement Countries.

Figure 7: Nuclear Stakeholders per business in the Enlargement Countries (%)

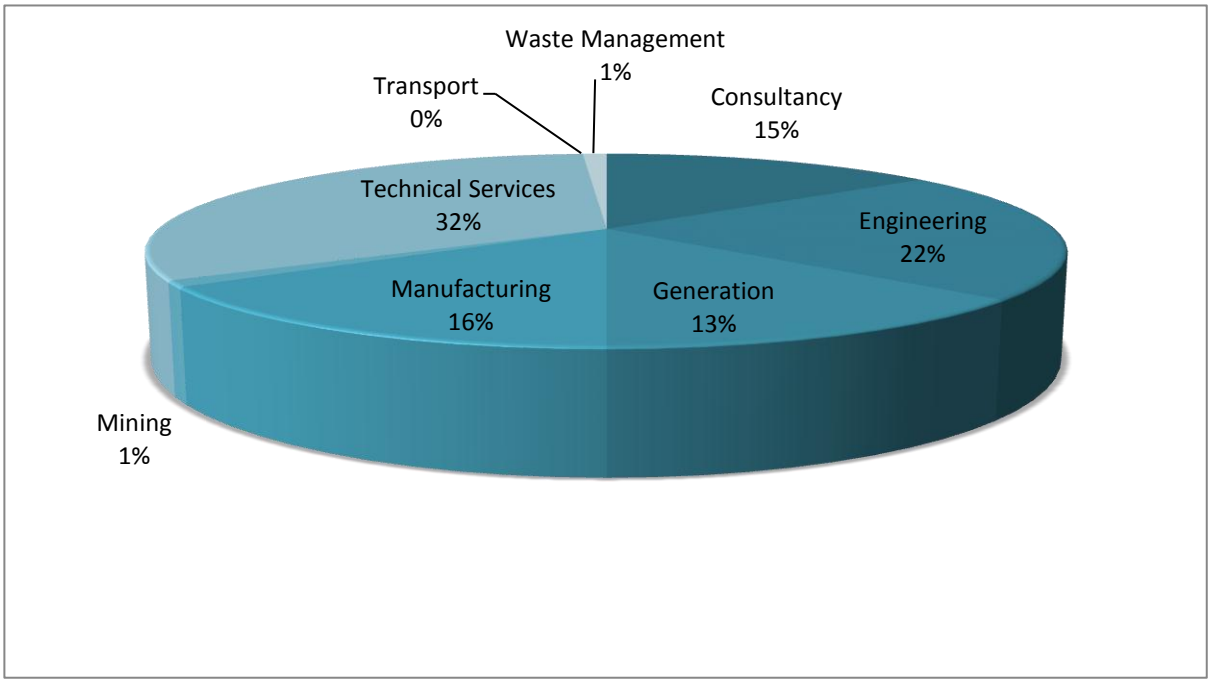
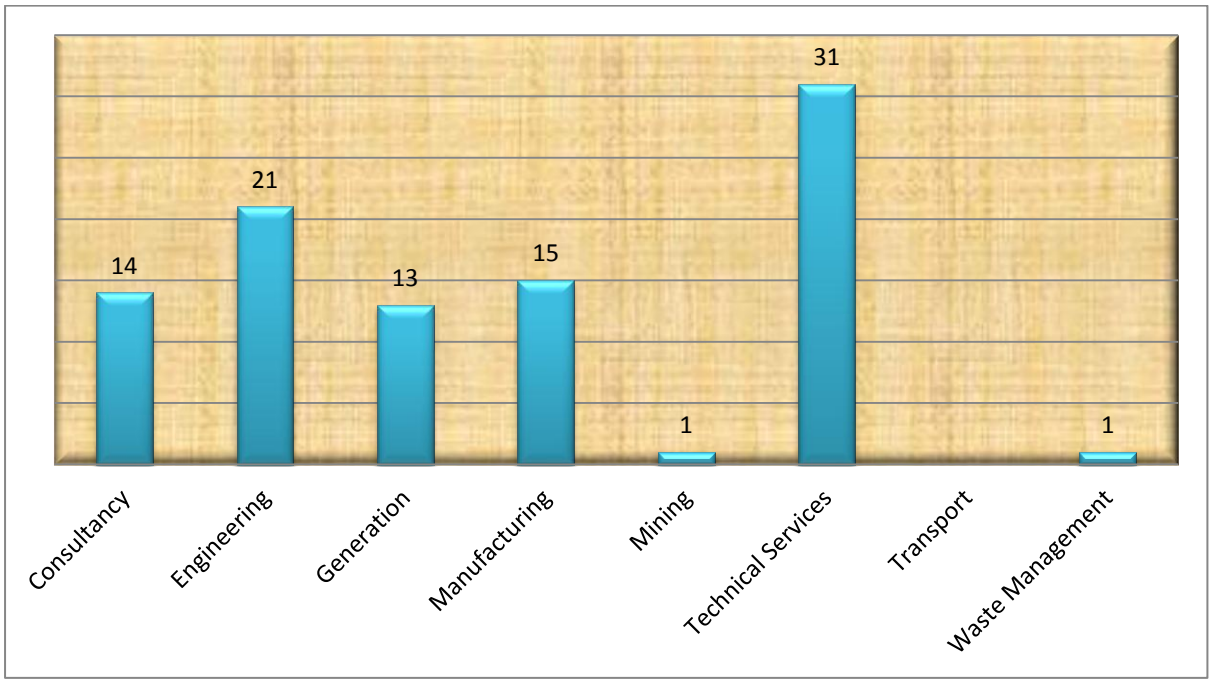


Figure 8: Number of Nuclear Stakeholders per business in the Enlargement Countries



3.2.2 Integration Countries

Figure 9 and 10 indicate that the majority of the companies involved in the nuclear field in the Integration Countries are also technical service companies. However, the figures below determine that in the Integration Countries the second strongest nuclear stakeholders are manufacturing and generation companies followed by engineering and consultancy companies. There are a total of 164 companies involved in the nuclear field located in the Integration Countries.

Figure 9: Nuclear Stakeholders per business in the Integration Countries (%)

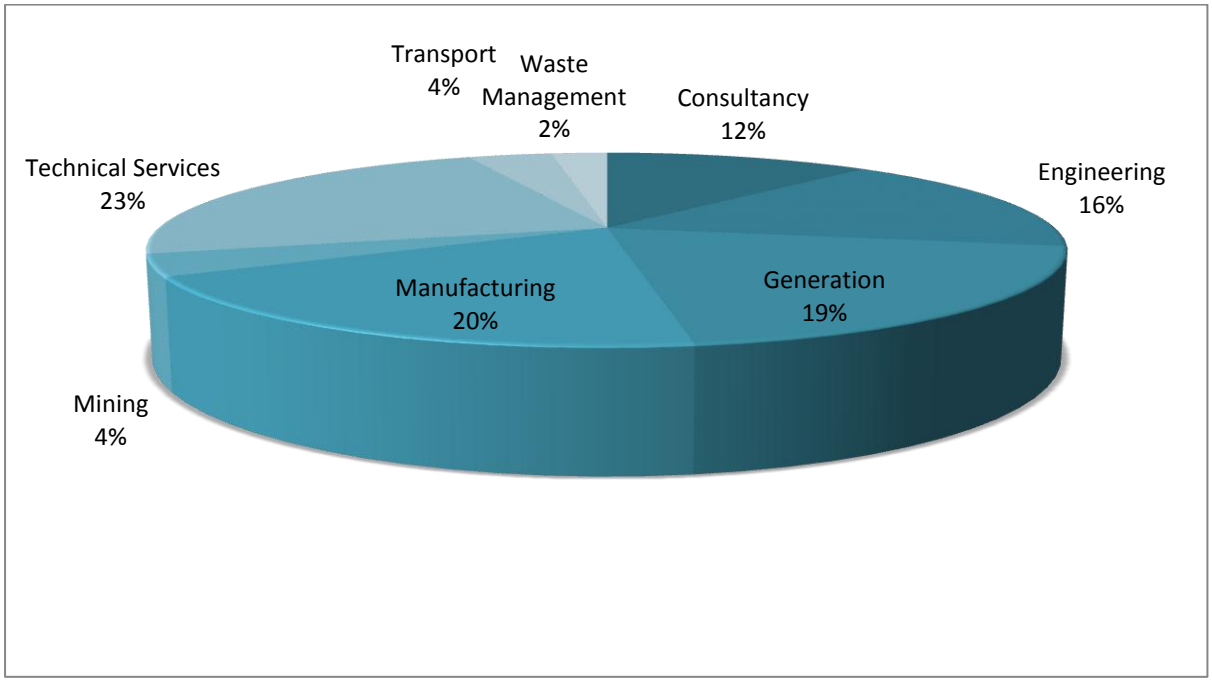
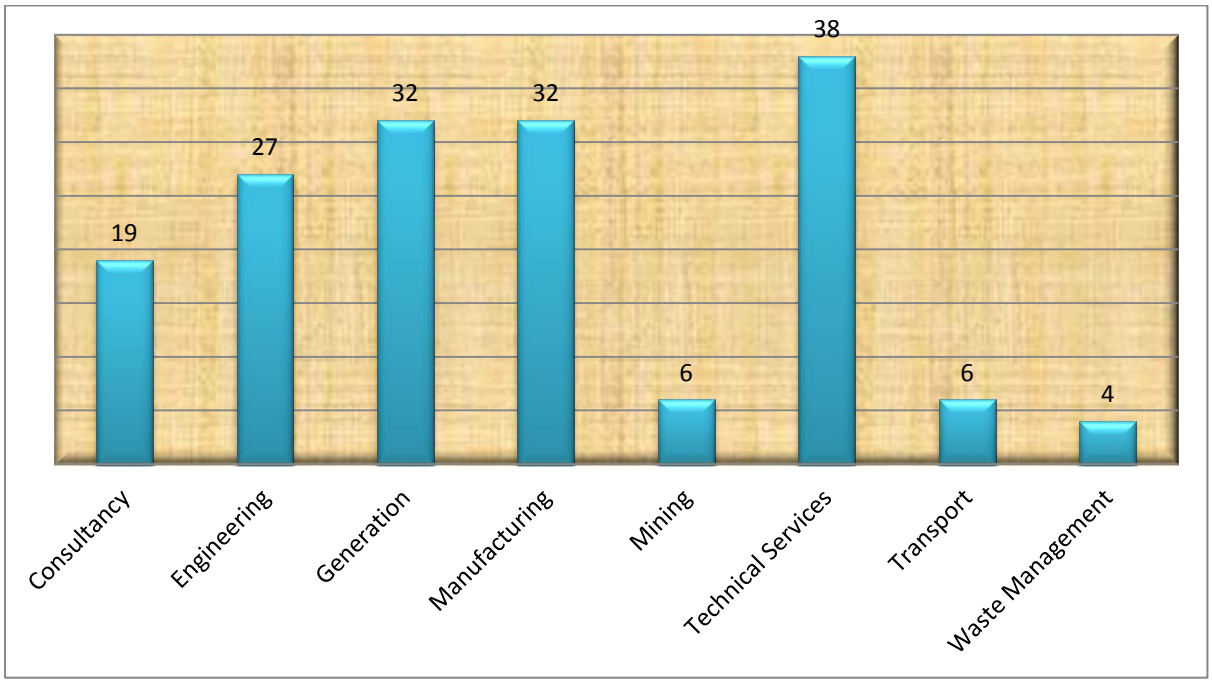


Figure 10: Number of Nuclear Stakeholders per business in the Integration Countries



3.2.3 E&I Countries

Figure 11 and 12 indicate the main nuclear stakeholders per industry in the E&I Countries. There are a total of 260 companies involved in the nuclear field that might be direct employers of highly qualified nuclear workforce in the E&I Countries.

Figure 11 determines that almost 30% of potential employers of qualified nuclear human resources are technical services companies, succeeded by 18 % of engineering and manufacturing companies and 17% of generation companies.

Figure 11: Nuclear Stakeholders per business in the E&I Countries (%)

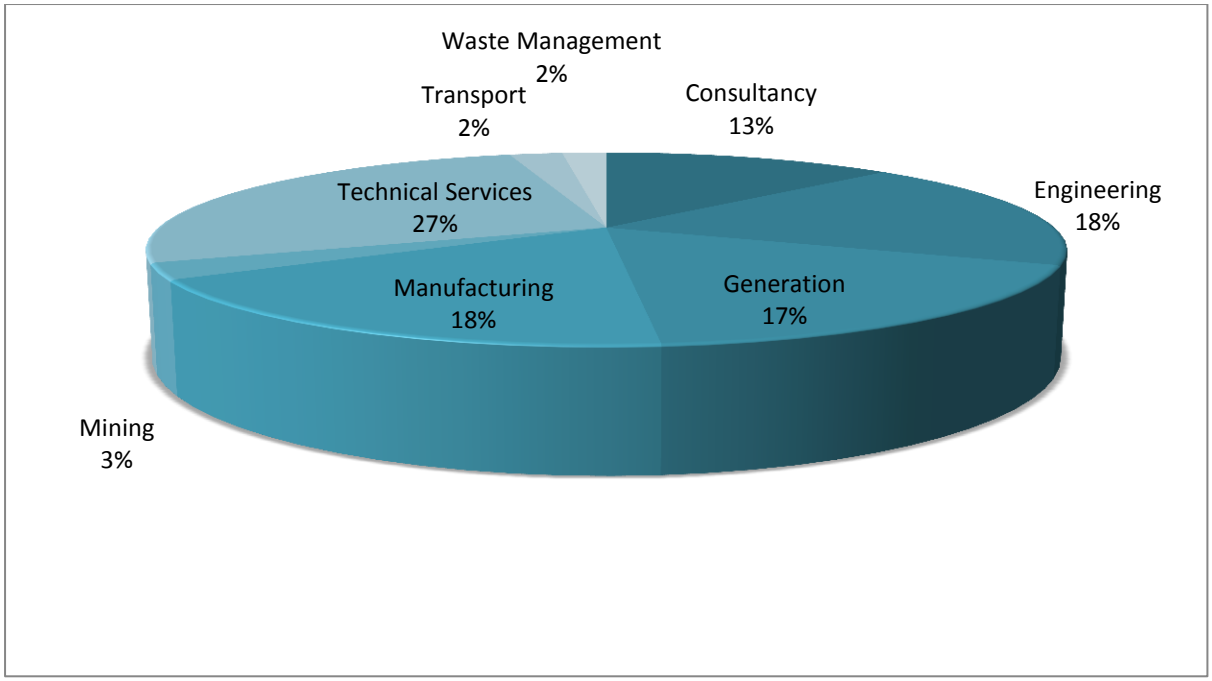


Figure 12: Number of Nuclear Stakeholders per business in the E&I Countries

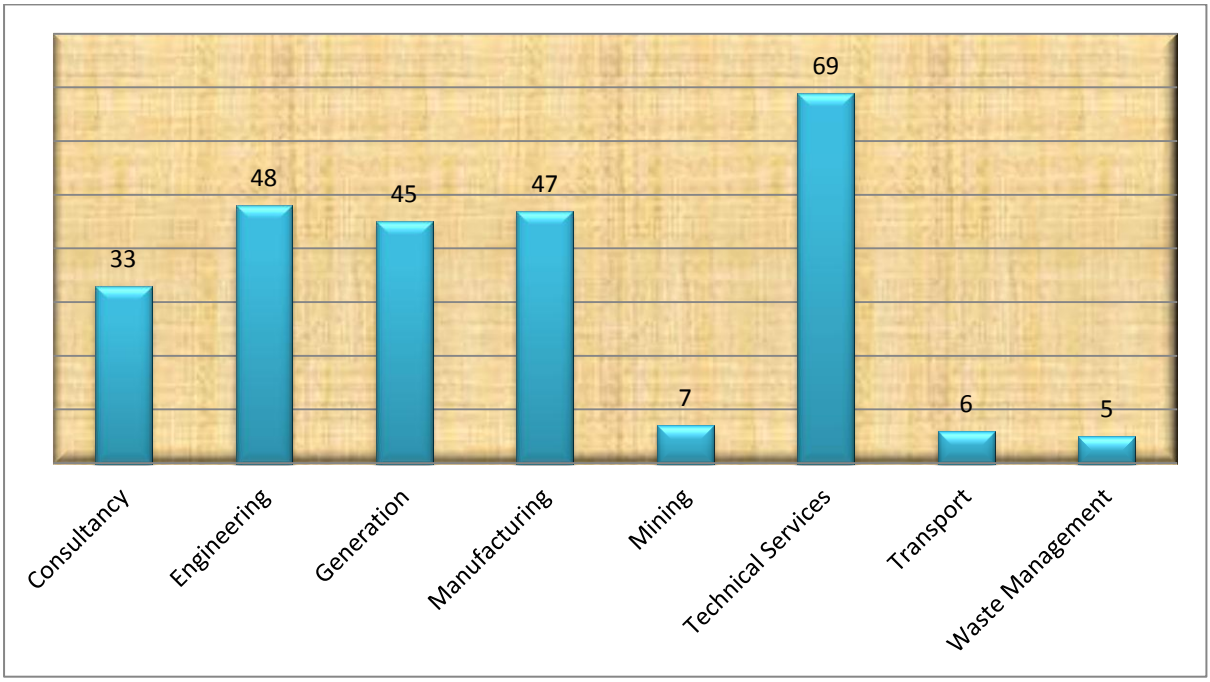
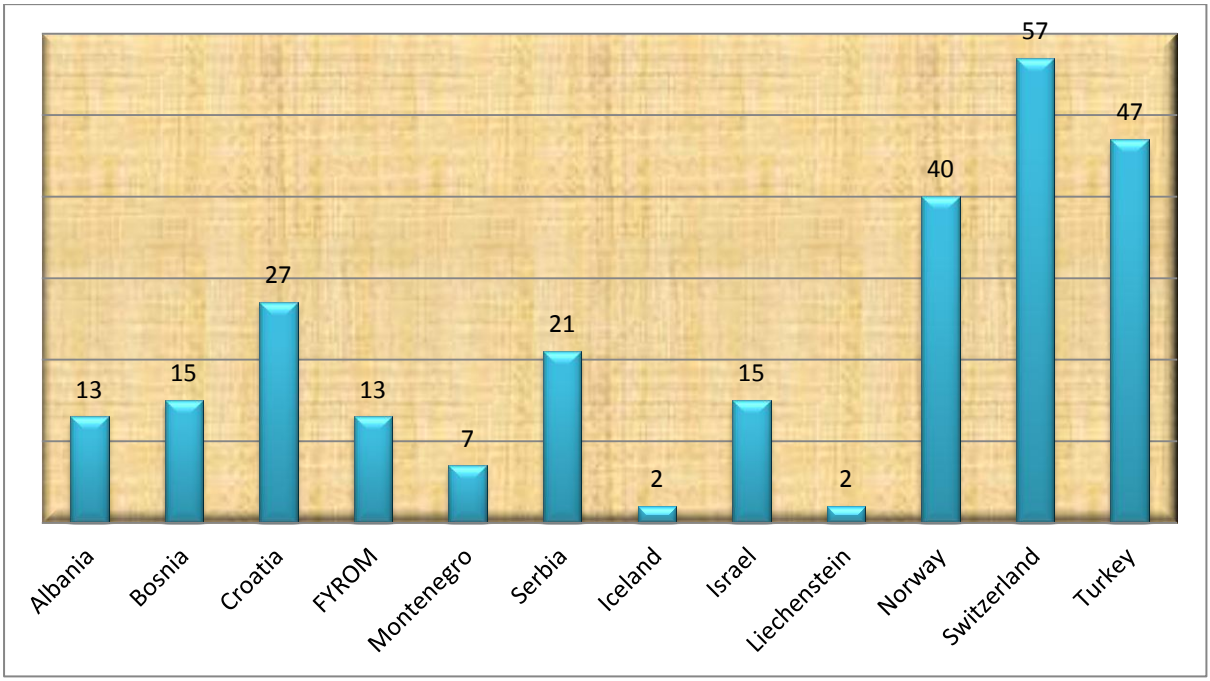


Figure 13 indicates that the highest presence of companies involved in the nuclear field is in Switzerland, followed by Turkey, Norway and Croatia.

Figure 13: Number of Nuclear Stakeholders per country



4. ENLARGEMENT COUNTRIES

4.1 Albania

4.1.1 Introduction

Currently, Albania has no nuclear power or research installations or other nuclear fuel cycle facilities.

In 2009, Albania and Croatia announced to jointly build a 1,500 MWe nuclear power plant at Lake Shkoder at the Montenegrin border[22]. In 2010, the Agjencia Kombetare Berthamore (National Atomic Agency) was established to support this endeavor and to supervise the development of future nuclear projects in the country. As many other countries, Albania slowed down the implementation of the nuclear power project after the Fukushima Daiichi accident in 2011. In early 2012, Albania announced to postpone its intention to construct a nuclear power plant in the Shkoder region, until all issues related to the impact on the environment have been assessed and a potential partner government has been identified that is interested in financially supporting the Albanian nuclear power project.[23]

Albania has a centralized radioactive waste management facility to store conditioned waste deriving from various applications of radiation sources.[24]

Despite the potential intentions of Albania to embark on a nuclear power program, there are currently almost no education or training opportunities promoted on the internet that are dedicated to build-up the necessary competences for a nuclear workforce at the national level.

4.1.2 Higher Education and Training

Albania is a full member of the Bologna Process[25] and therefore higher education is divided into three stages: Bachelor's, Master's and Doctorate degrees. None of the academic institutions in Albania offers a degree that specialises in the nuclear field and there is no or only very little research activities carried out in this field.

The University of Tirana[26] hosts a Nuclear Physics Centre[27] but presently no activities are promoted on its official website. The University of Tirana is a member of the Black Sea Universities Network[28].

[22] World Nuclear News: 17 April 2009 http://www.world-nuclear-news.org/newsarticle.aspx?id=25056
[23] Partnership for Global Security: Energy-Poor Albania Wants Nuclear Power Plant, Neighboring Montenegro Opposes http://www.partnershipforglobalsecurity.org/Projects%20and%20Publications/News/Nuclear%20News/222012102550AM.html
[24] Albania EU Progress Report 2010 http://ec.europa.eu/enlargement/pdf/key_documents/2010/package/al_rapport_2010_en.pdf
[25] European Commission http://ec.europa.eu/education/higher-education/bologna_en.htm
[26] University of Tirana http://www.unitir.edu.al/

The Department of Physics at the University Vlores Ismail Qemali[29] offers some related courses, such as nuclear physics or atomic and molecular physics[30].

4.1.3 Research

Research activities in the nuclear field are carried out by the Institute for Nuclear Physics at the Academy of Science of Albania[31]. The institute also used to be in charge of the calibration of radioactive sources in Albania.[32]

The Agency for Research, Technology and Innovation (ARTI)[33] does presently not carry out any research in the nuclear field.

4.1.4 Nuclear Energy Stakeholders

Regarding the stakeholders in the nuclear field, the most important employers in Bosnia and Herzegovina include the following: ABB Group[34], Alpiq Group[35], Axpo Group[36], Balfour Beatty[37], Calik Holding[38], CMS Cameron McKenna[39], Hilti Albania Shpk[40], Kuehne und Nagl[41], Mattig Management Partners[42], Mott MacDonald[43], Sulzer[44], TÜV Reihnland[45], Zumax AG[46];

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[27] Applied Nuclear Physics Centre http://www.unitir.edu.al/index.php?option=com_content&view=article&id=128&Itemid=144
[28] Black Sea Universities Network http://www.bsun.org/?task=homepage&web=bsun
[29] University Vlores Ismail Qemali http://www.univlora.edu.al/
[30] http://www.univlora.edu.al/departamentet/?page_id=563
[31] Academy of Science of Albania http://www.academyofsciences.net/
[32] Wate Management Symposia: Radioactive Waste Management practice in the Republic of Albania http://www.wmsym.org/archives/1998/html/sess36/36-42/36-42.htm
[33] Agency for Research, Technology and Innovation http://www.akti.gov.al/about_AKTI.html
[34] ABB Group http://www.abb.com/
[35] Alpiq Group http://www.alpiq.com/index.jsp
[36] Axpo Group http://www.axpo.com/content/axpo/global/en/home.html
[37] Balfour Beatty http://www.balfourbeatty.com/
[38] Calik Holding http://www.calik.com/EN/Sectors/energy
[39] CMS Cameron McKenna http://www.law-now.com/lawnow/
[40] Hilti Albania Shpk http://www.hilti.com/holcom/page/module/home/home_main.jsf?lang=en&nodeId=-8021
[41] Kuehne und Nagl http://www.kn-portal.com/
[42] Mattig Management Partners http://www.mattig-management.ch/en/2/austria/company/mattig-management-partners/
[43] Mott MacDonald http://www.mottmac.com/
[44] Sulzer http://www.sulzer.com/
[45] TÜV Reihnland http://www.tuv.com/uk/en/index.html
[46] Zumax AG http://zumaxag.com/index.html

Figure 14: Nuclear stakeholders per business in Albania (%)

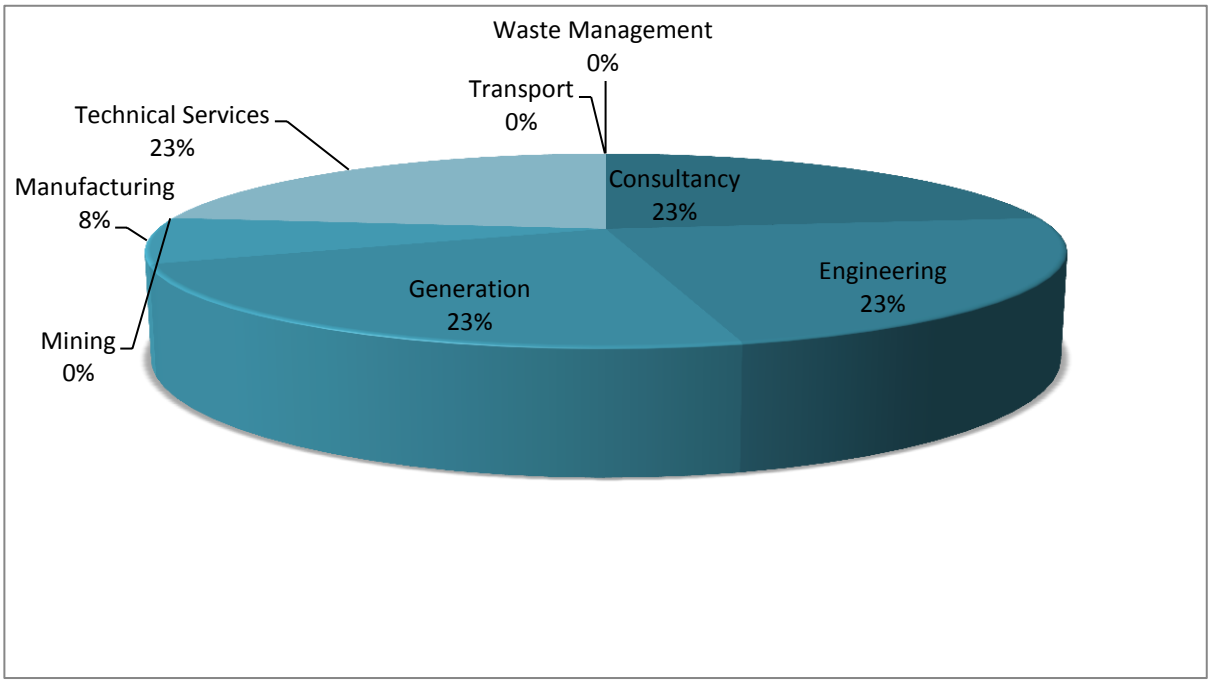
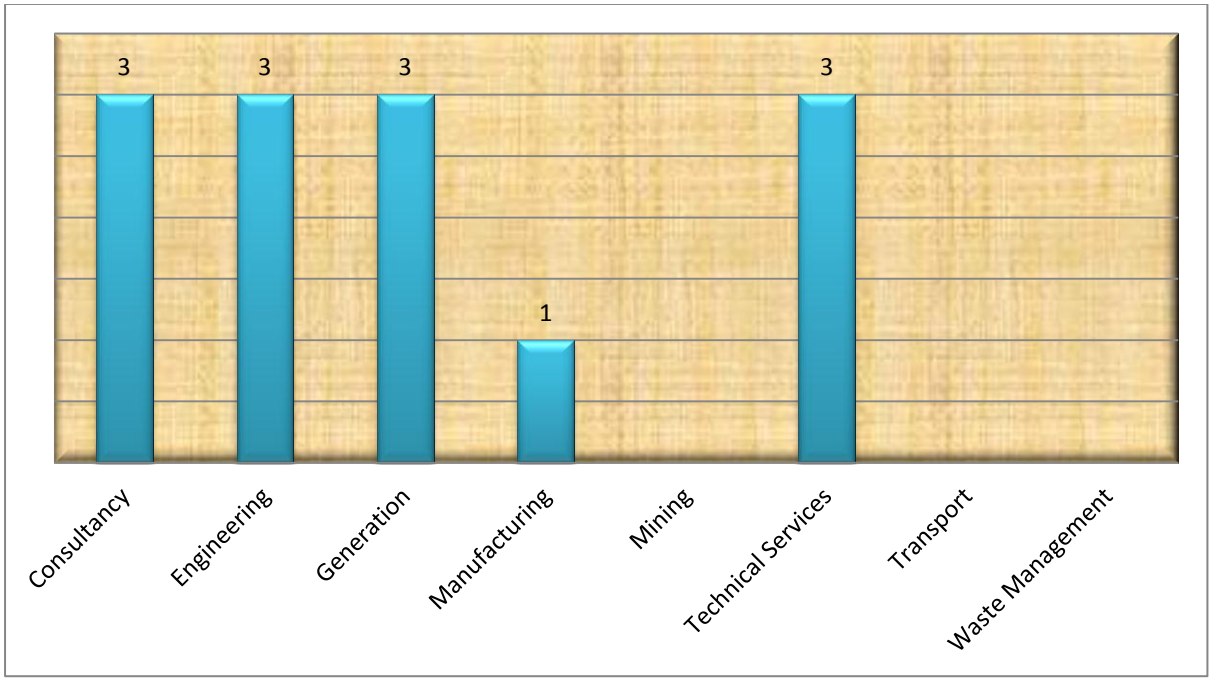


Figure 15: Nuclear stakeholders per business in Albania



4.2 Bosnia and Herzegovina

4.2.1 Introduction

Currently, Bosnia and Herzegovina has no nuclear power or research installations or other nuclear fuel cycle facilities.

The State Regulatory Agency for Radiation and Nuclear Safety[47] is the competent authority for nuclear safety, security and radiation protection.

The training and educational opportunities in Bosnia and Herzegovina are reflecting the lack of nuclear activities in the country.

4.2.2 Higher Education and Training

Bosnia and Herzegovina is a full member of the Bologna Process[48] and therefore higher education is divided into three stages: Bachelor's, Master's and Doctorate degrees. None of the academic institutions in Bosnia and Herzegovina offers an academic degree that specializes in the nuclear field and related training is not promoted on the internet.

4.2.3 Research

In Bosnia and Herzegovina, no or only very little research activities are carried out in the nuclear field.

4.2.4 Nuclear Energy Stakeholders

Regarding the stakeholders in the nuclear field, the most important employers in Bosnia and Herzegovina include the following: ABB Group[49], Alpiq Group[50], Axpo Group[51], B-U specijalni metali d.o.o.[52], Bureau Veritas Group[53], CMS Cameron McKenna [54], DLA Piper[55], Emka[56], Hilti Systems BH Sarajevo d.o.o.[57], Kuehne und Nagl[58], Mittal Steel Zenica[59], Piper Supports[60], PricewaterhouseCoopers[61], Siemens[62], TÜV Reihnland[63];

[47] State Regulatory Agency for Radiation and Nuclear Safety http://www.darns.gov.ba
[48] European Commission http://ec.europa.eu/education/higher-education/bologna_en.htm
[49] ABB Group http://www.abb.com/
[50] Alpiq Group http://www.alpiq.com/index.jsp
[51] Axpo Group http://www.axpo.com/content/axpo/global/en/home.html
[52] B-U specijalni metali d.o.o. http://bu-specijalnimetali.com
[53] Bureau Veritas Group http://www.bureauveritas.com/
[54] CMS Cameron McKenna http://www.law-now.com/lawnow/
[55] DLA Piper http://www.dlapiper.com/
[56] Emka http://www.emka.com/
[57] Hilti Systems BH Sarajevo d.o.o. http://www.hilti.ba/holba/
[58] Kuehne und Nagl http://www.kn-portal.com/
[59] Mittal Steel Zenica http://www.arcelormittalna.com/
[60] Piper Supports http://www.pipesupports.com/
[61] PricewaterhouseCoopers http://www.pwc.com/gx/en/index.jhtml?ld=no
[62] Siemens http://www.siemens.at/bosnia-herzegovina/
[63] TÜV Reihnland http://www.tuv.com/uk/en/index.html

Figure 16: Nuclear stakeholders per business in Bosnia and Herzegovina (%)

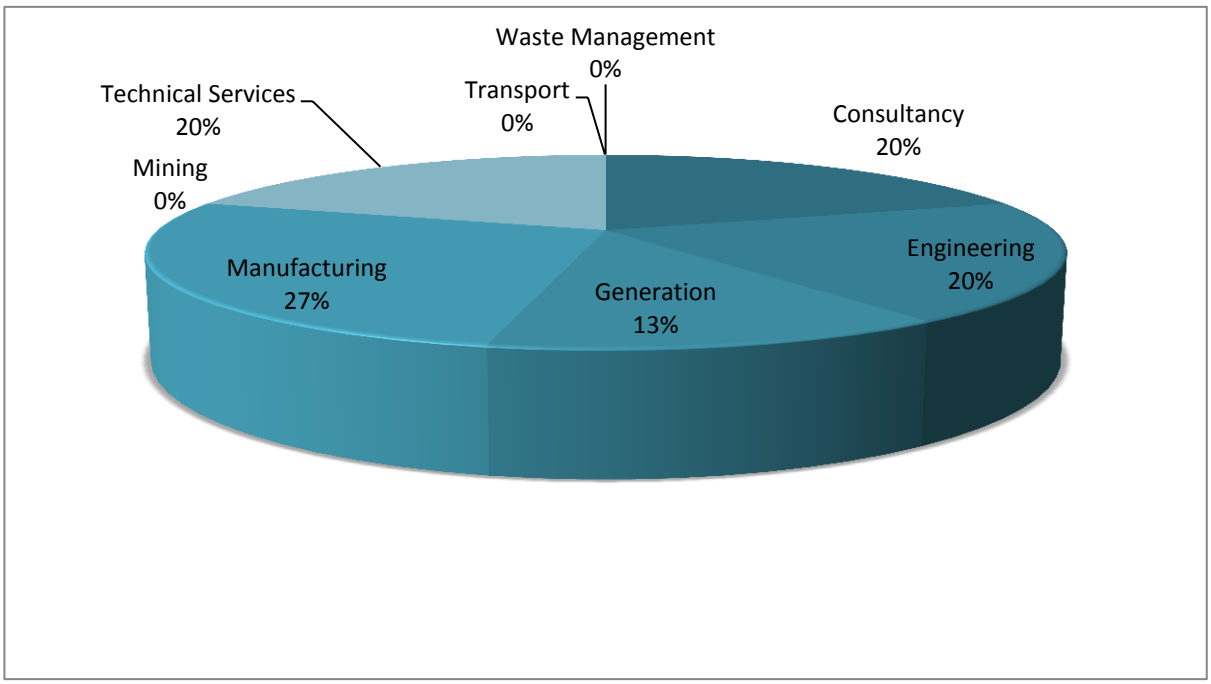
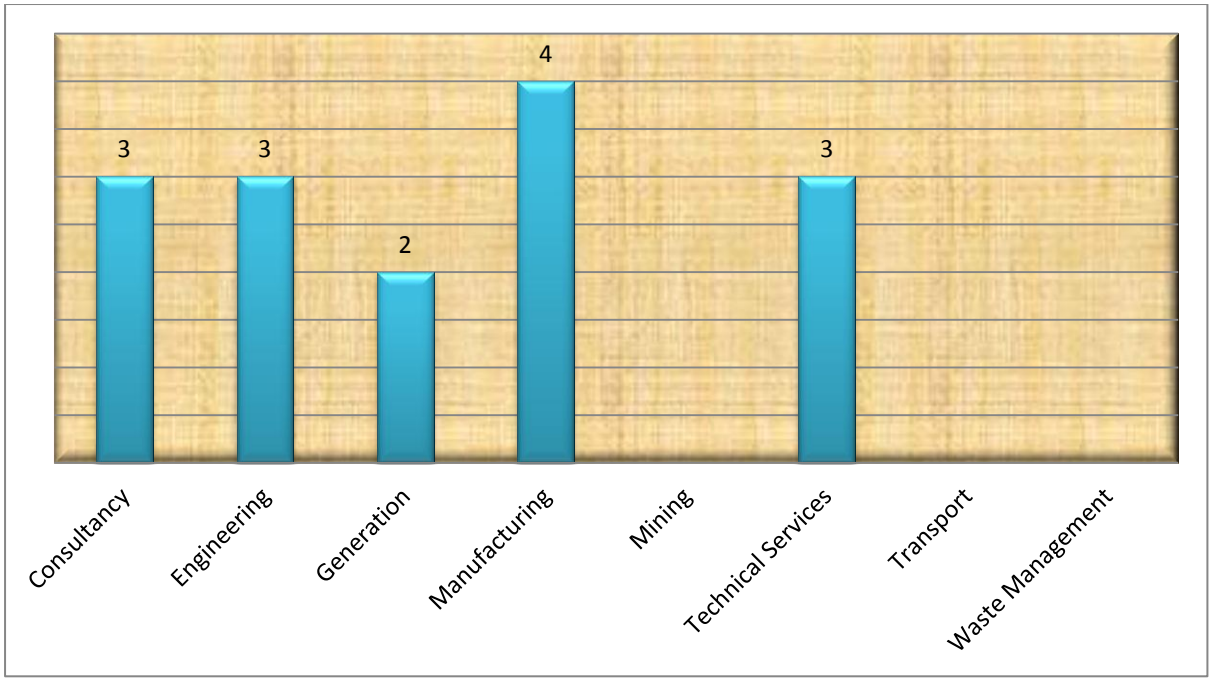


Figure 17: Nuclear stakeholders per business in Bosnia and Herzegovina



4.3 Croatia

4.3.1 Introduction

The Republic of Croatia has currently no nuclear power programme in place. The country imports around 15% of the total Croatian energy need from the Nuclear Power Plant Krško which is located in Slovenia. The Republic of Croatia is considering embarking on nuclear power in the future. A governmental decision is expected by end 2012[64].

The State Office for Radiological and Nuclear Safety (SORNS)[65] is the national competent authority for nuclear safety, security and radiation protection.

The Hazardous Waste Management Agency (APO)[66] deals with hazardous and radioactive waste management at the national level.

The training and educational opportunities in the Republic of Croatia are reflecting the limited nuclear activities in the country. There are some related academic courses available, but a comprehensive educational programme in the nuclear field is currently not offered at the national level.

4.3.2 Higher Education and Training

The faculty of electrical engineering and computing[67] of the University of Zagreb[68] offers a Master Programme of Electrical Power Engineering[69] including courses in the following areas: nuclear engineering, nuclear fuel cycle and reactor materials, nuclear safety, nuclear power plant safety analysis as well as a course on radiation effects and radiation protection. In addition, the MSc Programmes of Electrical Engineering Systems and Technology[70] at the University of Zagreb covers courses on fundamentals of nuclear physics. Graduate Study at the School of Medicine at the University of Zagreb include courses in Nuclear Medicine[71].

The University of Rijeka offers a Bachelor of Radiology Medicine[72] and the Polytechnic for Applied Health Studies in Zagreb[73] provides a professional study of radiology technology[74].

[64] National Statement Croatia IAEA GC 2011 http://www.iaea.org/About/Policy/GC/GC56/Statements/croatia.pdf
[65] SORNS http://cms.dzrns.hr/
[66] APO http://www.apo.hr/home/?lang=2
[67] http://www.fer.unizg.hr/issn/1848-3550
[68] University of Zagreb http://www.unizg.hr/homepage/
[69] Master Programme of Electrical Power Engineering http://www.fer.unizg.hr/en/education/msc_study/eit/ene
[70] MSc programs of Electrical Engineering Systems http://www.fer.unizg.hr/en/education/msc_study/eit/esit
[71] Courses in Nuclear Medicine at the University of Zagreb
http://www.mef.unizg.hr/eng/druga.php?grupa=030101000000
[72] University of Rijeka http://www.medri.uniri.hr/studiji/radiologija/o%20studiju.htm
[73] Polytechnic for Applied Health Studies http://www.zvu.hr/?lang=en
[74] http://www.zvu.hr/studij-radioloske-tehnologije/?lang=en

The following institutions are involved in training:

The Young Generation Network (YGN)[75] provides training for young professionals in the field of nuclear energy and fosters the transfer of knowledge and experience between older and younger generations.

The Institute for Nuclear Technology (INETEC)[76] offers multiple training opportunities in the area of non-destructive testing addressed to students.

The Institute for Medical Research and Occupational Health[77] provides training to students who specialize in occupational health.

The Croatian Nuclear Society (HND)[78] promotes the peaceful use of nuclear sciences, technologies and nuclear non-proliferation at the national and international level.

4.3.3 Research

In Croatia, several institutions are carrying out research in the nuclear field. The Ruđer Bošković Institute (RBI)[79] conducts, inter alia, research in the following areas: experimental and materials physics as well as in physical chemistry. The Institute has also a number of technical instruments supporting the research in the area of spectrometry[80].

The Institute for Medical Research and Occupational Health[81] is the second largest research institute in Croatia conducting research in different areas, including radiation. The Institute is also involved in the establishment of a national radioactive waste storage and reprocessing facility[82]. This is a national project in cooperation with the International Atomic Energy Agency.

The Croatian Radiation Protection Association (CRPA)[83] promotes and develops scientific, educational and cultural activity in the field of radiation protection and other related fields of science.

The Croatian Society of Nuclear Medicine[84] promotes research and education in the nuclear field.

[75] YGN http://www.nuklearno-drustvo.hr/en/young-generation-network/activities-ygn.html
[76] INETEC http://www.inetec.hr/en/services/training/training/
[77] Institute for Medical Research and Occupational Health http://www.imi.hr/djelatnosti.php?lan=EN
[78] HND http://www.nuklearno-drustvo.hr/en/
[79] RBI http://www.irb.hr/eng/About-the-RBI/
[80] http://www.irb.hr/eng/Research/Research-Instruments-Facilities
[81] Institute for Medical Research and Occupational Health http://www.imi.hr/djelatnosti.php?lan=EN
[82] http://www.imi.hr/projekti.php?id=2&lan=EN
[83] Croatian Radiation Protection Association http://www.hdzz.hr/Main.htm
[84] Croatian Society of Nuclear Medicine http://public.carnet.hr/nuclmedzg-rebro/

4.3.4 Nuclear Energy Stakeholders

The main companies involved in the nuclear business in Croatia include: Duro Daković[85], Ekonerg[86], EKOTEH dosimetry Radiation protection Co.[87], Enconet d.o.o[88], Institute for Nuclear Technology (INETEC)[89], INKO svetovanje d.o.o.[90], Hrvatska Elektroprivreda (HEP Group)[91];

The international companies that have a presence in Croatia include: ABB Group[92], Alpiq Group[93], Alstom[94], Apo[95], Axpo Group[96], Böhler-Uddeholm Zagreb d.o.o.[97], Bureau Veritas Group[98], CMS Cameron McKenna [99], Corporate Risk Associates Limited[100], DLA Piper[101], Emka[102], Hilti Croatia d.o.o.[103], Krško Nuclear Power Plant[104], Kuehne und Nagl[105], Mace[106], Piper Supports[107], Rautaruukki Oy[108], Siemens[109], TÜV Reihnland[110];

[85] Duro Daković http://www.duro-dakovic.com/index_2.aspx
[86] Ekonerg http://www.ekonerg.hr/ew/index?ev=hom
[87] EKOTEH dosimetry Radiation protection Co. http://www.ekoteh.hr/en/
[88] Enconet d.o.o http://enconet.com.hr/
[89] INETEC http://www.inetec.hr/en/
[90] INKO svetovanje d.o.o. http://www.inko.si/en/
[91] Hrvatska Elektroprivreda (HEP Group) http://www.hep.hr/hep/en/news/default.aspx
[92] ABB Group http://www.abb.com/
[93] Alpiq Group http://www.alpiq.com/index.jsp
[94] Alstom http://www.alstom.com/locations/
[95] Apo http://www.apo.hr/home/?lang=2
[96] Axpo Group http://www.axpo.com/content/axpo/global/en/home.html
[97] Böhler-Uddeholm Zagreb d.o.o. http://www.bohler-uddeholm.hr
[98] Bureau Veritas Group http://www.bureauveritas.com/
[99] CMS Cameron McKenna http://www.law-now.com/lawnow/
[100] Corporate Risk Associates Limited http://www.corporateriskassociates.com/
[101] DLA Piper http://www.dlapiper.com/
[102] Emka http://www.emka.com/
[103] Hilti Croatia d.o.o. http://www.hilti.hr/holhr/
[104] Krško Nuclear Power Plant http://www.nek.si/en/
[105] Kuehne und Nagl http://www.kn-portal.com/
[106] Mace http://www.macegroup.com/
[107] Piper Supports http://www.pipesupports.com/
[108] Rautaruukki Oy http://www.ruukki.com/
[109] Siemens http://www.siemens.com/answers/cee/hr/
[110] TÜV Reihnland http://www.tuv.com/uk/en/index.html

Figure 18: Nuclear stakeholders per business in Croatia (%)

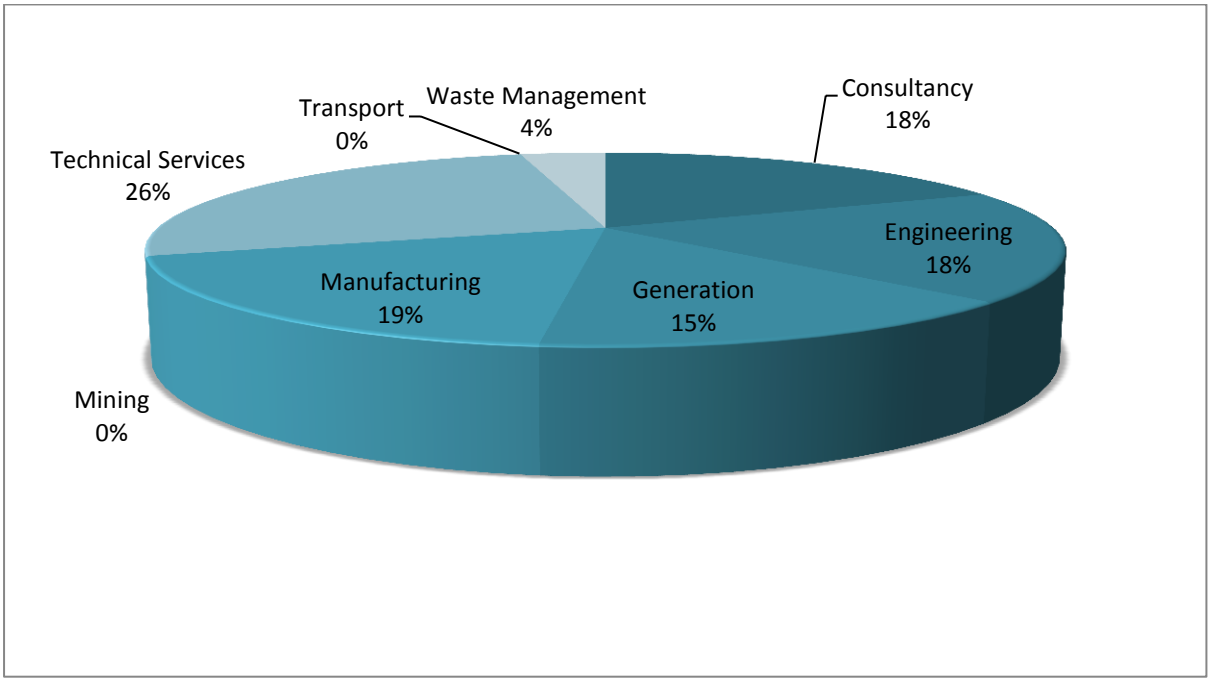
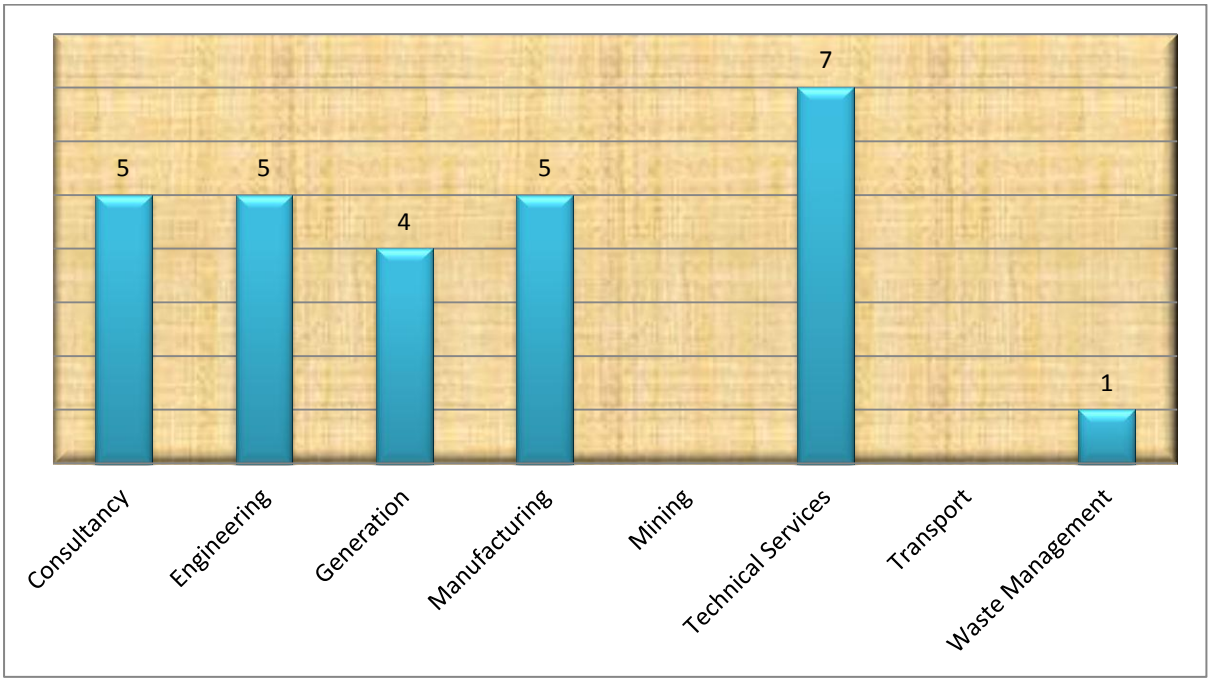


Figure 19: Nuclear stakeholders per business in Croatia



4.4 The former Yugoslav Republic of Macedonia

4.4.1 Introduction

Currently, the Former Republic of Macedonia has no nuclear power or research installations or other nuclear fuel cycle facilities. There is no designated national competent authority for nuclear or radioactive materials in the the former Yugoslav Republic of Macedonia.

The government of the former Yugoslav Republic of Macedonia is presently in the process of collecting information needed to come to a decision whether to embark on nuclear power in the future or not.[111]

Despite the country's interest in nuclear power, neither academic nor training institutions in the former Yugoslav Republic of Macedonia promote higher educational programmes or professional development programmes required to systematically build-up nuclear competences in the country on the internet.

4.4.2 Higher Education and Training

The former Yugoslav Republic of Macedonia takes part in the Bologna Process[112] and therefore higher education is divided into three stages: Bachelor's, Master's and Doctorate degrees. None of the academic institutions in the country offers a degree that specializes in the nuclear field.

4.4.3 Research

In the the former Yugoslav Republic of Macedonia no or only very little research activities are carried out in the nuclear field.

4.4.4 Nuclear Energy Stakeholders

Regarding the stakeholders in the nuclear field, the most important employers in the former Yugoslav Republic of Macedonia include the following: ABB Group[113], AF Group[114], Alpiq Group[115], Axpo Group[116], Cunico Resources NV[117], Famaki-ve doel[118], Kuehne und Nagl[119], Mace[120], Makstil A.D.[121], M&M Militzer and Münch[122], Piper Supports[123], Siemens[124], TÜV Reihnland[125].

[111] IAEA General Conference Delegates' Statement 2012: Republic of Macedonia. [Online] Available from: http://www.iaea.org/About/Policy/GC/GC56/Statements/macedonia.pdf
[112] European Commission http://ec.europa.eu/education/higher-education/bologna_en.htm
[113] ABB Group http://www.abb.com/
[114] AF Group **http://www.afconsult.com/en/Worldwide/Europe/Switzerland/**
[115] Alpiq Group http://www.alpiq.com/index.jsp
[116] Axpo Group http://www.axpo.com/content/axpo/global/en/home.html
[117] Cunico Resources NV http://www.cunicoresources.com/index.php
[118] Famaki-ve doel http://www.hilti.com/holcom/page/module/home/home_main.jsf?lang=en&nodeId=-8021
[119] Kuehne und Nagl http://www.kn-portal.com/
[120] Mace http://www.macegroup.com/
[121] Makstil A.D. http://www.makstil.com/

Figure 20: Nuclear stakeholders per business in the former Yugoslav Republic of Macedonia (%)

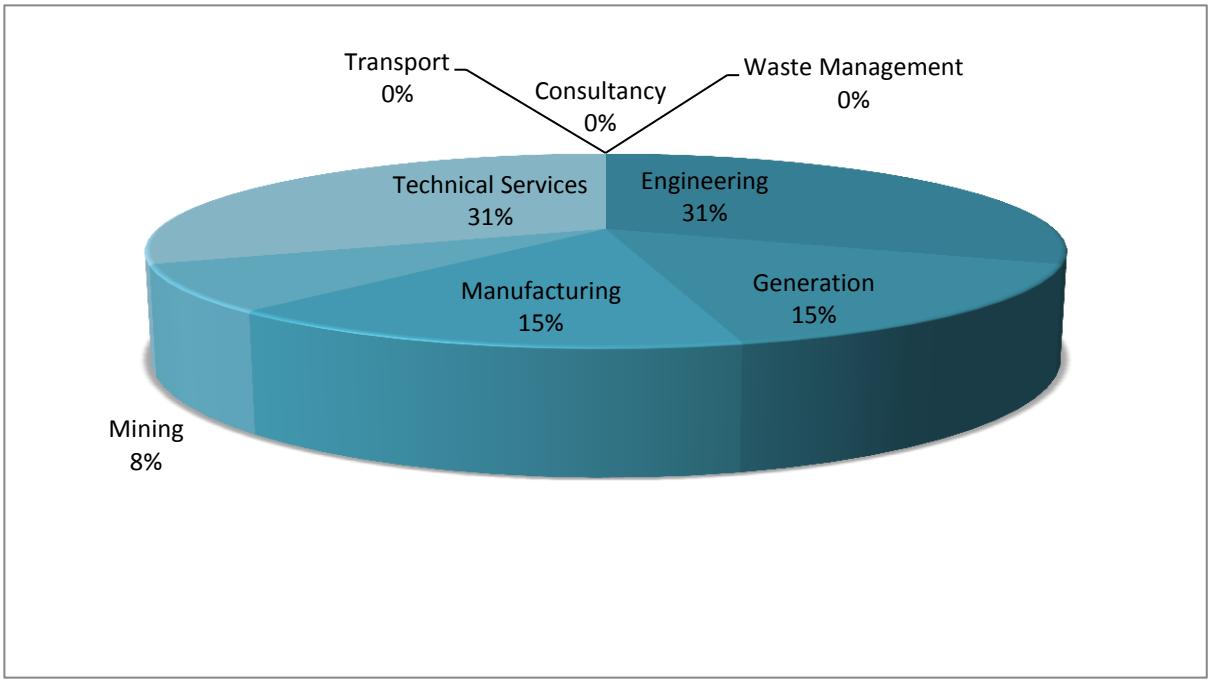
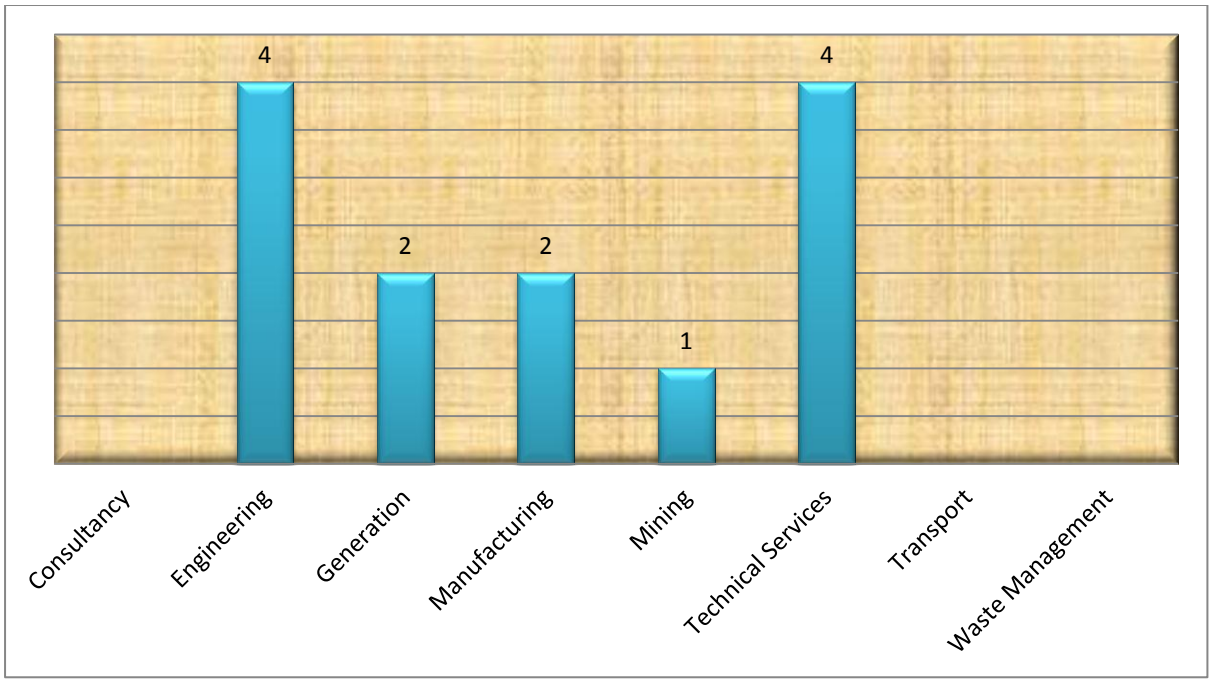


Figure 21: Nuclear stakeholders per business in the former Yugoslav Republic of Macedonia



[122] M&M Militzer and Münch http://www.mumnet.com/mmgroup.html
[123] Piper Supports http://www.pipesupports.com/
[124] Siemens http://www.siemens.com/answers/mk/en/
[125] TÜV Reihnland http://www.tuv.com/uk/en/index.html

4.5 Montenegro

4.5.1 Introduction

There are no nuclear power plants in Montenegro and there is no designated national nuclear regulatory authority in the country. Currently the Ministry of Education and Science is taking care of any related issues.

The non-nuclear policy in Montenegro is reflected in the lack of higher educational and opportunities in this field. There is one main provider for nuclear related training.

4.5.2 Higher Education and Training

Montenegro takes part in the Bologna Process[126] and therefore higher education is divided into three stages: Bachelor's, Master's and Doctorate degrees. None of the three academic institutions in Montenegro offers a degree that specializes in the nuclear field and there are only very few research activities carried out.

The Radiation Protection Association of Serbia and Montenegro[127] provides training dedicated to radiation protection[128].

4.5.3 Research

In Montenegro no or only very little research activities are carried out in the nuclear field.

4.5.4 Nuclear Energy Stakeholders

The international companies that have a presence in Montenegro include: Bureau Veritas Group[129], Gardiner & Theobald[130], Hilti SMN d.o.o.[131], Mace[132], Piper Supports[133], Siemens[134], TÜV Reihnland[135];

[126] European Commission http://ec.europa.eu/education/higher-education/bologna_en.htm
[127] Radiation Protection Association of Serbia and Montenegro http://www.dzz.org.rs/indexe.html
[128] http://www.srbatom.gov.rs/srbatom/nadleznost-agencije.htm
[129] Bureau Veritas Group http://www.bureauveritas.com/
[130] Gardiner & Theobald http://www.gardiner.com/
[131] Hilti SMN d.o.o. http://www.hilti.com/holcom/page/module/home/home_main.jsf?lang=en&nodeId=-8021
[132] Mace http://www.macegroup.com/
[133] Piper Supports http://www.pipesupports.com/
[134] Siemens http://www.siemens.com/answers/cee/me/
[135] TÜV Reihnland http://www.tuv.com/uk/en/index.html

Figure 22: Nuclear stakeholders per business in Montenegro (%)

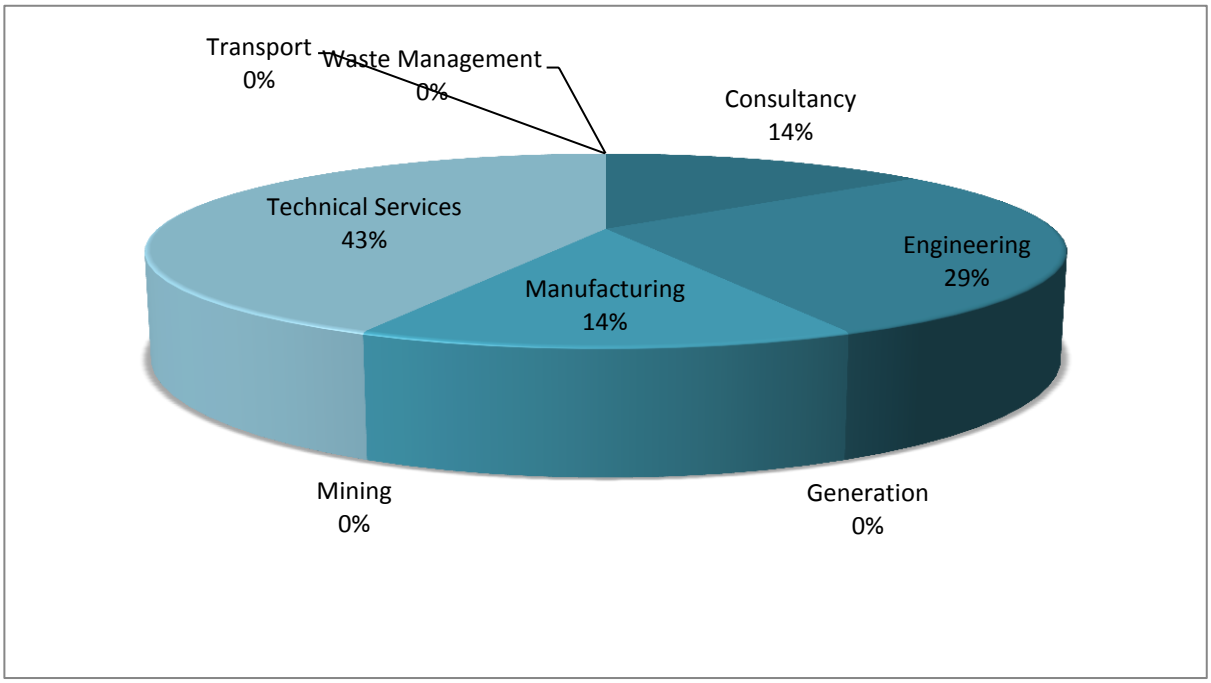
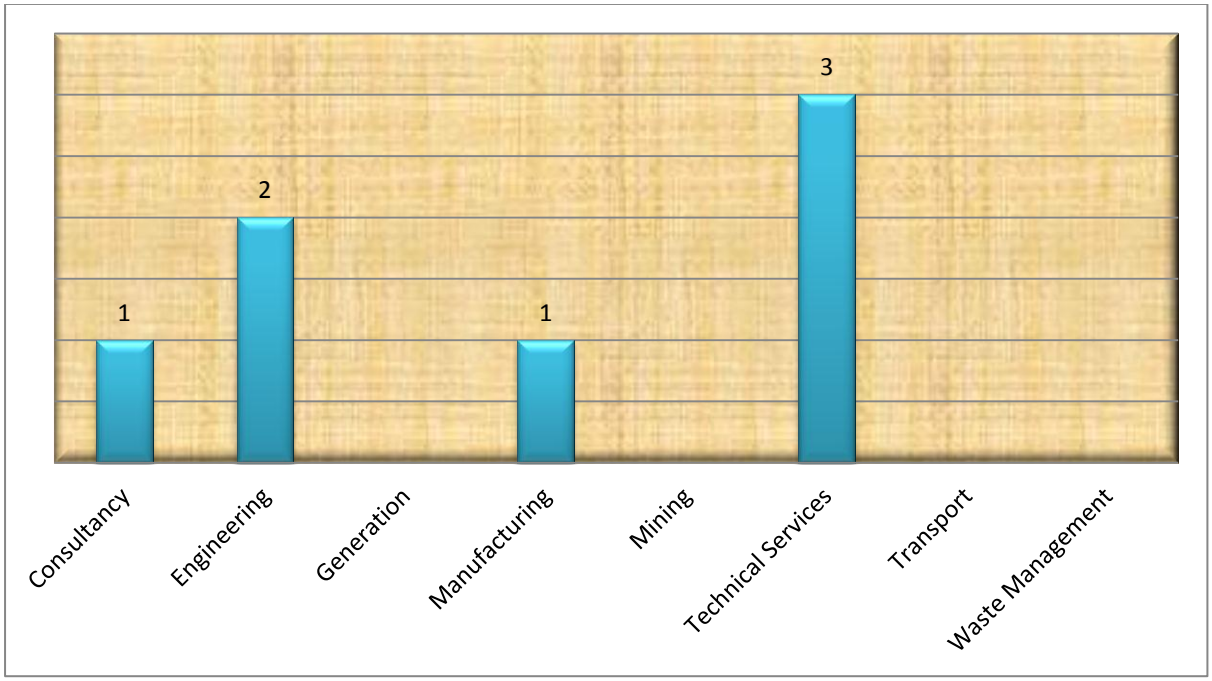


Figure 23: Nuclear stakeholders per business in Montenegro



4.6 Serbia

4.6.1 Introduction

Serbia has no nuclear power programme. In the past, Serbia had two research reactors in operation at the Center for Nuclear Technologies and Research NTI[136] within the Vinča Institute of Nuclear Sciences[137]. In 2010, the public company Nuclear Facilities of Serbia (NOS)[138] was established and became responsible for the operation of the two research reactors. To date only one research reactor (RB) is in operation.

The 6.5 MW heavy water moderated and cooled research reactor RA[139] was shut down for reconstruction in 1984. The research reactor was in extended shut down from 1984 until 2001. In 2002, the Serbian government decided to decommission the RA reactor and its ancillary facilities to repatriate its spent nuclear fuel to the country of origin and to improve the radioactive waste management. For this purpose the Vinča Institute Nuclear Decommissioning (VIND) programme[140] was set up.

The Serbian Radiation Protection and Nuclear Safety Agency (SRPNA)[141], which was founded in 2010, is the national competent authority responsible for nuclear safety and security, radiation protection and waste management.

The availability of nuclear related academic programmes in Serbia does not completely meet the national need for experts in this field. However, there are four entities providing vocational training for personnel responsible for radiation protection and radioactive sources in the country.

4.6.2 Higher Education and Training

Serbia is a full member of the Bologna Process[142] and therefore higher education is divided into three stages: Bachelor's, Master's and Doctorate degrees.

The University of Belgrade[143] in cooperation with the Laboratory for Nuclear and Plasma Physics[144] of the Vinča Institute provide the opportunity for BSc, MSc and PhD programmes in these fields.

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[136] Center for Nuclear Technologies and Research NTI http://www.vin.bg.ac.rs/150/index_e.htm
[137] Vinča Institute of Nuclear Sciences http://www.vin.bg.ac.rs/index.php/en/
[138] Nuclear Facilities of Serbia http://www.nuklearniobjekti.rs/
[139] Research Reactor RA http://www.vin.bg.ac.rs/150/RA_Reactor.htm
[140] VIND Program http://www.vin.bg.ac.rs/150/VINDprogram_e.htm The ambitious nuclear power program carried out in the former Yugoslavia after 1958 and, the sever economic crises in Serbia since 1991 led to a number of nuclear hazardous issues at the Vinča Institute of Nuclear Science , such as the leaking spent nuclear fuel in the storage water pools inside the research reactor RA building or the inadequate storage facilities for the low and intermediate radioactive waste. To improve the nuclear safety and security conditions by 2020, the Vinča Institue Nuclear Decommissioning Program (VIND Program) was launched. The VIND Program consists of three projects and three supporting activities, security at the institute.
[141] Serbian Radiation Protection and Nuclear Safety Agency (SRPNA) http://www.srbatom.gov.rs/srbatom/
[142] European Commission http://ec.europa.eu/education/higher-education/bologna_en.htm
[143] University of Belgrade http://www.bg.ac.rs/eng/memb/inst/en_instvinca.php

The University of Belgrade[145] in cooperation with the Physics Laboratories[146] of the Vinča Institute provide the opportunity for laboratory work related to BSc, MSc and PhD programmes.

The University of Novi Sad[147] offers a Diploma Programme in Physics[148], including courses in nuclear physics, nuclear energetics and nuclear instrumentations and a PhD Programme in Physics[149], including courses on nuclear energy, nuclear methods in medicine and nuclear analytical technics;

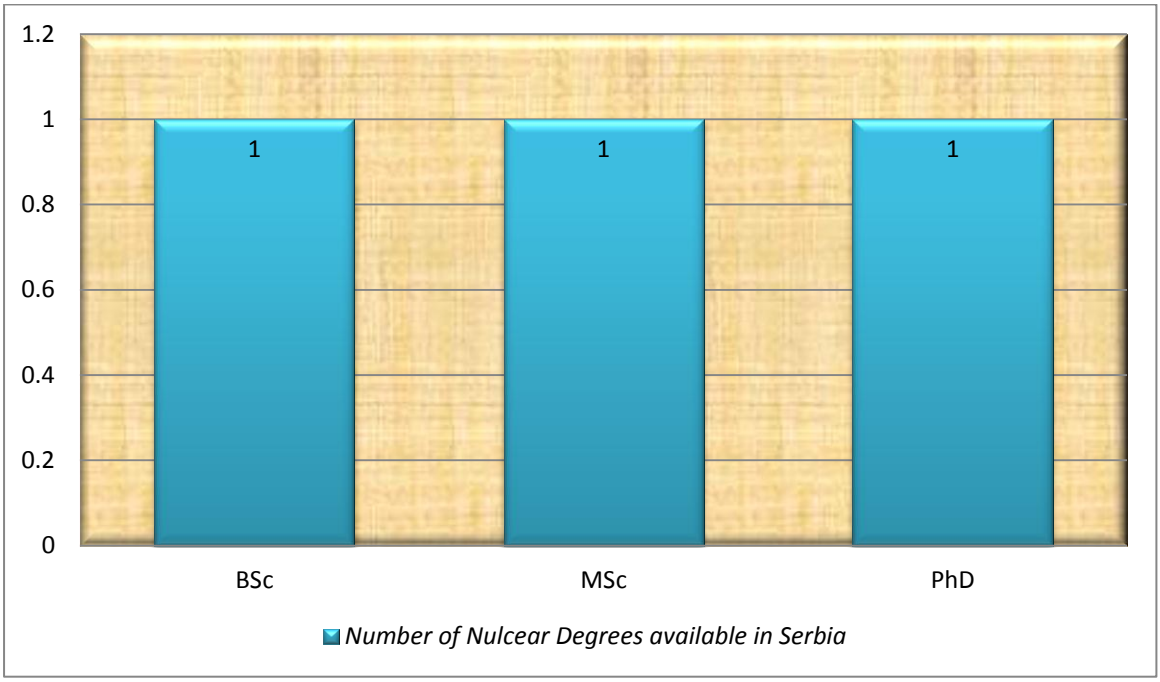
The following institutions are involved in nuclear related training:

The four main providers for training[150] dedicated to radiation protection and radioactive sources are the Centre for Permanent Education of the Vinča Institute, Institute for Occupational Health "Dr Dragomir Karajovic", the Universities of Kragujevac and Novi Sad. The licensing authority for approving these training activities is the Serbian Radiation Protection and Nuclear Safety Agency (SRPNA)[151].

Most of the universities in Serbia are a member of the Black Sea Universities Network[152].

[144] http://www.vin.bg.ac.rs/011/index.htm
[145] University of Belgrade http://www.bg.ac.rs/eng/memb/inst/en_instvinca.php
[146] Physics Laboratories at Vinča Institute of Nuclear Sciences http://www.vin.bg.ac.rs/index.php/en/research-activities/departments-centres
[147] University of Novi Sad http://www.uns.ac.rs/sr/
[148] MSc in Physics at the University of Novi Sad http://www2.pmf.uns.ac.rs/akreditacija/index.php?departman=2&tipstudija=diplomske&akademski=47
[149] PhD in Physics at the University of Novi Sad http://www2.pmf.uns.ac.rs/akreditacija/index.php?departman=2&tipstudija=doktorske&akademski=51
[150] http://www.srbatom.gov.rs/srbatom/spisak-ovlascenih-pravnih-lica.htm#obuka
[151] Serbian Radiation Protection and Nuclear Safety Agency (SRPNA) http://www.srbatom.gov.rs/srbatom/
[152] Black Sea Universities Network http://www.bsun.org/?task=homepage&web=bsun

Figure 24: Nuclear curricula in Serbia



4.6.3 Research

In the nuclear research field, there are mainly two institutions involved:

The Vinča Institute of Nuclear Sciences[153] is the largest Serbian research center in sciences and science applications. The research in the Institute covers the following areas: physics, chemistry, biology, energy engineering and technology, radiation and environmental protection, accelerator science and materials science. The Institute incorporates, 13 research departments/laboratories[154], the accelerator installation (Tesla) and an industrial scale irradiation unit (GAMA).

The Laboratory of Physics at the Vinča Institute[155] is involved in both, physics and detector research and development for the future linear colliders ILC and CLIC, and in the heavy-flavour studies. The Laboratory actively participates in Serbia's CERN[156] collaborations.

The Laboratory for Nuclear and Plasma Physics[157] at the Vinča Institute for Nuclear Science conducts research in the following areas: nuclear spectroscopy, nuclear reactions, hyperfine interactions, local structures and clusters, nuclear instruments and methods, accelerator physics, physics, solar energy, radiation detectors, organic electronics, ecology and sustainable development. The laboratory also provides the opportunity for laboratory work which is related to postgraduate studies led by faculties from different universities.

[153] Vinča Institute of Nuclear Sciences http://www.vin.bg.ac.rs/index.php/en/
[154] http://www.vin.bg.ac.rs/index.php/en/research-activities/departments-centres
[155] Laboratory of Physics at the Vinča Institute http://www.vin.bg.ac.rs/hep/about.html
[156] CERN http://public.web.cern.ch/public/ Serbia's CERN collaborations: ATLAS, SHINE and GRID Collaboration;
[157] http://www.vin.bg.ac.rs/011/index.htm

The Centre for Nuclear Technologies and Research (NTI)[158] carries out research activities in the following areas:

- Reactor Physics
- Safety and Control of Nuclear Reactors
- Nuclear Engineering
- Radiation Protection

The NTI was also responsible for the overall management of the VIND Programme, which was terminated in 2010, as well as for efficient implementation of two out of three major projects within the VIND Program[159].

The Institute of Physics Belgrade (IPB)[160] carries out research in various fields[161] such as nuclear physics; three laboratories within the IPB actively participate in the Serbia's CERN[162] collaborations.

The Institute for Technology of Nuclear and other Raw Materials (ITNMS)[163] focuses on research projects dedicated to mineral raw materials and their metallurgical processing.

The Nuclear Society of Serbia[164] promotes nuclear technology and the peaceful use of nuclear energy.

The Radiation Protection Association of Serbia and Montenegro[165] promotes protection against ionizing radiation for professionals and public, as well as environmental protection.

The Serbian Nuclear Medicine Society[166] promotes research and exchange of nuclear medicine knowledge through the organization of congresses and other events.

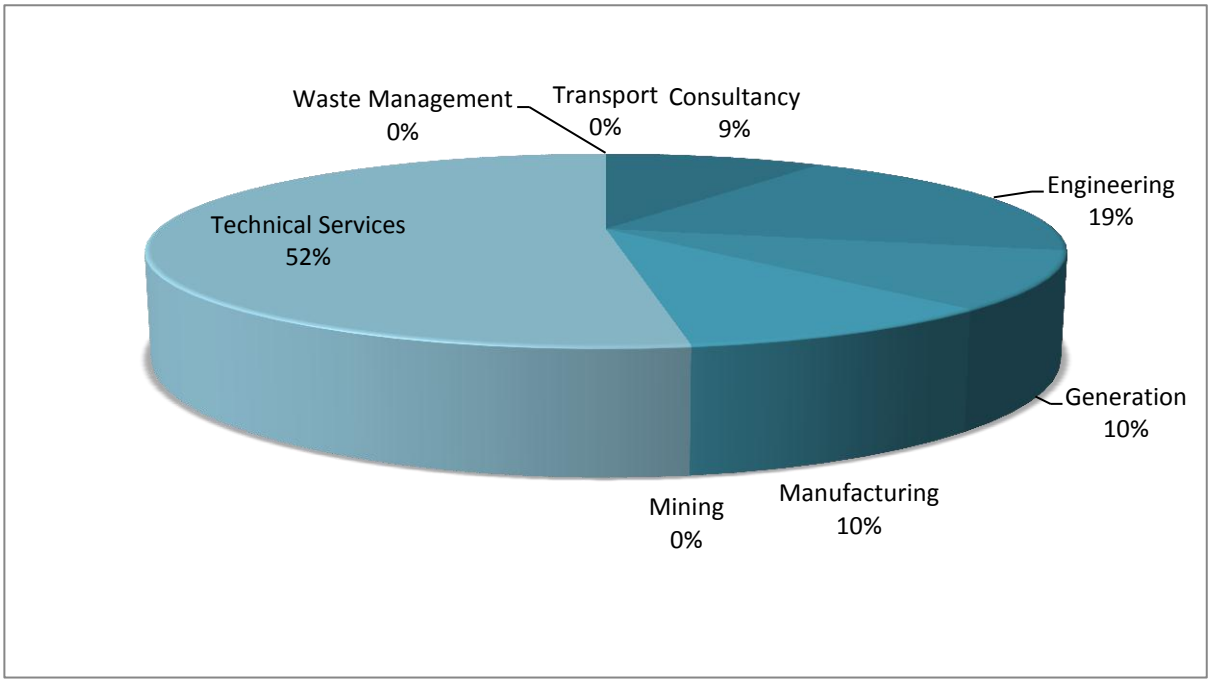
4.6.4 Nuclear Energy Stakeholders

Regarding the stakeholders in the nuclear field, the most important employers in Serbia include the following: ABB Group[167], AF Group[168], Alpiq Group[169], Arup[170], Axpo Group[171], Balfour Beatty[172], Bureau Veritas Group[173], CMS Cameron McKenna[174], Emka[175], Hilti SMN

[158] Center for Nuclear Technologies and Research NTI http://www.vin.bg.ac.rs/150/index_e.htm
[159] VIND Program http://www.vin.bg.ac.rs/150/VINDprogram_e.htm
[160] Institute of Physics http://www.phy.bg.ac.rs/index.php/en/
[161] http://www.phy.bg.ac.rs/index.php/en/research-areas
[162] CERN http://public.web.cern.ch/public/ Serbia's CERN collaborations: ATLAS, SHINE and GRID Collaboration;
[163] Institute for Technology of Nuclear and other Raw Materials http://www.itnms.ac.rs/?lang=en
[164] Nuclear Society of Serbia http://nss.vinca.rs/Links.htm
[165] Radiation Protection Association of Serbia and Montenegro http://www.dzz.org.rs/indexe.html
[166] Serbian Nuclear Medicine Society http://www.unms.rs/indexe.html
[167] ABB Group http://www.abb.com/
[168] AF Group http://www.afconsult.com/en/Worldwide/Europe/Switzerland/
[169] Alpiq Group http://www.alpiq.com/index.jsp
[170] Arup *http://www.arup.com/*
[171] Axpo Group http://www.axpo.com/content/axpo/global/en/home.html
[172] Balfour Beatty http://www.balfourbeatty.com/
[173] Bureau Veritas Group http://www.bureauveritas.com/
[174] CMS Cameron McKenna http://www.law-now.com/lawnow/

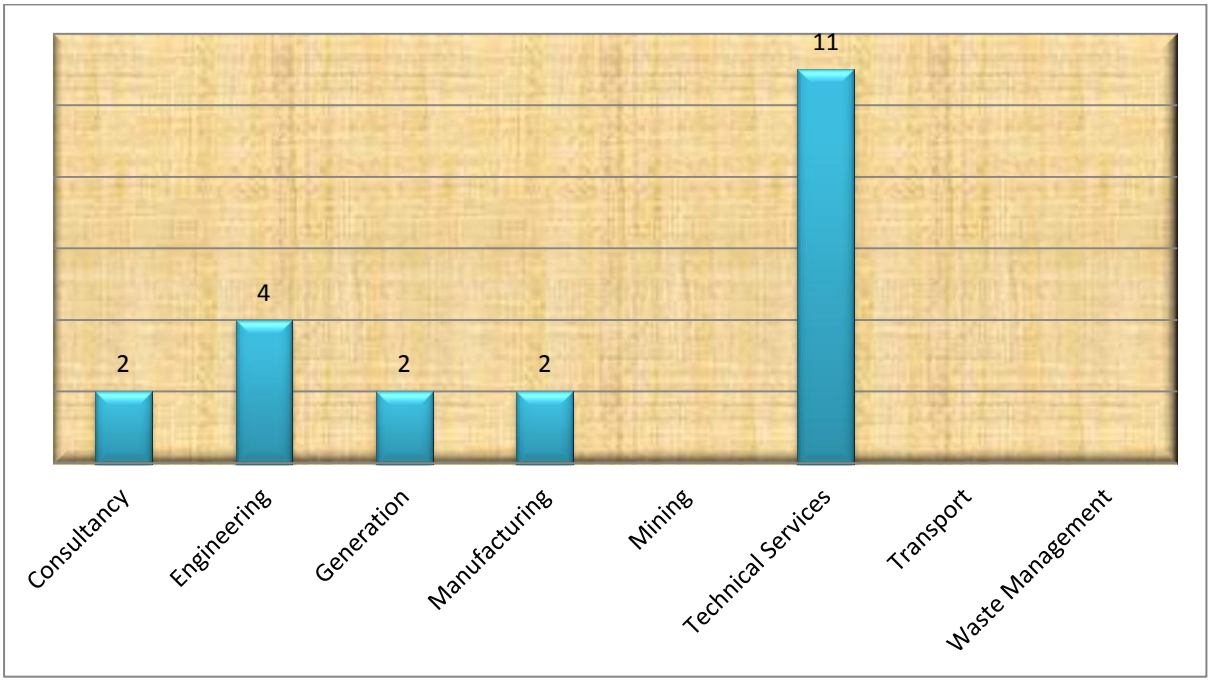
d.o.o.[176], Kuehne und Nagl[177], Mace[178], M+W Group GmbH[179], Morson Projects[180], Mott MacDonald[181], Piper Supports[182], Sarens Group[183], Scott Wilson[184], Siemens[185], TÜV Reihnland[186], URS[187].

Figure 25: Nuclear stakeholders per business in Serbia (%)



[175] Emka http://www.emka.com/
[176] Hilti SMN d.o.o. http://www.hilti.com/holcom/page/module/home/home_main.jsf?lang=en&nodeId=-8021
[177] Kuehne und Nagl http://www.kn-portal.com/
[178] Mace http://www.macegroup.com/
[179] M+W Group GmbH http://www.mwgroup.net/
[180] Morson Projects http://www.morson.com/offices/belgrade-serbia-morson-beograd-d-o-o-morson-projects/
[181] Mott MacDonald http://www.mottmac.com/
[182] Piper Supports http://www.pipesupports.com/
[183] Sarens Group http://www.sarens.com/en.aspx
[184] Scott Wilson http://www.scottwilson.com/
[185] Siemens http://www.siemens.com/entry/cee/sr/
[186] TÜV Reihnland http://www.tuv.com/uk/en/index.html
[187] URS http://www.ursglobal.com/regions/continental_europe/serbia.php

Figure 26: Nuclear stakeholders per business in Serbia



5. INTEGRATION COUNTRIES

5.1 Iceland

5.1.1 Introduction

There are no nuclear power plants in Iceland and no legislation in this respect.

The Icelandic Radiation Safety Authority[188] is the national competent authority for nuclear safety and security, radiation protection, trade in nuclear materials and equipment as well as radioactive waste management.

Iceland is member of the *European Community Steering Group on Strategic Energy Technologies* that is assigned to take forward the *European Strategic Energy Technology Plan* (SET-Plan) that establishes an energy technology policy for Europe and focuses on the acceleration of the development and deployment of cost-effective low carbon technologies.[189]

The non-nuclear policy in Iceland is reflected in the limited higher educational opportunities in the country.

5.1.2 Higher Education and Training

Iceland is a full member of the Bologna Process[190] and therefore higher education is divided into three stages: Bachelor's, Master's and Doctorate degrees. None of the seven academic institutions in Iceland offers a degree that specializes in the nuclear field and there are only very few research activities carried out.

The University of Reykjavik[191] offers an MSc in Sustainable Energy[192] that gives students the opportunity to carry out research in the nuclear field. However, the university does not offer academic programmes dedicated to the nuclear field per se.

The training on radiation protection, use of equipment and nuclear and other radioactive material is provided by the Icelandic Radiation Safety Authority[193].

5.1.3 Research

Even though there are a number of research institutes in Iceland, none of them is carrying out specific nuclear research projects.

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[188] Icelandic Radiation Safety Authority http://www.gr.is/english/
[189] European Commission. European Strategic Energy Technology Plan (SET-Plan) http://ec.europa.eu/energy/technology/set_plan/set_plan_en.htm
[190] European Commission http://ec.europa.eu/education/higher-education/bologna_en.htm
[191] University of Reykjavik http://en.ru.is/
[192] http://en.ru.is/departments/school-of-science-and-engineering/master-studies/msc-in-mechanical-and-electrical-engineering/msc-in-sustainable-energy-reyst/
[193] Icelandic Radiation Safety Authority http://www.gr.is/english/

5.1.4 Nuclear Energy Stakeholders

The international companies that have a presence in Iceland include: Bureau Veritas Group[194], Hagi ehf Hilti Iceland[195];

Figure 27: Nuclear stakeholders per business in Iceland (%)

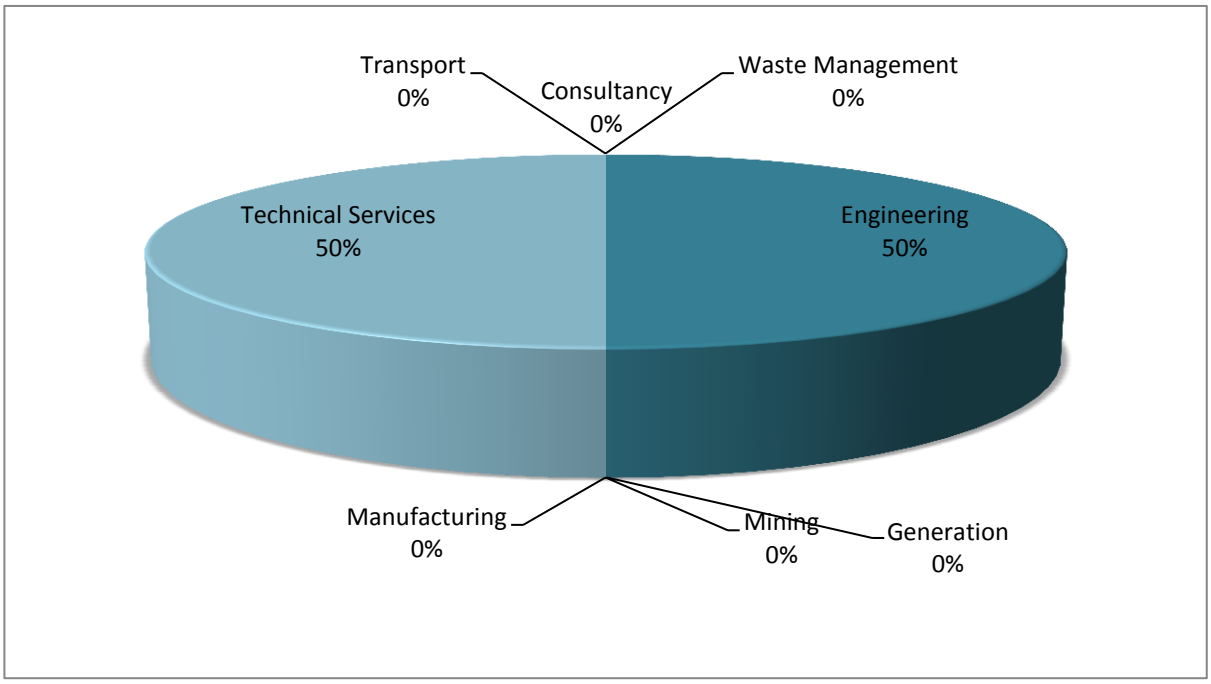
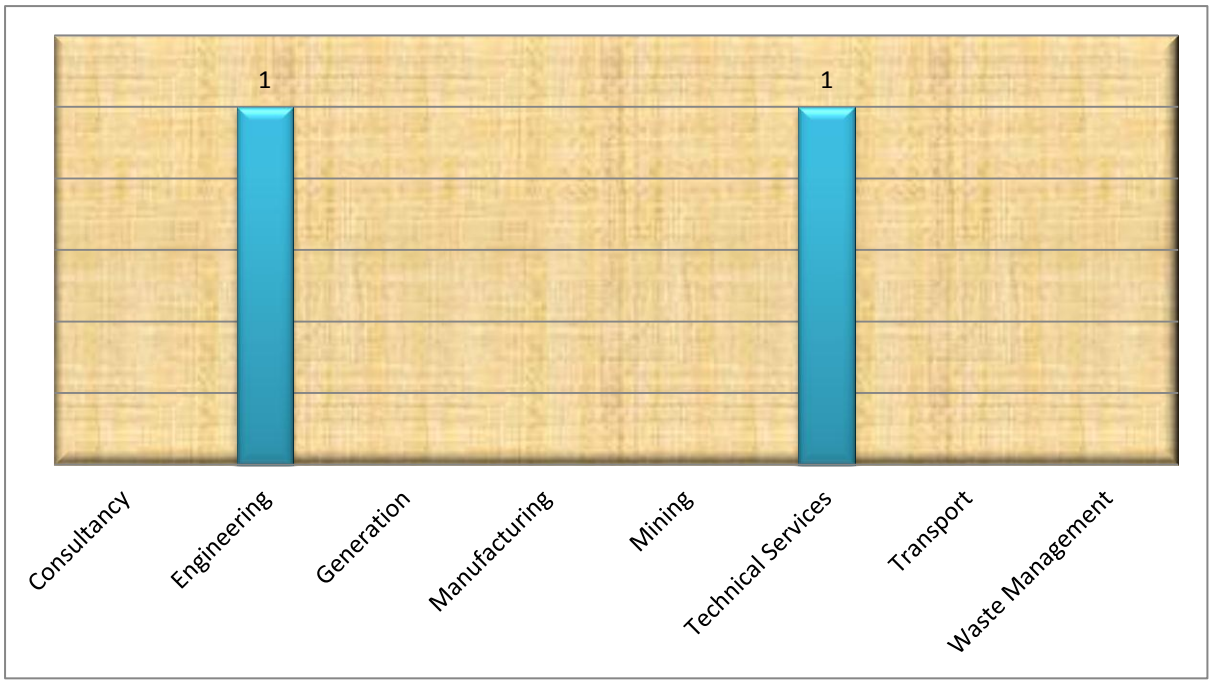


Figure 28: Nuclear stakeholders per business in Iceland



[194] Bureau Veritas Group http://www.bureauveritas.com/
[195] Hagi ehf Hilti Iceland http://www.hilti.com/holcom/page/module/home/home_main.jsf?lang=en&nodeId=-8021

5.2 Israel

5.2.1 Introduction

Israel does not have a civil nuclear power programme, but it has three research reactors which are operated by the Israel Atomic Energy Commission (IAEC)[196].

The 5 MW research reactor and the Israeli Research Reactor I (IRRI) are both located at the Soreq National Research Centre[197], and the 70 MW heavy water reactor is placed at the Nuclear Research Centre Negev (NRCN)[198].

The national radioactive waste disposal site is situated at the NRCN[199] hosting waste from hospitals, research institutions, higher education facilities and industry.

The Israel Atomic Energy Commission (IAEC)[200] is responsible for nuclear safety and security, radiation protection and health. The IAEC advises the government in nuclear policy and in nuclear research and development.

Nuclear science plays an important role in Israel which is reflected in the variety of academic programmes and research activities available in the country. There are also several opportunities at the training level to enhance nuclear knowledge and skills.

5.2.2 Higher Education and Training

The Ben-Gurion University of the Negev (BGU)[201] offers a Master and a PhD programme in Nuclear Engineering[202]. In addition, the Department of Nuclear Engineering is educating engineers in the fields of nuclear energy, nuclear medicine, and radiation related technologies and offers undergraduate and graduate (MSc, and PhD) degrees[203] in these areas.

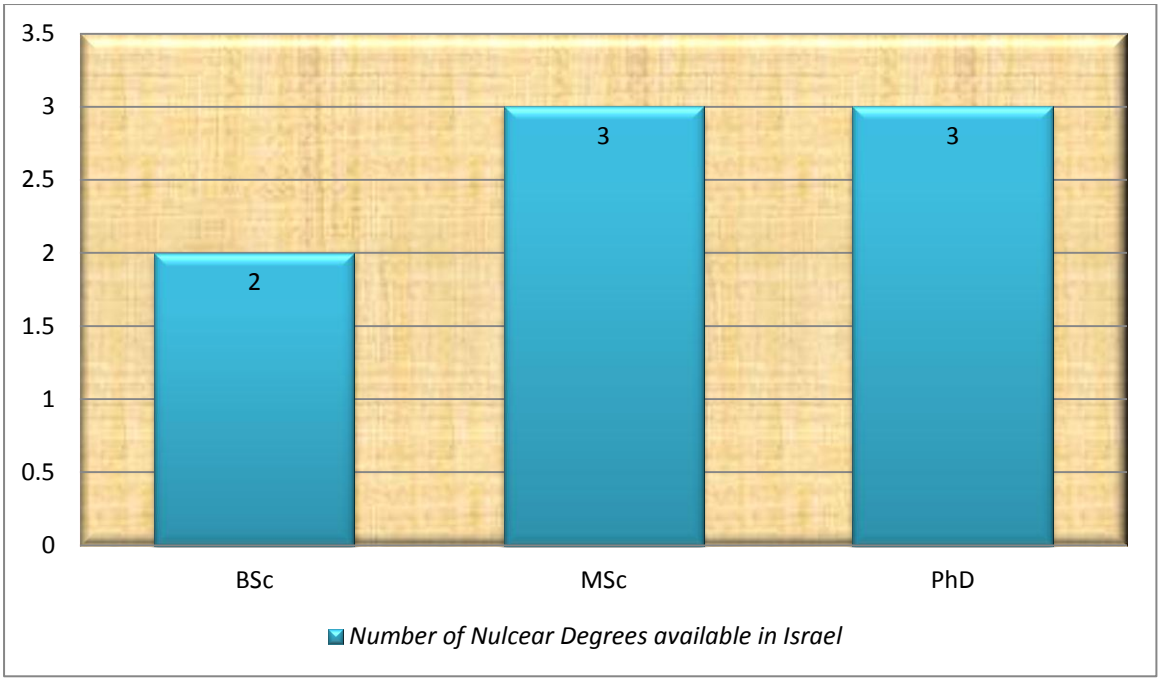
The following institutions are involved in training:

The Israeli Research Reactor 1 (IRR1)[204] provides training in nuclear engineering, neutron radiography and diffraction, activation analysis and changing colours of semi-precious and precious stones.

The Soreq Nuclear Research Centre (NRC)[205] provides radiation protection training.

[196] IAEC http://iaec.gov.il/english/About%20Us/Pages/default.aspx
[197] Soreq Nuclear Research Center http://www.soreq.gov.il/default_EN.asp
[198] NRCN http://iaec.gov.il/English/NRCN/Pages/default.aspx
[199] NRCN http://iaec.gov.il/English/NRCN/Pages/default.aspx
[200] IAEC http://iaec.gov.il/english/About%20Us/Pages/default.aspx
[201] Ben-Gurion University of the Negev http://in.bgu.ac.il/en/Pages/default.aspx
[202] MSC and PhD in Nuclear Engineering at BGU http://in.bgu.ac.il/en/engn/Pages/About.aspx
[203] http://cmsprod.bgu.ac.il/Eng/engn/nuclear/Addm/
[204] http://www.soreq.gov.il/default_EN.asp
[205] Soreq Nuclear Research Centre http://www.soreq.gov.il/default_EN.asp

Figure 29: Nuclear curricula in Israel



5.2.3 Research

In the nuclear research field, there are several institutions involved:

The Soreq Nuclear Research Centre (NRC)[206] includes a 5 MW research reactor, a 10 MeV proton cyclotron accelerator, laboratories for applied research and development. The Soreq NRC areas of research range from equipment for nuclear medicine and radio-pharmaceutics to non-destructive testing and development of sophisticated methods for detecting contraband and security-threat materials. Soreq NRC also operates a personal dosimetry service.

The research and development programs at the Soreq Applied Research Accelerator Facility (SARAF)[207] cover the following areas: particle physics, nuclear astrophysics, material science, neutron capture therapy of cancer, radiopharmaceuticals, neutron radiography and fast neutron based basic and applied research;

The main research conducted at the Negev Nuclear Research Center (NNRC)[208] aims at broadening the basic knowledge in nuclear sciences and related fields in Israel.

The Israeli Research Reactor 1 (IRR1)[209] conducts research the following areas: nuclear engineering, neutron radiography and diffraction, activation analysis and changing colours of semi-precious and precious stones.

[206] Soreq Nuclear Research Centre http://www.soreq.gov.il/default_EN.asp
[207] SARAF http://www.linac12.org.il//SARAF.ehtml
[208] NNRC http://iaec.gov.il/English/NRCN/Pages/default.aspx

The Ben-Gurion University of the Negev (BGU)[210] conducts research in nuclear energy, nuclear medicine and biology and radiation in industry and research[211].

The Department of Particle Physics within the Tel Aviv University[212] Raymond and Beverly Sackler School of Physics and Astronomy conducts research in nuclear physics[213].

The Weizmann Institute of Science (WIS)[214] conducts research devoted, inter alia, to biochemistry, biology, chemistry and physics.

The Israeli Society of Nuclear Medicine[215] promotes research and education in the nuclear field.

5.2.4 Nuclear Energy Stakeholders

The main companies involved in the nuclear business in Israel include: Rotem Amfert Negev Ltd [216] and Israel Electric Corp.[217];

The international companies that have a presence in Israel include: ABB Group[218], Alstom[219], Balfour Beatty[220], Bureau Veritas Group[221], Freshfields Bruckhaus Deringer[222], GE[223], Hilti[224], IN.P.C. Co Ltd[225], Kuehne und Nagl[226], M+W Group GmbH[227], Oxide Advanced Technology Ltd[228], Siemens[229], Uniweld Ltd. Distribution[230];

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[209] http://www.soreq.gov.il/default_EN.asp
[210] Ben-Gurion University of the Negev http://in.bgu.ac.il/en/Pages/default.aspx
[211] http://cmsprod.bgu.ac.il/Eng/engn/nuclear/research/
[212] Tel Aviv University http://english.tau.ac.il/
[213] http://proton.tau.ac.il/
[214] Weizmann Institute of Science http://wis-wander.weizmann.ac.il/
[215] Israeli Society of Nuclear Medicine http://www.isnm.org.il/
[216] Rotem Amfert Negev Ltd http://www.iclfertilizers.com/FERTILIZERS/ROTEMNEGEV/Pages/BUHomepage.aspx
[217] Israel Electric Corp. http://www.iec.co.il/EN/IR/Pages/AboutTheCompany.aspx
[218] ABB Group http://www.abb.com/
[219] Alstom http://www.alstom.com/locations/
[220] Balfour Beatty http://www.balfourbeatty.com/
[221] Bureau Veritas Group http://www.bureauveritas.com/
[222] Freshfields Bruckhaus Deringer http://www.freshfields.com/en/global/
[223] GE http://www.ge.com/il/
[224] Hilti http://www.hilti.co.il/he/home.asp
[225] IN.P.C. Co Ltd http://www.inpc.co.il
[226] Kuehne und Nagl http://www.kn-portal.com/
[227] M+W Group GmbH http://www.mwgroup.net/
[228] Oxide Advanced Technology Ltd http://www.oxide.co.il
[229] Siemens http://www.siemens.com/answers/il/he/
[230] Uniweld Ltd. Distribution http://www.sulzer.com/

Figure 30: Nuclear stakeholders per business in Israel (%)

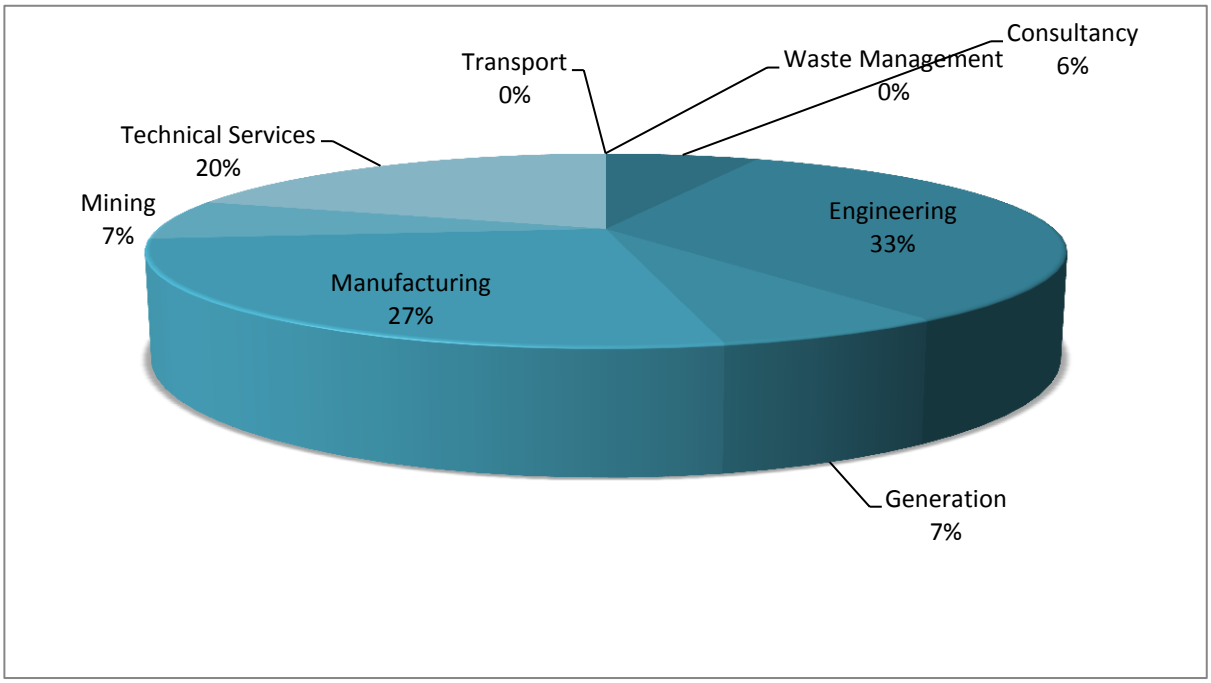
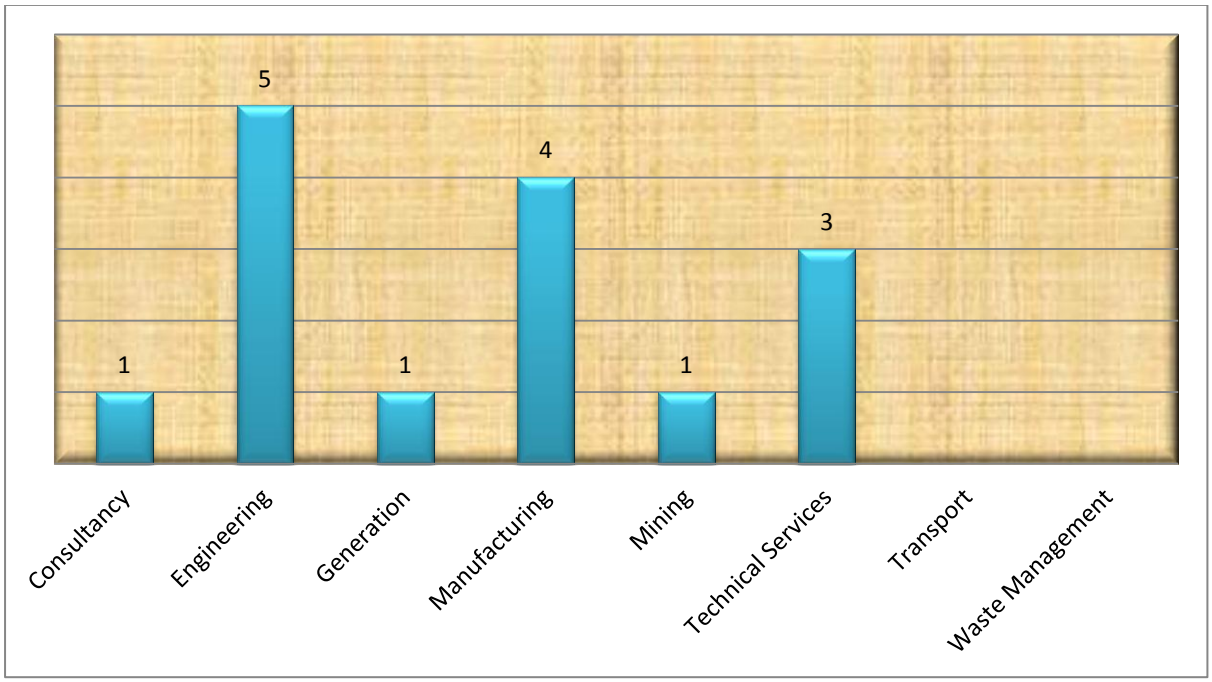


Figure 31: Nuclear stakeholders per business in Israel



5.3 Liechtenstein

5.3.1 Introduction

Liechtenstein does not have a nuclear power programme and has no plans to develop nuclear power in the future.

5.3.2 Higher Education and Training

Higher education in Liechtenstein is divided into three stages: Bachelor's, Master's and Doctorate degrees (as required by the Bologna Process). There are no academic degrees or training programmes available in the nuclear field.

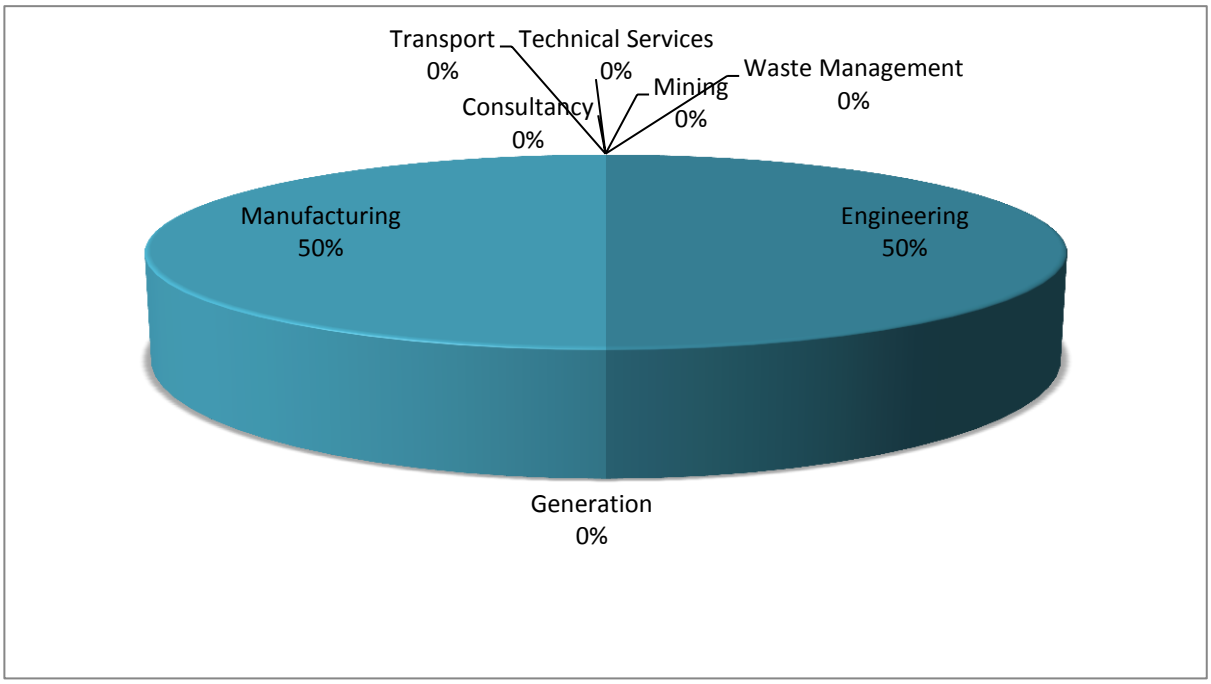
5.3.3 Research

In Liechtenstein are no opportunities to carry out research in the nuclear field.

5.3.4 Nuclear Energy Stakeholders

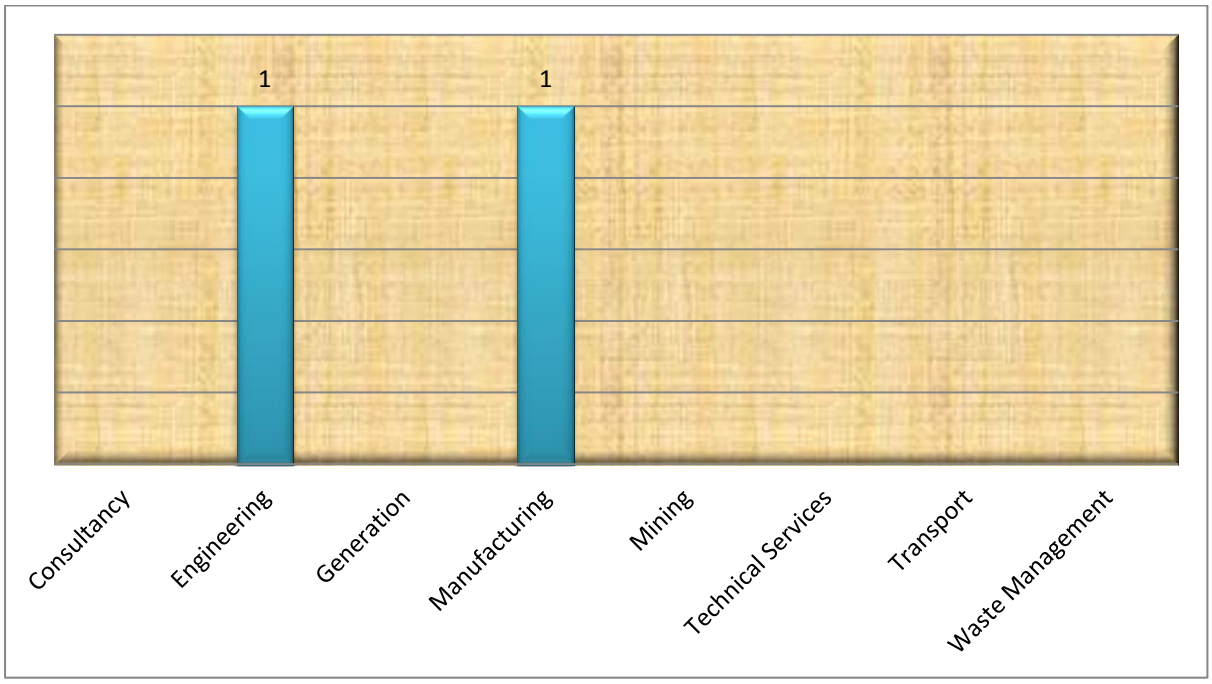
Companies potentially involved in the nuclear business with headquarters in Liechtenstein are Hilti Aktiengesellschaft[231] and Hoval AG[232];

Figure 32: Nuclear stakeholders per business in Liechtenstein (%)



[231] Hilti Aktiengesellschaft http://www.hilti.com/holcom/page/module/home/home_main.jsf?lang=en&nodeId=-8021
[232] Hovalwerk AG http://www.hoval.li/de/unternehmen

Figure 33: Nuclear stakeholders per business in Liechtenstein



5.4 Norway

5.4.1 Introduction

Norway has no nuclear power plants; nevertheless it has an established legal framework for licensing the construction and operation of nuclear installations.

Norway has built four research reactors. The JEEP I research reactor was operative from 1951 to 1966 and the Nora research reactor was operative from 1961 to 1968. Currently, two research reactors are operational: the Boiling Water Reactor (HBWR)[233] in Halden and Jeep II heavy water moderated reactor[234] in Kjeller; both are operated by the Institute for Energy Technology (IFE)[235]. The maximum power of the Halden reactor is 25 MW and its energy produced is used by Norske Skog Saugbrugsforeningen[236] in their paper production. The reactor plant includes also water-filled fuel storage pits in the reactor hall and in the bunker building. The JEEP II reactor has a maximum thermal power of 2000 kW and is used for basic research in the field of radiation pharmacy, use of nuclear methods, radiation protection and radioactive waste.

Norway has a combined repository for low-level and intermediate-level waste at Himdalen in Aurskog-Høland municipality which is operated by IFE.

The Norwegian Radiation Protection Authority (NRPA)[237] is the government authority for radiation protection, nuclear safety and security as well as the corresponding legislation on radiation protection and nuclear energy.

In 2007, the Norwegian Ministry of Petroleum and Energy[238] commissioned a study on the possibility of utilizing thorium as a source of energy in Norway which was finalized in 2008. The study[239] sets out that the current knowledge of thorium based energy generation and the geology is not solid enough to provide a final assessment regarding the potential value for Norway of a thorium based system for long term energy production. However, the study recommends that Norway should strengthen its international collaboration in nuclear energy and develop its human resources in nuclear science and engineering so as to keep the thorium option open as complementary to the uranium option.

Thor Energy AS[240] established a consortium to fund and run a 5-year thorium irradiation project to be conducted at the Halden Nuclear Reactor. Targeted start-up of the project was the beginning of 2012.

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[233] Halden research reactor http://www.ife.no/en/ife/laboratories/hbwr
[234] Jeep II http://www.ife.no/en/ife/laboratories/jeep-ii
[235] Institute for Energy Technology http://www.ife.no/en
[236] Norske Skog Saugbrugsforeningen http://www.norskeskog.com/Home-3.aspx
[237] Norwegian Radiation Protection Agency http://www.nrpa.no/eway/default.aspx?pid=240
[238] Ministry of Petroleum and Energy http://www.regjeringen.no/en/dep/oed.html?id=750
[239] Thorium Report Committee. THORIUM AS AN ENERGY SOURCE THORIUM AS AN ENERGY SOURCE - Opportunities for Norway. 2008. [Online] Available from http://www.regjeringen.no/upload/OED/Rapporter/ThoriumReport2008.pdf
[240] Thor Energy AS http://www.scatec.no/en/Topmenu/Vare-selskaper/Thor%20Energy.aspx

Norway is member of the *European Community Steering Group on Strategic Energy Technologies* that is assigned to take forward the *European Strategic Energy Technology Plan* (SET-Plan) that establishes an energy technology policy for Europe and focuses on the acceleration of the development and deployment of cost-effective low carbon technologies.[241]

Although Norway has no nuclear power program there a number of academic programs and research activities available in the nuclear field. This indicates that nuclear research, education and the maintenance of nuclear knowledge is of high importance for Norway.

5.4.2 Higher Education and Training

Higher education in Norway is divided into three stages: Bachelor's, Master's and Doctorate degrees (as required by the Bologna Process). There are currently three universities in the country providing full Master and PhD programs within nuclear sciences.

The main high education institution within the nuclear scope is the University of Oslo (UiO)[242] that offers a Master in Nuclear Chemistry, Master in Nuclear Physics, Master in Material Science and PhD within the same areas. Moreover, UiO is involved in capacity building and education in nuclear-disarmament offering the Oslo Disarmament Verification Seminar[243].

The University of Bergen[244] offers a Master and PhD in Nuclear Physics[245].

The Norwegian University of Life Science (UMB)[246] offers a Master in Radiochemistry[247], EU Master in Radioecology[248] and PhD within the same areas.

The Norwegian University of Science and Technology (NTNU)[249] offers a course on Nuclear and Radiation Physics[250];

The following institutions are involved in training: The Center for Accelerator-based Research and Energy Physics (SAFE)[251] at the University of Oslo (UiO)[252] provides a three-day course on radioprotection for personnel working with radioactive material[253].

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[241] European Commission. European Strategic Energy Technology Plan (SET-Plan) http://ec.europa.eu/energy/technology/set_plan/set_plan_en.htm

[242] University of Oslo http://www.uio.no/english/

[243] Oslo Disarmament Verification Seminar at UiO http://www.mn.uio.no/fysikk/english/research/projects/nuclear-disarmament/ This seminar brings together experts in the field and top graduate students to simulated negotiations of disarmament verification protocols. In addition, verification based on the negotiated protocol will be implemented through a simulated laboratory exercise.

[244] University of Bergen http://www.uib.no/en

[245] MSc and PhD in Nuclear Physics at UiB http://www.uib.no/programmeoption/MAMN-FYKJR

[246] UMB http://www.umb.no/english/

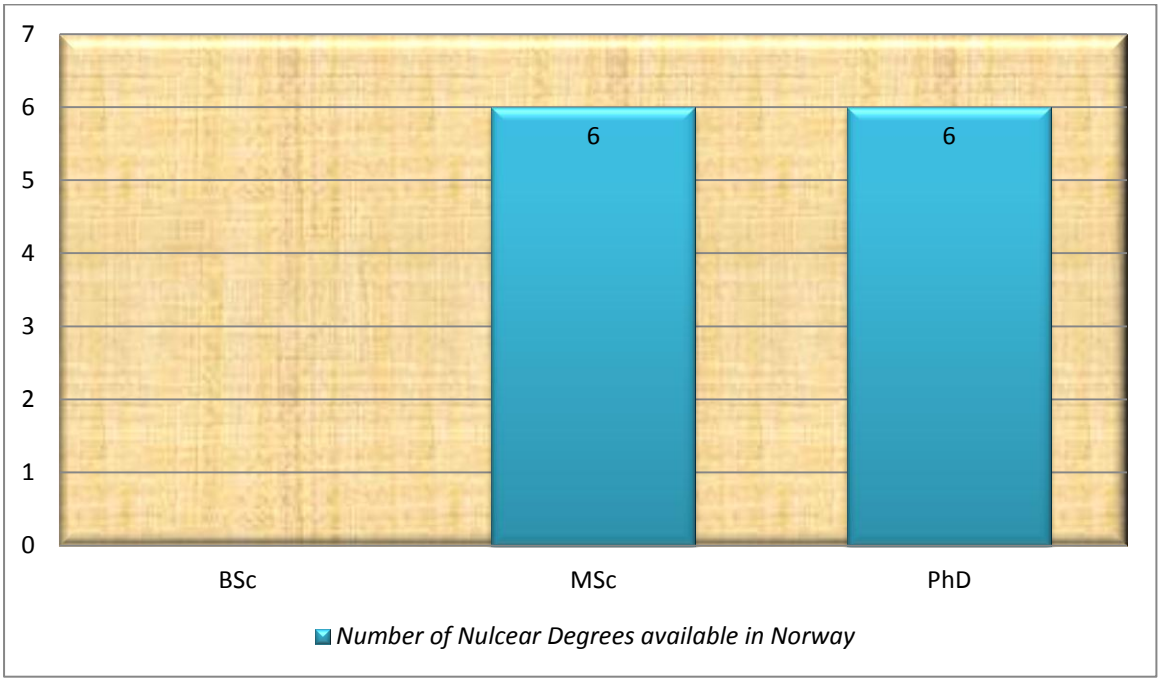
[247] Master in Radiochemistry at UMB http://www.umb.no/ipm/artikkel/faggruppe-miljokjemi-environmental-chemistry

[248] EU Master in Radioecology at UMB http://www.umb.no/study-options/article/european-master-of-science-in-radioecology

[249] NTNU http://www.ntnu.edu/

[250] http://www.ntnu.edu/studies/courses/TFY4225#tab=omEmnet

Figure 34: Nuclear curricula in Norway



5.4.3 Research

In the nuclear research field, there are several institutions involved:

The Institute for Energy Technology (IFE)[254] is the Norwegian centre of expertise on energy and nuclear technology and is the institute to maintain and further develop national expertise within reactor safety, radiation protection and nuclear technology based on the Halden and JEEP II research reactors. IFE undertakes research and development within the energy and petroleum sector and carries out assignments in the field of nuclear technology. IFE conducts basic research in physics based on the JEEP II reactor at Kjeller. IFE administers the international research cooperation 'Halden Reactor Project'[255] which aims at generating key information for safety and licensing assessments.

IFE conducts a number of research projects in the nuclear field, such as Virtual Environments for Maintenance and Outage Training[256], Virtual Flow[257], VNEM[258], ODIN/PUS2[259], Developing Neutron Reflectometry for Materials research in Norway[260], Total

[251] SAFE http://www.mn.uio.no/kjemi/english/research/groups/safe/index.html
[252] University of Oslo http://www.uio.no/english/
[253] Radiation Protection Course at SAFE http://www.mn.uio.no/kjemi/english/research/groups/safe/studies/
[254] Institute for Energy Technology http://www.ife.no/en
[255] Halden Reactor Project http://www.ife.no/no/ife/halden/haldenprosjektet/hrp-no
[256] http://www.ife.no/en/ife/departments/software-engineering/projects/vitualvideo This research project focuses on using virtual reality to provide nuclear power plant workers a better understanding of their work tasks, and get familiar with equipment and work area.
[257] http://www.ife.no/en/ife/departments/system-and-interface-design/projects/virtualflow The aim of this research project is to contribute to the development and validation of a flow sensor in a nuclear power plant.
[258] http://www.ife.no/en/ife/departments/system-and-interface-design/projects/vnem This research project focuses on a Nodal Neutron Transport Method for Calculating In-Core Power Distribution of Light Water Reactors.
[259] http://www.ife.no/en/ife/departments/physics/projects/project.2008-04-07.2209837766 New Instrument for material

Scattering Techniques for Investigations of disorder in the Solid State[261], Control and Distribution of Radiopharmaceuticals[262], Manufacturing of PET-radiopharmaceuticals[263];

Beside the IFE, there is the Center for Accelerator-based Research and Energy Physics (SAFE)[264] at the University of Oslo that conducts research in the following areas: experimental nuclear physics, chemistry and physics of super-heavy elements, radiopharmaceutical chemistry, nuclear energy technology and solar panels and energy systems, radiopharmaceutical chemistry and radiochemical separation methods, in particular liquid-liquid extraction. SAFE has research facilities available, such as the Oslo Cyclotron Laboratory[265] that focuses on research in nuclear physics and nuclear chemistry (including isotopes production for nuclear medicine) and several state-of-the-art laboratories to synthesize new PET compounds.

The research focus of the Nuclear Receptor Group[266] at the University of Oslo is to define the regulatory signaling pathways controlled by nuclear receptors in energy balance and lifestyle-related diseases.

The Norwegian University of Life Science (UMB)[267] hosts the Centre for Environmental Radioactivity (CERAD) which is a designated Centre of Excellence aiming to provide scientific basis for impact/risk assessments which underpin management of radiation risks.

5.4.4 Nuclear Energy Stakeholders

The main companies involved in the nuclear business in Norway include: Drammen Fjernvarme AS[268], Hafslund AS[269], Fortum Fjernvarme AS[270], Fredrikstad Energi AS[271], Ishavskraft AS[272], Lillestrøm Centre of Expertise[273], Norske Skog Saugbrugsforeningen [274], Thor Energy AS[275], Thor Industry[276], Wergeland-Haslvik[277];

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analysis by the use of the Neutron flux from JEEP II research reactor.

[260] http://www.ife.no/en/ife/departments/physics/projects/developing-neutron-reflectometry

[261] http://www.ife.no/en/ife/departments/physics/total-scattering-techniques-for-investigations-of-disorder-in-the-solid-state

[262] http://www.ife.no/en/ife/departments/isotope_laboratories/projects/radiofarmaka This research project focuses on inspecting and controlling all radiopharmaceuticals used in Norwegian hospitals.

[263] http://www.ife.no/en/ife/departments/isotope_laboratories/projects/PET-radiofarmaka-en This research project deals with the production of special radiopharmaceuticals which are not readily available on the market.

[264] SAFE http://www.mn.uio.no/kjemi/english/research/groups/safe/index.html

[265] Oslo Cyclotron Laboratory http://www.mn.uio.no/fysikk/english/research/about/infrastructure/OCL/

[266] Nuclear Receptor Group at UiO http://www.med.uio.no/imb/english/research/groups/nuclear-receptor-group/

[267] UMB http://www.umb.no/english/

[268] Drammen Fjernvarme http://df.no/

[269] Hafslund http://www.hafslund.no/english/facts/

[270] Fortum Fjernvarme AS http://www.fortum.no/

[271] Fredrikstad Energi AS http://www.feas.no/default.asp?fid=1012

[272] Ishavskraft AS http://www.ishavskraft.no/

[273] Lillestrøm Centre of Expertise http://www.kunnskapsbyen.no/?aid=9078696

[274] Norske Skog Saugbrugsforeningen http://www.norskeskog.com/Home-3.aspx

[275] Thor Energy AS http://www.scatec.no/en/Topmenu/Vare-selskaper/Thor%20Energy.aspx

[276] Thor Industry http://www.thorindustries.com/home/

[277] Wergeland-Haslvik http://www.wergeland-halsvik.no/en/

The international companies that have a presence in Norway include: ABB Group[278], AF Group[279], Aker Solution[280], Alpiq Group[281], Alstom[282], Applus Rtd Norway As[283], Atkins[284], Axpo Group[285], Balfour Beatty[286], BT[287], Bureau Veritas Group[288], Camfil Farr[289], Converteam[290], DLA Piper[291], Doosan[292], Fortum[293], Gammadata Instrument[294], GE[295], Golder Associates[296], Kuehne und Nagl[297], Motek AS[298], Mott MacDonald[299], Outokumpu AS[300], Piper Supports[301], Rautaruukki Oy[302], Rotex[303], Sarens Group[304], Siemens[305], TÜV Reihnland[306], White and Case[307].

[278] ABB Group http://www.abb.com/
[279] AF Group http://www.afconsult.com/en/Worldwide/Europe/Switzerland/
[280] Aker Solution http://www.akersolutions.com/en/Locations/Europe/Norway/
[281] Alpiq Group http://www.alpiq.com/index.jsp
[282] Alstom http://www.alstom.com/locations/
[283] Applus Rtd Norway As http://www.applus.com/
[284] Atkins http://www.atkinsglobal.com/
[285] Axpo Group http://www.axpo.com/content/axpo/global/en/home.html
[286] Balfour Beatty http://www.balfourbeatty.com/
[287] BT http://www.globalservices.bt.com/uk/en/home
[288] Bureau Veritas Group http://www.bureauveritas.com/
[289] Camfil Farr http://www.camfilfarr.com/ps/About-us/
[290] Converteam http://www.converteam.com/
[291] DLA Piper http://www.dlapiper.com/
[292] Doosan http://www.doosan.com/en/main.do
[293] Fortum http://www.fortum.no/
[294] Gammadata Instrument http://www.gammadata.net/productlist.aspx?MID=288&C=NO
[295] GE http://www.ge.com/no/
[296] Golder Associates http://www.golderassociates.dk/en/modules.php?name=Pages&sp_id=397
[297] Kuehne und Nagl http://www.kn-portal.com/
[298] Motek AS http://www.hilti.com/holcom/page/module/home/home_main.jsf?lang=en&nodeId=-8021
[299] Mott MacDonald http://www.mottmac.com/
[300] Outokumpu AS http://www.outokumpu.com/
[301] Piper Supports http://www.pipesupports.com/
[302] Rautaruukki Oy http://www.ruukki.no/
[303] Rotex http://www.roxtec.com/
[304] Sarens Group http://www.sarens.com/en.aspx
[305] Siemens http://www.siemens.com/entry/no/no/
[306] TÜV Reihnland http://www.tuv.com/uk/en/index.html
[307] White & Case http://www.whitecase.com/ankara/;http://www.whitecase.com/istanbul/

Figure 35: Nuclear stakeholders per business in Norway (%)

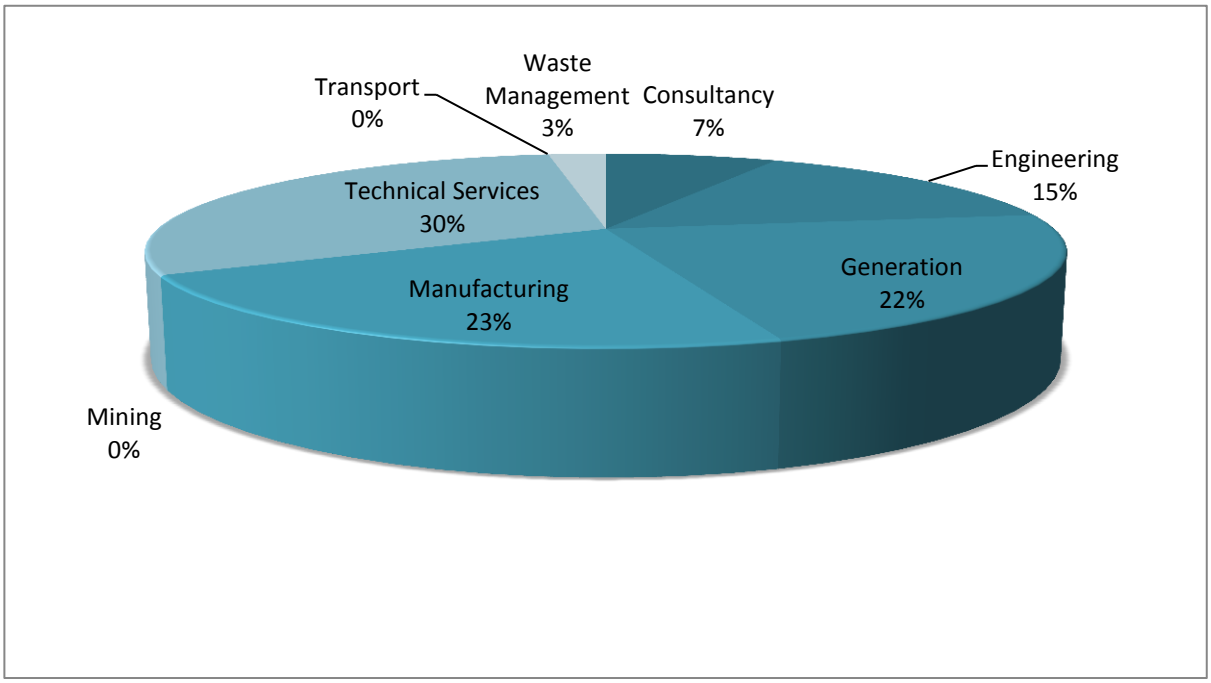
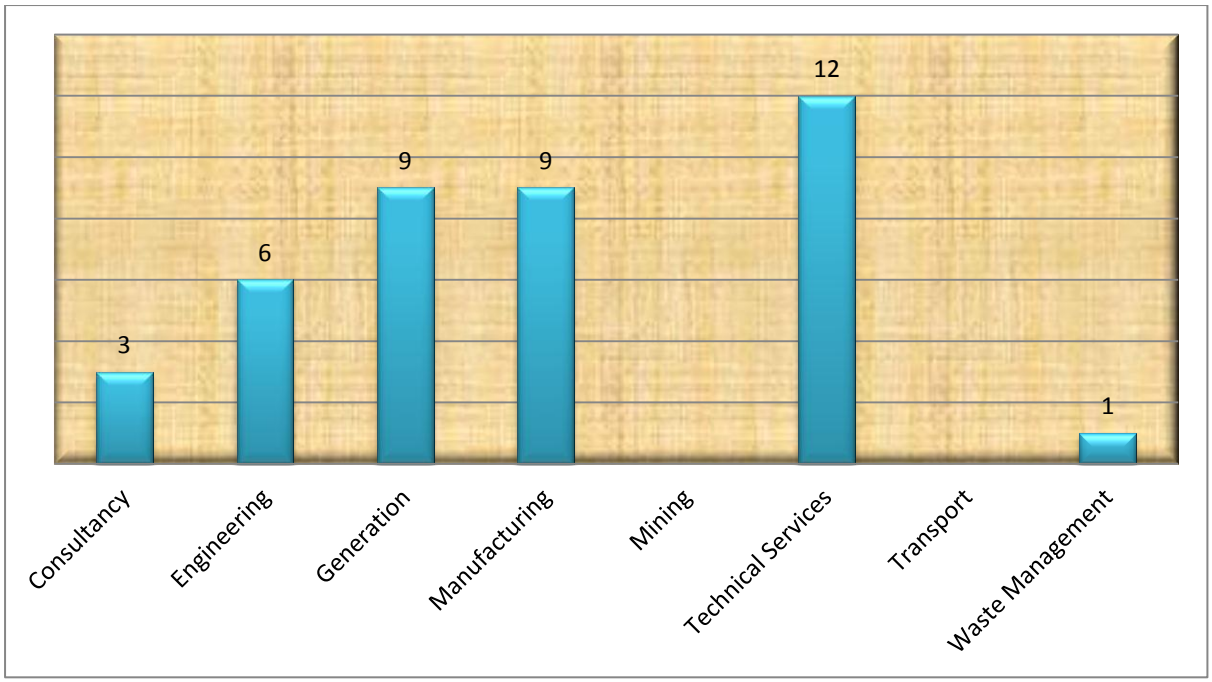


Figure 36: Nuclear stakeholders per business in Norway



5.5 Switzerland

5.5.1 Introduction

The first commercial nuclear power plant in Switzerland was Beznau I and started operating in 1969. Currently there are five nuclear power plants in place: *Beznau I & II, Mühleberg, Gösgen* and *Leibstadt*. Together they supply about two fifths of the country's electricity requirements and have a total capacity of 3.2 GW, and an annual availability rate of approximately 90%.[308]

Moreover, there are two research reactors in operation: *Crocus* at the Swiss Federal Institute of Technology (ETH) in Lausanne and AGN-211-P research reactor at the University of Basel.[309] The experimental nuclear power reactor *Lucens* (1966 - 1969), the three research reactors *Diorit* (1960 - 1977), *Saphir* (1957 - 1993) [310] and *Proteus* (1968-2011)[311] were shut down permanently.

In March 2011, after the events in Fukushima Daiichi, the Federal Council decided to suspend the pending procedures for handling applications for general licenses for new NPPs, and in May 2011, it was decided to phase out nuclear power on a step-by-step basis by decommissioning existing NPPs at the end of their operational lifespan and not replacing them by new ones.[312]

In order to assure Switzerland's high energy demand also without nuclear energy, the Federal Council and the Parliament approved in 2011 the new *Energy Strategy 2050* that focuses on increased energy savings, the expansion of hydropower and new renewable energies, and on fossil fuel-based electricity production as well as on imports. [313]

In addition to the interim storage facilities that are located at each NPP, there are several institutions in the country responsible for radioactive waste management. The ZWIBEZ is an interim storage facility located on the premises of the *Beznau* nuclear power plant. The ZWILAG central interim storage next to PSI site, is responsible for packaging and interim storage of radioactive waste. The PSI has facilities for conditioning of its own radioactive waste and for waste arising from the use of radioactive materials in medicine, industry and research which is stored at the federal interim storage facility also located at PSI premises.[314] The *National Cooperative for the Disposal of Radioactive Waste* (Nagra) is responsible for realizing the safe, long-term disposal of all radioactive waste arising in

[308] Swiss Federal Office for Nuclear Energy http://www.bfe.admin.ch/themen/00511/index.html?lang=en
[309] Swiss Federal Nuclear Safety Inspectorate http://www.ensi.ch/en/nuclear-facilities/nuclear-facilities-in-switzerland/
[310] IAEA Country Nuclear Power Profiles 2010 Edition. Switzerland http://www-pub.iaea.org/MTCD/publications/PDF/CNPP2010_CD/countryprofiles/Switzerland/CNPP2010Switzerland.htm
[311] http://proteus.web.psi.ch/
[312] Swiss Federal Office for Nuclear Energy http://www.bfe.admin.ch/themen/00511/index.html?lang=en
[313] Swiss Federal Office for Nuclear Energy http://www.bfe.admin.ch/themen/00526/00527/index.html?lang=en
[314] Swiss Federal Nuclear Safety Inspectorate http://www.ensi.ch/en/nuclear-facilities/nuclear-facilities-in-switzerland/waste-management-facilities/

Switzerland.[315] In addition, a wet storage for spent fuel assemblies went operational at the premises of the nuclear power plant Gösgen, in 2008.[316] The Federal Workgroup for Radioactive Waste monitors the activities relating to the disposal of radioactive nuclear waste in Switzerland.[317]

Since 2009, the Swiss Federal Nuclear Safety Inspectorate (ENSI) is the national regulatory authority with responsibility for the nuclear safety and security of nuclear facilities in the country. It monitors and regulates both safety and radiological protection in nuclear installations and waste facilities.[318] The Federal Nuclear Safety Commission (NSC)[319] advises the Federal Council, the Federal Department of the Environment, Transport, Energy and Communications (DETEC) and the nuclear supervisory authorities (Federal Assembly, Federal Energy Office, Federal Department of Interior, Federal Office of Public Health, Federal Office of Education and Science) [320] on issues relating to the safety of nuclear facilities.

Switzerland is member of the *European Community Steering Group on Strategic Energy Technologies* that is assigned to take forward the *European Strategic Energy Technology Plan* (SET-Plan) that establishes an energy technology policy for Europe and focuses on the acceleration of the development and deployment of cost-effective low carbon technologies.[321] In addition, Switzerland is also a member of the European Sustainable Nuclear Industrial Initiative Team that also supports the implementation of the SET-Plan.[322]

In Switzerland the need for skilled and knowledgeable nuclear workforce is reflected by the significant number of training programmes, academic courses and educational opportunities available as well as by the great number of research activities carried out in the country

5.5.2 Higher Education and Training

In 1999, Switzerland signed the European Union "Bologna Declaration". Since then, Swiss universities have introduced several reforms to harmonize their structures and course content to meet the new requirements. Hence, higher education in Switzerland is structured in three levels: Bachelor, Master[323] and PhD. [324]

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[315] Nagra http://www.nagra.ch/g3.cms/s_page/84410/s_name/ourmandate/close/true
[316] Wet Storage at the Nuclear Power Plant Gösgen https://www.kkg.ch/de/i/nasslager-_content---1--1295.html
[317] Swiss Federal Office for Nuclear Energy http://www.bfe.admin.ch/radioaktiveabfaelle/01275/02612/index.html?lang=en
[318] Swiss Federal Nuclear Safety Inspectorate (ENSI) http://www.ensi.ch/en/
[319] Federal Nuclear Safety Commission (NSC) http://www.bfe.admin.ch/kns/index.html?lang=en
[320] Nuclear Regulations in OECD Countries. Regulatory and Institutional Framework for Nuclear Activities. Switzerland http://www.oecd-nea.org/law/legislation/switzerland.pdf
[321] European Commission. European Strategic Energy Technology Plan (SET-Plan) http://ec.europa.eu/energy/technology/set_plan/set_plan_en.htm
[322] European Commission. European Industrial Initiatives http://ec.europa.eu/energy/technology/initiatives/initiatives_en.htm
[323] Access to doctoral level studies (dissertation) requires successful completion of a Master's degree with good grades. Some universities in Switzerland also offer an additional post-graduate degree called 'Master of Advanced Studies (MAS)'

In Switzerland, academic programmes are provided by ten cantonal universities, two Federal Institutes of Technology (ETH/EPF) and a number of professionally-oriented universities of applied sciences and universities of teacher education[325]. However, only few of these academic institutions provide higher education or professional development courses in the nuclear field.

Currently, the following institutions are involved in providing higher educational programmes or courses in the nuclear field:

The ETH Zürich[326] in cooperation with the EPF Lausanne[327] and in collaboration with the Paul Scherrer Institute (PSI)[328] offer a Master degree in Nuclear Engineering which was launched in 2008[329]. The degree programme is open for international audiences and compromises 3 academic semesters: the first semester takes place at the EPF in Lausanne, the second at the ETH Zürich. During the third semester, the research work for the master's thesis takes place at PSI. The students have also the opportunity to put their theoretical knowledge to the test and gain initial experience in the field by working on the CROCUS training reactor at Lausanne University. Moreover, they receive the opportunity to gain practical experience during industrial internships at the nuclear industry during this study programme.[330]

The ETH Zürich in cooperation with the Swiss Society of Radiobiology and Medical Physics[331] provides a Master of Advanced Studies (MAS) in medical physics.[332]

The University of Geneva offers a three semester Master of Science in Physics with a specialization in nuclear and particle physics; the programme comprises a combination of theory courses, practical work and tutorials.[333]

The University of Berne offers a three semester Master Program in Chemistry and Molecular Sciences, including courses on Nuclear and Radiochemistry.[334]

Since 1984, the ETH Zürich offers regularly a series of short courses on *Modelling and Computation of Multiphase Flows* that focus on multiphase flows and heat transfer with

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(minimum 60 ECTS credits or one year of full-time study). The MAS does not give access to doctoral level programmes. http://www.ond.vlaanderen.be/hogeronderwijs/bologna/links/documents/Studying_in_Switzerland-Universities%202010.pdf page 18. Therefore, MAS programmes are not considered in the statistical charts of this study.

[324] Studying in Switzerland http://www.ond.vlaanderen.be/hogeronderwijs/bologna/links/documents/Higher_Education_in_Switzerland.pdf

[325] Swiss Education http://www.swissuniversity.ch/system-swiss-education.htm

[326] ETH Zürich/Eidgenössische Technische Hochschule Zürich http://www.ethz.ch

[327] EPF Lausanne/École polytechnique fédérale de Lausanne EPFL http://www.epfl.ch/

[328] Paul Scherrer Institut http://www.psi.ch/

[329] Nuclear Engineering Master Programme http://www.ethz.ch/prospectives/programmes/nuclear/master/index_EN

[330] Nuclear Engineering Master Programme http://www.master-nuclear.ch/

[331] Swiss Society of Radiobiology and Medical Physics http://www.sgsmp.ch/sgsmp-e.htm

[332] Master of Advanced Studies Medical Physics http://www.phys.ethz.ch/phys/students/mas/

[333] Master of Science in Physics http://www.unige.ch/sciences/Enseignements/Formations/Masters/Physique_en.html

[334] Master Program in Chemistry and Molecular Sciences http://www.dcb.unibe.ch/content/studium/stundenplaene/stundenplaene_chemie/index_eng.html

phase change. These courses are addressed to researchers and engineers working in power, nuclear, chemical-process, oil-and-gas, cryogenic, space, food, bio-medical, micro-technology, and other industries.[335]

The Reactor School at the Paul Scherrer Institute[336] offers education and training programs for present and future reactor operators.

The Spiez Laboratory[337] is the Swiss centre of expertise for protection against nuclear, biological and chemical (NBC) threats and hazards. It deals with the scientific and technical aspects of hazards associated with NBC incidents and provides related training.

The following institutions are involved in training on radiation protection for physicians: Swiss Society for Interventional Pain Management[338], Union of Vascular Societies of Switzerland[339], Swiss Society of Cardiology[340], College of Primary Care Medicine[341], Swiss Society of Dermatology and Venereology[342], Institut de radiophysique (IRA)[343]. In addition, the Swiss Medical Association[344] organizes advanced training in the following areas: pediatric radiology, pediatric oncology-hematology and, offers continuing education in nuclear medicine, radiology, radio-oncology.

The Swiss Society of Radiobiology and Medical Physics (SGSMP)[345] provides several courses and seminars in the field of radiation protection and offers the SGSMP professional certificate.

The Swiss Society of Radiopharmacy/Radiopharmaceutical Chemistry[346] and the Institute of Applied Radiophysics[347] offer jointly training in the medical use of radioactive substances in humans.

Since 2011, the Swiss Association for Nuclear Medicine (SGNM)[348] offers scientific scholarships through their established fund.

The School for Radiation Protection[349] at the Paul Scherrer Institute, the Institute of Applied Radiophysics[350], the SafPro AG[351] and the Swiss Accident Insurance Fund[352] provide

[335] http://www.lke.mavt.ethz.ch/shortcourse/index
[336] Reactor School at the Paul Scherrer Institute http://rs.web.psi.ch/
[337] Spiez Laboratory http://www.labor-spiez.ch/en/lab/ku/index.htm
[338] Swiss Society for Interventional Pain Management http://www.ssipm.ch/
[339] Union of Vascular Societies in Switzerland http://www.uvs.ch/
[340] Swiss Society of Cardiology http://www.escardio.org/Pages/index.aspx
[341] College of Primary Care Medicine http://www.kollegium.ch/index.las
[342] Swiss Society of Dermatology and Venereology http://www.derma.ch/
[343] Institut de radiophysique http://www.chuv.ch/ira/ira_home/ira-en-bref.htm
[344] Swiss Medical Association http://www.fmh.ch/bildung-siwf/weiterbildung_allgemein/f_higkeitsprogramme.html
[345] Swiss Society of Radiobiology and Medical Physics http://www.sgsmp.ch/sgsmp-e.htm
[346] Swiss Society of Radiopharmacy/Radiopharmaceutical Chemistry http://www.sgrrc.ch/index.htm
[347] Institute of Applied Radiophysics http://www.chuv.ch/ira/ira_home/ira-en-bref.htm
[348] Schweizerische Gesellschaft für Nuklearmedizin http://www.nuklearmedizin.ch/index.php/sgnm-stipendienfonds-menu-item
[349] PSI School for Radiation Protection http://srp.web.psi.ch/
[350] Institute of Applied Radiophysics http://www.chuv.ch/ira/ira_home/ira-en-bref.htm

radiological protection training for personnel working in the non-medical sector (, teaching, medical analysis, industry, nuclear facilities, transport and trade).

The Swiss Nuclear Society[353] together with the Swiss Young Generation Network provides several seminars during the year. Especially a Basic Seminar on Nuclear Energy in autumn time.[354]

ASCOMP GmbH a technology development company specialized in the simulation of industrial fluid dynamics and heat & mass transfer organizes a bi-annual hands-on training session on its software TransAT.[355]

The following bodies are responsible for the recognition of radiological protection training in the various sectors: Swiss Federal Office of Public Health[356], Federal Nuclear Safety Inspectorate[357], Swiss Accident Insurance Fund[358].

The Nuclear Forum Switzerland[359] promotes the peaceful use and development of nuclear energy in the country and provides training and seminars in the nuclear field.

The Forum VERA[360] is promoting the technical, safe and acceptable disposal of radioactive waste in Switzerland. In addition, the Association for Regional and International Underground Storage (ARIUS)[361], an international non-commercial association based in Switzerland, promotes concepts for shared nuclear waste facilities.

The Swiss Society of Nuclear Medicine[362] fosters the professional exchange of experience through seminar and workshops that are jointly organized in cooperation with different universities and, promotes the education and training of medical and technical staff.

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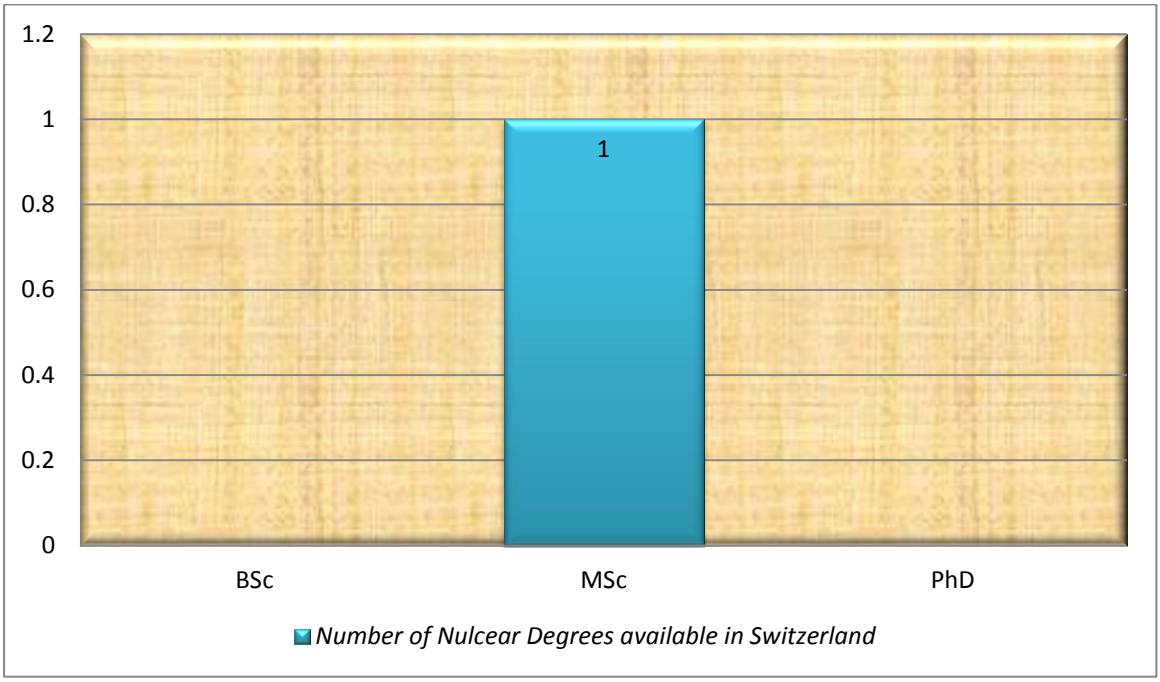
[351] SafPro Ag http://www.safpro.ch/
[352] Swiss Accident Insurance Fund is the supervisory authority responsible for industrial and commercial facilities in Switzerland. http://www.suva.ch/english/english/startseite-en-suva/suva-en-suva/unfallversicherung-schweiz-en-suva.htm
[353] Swiss Nuclear Society http://www.sns-online.ch
[354] Basic Seminar on Nuclear Energy http://www.sns-online.ch
[355] ASCOM http://www.ascomp.ch/services/training/
[356] Swiss Federal Office of Public Health http://www.bag.admin.ch/themen/strahlung/10468/10469/index.html?lang=en
[357] Swiss Federal Nuclear Safety Inspectorate http://www.ensi.ch/en/
[358] Swiss Accident Insurance Fund http://www.suva.ch/english/english/startseite-en-suva/suva-en-suva/unfallversicherung-schweiz-en-suva.htm
[359] Nuclear Forum Switzerland http://www.nuklearforum.ch/de
[360] Forum Vera http://www.forumvera.info/
[361] Association for Regional and International Underground Storage http://www.arius-world.org/
[362] Swiss Society of Nuclear Medicine http://www.nuklearmedizin.ch/

Figure 37: Nuclear curricula in Switzerland



5.5.3 Research

In the nuclear research field, there are several institutions involved: The Nuclear Energy and Safety (NES)[363] research department at the Paul Scherrer Institute concentrates on research of reactor safety and safety-related operational aspects of Swiss nuclear power plants and on nuclear waste disposal. NES operates the following laboratories:

- Laboratory for Reactor Physics and Systems Behavior
- Laboratory for Thermal-Hydraulics
- Hot Laboratory Division
- Laboratory for Nuclear Material
- Laboratory for Waste Management
- Laboratory for Energy Systems Analysis

Further institutions involved in the nuclear research field are the Grimsel Test Site (GTS)[364], Mont Terri Rock laboratory[365] and the Swiss Federal Office of Public Health[366]. In addition, the Laboratory for High Energy Physics[367], a division of the Physics Institute at the University of Bern, conducts research in the field of experimental particle physics.

[363] Nuclear Energy and Safety (NES)[363] research department at PSI http://nes.web.psi.ch/
[364] Grimsel Test Site http://www.grimsel.com/
[365] Mont Terri Rock Laboratory http://www.mont-terri.ch/
[366] Swiss Federal Office of Public Health http://www.bag.admin.ch/themen/strahlung/10468/10469/index.html?lang=en
[367] http://www.lhep.unibe.ch/

Moreover, the Swiss National Science Foundation[368] supports also joint research projects in the nuclear field.

The Swiss Nuclear Society[369] together with the Swiss Young Generation Network supports research and development in the nuclear field.

5.5.4 Nuclear Energy Stakeholders

The main companies involved in the nuclear business in Switzerland include: AEW Energie AG[370], Axpo Group[371], Alpiq Holding SA[372], Amberg Group[373], Barnes Group Inc[374], Baser und Hofmann[375], BKW FMB Energie[376], Brütsch/Rüegger Group[377], Centralschweizerische Kraftwerke AG [378], Energie Wasser Bern[379], Gerhard Wegmüller GmbH[380], Hans Kohler AG[381],Indermühle AG[382], Kernkraftwerk Niederamt AG[383], Kernkratwerk Leibstadt AG[384], Kernkraftwerk Gösgen-Däniken AG[385], Kuehne + Nagel[386], Liebherr Group[387], Marti Holding AG[388], Mattig Management Partners[389], Metal Improvement Company[390], Nanotrans GmbH[391], National Cooperative for the Disposal of Radioactive Waste[392], Notz Metal AG[393], Parsons Brinckerhoff[394], SAR Transporte AG[395], Sulzer[396], Swisselectric[397], Swisselectric

[368] Swiss National Science Foundationhttp://www.snf.ch/E/Pages/default.aspx
[369] Swiss Nuclear Society http://www.sns-online.ch
[370] AEW Energie AG http://www.aew.ch/home.html
[371] Axpo Group http://www.axpo.com/axpo/ch/en/home.html The Axpo Group is also a member of the Steam Generator Technical Committee of the FROG Owners Group http://www.fraog.org/scripts/FROG_home/publigen/content/templates/show.asp?P=82&L=EN
[372] Alpiq Holding SA is a Swiss company with presence in, inter alia, Albania, Macedonia, Turkey, Bosnia and Herzegovina, Croatia, Serbia, Norway http://www.alpiq.com/index.jsp
[373] Amberg Group http://www.ambergtechnologies.ch/en/home/
[374] Barnes Group Inc http://www.barnesgroupinc.com/
[375] Basler und Hofmann http://www.baslerhofmann.ch/home/
[376] BKW FMB Energie http://www.bkw-fmb.ch/bkwfmb/en/home.html
[377] Brütsch/Rüegger Group http://www.b-r.ch/holding/main/index.html?i2cms_i2connect=i2c_login.i2connect(Method,sprache,Data,3,)
[378] Centralschweizerische Kraftwerke AG http://www.ckw.ch/internet/ckw/de/home.html
[379] Energie Wasser Bern http://www.ewb.ch/de/ueber-uns.html
[380] Gerhard Wegmüller GmbH http://www.wegi.ch/
[381] Hans Kohler AG http://www.kohler.ch/flash.html
[382] Indermühle AG http://www.indermuehle.ch/
[383] Kernkraft Niederamt AG http://www.kkn-ag.ch/?id=89&top=87&typ=1&s=en
[384] Kernkraft Leibstadt AG http://www.kkl.ch/de/i/intro.html
[385] Kernkraftwerk Gösgen-Däniken AG Kernkraftwerk Gösgen-Däniken AG
[386] Kuehne + Nagel is a Swiss company with offices, inter alia, in Albania, Bosnia Herzegovina, Croatia, Macedonia, Serbia, Norway and Israel http://www.kn-portal.com/
[387] Liebherr Grouphttp://www.liebherr.com/en-GB/default_lh.wfw
[388] Marti Holding AG http://www.martiag.ch/
[389] Mattig Management Partners http://www.mattig-management.ch/en/2/austria/company/mattig-management-partners/
[390] Metal Improvement Company http://www.metalimprovement.co.uk/
[391] Nanotrans GmbH http://www.nanotrans.ch/
[392] National Cooperative for the Disposal of Radioactive Waste http://www.nagra.ch/
[393] Notz Metal AG http://notzmetall.ch/de/index_html
[394] Parsons Brinckerhoff http://www.pbworld.com/
[395] SAR Transporte AG http://www.sar.ch/
[396] Sulzer http://www.sulzer.com/
[397] Swisselectric http://www.swisselectric.ch/en/home.html

Research[398], Swissnuclear[399], Swiss Federal Workgroup for nuclear Waste Disposal[400], Verband Schweizerischer Elektrizitätsunternehmen[401], PRK Partners[402], Walder Wyss[403], Zumax AG[404], ZWILAG[405],

The international companies that have a presence in Switzerland include: ABB Group[406], AF Group[407], Alstom[408], Applus + RTD Switzerland and Applus Idiada Switzerland[409], Balfour Beatty[410], BT[411], Camfil Farr[412], CMS Cameron McKenna[413], EDF Helvetica[414], Eversheds LLP[415], Freshfields Bruckhaus Deringer[416], Gardiner & Theobald[417], GE[418], M&M Militzer and Münch[419], Switzerland Hilti (Schweiz) AG[420], Interserve[421], M+W Group GmbH[422], Pöyry[423], Siemens Switzerland[424], Studsvik[425].

[398] Swisselectric Research http://www.swisselectric-research.ch/en/home.html
[399] Swissnuclear http://www.swissnuclear.ch/en/home.html
[400] Swiss Federal Office for Nuclear Energy http://www.bfe.admin.ch/radioaktiveabfaelle/01275/02612/index.html?lang=en
[401] Verband Schweizerischer Elektrizitätsunternehmen http://www.strom.ch/de.html
[402] PRK Partners http://www.prkpartners.com/en/
[403] Walder Wyss http://www.walderwyss.com/en/
[404] Zumax AG http://zumaxag.com/index.html
[405] Zwilag http://www.zwilag.ch/
[406] ABB Group http://www.abb.com/
[407] AF Group http://www.afconsult.com/en/Worldwide/Europe/Switzerland/
[408] Alstom http://www.alstom.com/locations/
[409] Applus http://www.applus.com/
[410] Balfour Beatty http://www.balfourbeatty.com/
[411] BT http://www.globalservices.bt.com/uk/en/home
[412] Camfil Farr http://www.camfilfarr.ch/
[413] CMS Cameron McKenna http://www.cms-cmck.com/Pages/Default.aspx
[414] EDF Helvetica http://www.edf.com/suisse-41377.html
[415] Eversheds LLP http://www.eversheds.com/
[416] Freshfields Bruckhaus Deringer http://www.freshfields.com/en/global/
[417] Gardiner & Theobald http://www.gardiner.com/
[418] GE http://www.ge.com/ch/de/index.html
[419] M&M Militzer and Münch http://www.mumnet.com/mmgroup.html
[420] Switzerland Hilti 8schweiz) AG http://www.hilti.ch/holch/
[421] Interserve http://www.interserve.com/
[422] M+W Group GmbH http://www.mwgroup.net/en/contact/contact_us.html
[423] Pöyry http://www.poyry.com/
[424] Siemens Switzerland http://www.siemens.ch/home/index.php
[425] Studsvik http://www.studsvik.com/en/

Figure 38: Nuclear stakeholders per business in Switzerland (%)

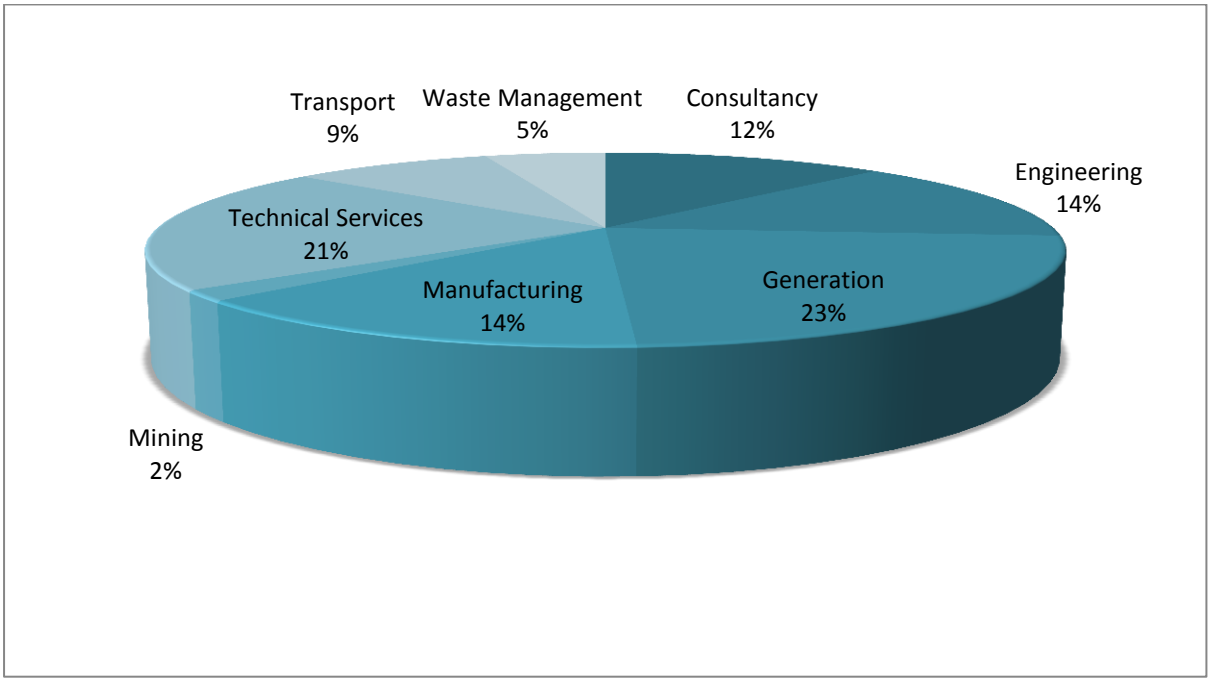
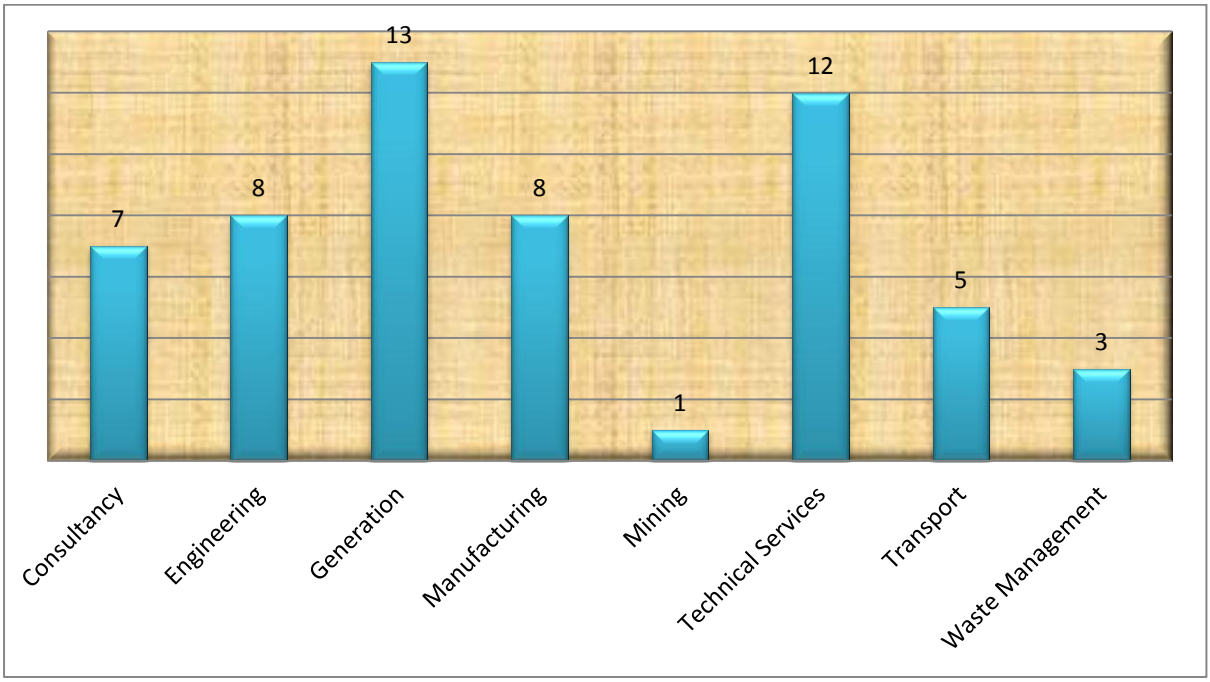


Figure 39: Nuclear stakeholders per business in Switzerland



5.6 Turkey

5.6.1 Introduction

Currently Turkey has no nuclear power plants, although its interest in nuclear technology dates back to 1956 when the Turkish Atomic Energy Commission was established. In the past, the Turkish government made several attempts to acquire power plants, but none succeeded so far[426].

In 2007, the Turkish parliament passed a new bill concerning construction and operation of nuclear power plants and the sale of their electricity. In 12 May 2010, Russian and Turkish heads of state signed an intergovernmental agreement to cooperate for constructing and operating a nuclear power plant at the Akkuyu site in the Turkish Mersin province. The agreement was ratified by the Turkish and Russian parliament in 2010 and foresees to establish 4 units of 1200 MWe Russian design VVER reactors[427]. The agreement also provides for setting up a fuel fabrication plant in Turkey[428]. However, it is not clear at what point the construction of Akkuyu NPP currently stands and when it is planned to start its operation.

To date, there are two research reactors operating in Turkey. The Istanbul Technical University operates a 250 kW TRIGA Mark II plus research reactor for educational purposes and the Çekmece Nuclear Research and Training Center (ÇNAEM) operates the TR-2 research reactor for radioisotope production, material tests and educational purposes. In 1977, ÇNAEM dismantled a TR-1 research reactor which started operation in 1962. Since 1986, ÇNAEM operates also a *Nuclear Fuel Pilot Plant* and manages the radioactive waste stored in the centralized waste processing facility at the ÇNAEM premises[429]. The Turkish nuclear regulatory authority is the Turkish Atomic Energy Authority (TAEK)[430] that replaced the Atomic Energy Commission in 1982. Licenses for energy retail and/or wholesale activities are granted by the Energy Market Regulatory Authority (EPDK)[431].

Turkey is member of the *European Community Steering Group on Strategic Energy Technologies* that is assigned to take forward the *European Strategic Energy Technology Plan* (SET-Plan) that establishes an energy technology policy for Europe and focuses on the acceleration of the development and deployment of cost-effective low carbon technologies.[432]

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[426] Nuclear Threat Initiative http://www.nti.org/country-profiles/turkey/
[427] Taek http://www.taek.gov.tr/eng/services/206-akkuyu-nuclear-power-plant/789-akkuyu-nuclear-power-plant.html
[428] World Nuclear Association http://www.world-nuclear.org/info/default.aspx?id=28958&terms=nuclear%20power%20in%20Turkey
[429] OECD (Organization for Economic Co-operation and Development). 2008. Regulatory and Institutional Framework for Nuclear Activities Turkey, [Online] Available from: http://www.oecd-nea.org/law/legislation/turkey.pdf
[430] TAEK http://www.taek.gov.tr/eng/about-us/mission.html
[431] EPDK http://www.emra.org.tr/
[432] European Commission. European Strategic Energy Technology Plan (SET-Plan) http://ec.europa.eu/energy/technology/set_plan/set_plan_en.htm

In Turkey power nuclear power plays an important role which is indicated by the significant opportunities for higher education in this area. There are a number of research opportunities as well as nuclear academic and training programmes available in the country, involving universities and affiliates of TAEK.

5.6.2 Higher Education and Training

Turkey is a full member of the Bologna Process since 2001[433] and higher education is therefore divided into three stages: Bachelor's, Master's and Doctorate degrees.

Istanbul Technical University (ITU)[434] provides MSc and PhD programs in Energy Science and Technology[435] with the opportunity to specialize in research topics such as nuclear research, conventional energy, and energy planning and management. In addition, the ITU provides a MSc program in Radiation Science and Technologies[436] to develop Radiation Protection Advisers, Radiation Workers and Radiation Officers. The ITU has well equipped laboratories[437] for radiation activation analysis, nuclear chemistry, and other analysis related to radioisotopes.

The Department of Physics of the Middle East Technical University[438] offers BSc, MSc and PhD programmes in Nuclear Physics[439].

The Hacettepe University[440] offers MSc and PhD programmes in Nuclear Engineering[441]. Under the Physics Engineering programme the university offers also courses on Nuclear Physics and Applied Radiation Physics[442]. In addition, the university offers MSc programmes in Nuclear Medicine, Radiation Oncology and Radiology[443] and a MSc programme in Dosimetry[444].

The Bogazici University offers also MSc and PhD programmes in Nuclear Engineering[445].

The Institute for Nuclear Sciences at Ege University offers MSc and PhD programmes in nuclear energy, nuclear technology and nuclear applications[446].

The Marmara University[447] offers under its programme of Basic Science Courses an advanced course on chemistry which covers the topic of nuclear chemistry[448].

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[433] Bologna Process Turkey http://www.ond.vlaanderen.be/hogeronderwijs/bologna/links/Turkey.htm
[434] Istanbul Technical University http://www.energy.itu.edu.tr/
[435] MSc & PhD in Energy Science and Technology http://www.energy.itu.edu.tr/Icerik.aspx?sid=10152
[436] MSc in *Radiation Science and Technologies* *http://www.energy.itu.edu.tr/Icerik.aspx?sid=10499*
[437] ITU laboratories http://www.energy.itu.edu.tr/Icerik.aspx?sid=9610
[438] Middle East Technical University http://www.metu.edu.tr/
[439] http://www.physics.metu.edu.tr/
[440] Hacettepe University http://www.hacettepe.edu.tr/?_dil=2
[441] MSc & PhD in Nuclear Engineering http://www.nuke.hacettepe.edu.tr/en/index.html
[442] http://www_en.phys.hacettepe.edu.tr/course_contents.pdf
[443] http://www.tip.hacettepe.edu.tr/english/education/post.php#p1
[444] MSc in Dosimetry http://www.nukleerbilimler.hacettepe.edu.tr/
[445] MSc & PhD at Bogyzici University http://www.nuce.boun.edu.tr/
[446] Ege University http://ege.edu.tr/index.php?lid=2&SayfaID=343&cat=details

The Department of Physics of the Bilkent University offers a course on Nuclear and Particle Physics in the framework of its Undergraduate Curriculum[449].

The Ankara University offers an MSc and a PhD programme in nuclear sciences, including courses in physics of diagnostic radiology, radiation detection and measurement physics of radiotherapy, physics of nuclear medicine, imaging techniques, radiation biology, radiation protection, advanced radiation therapy[450].

The Çekmece Nuclear Research and Training Center (ÇNAEM)[451] and the Sarayköy Nuclear Research and Training Center[452], both affiliates of the Turkish Atomic Energy Authority (TAEK), are the main provider for professional training in the nuclear field in Turkey.

The Health Physics Unit of the ÇNAEM provides training for staff of the Emergency Response Teams in the area of radiological hazards, including tailored drills, training for reactor staff, radiation protection officers, and holds summer workshop for university students. In addition, ÇNAEM provides also courses at high schools and hospitals when requested and gives briefings to the public visiting the TR-2 reactor[453], the Radioisotope Unit of provides every year a Basic Radiopharmacy Course for staff working in nuclear medicine centers which is awarded after successful completion with a certificate from TAEK[454] and the Industry Unite provides different level of courses in the area of Non Destructive Test (NDT) to engineers and technicians[455]. The Measurement and Instrumentation Division at ÇNAEM provides training on quality assurance for measurement and instrumentation.

The Sarayköy Nuclear Research and Training Center (SANAEM) provides, every 3 to 4 years, theoretical and practical training for researchers at universities or other research institutes on “Mutation Breeding” and “N-15 analysis” which is awarded with a certificate. The Centre also offers a summer practicum for senior university students with a focus on the areas indicated above[456].

The Nuclear Research and Training Centre for Turkish Speaking Countries (TÜDNAEM) was established in 1999 for enhancing cooperation in peaceful uses of nuclear energy among the Turkish Speaking Countries for improving bilateral and multilateral scientific and technical cooperation and also offers a range of related courses[457].

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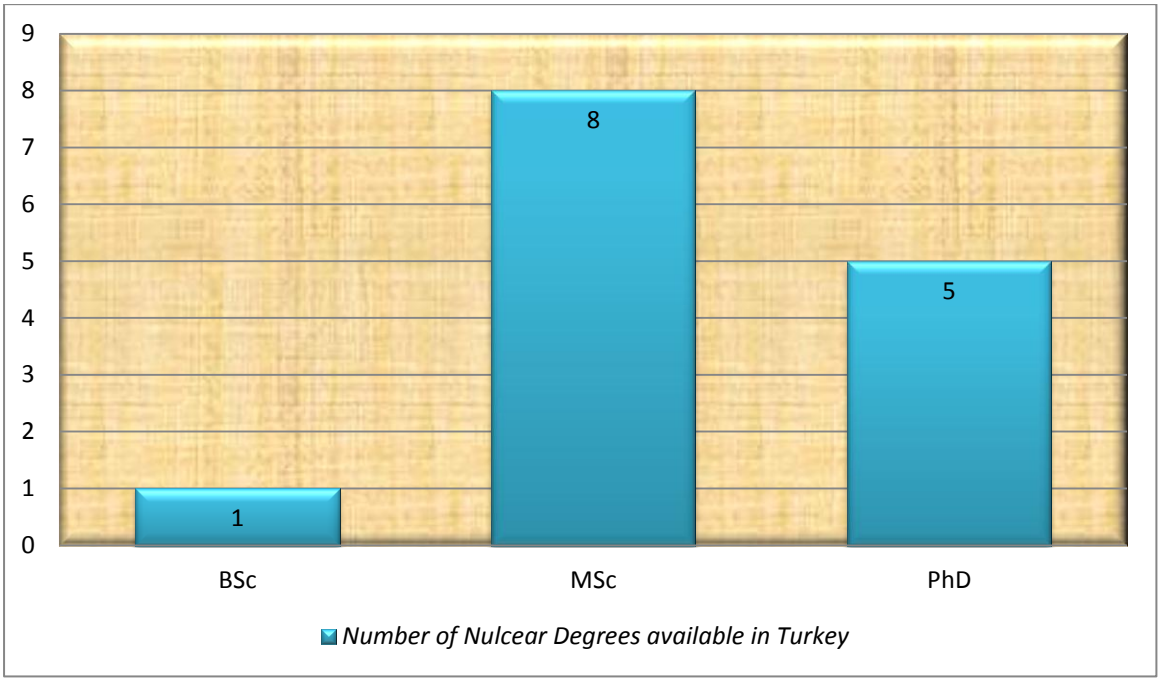
[447] Marmara University http://www.marmara.edu.tr/en
[448] Advanced Course on General Chemistry http://eng.marmara.edu.tr/sayfa/682/basic-science-courses
[449] Bilkent University http://www.physics.bilkent.edu.tr/index.php/general/undergraduate-curriculum
[450] Ankara University MSc and Phd programmes http://nukbilimler.ankara.edu.tr/english/education.htm
[451] Çekmece Nuclear Research and Training Center http://www.taek.gov.tr/eng/cnaem.html
[452] Sarayköy Nuclear Research and Training Center http://www.taek.gov.tr/eng/sanaem.html
[453] TAEK http://www.taek.gov.tr/eng/cnaem/201-nuclear-facility-division/765-reactor-operation-unit.html
[454] TAEK http://www.taek.gov.tr/eng/cnaem/199-application-division/767-radioisotope-unit.html
[455] TAEK http://www.taek.gov.tr/eng/cnaem/199-application-division/768-industry-unit.html
[456] Sanaem http://www.taek.gov.tr/eng/sanaem/192-application-division/747-agriculture-unit.html

SGS NDT Training Center[458] provides training in basic radiation safety and specialized radiation protection courses for radiation protection supervisors.

The Ankara University plays a pivotal role in Nuclear Medicine Training in Turkey and conducts also extensive research in this area[459].

Most of the universities in Turkey are a member of the Black Sea Universities Network[460].

Figure 40: Nuclear curricula in Turkey



5.6.3 Research

In the nuclear research field, there are several institutions involved: The Turkish Atomic Energy Authority (TAEK)[461] is the national authority responsible for research and development activities in nuclear energy and technology. The specialized departments of TAEK involved in nuclear research: Nuclear Safety Department, Radiation Health and Safety Department, Technology Department, Research, Development and Coordination Department; In addition, the following two TAEK affiliates are performing research in the nuclear field:

[457] OECD (Organization for Economic Co-operation and Development). 2008.Nuclear Legislation in OECD Countries Regulatory and Institutional Framework for Nuclear Activities Turkey.[Online] Available from: http://www.oecd-nea.org/law/legislation/turkey.pdf

[458] SGS NDT Training Centre http://www.sgs.com.tr/en/Training-Courses-Seminars/Subject-Specific-Training/Non-Destructive-Testing-NDT-Training/Basic-Radiation-Safety-Training.aspx

[459] Ankara University MSc and Phd programmes http://nukbilimler.ankara.edu.tr/english/education.htm

[460] Black Sea Universities Network http://www.bsun.org/?task=homepage&web=bsun

[461] TAEK http://www.taek.gov.tr/eng/about-us/mission.html

The research infrastructure at the Çekmece Nuclear Research and Training Center (ÇNAEM)[462] is specially devoted to research and development programmes addressing the issues of nuclear reactor and fuel technology. ÇNAEM cooperates with universities and other scientific and research institutes in the development and application of nuclear science and technology for peaceful uses. Main installations and systems at ÇNAEM:

- Research reactor (TR-2)
- Ion accelerator with low energy (neutron generation)
- Nuclear fuel pilot plant, low level radioactive waste processing plant
- Radioisotope and radiopharmaceuticals laboratory
- Calibration laboratory for radiation measurement instrument (SSDL)
- Development and production laboratory for radiation measurement instrument
- Chromosome aberration analysis laboratory
- Radioactivity analysis laboratory
- Chemical analysis laboratory
- Non-destructive testing laboratory
- Ceramic material laboratory
- Instrument for radiation measurement
- Computer and network systems

The Sarayköy Nuclear Research and Training Center (SANAEM)[463] was established in 2005 and replaced the following former research centres: Ankara Nuclear Research and Training Centre and Ankara Nuclear Research Centre for Agriculture and Animal Science. SANAEM conducts fundamental researches on detectors and dosimeters, research on radiological and related techniques considering the principle of public health and safety and carries out innovative nuclear and nuclear-related researches. The Centre operates an industrial irradiation facility and an experimental gamma cell. There is also a registered Fusion Laboratory and a cyclotron accelerator system (Cyclone-30) that has the state-of-art technological features of its kind. The cyclotron system has four beam lines; three of them are used for radioisotope production and one for research and training. There is also an electron accelerator at the Centre which is used for flue gas and waste water treatment in addition to other research activities. Further, the centre operates a fusion laboratory and a plasma physics laboratory for dedicated research.

The General Directorate of Mineral Research and Exploration (MTA)[464] is responsible for the systematic investigation and research on all kinds of resources including thorium and uranium.

[462] Çekmece Nuclear Research and Training Center http://www.taek.gov.tr/eng/cnaem.html
[463] Sarayköy Nuclear Research and Training Center http://www.taek.gov.tr/eng/sanaem.html
[464] MTA http://www.mta.gov.tr/v2.0/eng/

Research and development activities in nuclear technology are performed by the related departments of some universities in Turkey, such as:

The Istanbul Technical University (ITU) has a nuclear research[465] division that focuses on radiation sciences and nuclear engineering. In addition, ITU has established a research group on *Nuclear Techniques*[466], on *Radiation Protection* and *Radioecology*[467] and on *Radiological Materials*[468].

The Hacettepe University focuses on research in the following areas: Nuclear reactor analysis, engineering and design (neutronic and thermal-hydraulic computations); nuclear accident, risk, and reliability analyses; nuclear fuel management, fuel cycle and processes, nuclear materials; radiation monitoring and measurement projects; public awareness studies[469].

The Ankara University carries out research in the following areas: dosimetric studies for patient and staff in interventional and conventional radiology, image quality and dose optimization studies for CR and DR systems, optimization of quality control and acceptance tests for CT systems; In addition, they conduct research studies for the SPECT, medical image processing and software development, improvement of low level alpha, beta counting systems and gamma spectroscopy, investigation luminescence properties of solids for retrospective dosimetry and retrospective dosimetry using luminescence techniques and EPR Spectroscopy; The following laboratories are available at the Ankara University:

- Low-Level Alpha-Beta Counting Laboratory
- Spectroscopy Laboratory
- Radiation Detection and Measurement Laboratory
- Secondary Calibration Laboratory
- TLD Dosimetry Laboratory
- Nuclear Medicine Imaging Laboratory
- Diagnostic Radiology Imaging Laboratory
- Retrospective Dosimetry Laboratory

The Turkish Nuclear Engineers Society (NMD)[470] supports research and development in the nuclear field.

In addition, the Turkish Nuclear Medicine Society supports the dissemination of research results through the organization of congresses and other events[471].

[465] ITU Nuclear Research Division http://www.energy.itu.edu.tr/Icerik.aspx?sid=9588
[466] Research Group on Nuclear Techniques http://www.energy.itu.edu.tr/Icerik.aspx?sid=10062
[467] Radiation Protection and Radioecology Research Group http://www.energy.itu.edu.tr/Icerik.aspx?sid=10063
[468] Radiological Materials Research Group http://www.energy.itu.edu.tr/Icerik.aspx?sid=10064
[469] Research at Hacettepe University http://www.nuke.hacettepe.edu.tr/en/index.html
[470] Turkish Nuclear Engineers Society http://www.nmd.org.tr/
[471] Turkish Nuclear Medicine Society http://tsnm.org/english.php

5.6.4 Nuclear Energy Stakeholders

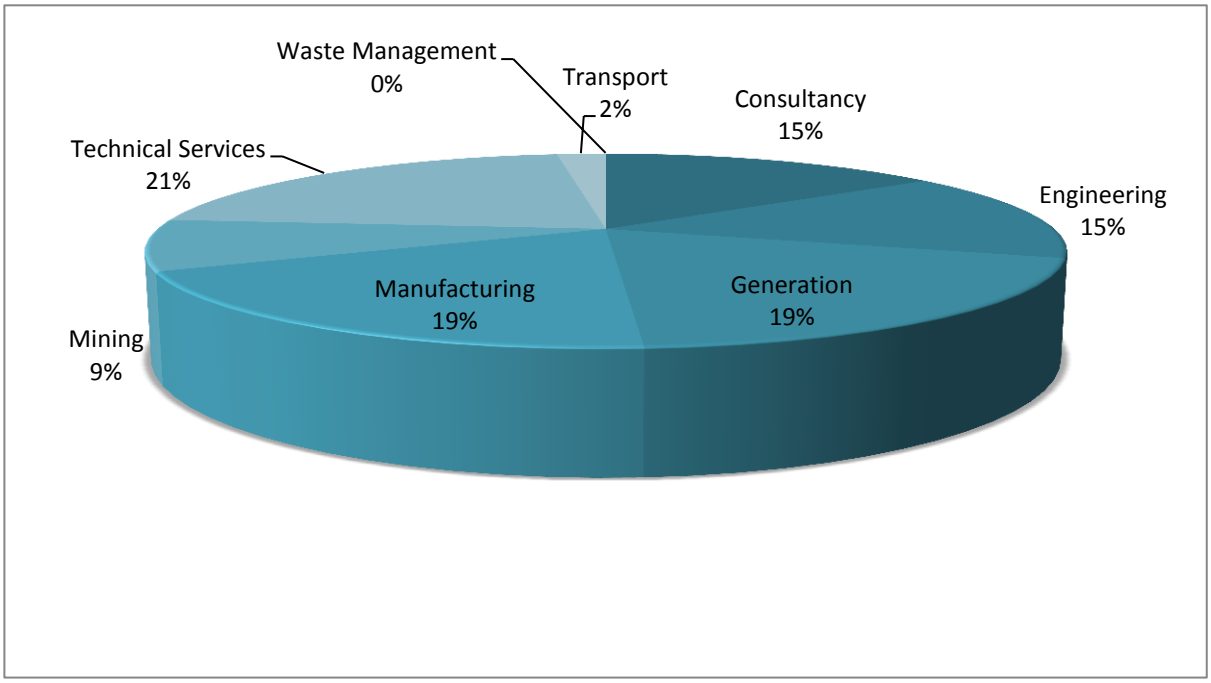
The main companies involved in the nuclear business in Turkey include: Ab Etiproducts Oy[472], Anatolia Energy[473], Enka[474], Elektrik Uretim AS[475], Calik Holding[476], Park Teknik[477], Turkey Electricity[478], Turkish Electricity Transmission Company[479];

The international companies that have a presence in Turkey include: ABB Group[480], AF Group[481], Allen & Overy LLP[482], Alpiq Group[483], Alstom[484], Applus Lgai Belgelendirme Ve Muayene Limited Şirketi Applus and Idiada Turkey[485], Arup[486], Atomstroyexport[487], Axpo Group[488], Balfour Beatty[489], Bechtel Power Corporation[490], Biwater Treatment[491], Böhler Celik Ticaret Ltd. Sti.[492], BT[493], Clifford Change[494], DLA Piper[495], Emka[496], Fenwick Elliott[497], Freshfields Bruckhaus Deringer[498], GE[499], Golder Associates[500], Hilti Türkiye[501], Inter RAO UES (TGR Enerji)[502], Ironet LTD.[503], İşletme Limited Distribution[504], Liebherr Group[505], Mace[506], M&M Militzer and Münch[507], Mott MacDonald[508], MWH[509], Ormet Metal Ticaret

[472] Ab Etiproducts OY http://www.etiproducts.com/
[473] Anatolia Energy http://www.anatoliaenergy.com/
[474] Enka http://www.enka.com/
[475] Elektrik Uretim AS http://www.euas.gov.tr/Sayfalar/AnaSayfa.aspx
[476] Calik Holding http://www.calik.com/EN/Sectors/energy
[477] Park Teknik http://www.cinergroup.com.tr/companies/park-technique
[478] Turkey Electricity http://www.turkey-electricity.com/page3.html
[479] Turkish Electricity Transmission Company http://www.teias.gov.tr/eng/
[480] ABB Group http://www.abb.com/
[481] AF Group http://www.afconsult.com/en/Worldwide/Europe/Switzerland/
[482] Allen & Overy LLP http://www.allenovery.com
[483] Alpiq Group http://www.alpiq.com/index.jsp
[484] Alstom http://www.alstom.com/locations/
[485] Applus http://www.applus.com/
[486] Arup http://www.arup.com/
[487] Atomstroyexport http://www.atomstroyexport.com/project/eng/38
[488] Axpo Group http://www.axpo.com/content/axpo/global/en/home.html
[489] Balfour Beatty http://www.balfourbeatty.com/
[490] Bechtel Power Corporation, http://www.bechtel.com/
[491] Biwater Treatment http://www.biwater.co.uk/
[492] Böhler Celik Ticaret Ltd. Sti.Sti.http://www.bohlercelik.com.tr
[493] BT http://www.globalservices.bt.com/uk/en/home
[494] Clifford Change http://www.cliffordchance.com/offices/turkey.html
[495] DLA Piper http://www.dlapiper.com/
[496] Emka http://www.emka.com/
[497] Fenwick Elliott http://www.fenwickelliott.co.uk/
[498] Freshfields Bruckhaus Deringer http://www.freshfields.com/en/global/
[499] GE http://www.ge.com/ch/de/index.html
[500] Golder Associates http://www.golderassociates.dk/en/modules.php?name=Pages&sp_id=397
[501] Hilti Türkiye http://www.hilti.com.tr/holtr/
[502] Inter RAO UES http://interrao.ru/en/
[503] Ironet LTD. http://www.makstil.com/
[504] İşletme Limited Distribution http://www.sulzer.com/
[505] Liebherr Group http://www.liebherr.com/en-GB/default_lh.wfw
[506] Mace http://www.macegroup.com/
[507] M&M Militzer and Münch http://www.mumnet.com/mmgroup.html
[508] Mott MacDonald http://www.mottmac.com/
[509] MWH http://www.mwhglobal.com/

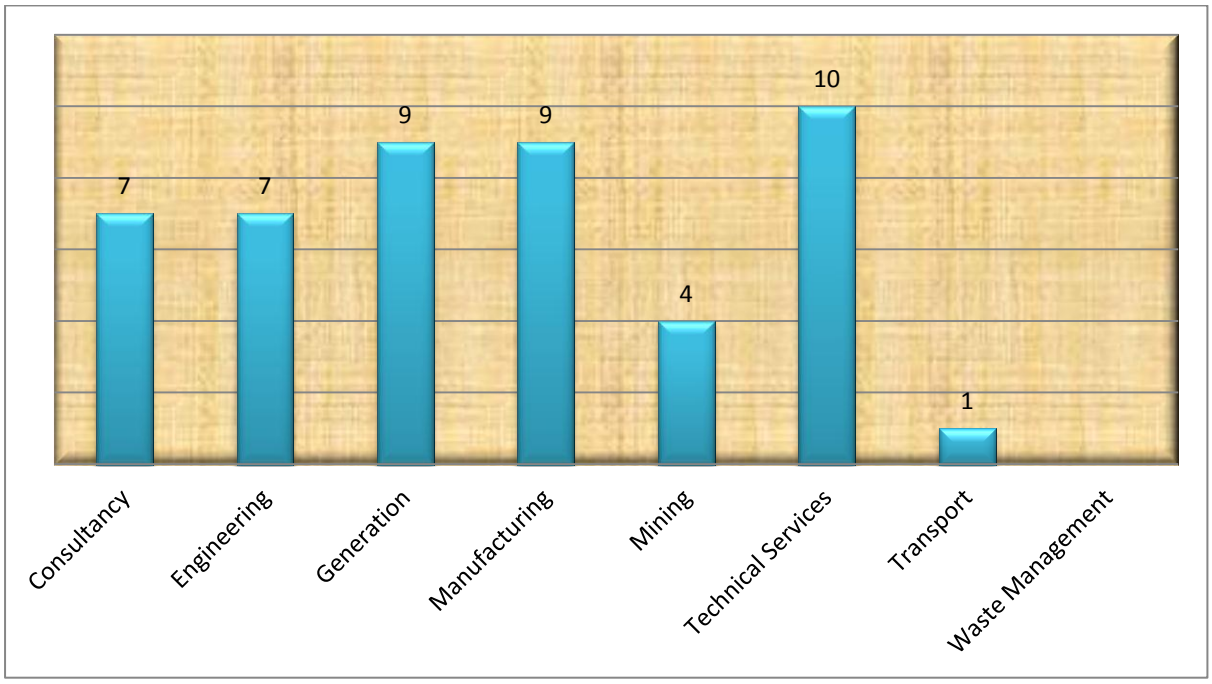
A.S.[510], Outokumpu Istanbul Ltd. Sti[511], Piper Supports[512], Rautaruukki Oy[513], Rotem Turkey[514], Sarens Group[515], Siemens[516], TÜV Reihnland[517], White and Case[518].

Figure 41: Nuclear stakeholders per business in Turkey (%)



[510] Ormet Metal Ticaret A.S. http://www.iclfertilizers.com/Fertilizers/RotemNegev/Pages/WorldwideOffices.aspx
[511] Outokumpu Istanbul Ltd. Sti http://www.outokumpu.com/
[512] Piper Supports http://www.pipesupports.com/
[513] Rautaruukki Oy http://www.ruukki.com/
[514] Rotem Turkey http://www.iclfertilizers.com/Fertilizers/RotemNegev/Pages/WorldwideOffices.aspx
[515] Sarens Group http://www.sarens.com/en.aspx
[516] Siemens http://www.siemens.com/answers/tr/tr/
[517] TÜV Reihnland http://www.tuv.com/uk/en/index.html
[518] White & Case http://www.whitecase.com/ankara/;http://www.whitecase.com/istanbul/

Figure 42: Nuclear stakeholders per business in Turkey



6. CONCLUSIONS

One of the most important factors for further expansion or development of nuclear power programmes is the presence of highly educated personnel. A recent study[519] developed by the Nuclear Energy Agency (NEA) sets out that States such as France or the United Kingdom indicate future workforce DEMAND in the tens-to hundreds of thousands of skilled staff. The NEA study also determines that although a greater awareness of the overall nuclear skills deficit has been achieved during the past years, no adequate breakthrough in addressing the downturn in qualified nuclear personnel had been taken so far. This also applies to the EU-27 and the E&I Countries.

The continuous supply of sufficient skilled and knowledgeable nuclear human resources is a challenge. Several issues need to be considered to succeed and to meet the increasing demand for a highly qualified workforce in the nuclear field. It is essential that accredited academic programmes providing in-depth nuclear knowledge are available, and that comprehensive nuclear training programmes are established to ensure the continuous professional development in this sensitive field. In addition, appropriately equipped laboratories are necessary to be in place in order to support nuclear education, training and research activities. However, the biggest challenge is certainly to attract the next generation to opt for a nuclear career and to enroll in a nuclear academic programme. This can be achieved by reaching out to the next generation benefitting from social media networks, by offering high quality academic programmes using latest teaching methods and by offering a wide range of job opportunities signaling that nuclear competences will be needed in the long term.

The decision for expanding or developing a nuclear power programme is entirely the responsibility of each individual State. This report sets out that only few of the E&I Countries support nuclear science and technology. This is also reflected in the limited education, training and research opportunities available in some of the E&I Countries and results in the limited availability of highly qualified nuclear staff in these countries and ultimately in Europe.

Concluding, it can be said that deeper analysis on both, the SUPPLY and the DEMAND side, are necessary prior defining if the current SUPPLY of nuclear personnel is satisfactory or if a systematic approach on either how to expand or how to establish new education, training and research programmes is required that aim at meeting more effectively the DEMAND for competent nuclear personnel in the E&I Countries.

[519] NEA (Nuclear Energy Agency) Nuclear Education and Training: From Concern to Capability. 2012. [Online] Available from: http://www.oecd-nea.org/ndd/reports/2012/nuclear-edu-training-ex.pdf

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- European Nuclear Education Network website http://www.enen-assoc.org/
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- Energy Regulations Regional Association website http://www.erranet.org/
- European Commission website http://ec.europa.eu/index_en.htm
- European Human Resources Observatory for the Nuclear Energy Sector website http://ehron.jrc.ec.europa.eu/
- EHRO-N (European Human Resources Observatory for the Nuclear Energy Sector). 2011. Mapping of Nuclear Education Possibilities and Nuclear Stakeholders in the EU-27. [Online] Available from: http://ehron.jrc.ec.europa.eu/ehron/sites/ehron/files/documents/public/ehro-n_reports/mapping_nuclear_stakeholdersonline_2.pdf
- EHRO-N (European Human Resources Observatory for the Nuclear Energy Sector). 2012. Putting into Perspective the supply of and the demand for nuclear experts by 2020 within the EU-27 Nuclear Energy Sector. [Online] Available from: http://ehron.jrc.ec.europa.eu/ehron/sites/ehron/files/documents/public/ehro-n_reports/ehro-n_putting_into_perspective_report_2012_05_25.pdf
- European Nuclear Safety Regulators Group website http://www.ensreg.eu/
- European Nuclear Society website http://www.euronuclear.org/
- Eurostat website http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home

- Eurostat. Keyfigures on Europe 2012. [Online] Available from: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-EI-12-001/EN/KS-EI-12-001-EN.PDF
- International Atomic Energy Agency website http://www.iaea.org/
- IAEA General Conference Delegates' Statement: Republic of Macedonia. 2012. [Online] Available from: http://www.iaea.org/About/Policy/GC/GC56/Statements/macedonia.pdf
- Liechtenstein in Figures 2012. Office of Statistics Principality of Liechtenstein [Online] Available from: http://www.liechtenstein.li/uploads/media/pdf-llv-as-liechtenstein_in_figures_2012_01.pdf
- Nuclear Energy Agency website http://www.oecd-nea.org/
- NEA (Nuclear Energy Agency) Nuclear Education and Training: From Concern to Capability. 2012. [Online] Available from: http://www.oecd-nea.org/ndd/reports/2012/nuclear-edu-training-ex.pdf
- Nuclear Legislation in OECD Countries Regulatory and Institutional Framework for Nuclear Activities Iceland. OECD (Organization for Economic Co-operation and Development). 2008. [Online] Available from: https://www.oecd-nea.org/law/legislation/iceland.pdf
- Nuclear Legislation in OECD Countries Regulatory and Institutional Framework for Nuclear Activities Turkey. OECD (Organization for Economic Co-operation and Development). 2008. [Online] Available from: http://www.oecd-nea.org/law/legislation/turkey.pdf
- Nuclear Threat Initiative website http://www.nti.org/
- The Principality of Liechtenstein. Version 6.1 - 2010. [Online] Available from: http://www.liechtenstein.li/uploads/media/zahlenfakten-eng_01.pdf
- The 20th International Conference Nuclear Energy for New Europe 2011. Radioactive Waste Management in Serbia: 2002-2010. 2011. [Online] Available from: http://www.djs.si/proc/nene2011/pdf/705.pdf
- Higher Education in the Former Republic of Macedonia. European Commission. 2010. [Online] Available from: http://eacea.ec.europa.eu/tempus/participating_countries/reviews/fyromacedonia_review_of_higher_education.pdf
- World Nuclear Association website http://www.world-nuclear.org/

ANNEXES

ANNEX I: EDUCATION, TRAINING AND RESEARCH POSSIBILITIES IN ENLARGEMENT COUNTRIES

Country	Institution	Website	Type
Albania	University of Tirana	http://www.unitir.edu.al/	Course
Albania	University Vlores Ismail Qemali	http://www.univlora.edu.al/	Course
Albania	Academy of Science of Albania	http://www.academyofsciences.net/	Research
Croatia	University of Zagreb	http://www.unizg.hr/homepage/	Course
Croatia	University of Rijeka	http://www.medri.uniri.hr/studiji/radiologija/o%20studiju.htm	Course
Croatia	Polytechnic for Applied Health Studies in Zagreb	http://www.zvu.hr/?lang=en	Professional Study
Croatia	Young Generation Network	http://www.nuklearno-drustvo.hr/en/young-generation-network/activities-ygn.html	Training
Croatia	Institute for Nuclear Technology (INETEC)	http://www.inetec.hr/en/services/training/training/	Training
Croatia	Institute for Medical Research and Occupational Health	http://www.imi.hr/djelatnosti.php?lan=EN	Training/Research
Croatia	Ruđer Bošković Institute (RBI)	http://www.irb.hr/eng/About-the-RBI/	Research
Montenegro	Radiation Protection Association of Serbia and Montenegro	http://www.dzz.org.rs/indexe.html	Training
Serbia	University of Belgrade	http://www.bg.ac.rs/eng/memb/inst/en_instvinca.php	BSc, MSc, PhD
Serbia	University of Novi Sad	http://www.uns.ac.rs/sr/	Course
Serbia	University of Kragujevac	http://www.kg.ac.rs/eng/index.php	Training
Serbia	Institute for Occupational Health "Dr Dragomir Karajovic"	http://www.srbatom.gov.rs/srbatom/spisak-ovlascenih-pravnih-lica.htm#obuka	Training

Country	Institution	Website	Type
Serbia	Vinča Institute of Nuclear Science - CPO – Centre for permanent education – Vinca - Centre for Nuclear Technologies and Research (NTI)	http://www.vin.bg.ac.rs/index.php/en/ http://www.srbatom.gov.rs/srbatom/spisak-ovlascenih-pravnih-lica.htm#obuka http://www.vin.bg.ac.rs/150/index_e.htm	Research/Training
Serbia	Institute of Physics Belgrade (IPB)	http://www.phy.bg.ac.rs/index.php/en/	Research
Serbia	Institute for Technology of Nuclear and other Raw Materials (ITNMS)	http://www.itnms.ac.rs/?lang=en	Research

ANNEX II: EDUCATION, TRAINING AND RESEARCH POSSIBILITIES IN INTEGRATION COUNTRIES

Country	Institution	Website	Type
Iceland	University of Reykjavik	http://en.ru.is/	Research
Iceland	Icelandic Radiation Safety Authority	http://www.gr.is/english/	Training
Israel	Ben-Gurion University of the Negev	http://in.bgu.ac.il/en/Pages/default.aspx	MSc, PhD, Training
Israel	Israeli Research Reactor 1	http://www.soreq.gov.il/default_EN.asp	Training, Research
Israel	Soreq Nuclear Research Centre	http://www.soreq.gov.il/default_EN.asp	Training, Research
Israel	Soreq Applied Research Accelerator Facility	http://www.linac12.org.il//SARAF.ehtml	Research
Israel	Negev Nuclear Research Center	http://iaec.gov.il/English/NRCN/Pages/default.aspx	Research
Israel	Ben-Gurion University of the Negev	http://in.bgu.ac.il/en/Pages/default.aspx	Research
Israel	Tel Aviv University	http://english.tau.ac.il/	Research
Israel	Weizmann Institute of Science	http://wis-wander.weizmann.ac.il/	Research
Norway	University of Oslo	http://www.uio.no/english/	MSc, PhD, seminar, Research
Norway	University of Bergen	http://www.uib.no/en	MSc, PhD
Norway	Norwegian University of Life Science	http://www.umb.no/english/	MSc, PhD, Research
Norway	Center for Accelerator-based Research and Energy Physics	http://www.mn.uio.no/kjemi/english/research/groups/safe/index.html	Training, Research
Norway	Institute for Energy Technology	http://www.ife.no/en	Research
Switzerland	ETH Zürich/Eidgenössische Technische Hochschule Zürich	http://www.ethz.ch	MSc, Course
Switzerland	EPF Lausanne/École polytechnique fédérale de Lausanne EPFL	http://www.epfl.ch/	MSc
Switzerland	University of Geneva	http://www.unige.ch/	Course
Switzerland	University of Berne	http://www.dcb.unibe.ch/	Course, Research
Switzerland	Reactor School at the Paul Scherrer Institute	http://rs.web.psi.ch/	Course, Training
Switzerland	Spiez Laboratory	http://www.labor-spiez.ch/en/lab/ku/index.htm	Training

Country	Institution	Website	Type
Switzerland	Swiss Society for Interventional Pain Management	http://www.ssipm.ch/	Training
Switzerland	Union of Vascular Societies of Switzerland	http://www.uvs.ch/	Training
Switzerland	Swiss Society of Cardiology	http://www.escardio.org/Pages/index.aspx	Training
Switzerland	College of Primary Care Medicine	http://www.kollegium.ch/index.las	Training
Switzerland	Swiss Society of Dermatology and Venereology	http://www.derma.ch/	Training
Switzerland	Institut de radiophysique	http://www.chuv.ch/ira/ira_home/ira-en-bref.htm	Training
Switzerland	Swiss Medical Association	http://www.fmh.ch/bildung-siwf/weiterbildung_allgemein/f_higkeitsprogramme.html	Training
Switzerland	Swiss Society of Radiobiology and Medical Physics	http://www.sgsmp.ch/sgsmp-e.htm	Training
Switzerland	Swiss Society of Radiopharmacy/Radiopharmaceutical Chemistry	http://www.sgrrc.ch/index.htm	Training
Switzerland	Institute of Applied Radiophysics	http://www.chuv.ch/ira/ira_home/ira-en-bref.htm	Training
Switzerland	School for Radiation Protection at the Paul Scherrer Institute	http://srp.web.psi.ch/	Training
Switzerland	Institute of Applied Radiophysics	http://www.chuv.ch/ira/ira_home/ira-en-bref.htm	Training
Switzerland	SafPro AG	http://www.safpro.ch/	Training
Switzerland	Swiss Accident Insurance Fund	http://www.suva.ch/english/english/startseite-en-suva/suva-en-suva/unfallversicherung-schweiz-en-suva.htm	Training
Switzerland	ASCOMP GmbH	http://www.ascomp.ch/services/training/	Training
Switzerland	Paul Scherrer Institute	http://www.psi.ch/	Research
Switzerland	Grimsel Test Site	http://www.grimsel.com/	Research
Switzerland	Mont Terri Rock laboratory	http://www.mont-terri.ch/	Research
Turkey	Istanbul Technical University	http://www.energy.itu.edu.tr/	MSc, Course, Research
Turkey	Middle East Technical University	http://www.metu.edu.tr/	BSc, MSc, PhD

Country	Institution	Website	Type
Turkey	Hacettepe University	http://www.hacettepe.edu.tr/?_dil=2	MSc, PhD, Research
Turkey	Bogazici University	http://www.nuce.boun.edu.tr/	MSc, PhD
Turkey	Ege University	http://ege.edu.tr/index.php?lid=2&SayfaID=343&cat=details	MSc, PhD
Turkey	Marmara University	http://www.marmara.edu.tr/en	Course
Turkey	Bilkent University	http://www.physics.bilkent.edu.tr/index.php/general/undergraduate-curriculum	Course
Turkey	Ankara University	http://nukbilimler.ankara.edu.tr/english/education.htm	MSc, PhD, Training, Research
Turkey	Çekmece Nuclear Research and Training Center	http://www.taek.gov.tr/eng/cnaem.html	Training, Research
Turkey	Sarayköy Nuclear Research and Training Center	http://www.taek.gov.tr/eng/sanaem.html	Training, Research
Turkey	Nuclear Research and Training Centre for Turkish Speaking Countries	N/A	Training
Turkey	SGS NDT Training Center	http://www.sgs.com.tr/en/	Training
Turkey	Turkish Atomic Energy Authority	http://www.taek.gov.tr/eng/about-us/mission.html	Training, Research
Turkey	General Directorate of Mineral Research and Exploration	http://www.mta.gov.tr/v2.0/eng/	Research

ANNEX III: NUCLEAR NETWORKS

Network	Website
Black See Universities Network (BSUN)	http://www.bsun.org/?task=homepage&web=bsun
Young Generation Network (YGN) - Croatia	http://www.nuklearno-drustvo.hr/en/young-generation-network/activities-ygn.html
Young Generation Network (YGN) – Switzerland	http://www.snsyg.ch

ANNEX IV: NUCLEAR NATIONAL SOCIETIES and ASSOCIATIONS

Country	Institute	Website
Croatia	Croatian Nuclear Society (HND)	http://www.nuklearno-drustvo.hr/hr
Montenegro	Radiation Protection Association of Serbia and Montenegro	http://www.dzz.org.rs/indexe.html
Israel	Israeli Society of Nuclear Medicine	http://www.isnm.org.il/
Serbia	Nuclear Society of Serbia	http://nss.vinca.rs/Links.htm
Serbia	Radiation Protection Association of Serbia and Montenegro	http://www.dzz.org.rs/indexe.html
Serbia	Serbian Nuclear Medicine Society	http://www.unms.rs/indexe.html
Switzerland	Swiss Nuclear Society (SNS)	http://www.sns-online.ch
Switzerland	Swiss Society of Nuclear Medicine	http://www.nuklearmedizin.ch/
Switzerland	Nuclear Forum Switzerland	http://www.nuklearforum.ch/de
Switzerland	Forum VERA	http://www.forumvera.info/
Switzerland	Association for Regional and International Underground Storage	http://www.arius-world.org/
Turkey	Turkish Nuclear Engineers Society (NMD)	http://www.nmd.org.tr/
Turkey	Turkish Nuclear Medicine Society	http://tsnm.org/english.php

ANNEX V: NUCLEAR REGULATORY AUTHORITIES

Country	Institute	Website
Albania	National Atomic Agency (ANA)	N/A
Bosnia and Herzegovina	State Regulatory Agency for Radiation and Nuclear Safety	http://www.darns.gov.ba
Croatia	State Office for Radiological and Nuclear Safety (SORNS)	http://cms.dzrns.hr/
Iceland	Icelandic Radiation Safety Authority	http://www.gr.is/english/
Israel	Israel Atomic Energy Commission (IAEC)	http://iaec.gov.il/English/About%20Us/Pages/default.aspx
Norway	Norwegian Radiation Protection Authority (NRPA)	http://www.nrpa.no/eway/default.aspx?pid=240
Serbia	Serbian Radiation Protection and Nuclear Safety Agency (SRPNA)	http://www.srbatom.gov.rs/srbatom/
Switzerland	Swiss Federal Nuclear Safety Inspectorate (ENSI)	http://www.ensi.ch/en
Switzerland	The Swiss Society for Interventional Pain Management	http://www.ssipm.ch/
Turkey	Turkish Atomic Energy Authority (TAEK)	http://www.taek.gov.tr/eng/

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Abstract

The Fukushima Daiichi accident in March 2011 has definitely slowed down the expansion or development of nuclear power programs. However, a number of countries are still decided to embark on nuclear power or to expand their existing programmes in the coming years. This development will be characterized by the continuous need for a skilled and knowledgeable workforce able to meet the international requirements for handling nuclear energy.

The Council of the EU recognized on several occasions that training and education are the back-bone of a sustainable development of highly qualified experts in the nuclear field. The European Human Resource Observatory for the Nuclear Energy Sector (EHRO-N) is at the forefront of European efforts to monitor and analyze short- and long-term trends in supply of and demands for personnel in the nuclear field to support the systematic and continuous capacity building in this area in the EU-27 and beyond its borders.

This EHRO-N report examines the current situation of the nuclear human resource SUPPLY – the availability of nuclear education and training programmes, including research opportunities – as well as the DEMAND situation for such experts – companies involved e.g. in consultancy, manufacturing, engineering, provision of technical services, mining, decommissioning and waste management representing direct employment opportunities – in the Enlargement and Integration Countries. In addition, the report provides a brief overview of the nuclear infrastructure of each of the E&I Countries, if applicable.

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