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Survey of Competence in the Nuclear Energy Sector 2017–2018 in Finland

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Survey of Competence in the Nuclear Energy Sector 2017–2018 in Finland

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Abstract

The working group examining long-term competence development in the national nuclear energy sector appointed by the Ministry of Economic Affairs and Employment in 2010 published a report in 2012 (OTR2010) in which it offered an extensive review of the human resources, research infrastructure, funding, international research and educational offering in the nuclear energy sector. The objective of this study was to update the data provided in the OTR2010 report concerning human resources in the nuclear energy sector.

The results are based on information provided by organisations in the nuclear energy sector in a survey. Due to the survey method, the results should be comparable with those given in the OTR2010 report. All key industry players responded to the survey. Industrial enterprises provided fewer responses than expected; therefore the survey was not entirely comprehensive. The OTR2010 survey was not comprehensive where companies were concerned.

According to the survey, the number of experts was 3,807; an increase of 16% from 2010 (3,285). The number of persons with a Master's degree was 1,895 (50%), with a Bachelor's degree 1,232 (32%), and with a secondary education qualification 680 (18%). The distribution by years of experience has changed from the previous bimodal pattern (OTR2010), now concentrating around younger experts.The number of experts reported was slightly higher (+2%) than what was the estimate for 2015 in 2010. The estimates in the present survey for need in the near future were clearly smaller than in the previous report for 2020 (-16%) and 2025 (-14%). In terms of the results, the most significant change in the operating environment compared the situation forecast in 2010 is the suspension of the Olkiluoto 4 project.

The demand for personnel in 2030 is estimated to be 5% higher than in 2017. The need is estimated to decrease in the near future (3,672 in 2020) and then return on a growth track (3,981 in 2030). The current number of personnel with a Bachelor's degree or a secondary qualification is expected to be sufficient, whereasthe number of Master's degree-holders should increase by 10% on the current level.

According to the results of this survey, and based on development seen in previous years, it is to be expected that sufficient personnel will be available in Finland in the future. However, in certain competence areas special attention should be paid to the training and induction of junior experts.

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Tiivistelmä

Työ- ja elinkeinoministeriön (TEM) vuonna 2010 asettama kansallisen ydinenergia-alan pitkän aikavälin osaamista selvittävä työryhmä (osaamistyöryhmä, OTR2010) julkaisi vuonna 2012 raportin, jossa on tarkasteltu laajasti ydinenergia-alan henkilöstöresursseja, tutkimusinfrastruktuuria, rahoitusta, kansainvälistä tutkimusta ja koulutustarjontaa. Tämän selvitykseen tavoitteena oli päivittää OTR2010-selvitys ydinenergia-alan henkilöstöresurssien osalta.

Tulokset perustuvat ydinenergia-alan organisaatioiden antamiin tietoihin, joita kysyttiin valituilta organisaatioilta verkkokyselynä. Saadut tulokset ovat kyselyn toteutustavan perusteella arvioiden vertailukelpoisia OTR2010-selvityksen tulosten kanssa. Vastaukset saatiin kaikilta merkittäviltä alan toimijoilta. Teollisuusyrityksiltä vastauksia saatiin odotettua vähemmän, joten teollisuusyritysten osalta kysely ei ollut täysin kattava. Myöskään OTR2010-kysely ei ollut kattava yritysten osalta.

Kaikkiaan raportoitiin yhteensä 3807 asiantuntijaa, mikä on 16% enemmän kuin vuonna 2010 (3285). Ylemmän korkeakoulututkinnon suorittaneita raportoitiin yhteensä 1895 (50%), alemman 1232 (32%) ja toisen asteen tutkinnon suorittaneita 680 (18%) henkeä. Alan työkokemusta kerryttäneiden työntekijöiden kokemusvuosien jakautuma on muuttunut kaksihuippuisesta (OTR2010) ja painottuu nyt nuorempiin asiantuntijoihin.

Asiantuntijoita raportoitiin kaikkiaan hieman enemmän (+2%) kuin vuonna 2010 arvioitiin vuodelle 2015. Lähitulevaisuuden tarve on kuitenkin nyt arvioitu selvästi aiempaa arviota pienemmäksi vuosille 2020 (-16%) ja 2025 (-14%). Tulosten kannalta merkittävin muutos toimintaympäristössä vuonna 2010 ennakoituun tilanteeseen verrattuna on Olkiluoto 4-projektin keskeytyminen.

Henkilöstötarpeen arvioidaan vuonna 2030 olevan 5% suurempi kuin henkilöstö vuonna 2017. Henkilöstötarpeen arvioidaan lähitulevaisuudessa vähenevän (3672 vuonna 2020) ja sen jälkeen kasvavan (3981 vuonna 2030). Alemman korkeakoulututkinnon ja toisen asteen tutkinnon suorittaneiden nykyisten henkilömäärien arvioidaan riittävän, mutta ylemmän korkeakoulututkinnon suorittaneiden määrän tulisi lisääntyä nykyisestä 10% vuoteen 2030 mennessä.

Selvityksen tulosten ja aiempien vuosien kehityksen perusteella arvioidaan, että Suomessa tarvittavat henkilöstöresurssit saavutetaan myös tulevaisuudessa. Tietyillä osaamisalueilla nuorempien asiantuntijoiden kouluttamiseen ja perehdyttämiseen tulee kuitenkin kiinnittää erityistä huomioita.

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Arbets- och näringsministeriet (ANM) tillsatte 2010 en nationell arbetsgrupp för att kartlägga behovet av kompetens på kärnenergiområdet på lång sikt (kompetensarbetsgrupp, OTR2010). År 2012 publicerade arbetsgruppen en rapport i vilken personalresurserna, forskningsinfrastrukturen, finansieringen, den internationella forskningen och utbildningsutbudet på kärnenergiområdet granskades utförligt. Syftet med den här utredningen har varit att uppdatera OTR2010-utredningen i fråga om personalresurserna på kärnenergiområdet.

Resultaten baserar sig på uppgifter som organisationer på kärnenergiområdet lämnat i en webbenkät. Enkäten riktades till utvalda organisationer. På basis av hur enkätundersökningen genomfördes kan det bedömas att resultaten är jämförbara med resultaten av OTR2010-utredningen. Enkäten besvarades av alla betydande aktörer i branschen. Däremot kom det in färre svar än väntat från industriföretag, så i fråga om industriföretagen var enkäten inte helt täckande. Inte heller OTR2010-enkäten var heltäckande i fråga om industriföretagen.

Allt som allt kom det in uppgifter om 3 807 experter, vilket är 16 % fler än år 2010 (3 285). Av dessa hade 1 895 (50 %) avlagt högre högskoleexamen, 1 232 (32 %) avlagt lägre högskoleexamen och 680 (18 %) avlagt examen på andra stadiet. Fördelningen av erfarenhetsåren inom branschen var tidigare bimodal (OTR2010), medan tyngdpunkten för närvarande ligger på yngre experter.

Allt som allt inrapporterades något fler experter (+2 %) än vad som 2010 hade uppskattats för 2015. Nu bedöms det emellertid att behovet av experter är betydligt mindre åren 2020 (-16 %) och 2025 (-14 %) än vad som uppskattats tidigare. Den mest betydande förändringen i omvärlden med tanke på resultaten, jämfört med den utveckling som förväntades 2010, är att projektet Olkiluoto 4 har avbrutits.

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Contents

1 Introduction

1.1 General situation in the Finnish nuclear energy sector

In Finland, nuclear energy has a significant role in basic electrical energy production. Electricity generated by nuclear energy accounts for about 25% of total electrical energy consumption. The proportion of nuclear-generated electricity will increase significantly once the Olkiluoto 3 unit (OL3) is completed and has received an operating licence.

In Finland, four reactor units have been operating for a long time.. The Loviisa 1&2 reactors are VVER-440-type pressurised water reactors based on Russian design. Following prior modernisation and power capacity upgrade projects, their electricity outputs currently are 507 MW and 502 MW. The Olkiluoto 1&2 reactors are Swedish-designed boiling water reactors. Following the modernisation projects carried out during their years in operation, their electricity outputs currently are 880 MW and 890 MW.

At the time when the Committee for Nuclear Energy Competence in Finland (OTR), appointed by the Ministry of Economic Affairs and Employment, conducted the previous survey, OTR2010 [1], it was known that the Finnish government had granted the Olkiluoto 3 reactor a construction licence in 2005, and construction was started in 2010. Furthermore, the government granted a decision of principle for the Olkiluoto 4 (OL4) reactor and Fennovoima's Hanhikivi 1 reactor in 2010. Fennovoima's nuclear power plant project was ongoing at the time of this survey, but Teollisuuden Voima did not apply for a construction licence for its OL4 reactor unit. The suspension of the Olkiluoto 4 project was the most significant change in the operating environment when compared with the previous OTR2010 survey.

No unexpected developments have taken place with regard to nuclear waste management plans. It was already known in 2010 that Posiva was planning to apply for a construction licence in 2012, in order to build a final disposal facility for spent nuclear fuel in the Olkiluoto bedrock by expanding the Onkalo research facility to accommodate spent fuel. The government granted Posiva Oy a construction licence in November 2015.

Finland's nuclear energy research infrastructure has been developed systematically so as to enable tests that are important for safety research and for validating the computer models used in safety analyses. The key facilities for thermal hydraulics experiments are located at the Lappeenranta-Lahti University of Technology (LUT). In addition to domestic assignments, the equipment has also been used to perform tests for international nuclear research programmes (OECD/NEA).

The new VTT Centre for Nuclear Safety hosts hot cells and radiochemistry research laboratories, which offer excellent conditions for, e.g., analysis of radiated material or making use of radiochemistry applications in various research themes related to nuclear power plants and nuclear waste management.

In Finland, technical nuclear energy sector education is provided by Aalto University and the LUT University. The Universities of Helsinki, Jyväskylä and Oulu provide theoretical and applied education in nuclear physics and radiochemistry and conduct related research. The current number of nuclear energy sector personnel at universities and estimates of their future personnel needs form one area of this report.

1.2 Objectives and research methodology of the competence survey

In October 2010, the Ministry of Economic Affairs and Employment (MEAE) set up a national committee to examine long-term competence needs within the nuclear energy sector (Committee for Nuclear Energy Competence in Finland, OTR2010). As a result of the survey, a public report [1] was completed in 2012, presenting an extensive review of personnel resources, research infrastructure, funding,

international research and education in the nuclear energy sector. The data was obtained by a questionnaire sent to the organisations operating within the nuclear energy sector.

The present report updates the above-mentioned previous report with regard to personnel resources within the nuclear energy sector. Based on the implementation of the survey, the results obtained should be comparable with those of the previous survey. The previous survey identified experts in 2010 and estimated personnel needs for 2015, 2020 and 2025. This survey covers the situation in autumn 2017 and estimates for 2020, 2025 and 2030. The change in the operating environment is described by the responses for 2020 and 2025 provided in the two surveys.

The research methodology used in the survey was a questionnaire that selected organisations were invited to fill in online. The organisations were selected with a view to keeping the validity of the survey as high as possible when compared with the previous survey. The key target groups of the survey included:

- key nuclear sector actors;
- universities and universities of applied sciences;
- industries closely associated with power companies.

Key nuclear sector actors include power companies Fortum, Teollisuuden Voima Oyj (TVO) and Fennovoima Oy; nuclear waste management company Posiva Oy; VTT Technical Research Centre of Finland Ltd; the Radiation and Nuclear Safety Authority (STUK) and the Ministry of Economic Affairs and Employment (MEAE).

For the purposes of analysing and comparing the results of the survey, the respondents were further divided into the following groups, which are the same as in the previous report [1]:

1. **power companies and Posiva;**
2. **public authorities (STUK and MEAE);**
3. **universities and research institutes (incl. universities of applied sciences);**
4. **other industrial companies;**
5. **all respondents.**

The general objective of the competence survey was to estimate the current number of and future demand for experts working in different branches of the nuclear energy sector. Estimates of future demand are influenced by the prospects for additional nuclear power construction and by demand for personnel resources related to the maintenance of existing plants and research in support of their safe operation.

1.3 Presentation of the survey and its implementation method

The survey (see Appendix A) was implemented by VTT as an online survey (Webropol). The practical work was carried out by Vesa Suolanen, Project Coordinator of the SAFIR2018 Programme; Harri Nuuttila, VTT's Webropol specialist; and Jari Hämäläinen, SAFIR2018 Programme Director. The contact person for the Ministry of Economic Affairs and Employment was Jorma Aurela.

The link to the online questionnaire was sent to the following 127 respondents (the survey was open from 8 to 29 September 2017 and the period was further extended to 31 December 2017):

- key nuclear sector actors (7);
- universities and universities of applied sciences (28);
- industries closely associated with power companies (92, including the mailing lists of the FinNuclear Association and the Technology Industries of Finland).

Answers were submitted by the following 41 respondents:

- key nuclear sector actors (7);
- universities and universities of applied sciences (6+3=9);
- industries closely associated with power companies (25).

Responses were submitted by all key actors operating in the sector, including the power companies, Posiva, STUK, MEAE, Aalto University, Lappeenranta University of Technology (LUT) and VTT.

Industrial companies submitted fewer responses than expected, which means that the survey was not fully comprehensive in this respect. The OTR2010 survey was also not comprehensive with regard to these companies, as indicated in the report [1].

Each of the organisations targeted by the survey had a designated contact person who collected their own organisation's responses and filled the electronic questionnaire, which was then stored in the Webropol database.

The survey was implemented confidentially and the responses have been analysed and presented by result group or in terms of the entire response data. The responses given by any individual organisation cannot be identified.

In terms of the areas of competence, the questionnaire was consistent with the previous survey. Some necessary updates and probing questions were added to the questionnaire (see Appendix A). The first part of the questionnaire surveyed the existing personnel resources such that the number of experts was defined, on the one hand, on the basis of educational background and, on the other, as years of experience within the nuclear energy sector (see Chapter 2). The educational background was defined as covering a suitable Master's or Bachelor's degree from a university or a university of applied sciences, or a post-compulsory secondary-level vocational qualification relevant to the sector.

The second part surveyed the organisations' demand for labour in 2020, 2025 and 2030 (see Chapter 3).

The respondents were also able to include free-form text in their responses. Furthermore, the organisations were asked to indicate what other types of nuclear energy experts they might need in the future and how many (questionnaire part 3).

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2 Nuclear energy sector personnel resources in 2017

This chapter outlines nuclear energy sector personnel from the perspectives of work experience, education and competence areas, and compares the results with those of the OTR2010 survey conducted in 2010 [1].

Work experience is defined in terms of years worked in the sector. While it is also possible to qualify for many work assignments based on experience gained from fields outside the nuclear energy sector, this was not taken into account in the survey due to the sector's safety-related characteristics.

The educational background was defined on the basis of the educational qualifications completed, i.e., a secondary-level vocational qualification, a Bachelor's degree and a Master's degree. Master's degree-holders were further analysed in terms of the number of those with a postgraduate (Doctor's or Licentiate's) degree.

The areas of competence covered in this survey were the same as in the OTR2010 survey. In total, there are 22 areas of expertise, which are described in more detail in the report of the 2010 survey [1].

Personnel resources are analysed as a whole (all respondents) and by group (groups 1–4).

2.1 All respondents

2.1.1 Distribution by experience and comparison with the 2010 competence survey

In total, the number of experts reported in the survey was 3,807, which is 522 individuals (16%) more than in the 2010 survey (3,285). The distribution by years of experience has changed from the previous bimodal pattern, concentrating around younger experts (Figure 2.1).

The proportion of Bachelor's degree-holders is highest among recent entrants to the sector and lowest among the most experienced personnel (38% with 0–5 years and 26% with over 20 years of experience).

The proportion of secondary-level vocational qualification-holders is lowest among recent entrants to the sector and highest among the most experienced personnel (13% with 0–5 years and 28% with over 20 years of experience).

Of the whole, Master's and Bachelor's degree-holders account for 50% and 32%, respectively, while the remaining 18% have a secondary-level vocational qualification.

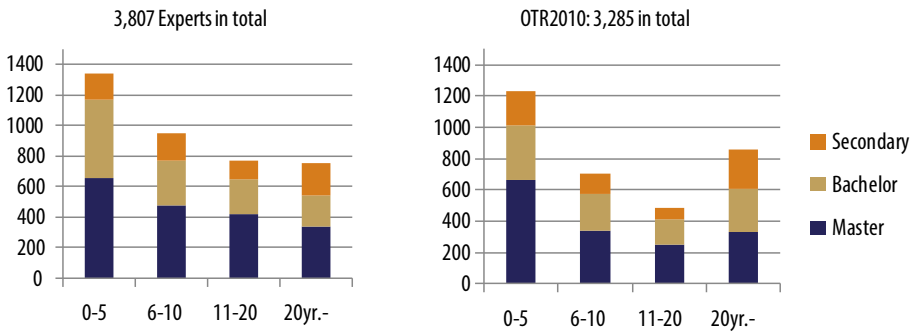

Figure 2.1 Number of experts by years of experience (0–5 years, 6–10 years, 11–20 years and over 20 years in the nuclear energy sector) and by educational qualification (secondary-level vocational qualification, Bachelor's degree and Master's degree) in 2017 (left) and 2010 (right). All respondents.

2.1.2 Master's degree

In total, there are 1,895 Master's degree-holders, which amounts to 310 individuals (20%) more than in 2010 (1,585). The largest increases are in the following competence areas (Figure 2.2): nuclear and particle physics; project management; mechanics and mechanical engineering; other nuclear sector expert duties; quality management and inspections.

The number of experts has decreased the most in the following areas: radiation protection; R&D and planning in nuclear waste management.

Other expert duties mentioned in responses included the following areas: technical sales support; procurement; management system; information security; fusion and plasma physics research; official duties; technical business expert duties; management duties; duties related to financial profitability; strategic planning; extensive licensing-related functions; legal duties; environmental control.

The number of experts holding a Master's degree is highest in the following areas (Figure 2.3): R&D and planning in nuclear waste management; nuclear and particle physics; mechanics and mechanical engineering; construction engineering; project management; other expert duties.

Judging by the proportions of those who have worked in the sector from 0 to 5 years, recruitments have been made quite comprehensively in almost all competence areas in recent years. The number of recent entrants to the sector is relatively small in the following areas of competence: safeguards; reactor physics and dynamics; severe accidents; operator duties (see also Section 3.1.2).

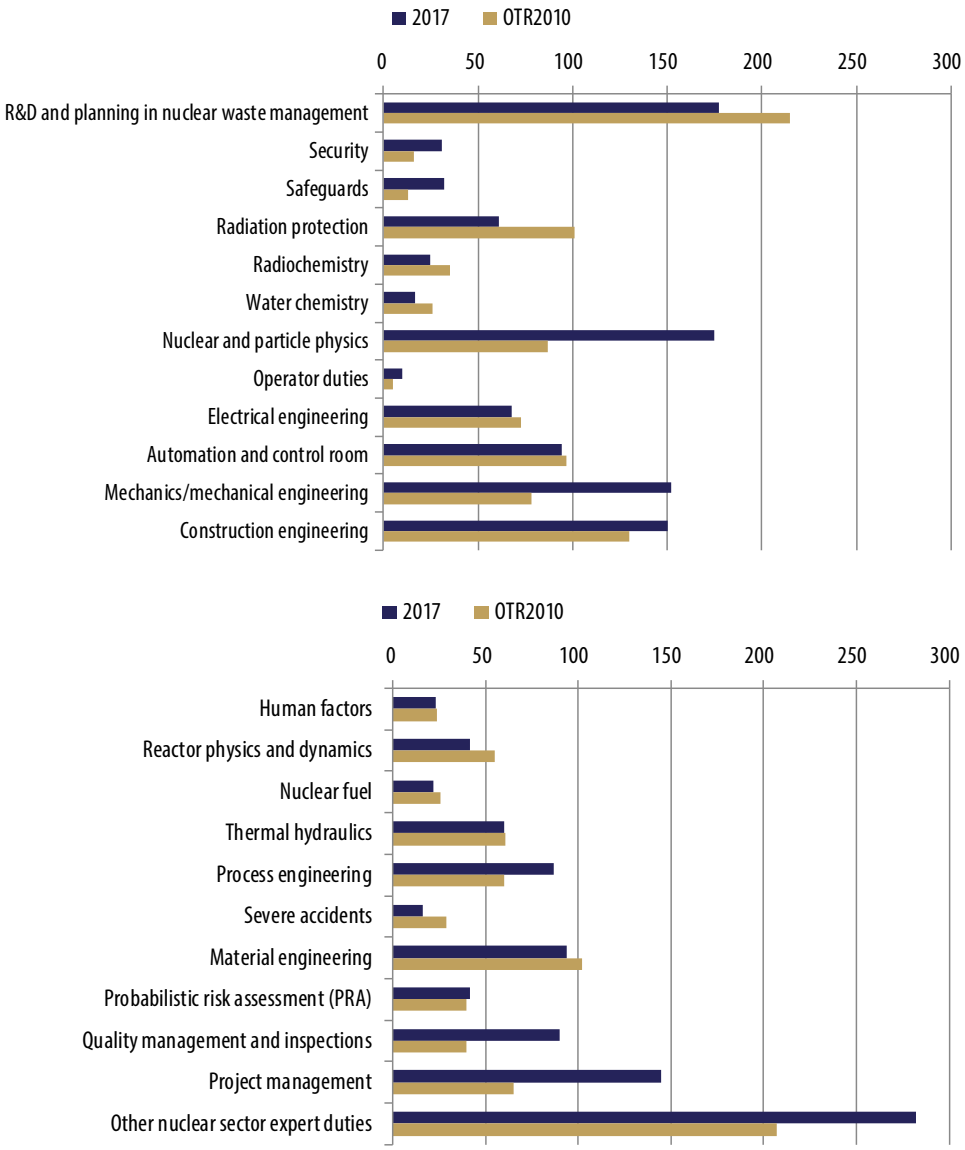

Figure 2.2 Number of experts with Master's degree by area of competence in 2017 and 2010. All respondents.

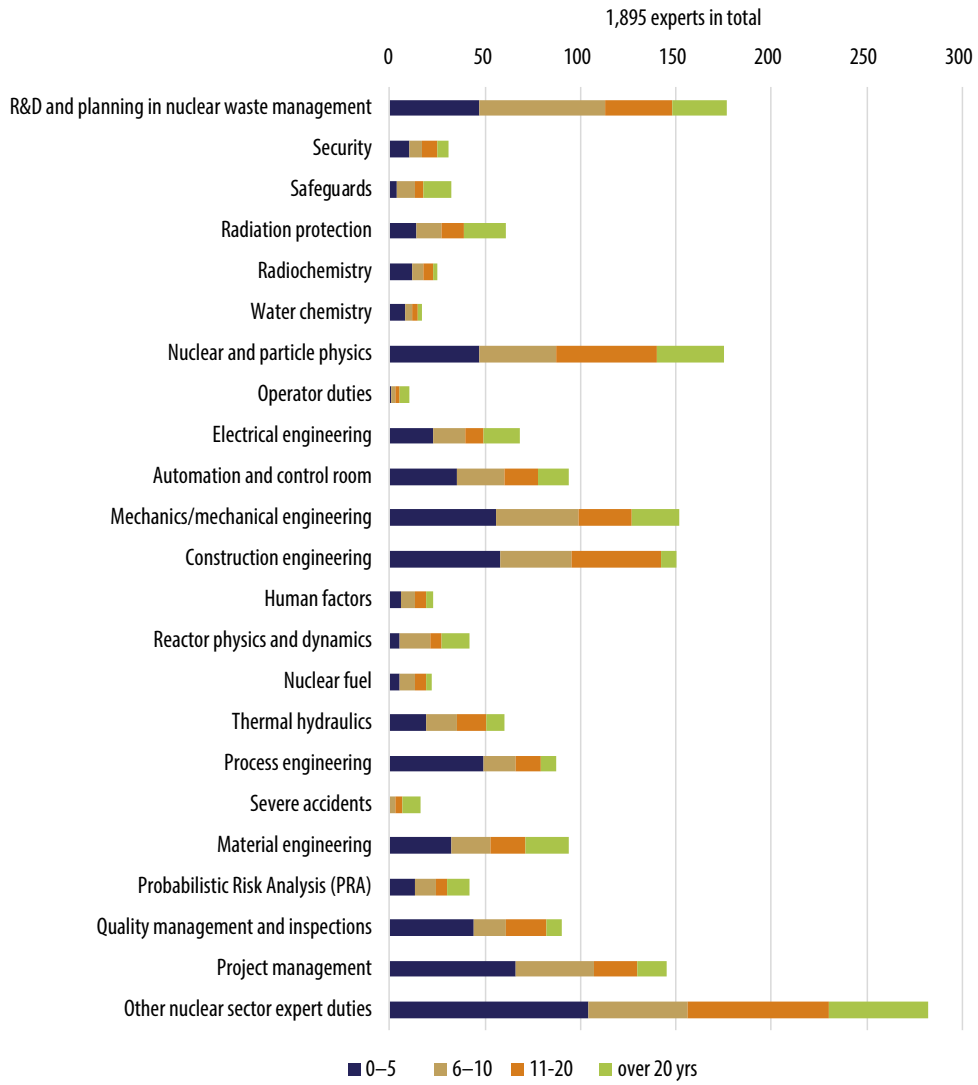

Figure 2.3 **Number of experts with Master's degree by area of competence and years of experience (0–5 years, 6–10 years, 11–20 years and over 20 years in the nuclear energy sector). All respondents.**

2.1.3 Bachelor's degree

In total, there are 1,232 Bachelor's degree-holders, which amounts to 208 individuals (20%) more than in 2010 (1,024). The largest increases are in the following competence areas (Figure 2.4): mechanics and mechanical engineering; other expert duties; project management; material engineering; construction engineering.

The number of experts has decreased the most in the following areas: operator duties; electrical engineering.

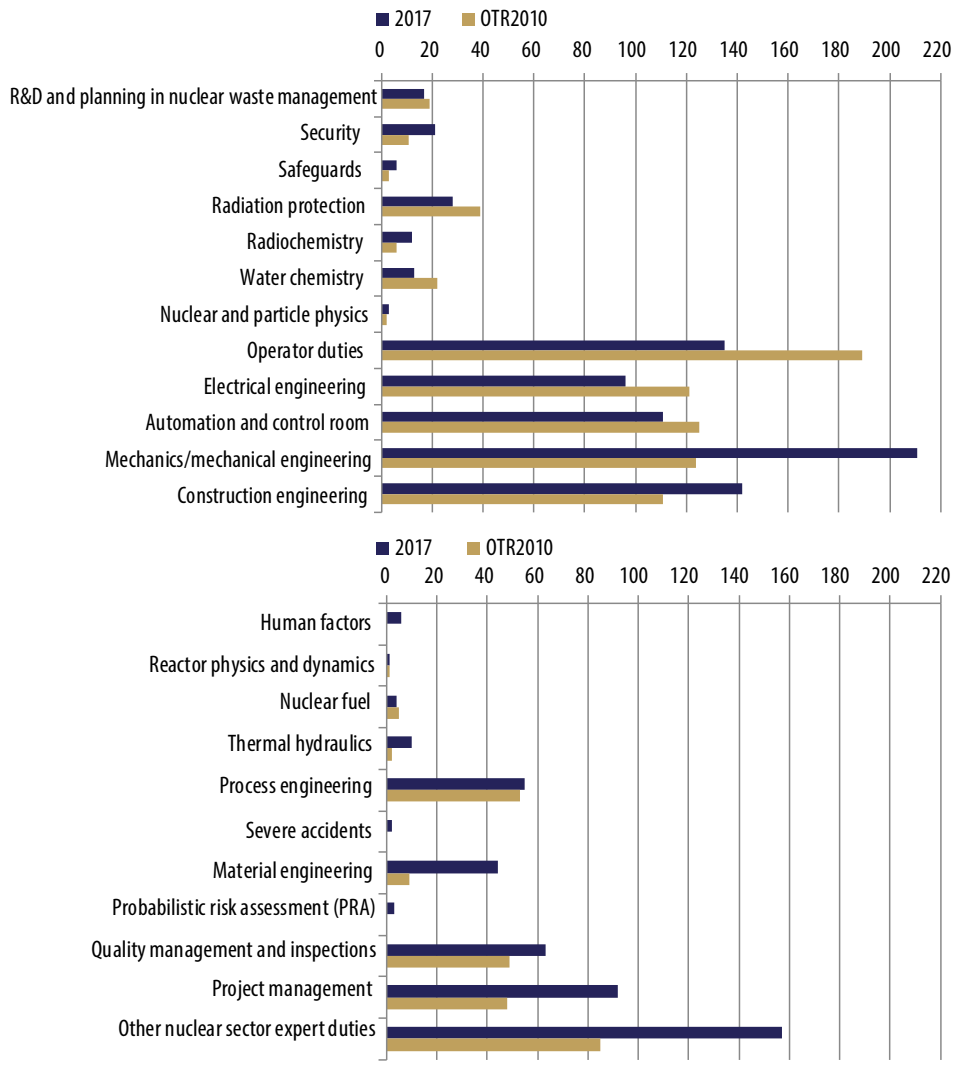

Figure 2.4 Number of experts with Bachelor's degree by area of competence in 2017 and 2010. All respondents.

Other expert duties mentioned in responses included the following areas: nuclear fuel treatment; maintenance; information security; environmental engineering; HPAC (heating, plumbing, air-conditioning); official duties; business-related duties; information technology; HR (human resources); supervisory duties; duties related to technical documentation and document management.

The number of experts holding a Bachelor's degree is highest in the following areas (Figure 2.5): mechanics and mechanical engineering; other duties; construction engineering; operator duties; automation and control room; electrical engineering; project management.

In relative terms, the number of recent entrants to the sector are not very small in any of the competence areas. Based on the results, quite a lot of recruitments have been specifically made in the above-mentioned largest competence areas in recent years.

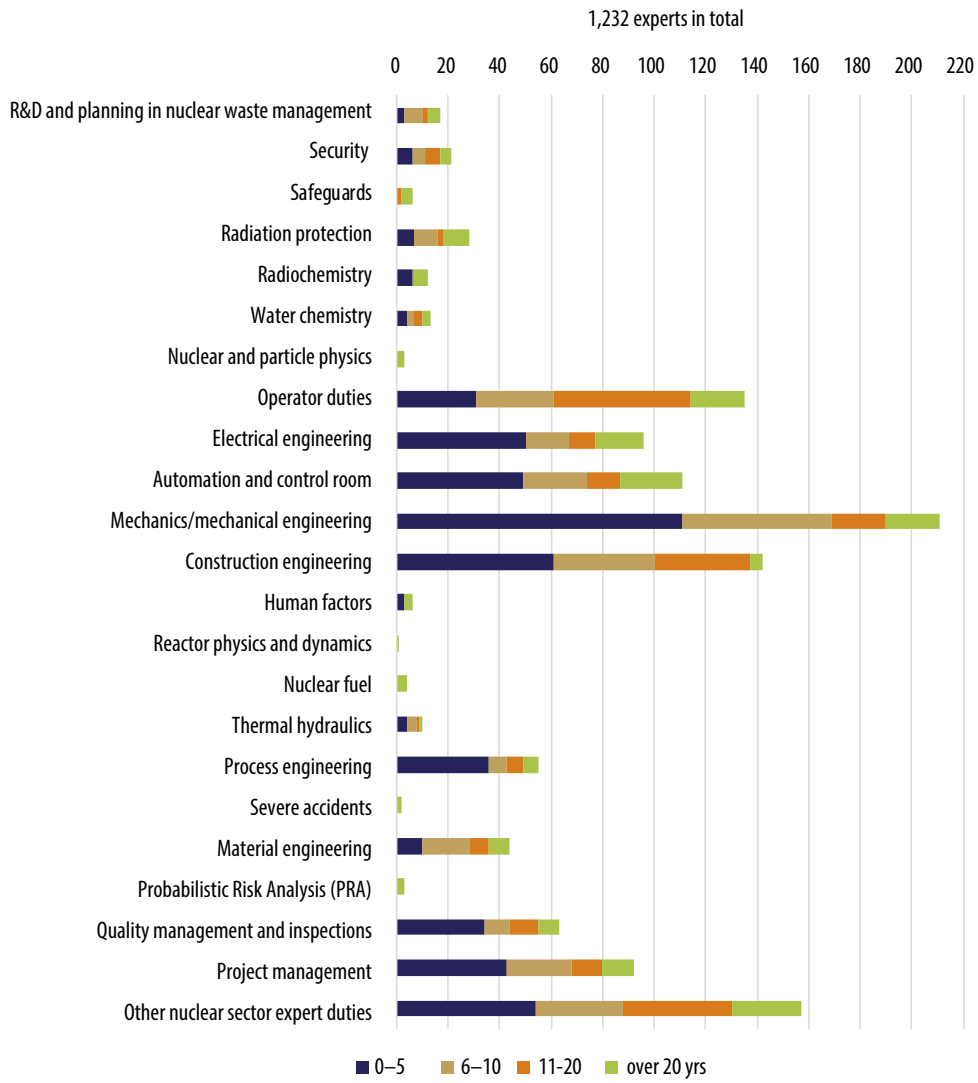

Figure 2.5 Number of experts with Bachelor's degree by area of competence and years of experience (0–5 years, 6–10 years, 11–20 years and over 20 years in the nuclear energy sector). All respondents.

2.1.4 Secondary-level vocational qualifications

In total, there are 680 secondary-level vocational qualification-holders, which amounts to 4 individuals (1%) more than in 2010 (676). The largest increases are in the following competence areas (Figure 2.6): other duties; mechanics and mechanical engineering.

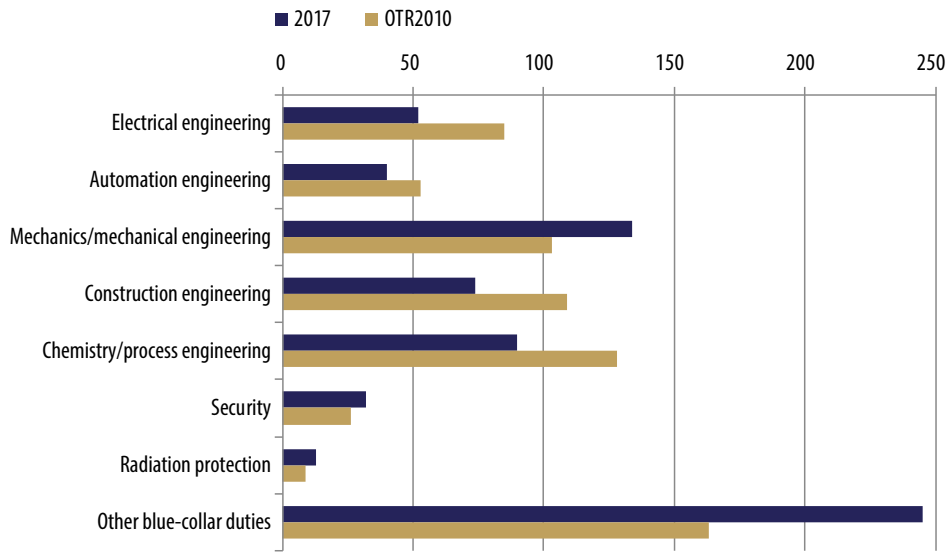

Figure 2.6 Number of experts with secondary-level vocational qualifications by area of competence in 2017 and 2010. All respondents.

Personnel number has decreased the most in the following areas: chemistry and process engineering; construction engineering; electrical engineering.

Other duties mentioned in responses included the following areas: nuclear fuel treatment; maintenance duties; support functions; installation duties; operator duties; and technical documentation.

The number of secondary-level vocational qualification-holders is highest in the following areas (Figure 2.7): other duties; mechanics and mechanical engineering; chemistry and process engineering; construction engineering; electrical engineering.

In relative terms, the number of recent entrants to the sector is not very small in any of the competence areas, with the exception of radiation protection, which means that recruitments have been made quite comprehensively in different competence areas in recent years.

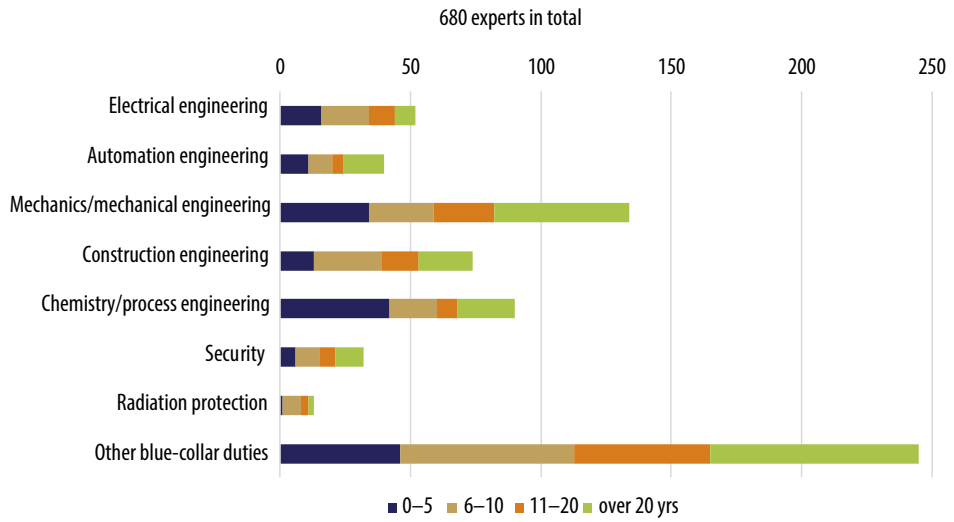

Figure 2.7 Number of experts with secondary-level vocational qualifications by area of competence and years of experience (0–5 years, 6–10 years, 11–20 years and over 20 years in the nuclear energy sector). All respondents.

2.1.5 Summary of personnel by educational qualification

Table 2.1 shows the number of experts with different educational qualifications in total and in groups 1–4. The groups are as follows:

1. Power companies and Posiva;
2. Public authorities (STUK and MEAE);
3. Universities and research institutes (incl. universities of applied sciences);
4. Other industrial companies.

The total number of Master's degree-holders is 1,895, 32% of whom work for power companies or Posiva, while those employed by public authorities, universities or research institutes and other industrial companies account for 8%, 26% and 34%, respectively.

The total number of those holding a postgraduate – i.e., a Doctor's or Licentiate's – degree is 332, equating to 18% of Master's degree-holders (the figures in the 2010 survey were 287 and 18%). The majority of postgraduate degree-holders (67%) work at universities and research institutes (Table 2.1), while another significant proportion (18%) are employed by power companies.

Table 2.1 Nuclear energy sector personnel broken down by educational qualification in different groups: Master's degree ('Master'), Bachelor's degree ('Bachelor') and secondary-level vocational qualification ('Secondary').

Qualification	All	Group 1	Group 2	Group 3	Group 4
Master	1895	597	160	487	651
Doctor	292	45	18	212	17
Licentiate	40	15	6	12	7
Bachelor	1232	535	24	22	651
Secondary	680	447	0	20	213
Total	3807	1579	184	529	1515

The total number of Bachelor's degree-holders is 1,232, 43% of whom work for power companies or Posiva, while those employed by public authorities and universities or research institutes account for 2% each, and the remaining 53% work for other industrial companies.

The total number of secondary-level vocational qualification-holders is 680, 66% of whom work for power companies or Posiva, while those employed by public authorities, universities or research institutes and other industrial companies account for 0%, 3% and 31%, respectively.

The group-specific results are presented in more detail in Sections 2.2–2.5.

2.2 Power companies and Posiva

2.2.1 Distribution by experience and comparison with the 2010 competence survey

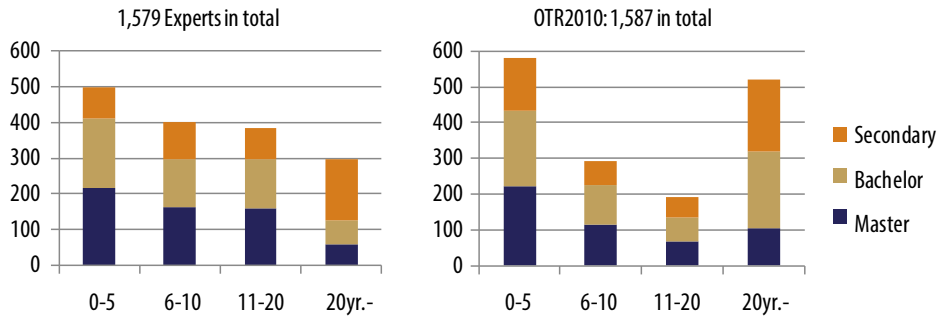

Figure 2.8 Number of experts by years of experience (0–5 years, 6–10 years, 11–20 years and over 20 years in the nuclear energy sector) and by educational qualification (secondary-level vocational qualification, Bachelor's degree and Master's degree) in 2017 (left) and 2010 (right). Group 1: power companies and Posiva.

The power companies and Posiva reported a total of 1,579 experts, amounting to 8 (1%) fewer than in the 2010 survey (1,587). The distribution by years of experience has changed from the previous highly bimodal pattern, concentrating around younger experts (Figure 2.8).

The proportion of secondary-level vocational qualification-holders is lowest among recent entrants to the sector and highest among the most experienced personnel (17% with 0–5 years and 57% with over 20 years of experience).

The proportion of Bachelor's degree-holders is highest among recent entrants to the sector and lowest among the most experienced personnel (39% with 0–5 years and 23% with over 20 years of experience). Likewise, the proportion of Master's degree-holders is highest among recent entrants to the sector and lowest among the most experienced personnel (43% with 0–5 years and 20% with over 20 years of experience).

Of the whole, Master's and Bachelor's degree-holders account for 38% and 34%, respectively, while the remaining 28% have a secondary-level vocational qualification.

2.2.2 Master's degree

In total, there are 597 Master's degree-holders, which amounts to 88 individuals (17%) more than in 2010 (509). The largest increases are in the following competence areas (Figure 2.9): safeguards (nuclear material control); mechanics and mechanical engineering; project management; other expert duties (see Section 2.1.2).

The number of experts has decreased the most in the following areas: R&D and planning in nuclear waste management; reactor physics and dynamics; process engineering.

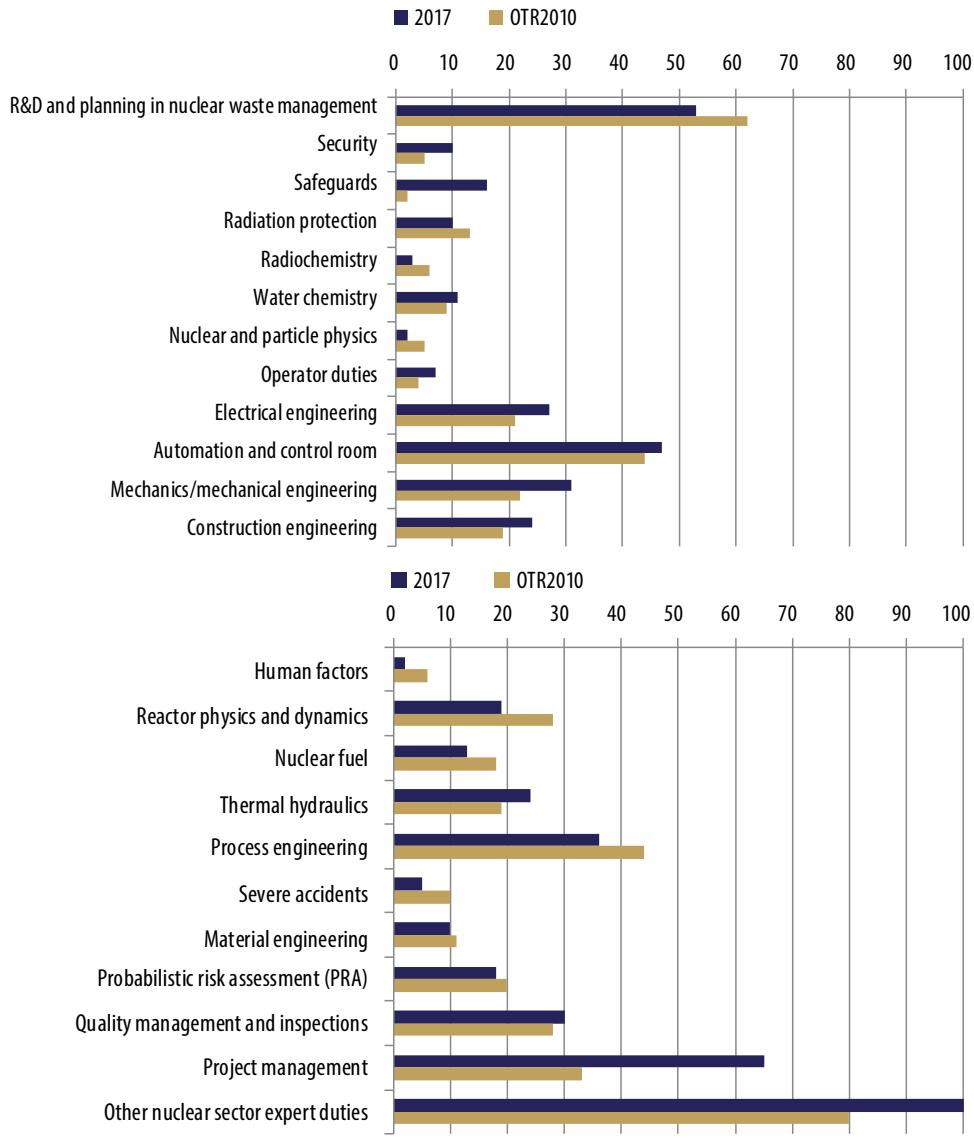

Figure 2.9 Number of experts with Master's degree by area of competence in 2017 and 2010. The number of Master's degree-holders in the 'other nuclear sector expert duties' survey group was 134 (in the figure, the bar extends beyond the scale). Group 1: power companies and Posiva.

The number of experts holding a Master's degree is highest in the following areas (Figure 2.10): R&D and planning in nuclear waste management; automation and control room; project management; other expert duties.

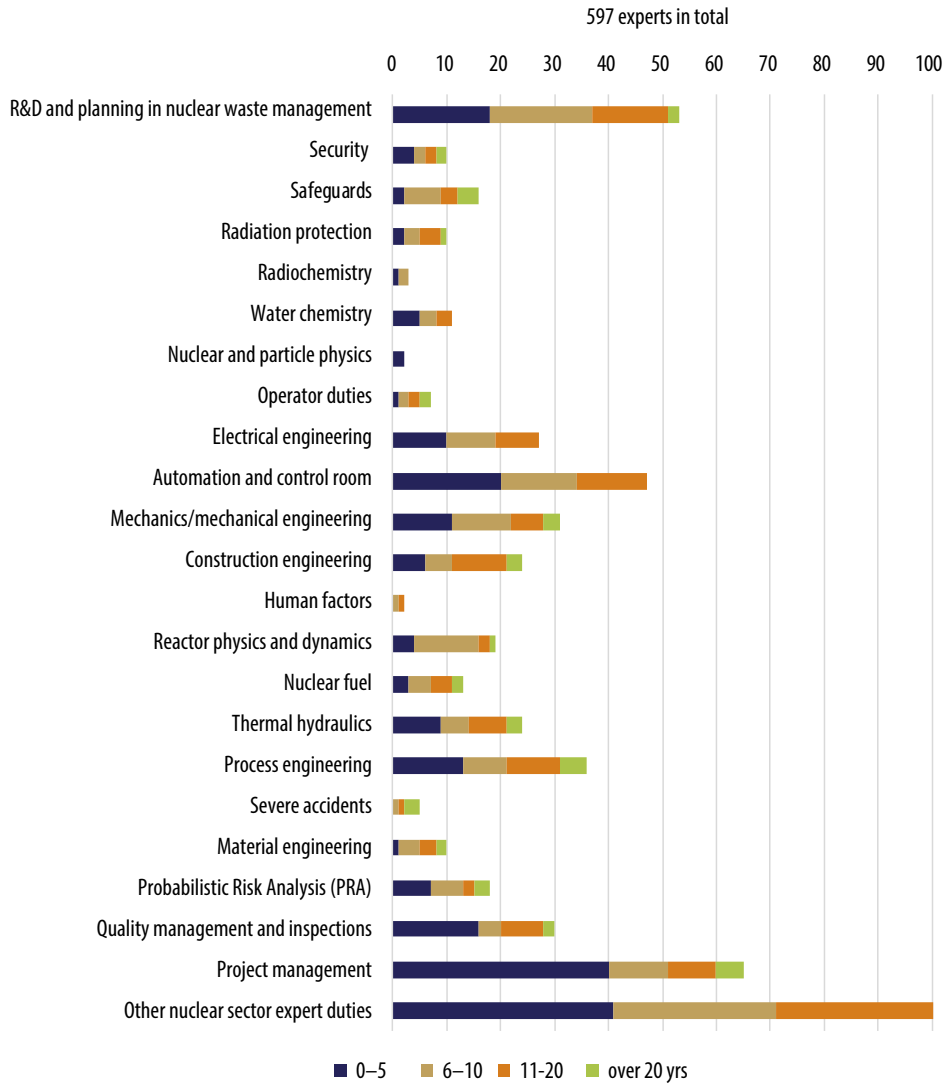

Figure 2.10 **Number of experts with Master's degree by area of competence and years of experience (0–5 years, 6–10 years, 11–20 years and over 20 years in the nuclear energy sector). The number of Master's degree-holders in the 'other nuclear sector expert duties' survey group was 134 (the bar in the figure extends beyond the scale), 47 of whom had 11–20 years of experience while another 16 had over 20 years of experience. Group 1: power companies and Posiva.**

2.2.3 Bachelor's degree

In total, there are 535 Bachelor's degree-holders, which amounts to 71 individuals (12%) fewer than in 2010 (606). The largest increases are in the following competence areas (Figure 2.11): material engineering; construction engineering; project management.

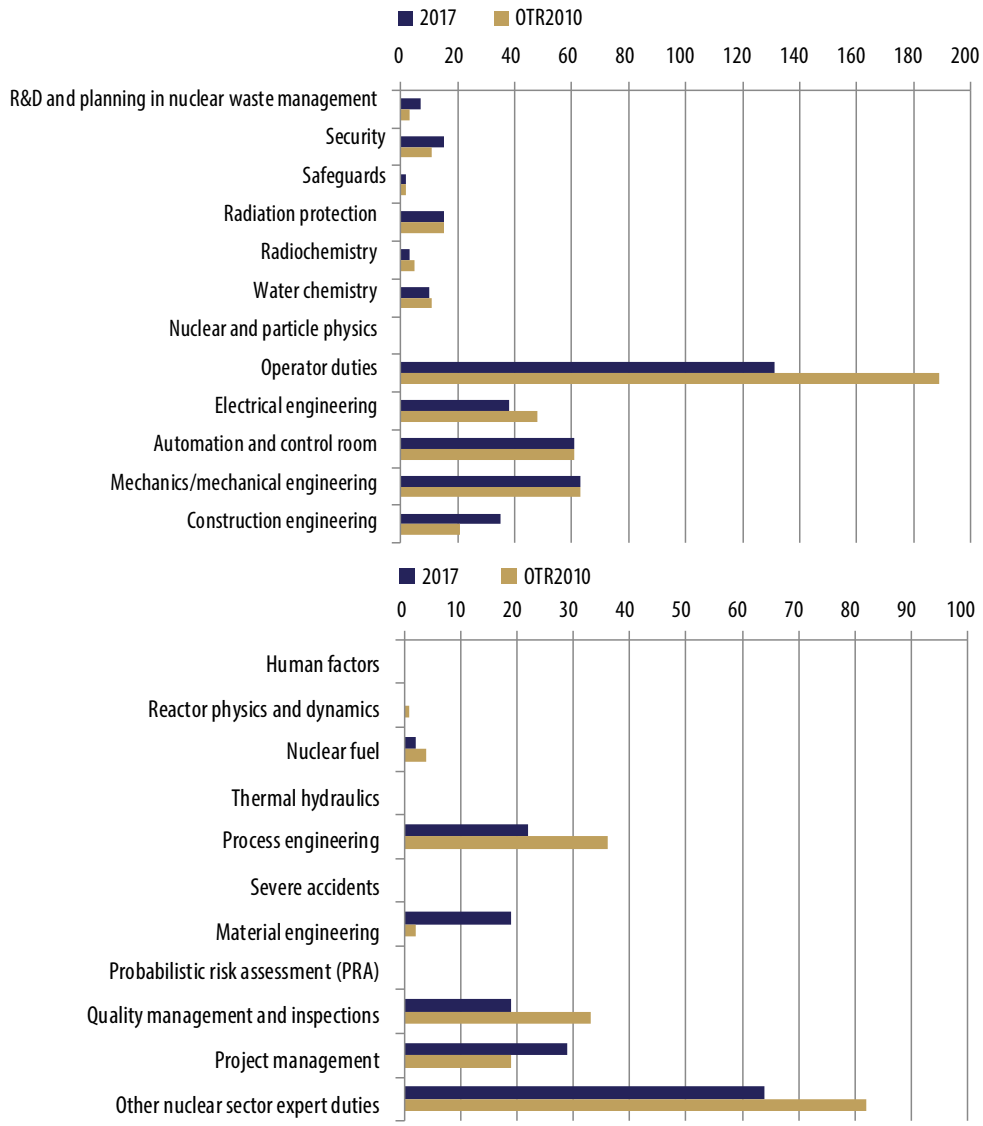

Figure 2.11 Number of experts with Bachelor's degree by area of competence in 2017 and 2010. The scale in the top figure (max 200) is twice as large as the scale in the bottom figure (max 100). Group 1: power companies and Posiva.

The number of experts has decreased the most in the following areas: operator duties; other duties; quality management and inspections; process engineering; electrical engineering. In particular, the number of operators is clearly below the 2010 level.

The number of experts holding a Bachelor's degree is highest in the following areas (Figure 2.12): operator duties; other duties; mechanics and mechanical engineering; automation and control room.

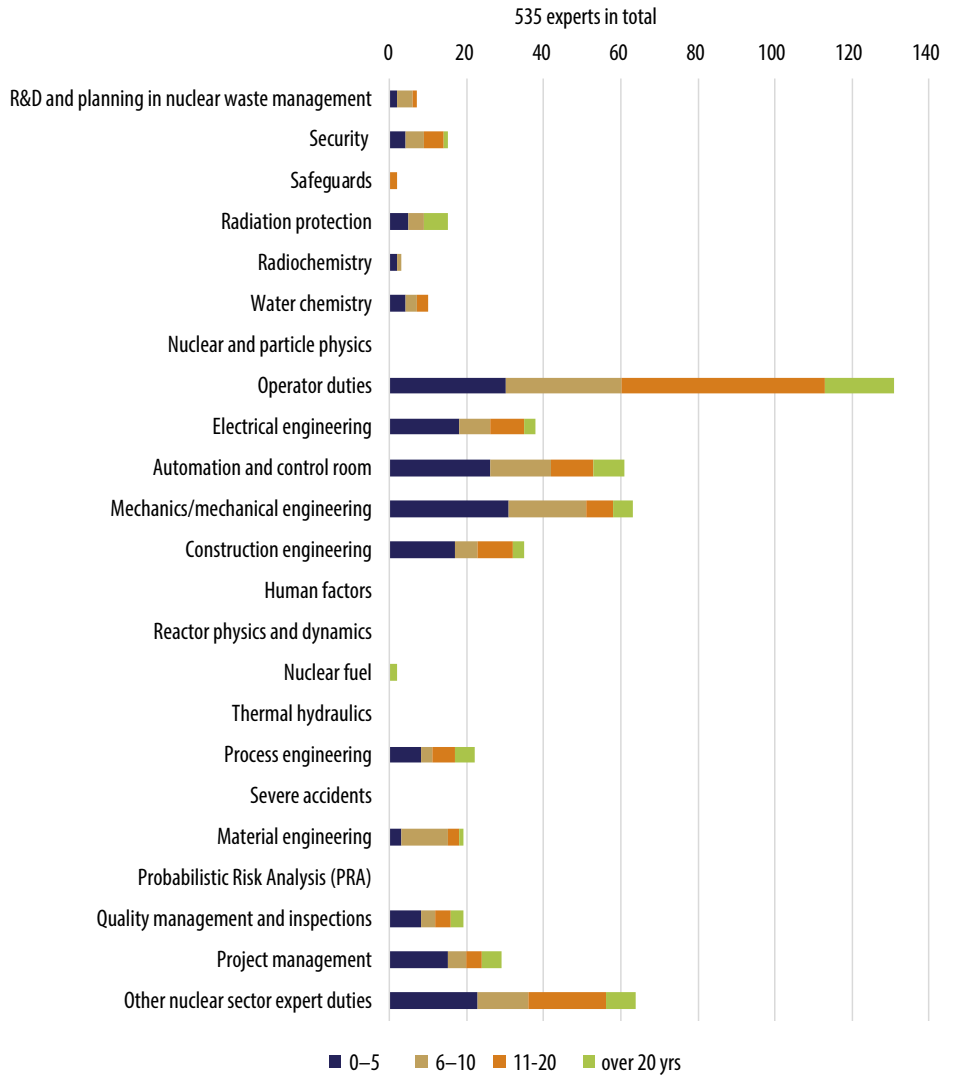

Figure 2.12 Number of experts with Bachelor's degree by area of competence and years of experience (0–5 years, 6–10 years, 11–20 years and over 20 years in the nuclear energy sector). Group 1: power companies and Posiva.

2.2.4 Secondary-level vocational qualifications

In total, there are 447 secondary-level vocational qualification-holders, which amounts to 25 individuals (5%) fewer than in 2010 (472). The largest increases are in the following competence areas (Figure 2.13): mechanics and mechanical engineering; other duties.

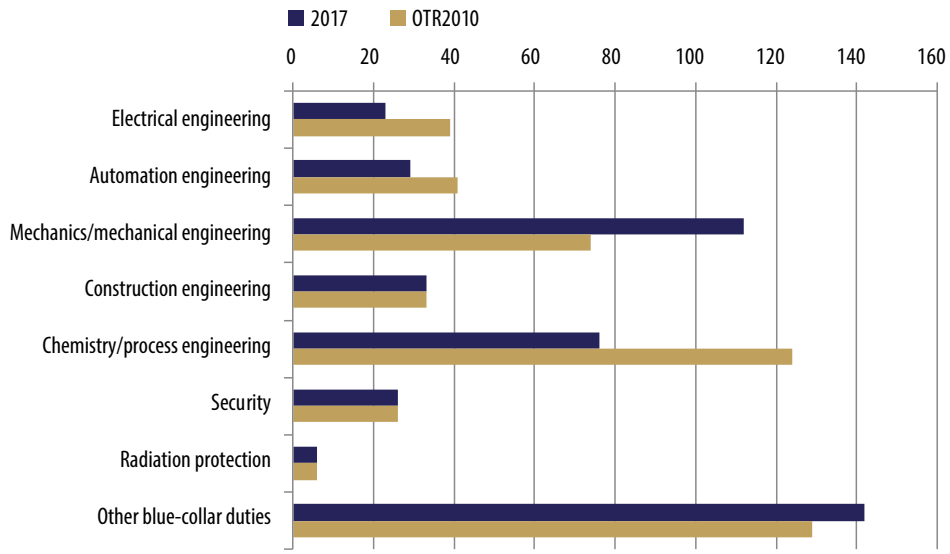

Figure 2.13 Number of experts with secondary-level vocational qualifications by area of competence in 2017 and 2010. Group 1: power companies and Posiva.

Personnel number has decreased the most in the following areas: chemistry and process engineering; electrical engineering; automation engineering.

The number of secondary-level vocational qualification-holders is highest in the following areas (Figure 2.14): other duties; mechanics and mechanical engineering; chemistry and process engineering

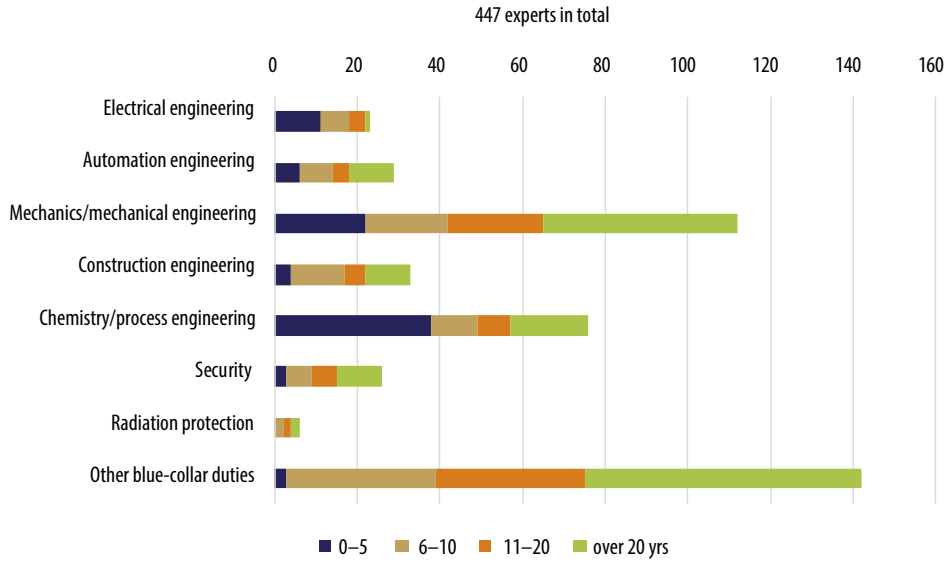

Figure 2.14 **Number of experts with secondary-level vocational qualifications by area of competence and years of experience (0–5 years, 6–10 years, 11–20 years and over 20 years in the nuclear energy sector). Group 1: power companies and Posiva.**

2.3 Public authorities (STUK and MEAE)

2.3.1 Distribution by experience and comparison with the 2010 competence survey

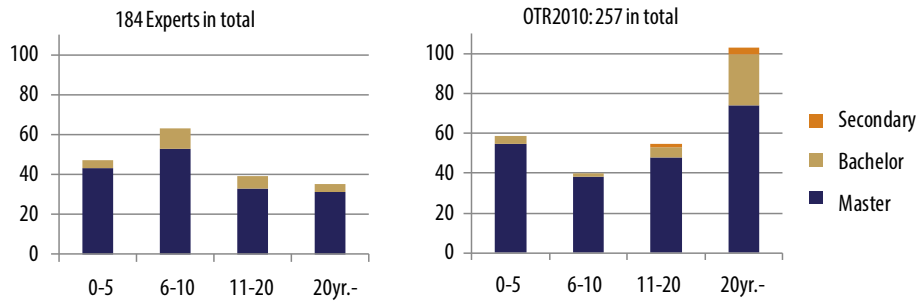

Figure 2.15 **Number of experts by years of experience (0–5 years, 6–10 years, 11–20 years and over 20 years in the nuclear energy sector) and by educational qualification (secondary-level vocational qualification, Bachelor's degree and Master's degree) in 2017 (left) and 2010 (right). Group 2: public authorities (STUK and MEAE).**

Public authorities reported a total of 184 experts, amounting to 73 (28%) fewer than in the 2010 survey (257). The distribution by years of experience has changed from the previous bimodal pattern, concentrating around experts who have worked in the sector for some time (6–10 yrs; Figure 2.15).

Of the whole, Master's and Bachelor's degree-holders account for 87% and 13%, respectively. There are no secondary-level vocational qualification-holders in this group.

2.3.2 Master's degree

In total, there are 160 Master's degree-holders, which amounts to 55 individuals (26%) fewer than in 2010 (215). A few more individuals have entered the following competence areas (Figure 2.16): quality management and inspections; thermal hydraulics.

The number of experts has decreased the most in the following areas: radiation protection; material engineering; other duties.

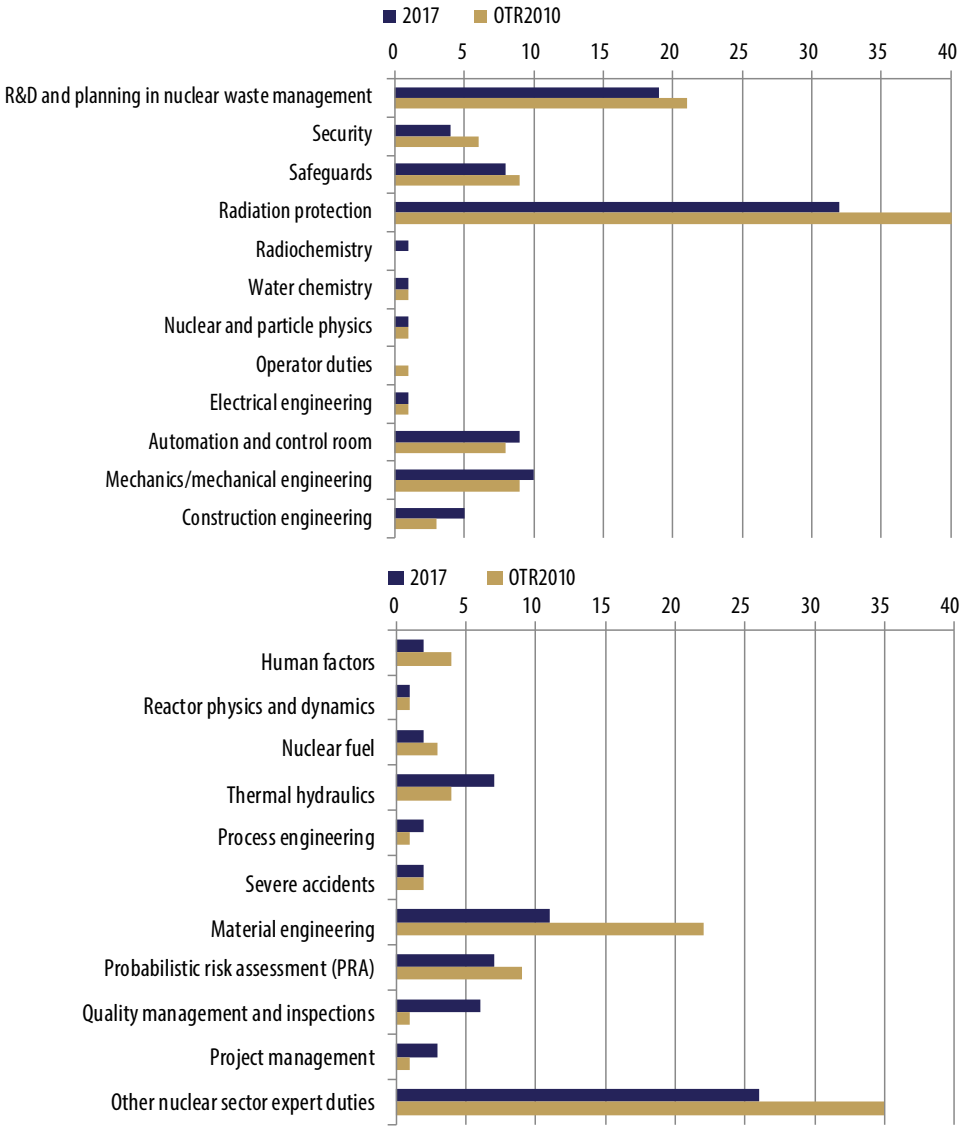

Figure 2.16 Number of experts with Master's degree by area of competence in 2017 and 2010. The total number of Master's degree-holders in the 'radiation protection' group in 2010 was 72 (the bar in the figure extends beyond the scale). Group 2: public authorities (STUK and MEAE).

The number of experts holding a Master's degree is highest in the following areas (Figure 2.17): radiation protection; R&D and planning in nuclear waste management; other duties.

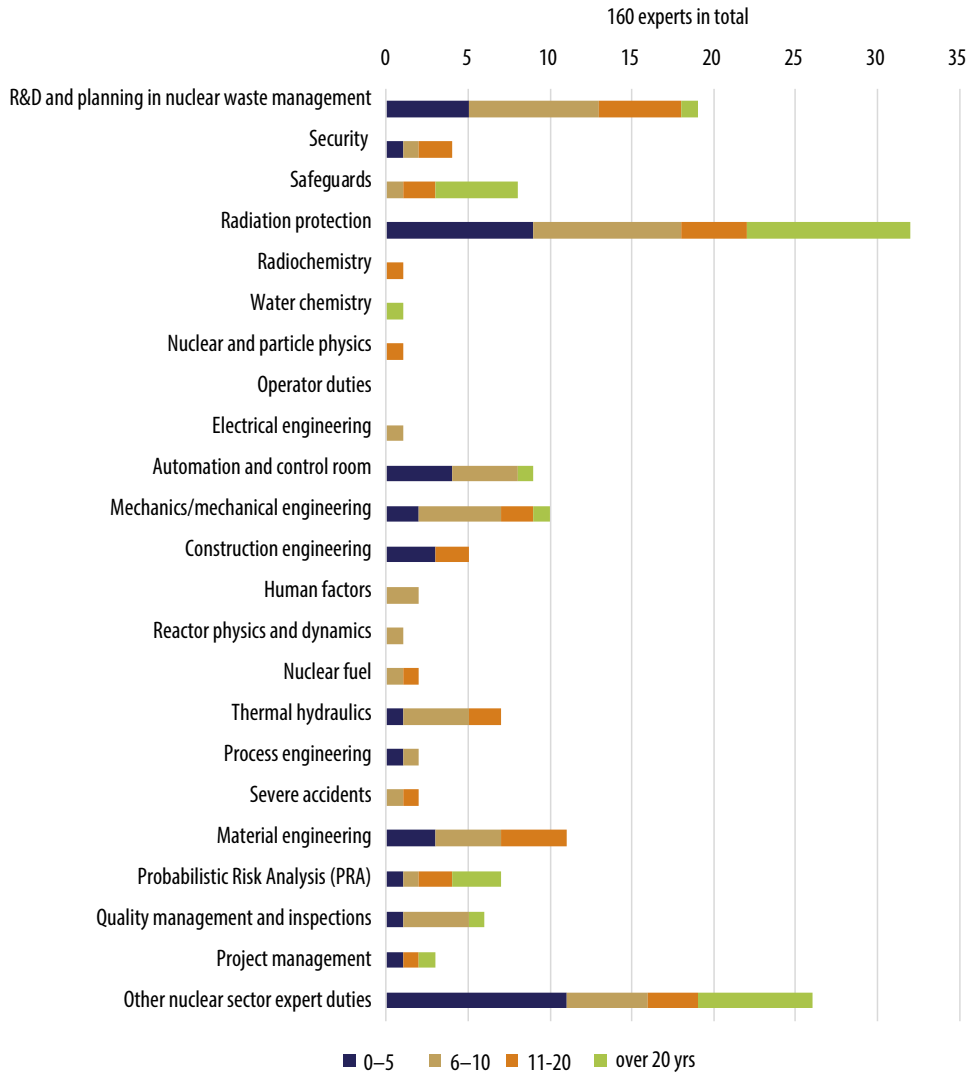

Figure 2.17 Number of experts with Master's degree by area of competence and years of experience (0–5 years, 6–10 years, 11–20 years and over 20 years in the nuclear energy sector). Group 2: public authorities (STUK and MEAE).

2.3.3 Bachelor's degree

In total, there are 24 Bachelor's degree-holders, which amounts to 13 individuals (35%) fewer than in 2010 (37). The number of experts has increased in the area of other nuclear sector expert duties (Figure 2.18).

The number of experts has decreased the most in the area of radiation protection.

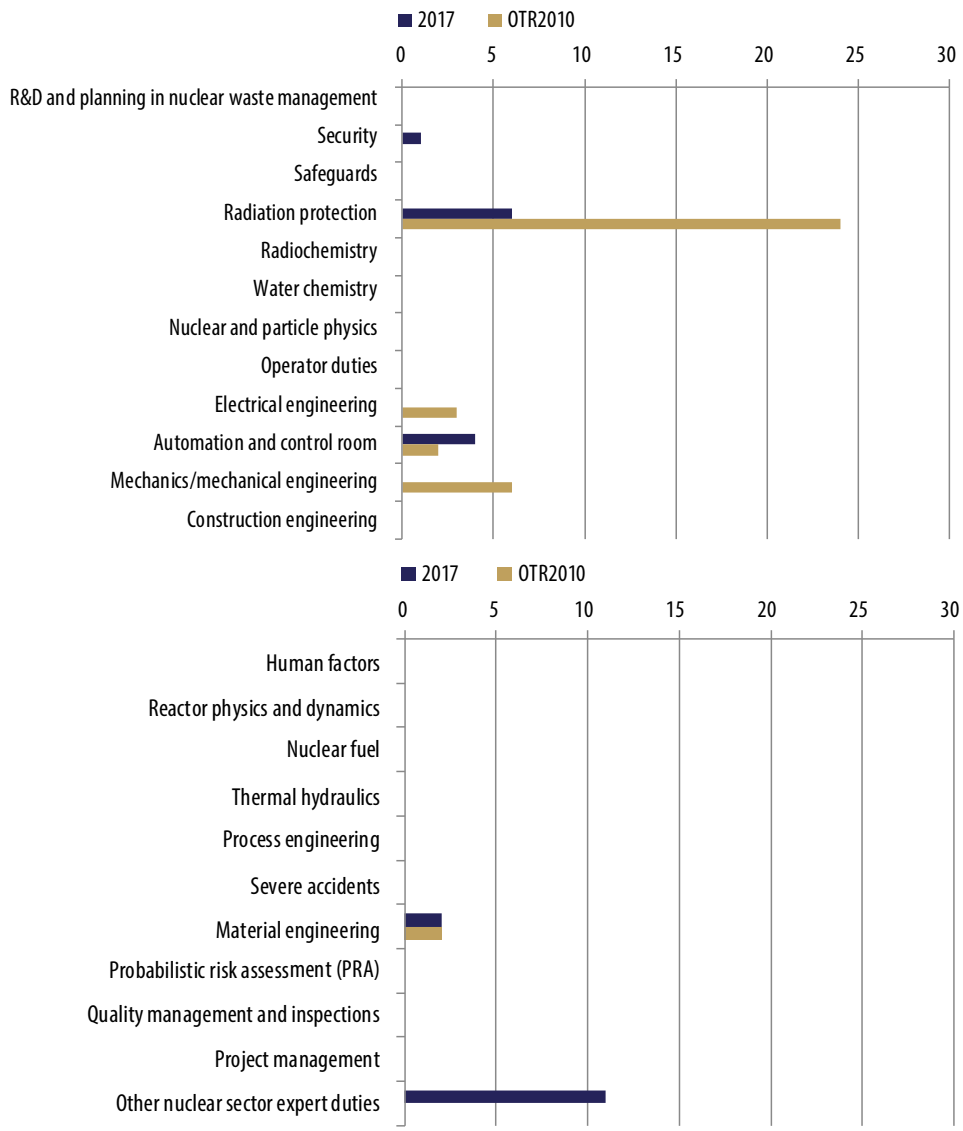

Figure 2.18 Number of experts with Bachelor's degree by area of competence in 2017 and 2010. Group 2: public authorities (STUK and MEAE).

The number of Bachelor's degree-holders is highest in the area of other duties (Figure 2.19).

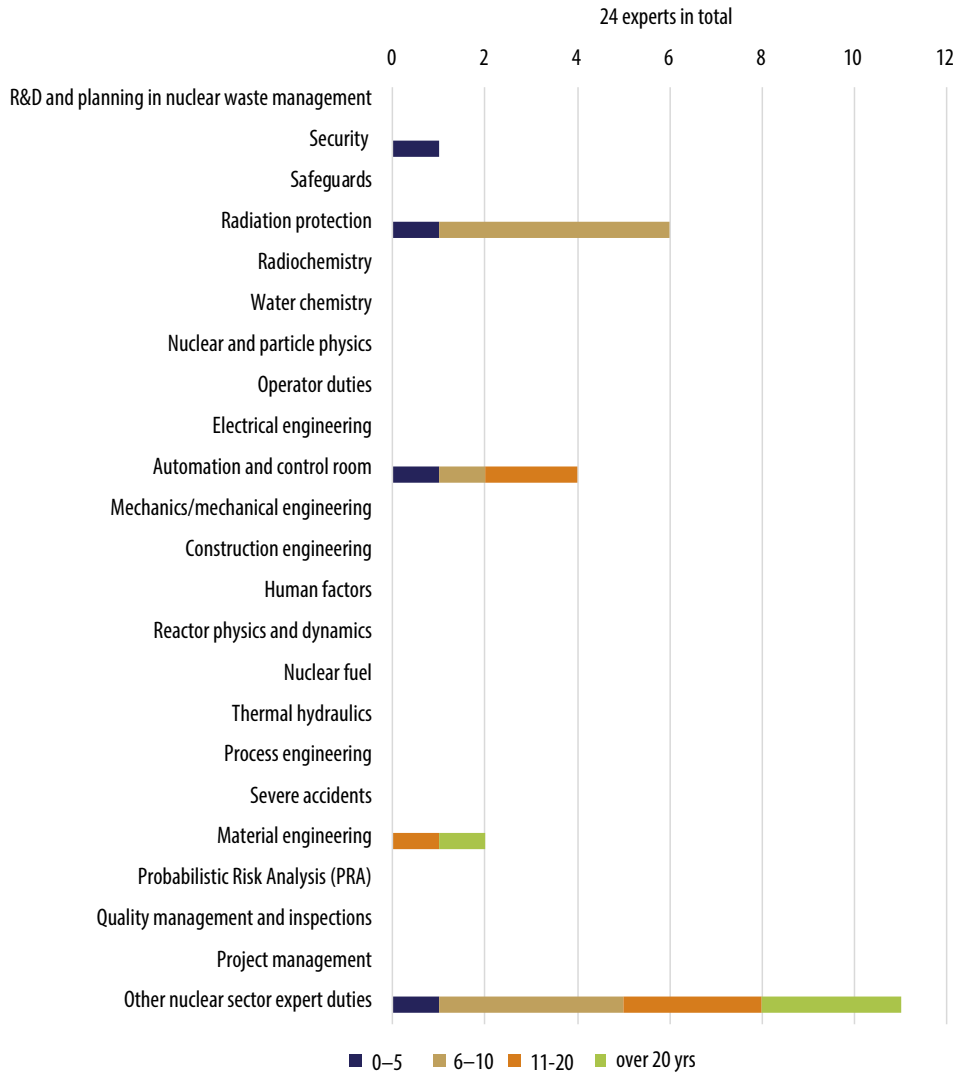

Figure 2.19 Number of experts with Bachelor's degree by area of competence and years of experience (0–5 years, 6–10 years, 11–20 years and over 20 years in the nuclear energy sector). Group 2: public authorities (STUK and MEAE).

2.3.4 Secondary-level vocational qualifications

In 2010, there were only 5 secondary-level vocational qualification-holders in the group consisting of public authorities (STUK and MEAE). In 2017, this group did not include any secondary-level vocational qualification-holders.

2.4 Universities and research institutes

2.4.1 Distribution by experience and comparison with the 2010 competence survey

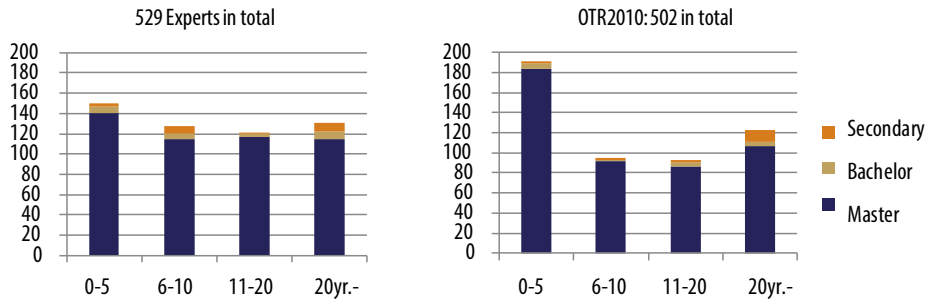

Figure 2.20 Number of experts by years of experience (0–5 years, 6–10 years, 11–20 years and over 20 years in the nuclear energy sector) and by educational qualification (secondary-level vocational qualification, Bachelor's degree and Master's degree) in 2017 (left) and 2010 (right). Group 3: universities and research institutes.

The universities and research institutes (as well as three universities of applied sciences) reported a total of 529 experts, amounting to 27 (5%) more than in the 2010 survey (502). The distribution by years of experience has almost levelled off from the previous bimodal pattern, concentrating around younger experts to a lesser extent than before (Figure 2.20).

Of the whole, Master's degree-holders account for 92%, while holders of Bachelor's degree and secondary-level vocational qualifications account for 4% each.

2.4.2 Master's degree

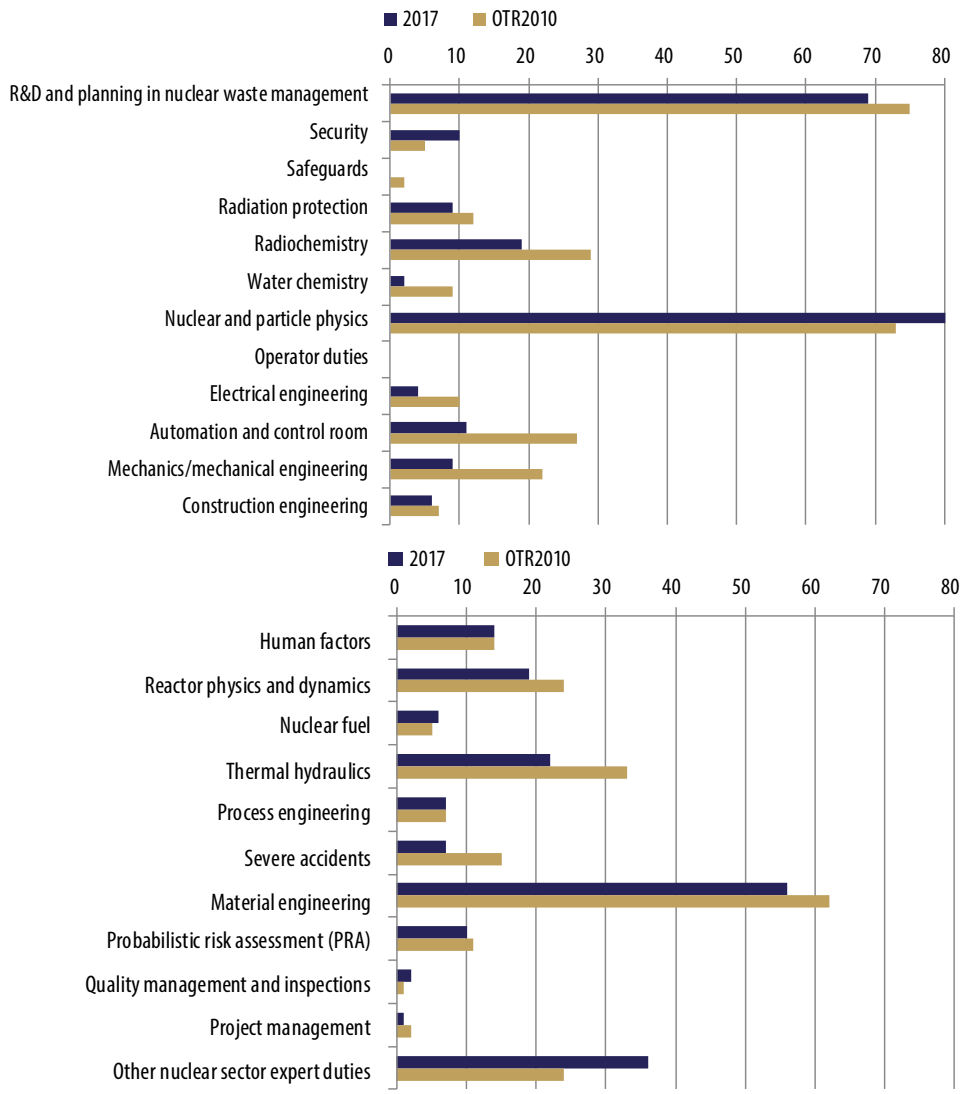

Figure 2.21 Number of experts with Master's degree by area of competence in 2017 and 2010. The total number of Master's degree-holders in the 'nuclear and particle physics' group in 2017 was 168 (the bar in the figure extends beyond the scale). Group 3: universities and research institutes.

In total, there are 487 Master's degree-holders, which amounts to 18 individuals (4%) more than in 2010 (469). The largest increases are in the following competence areas (Figure 2.21): nuclear and particle physics (an addition of 95 individuals); other duties.

The number of experts has decreased the most in the following areas: automation and control room; mechanics/mechanical engineering; thermal hydraulics; radiochemistry.

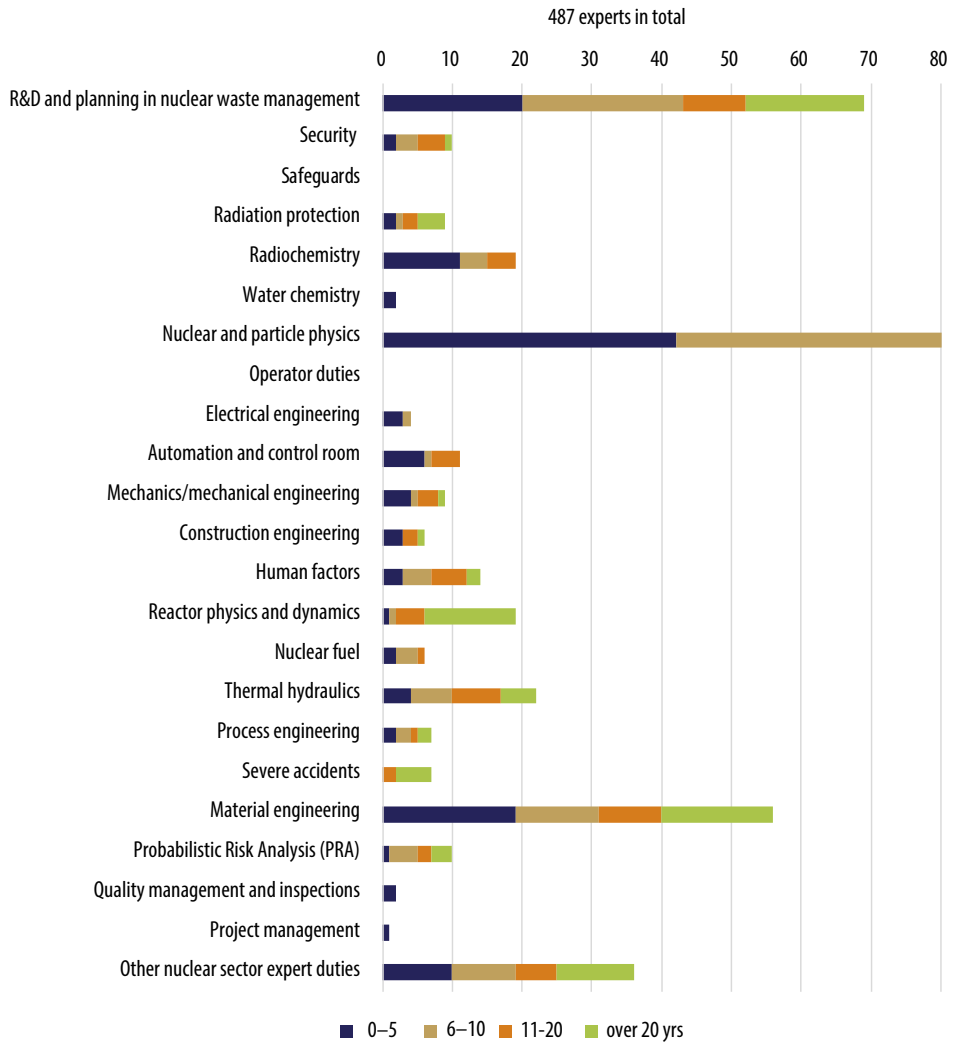

Figure 2.22 Number of experts with Master's degree by area of competence and years of experience (0–5 years, 6–10 years, 11–20 years and over 20 years in the nuclear energy sector). The total number of Master's degree-holders in the 'nuclear and particle physics' group was 168 (42 with 0–5 years, 40 with 6–10 years, 52 with 11–20 years; 34 with over 20 years of experience; the bar in the figure extends beyond the scale). Group 3: universities and research institutes.

The number of experts holding a Master's degree is highest in the following areas (Figure 2.22): nuclear and particle physics; R&D and planning in nuclear waste management; material engineering; other duties.

2.4.3 Bachelor's degree

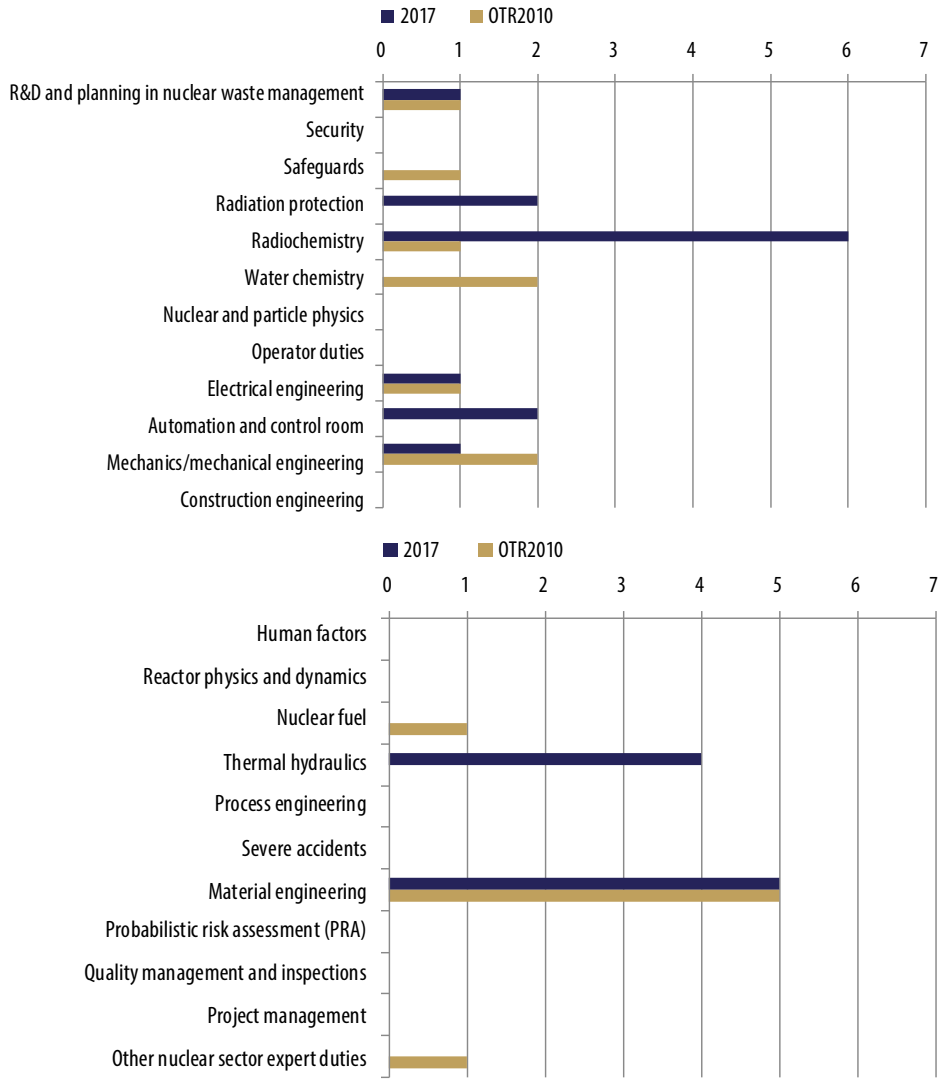

Figure 2.23 Number of experts with Bachelor's degree by area of competence in 2017 and 2010. Group 3: universities and research institutes.

In total, there are only 22 Bachelor's degree-holders, which amounts to 7 individuals (47%) more than in 2010 (15), and they are distributed into a larger number of competence areas (Figures 2.23 and 2.24).

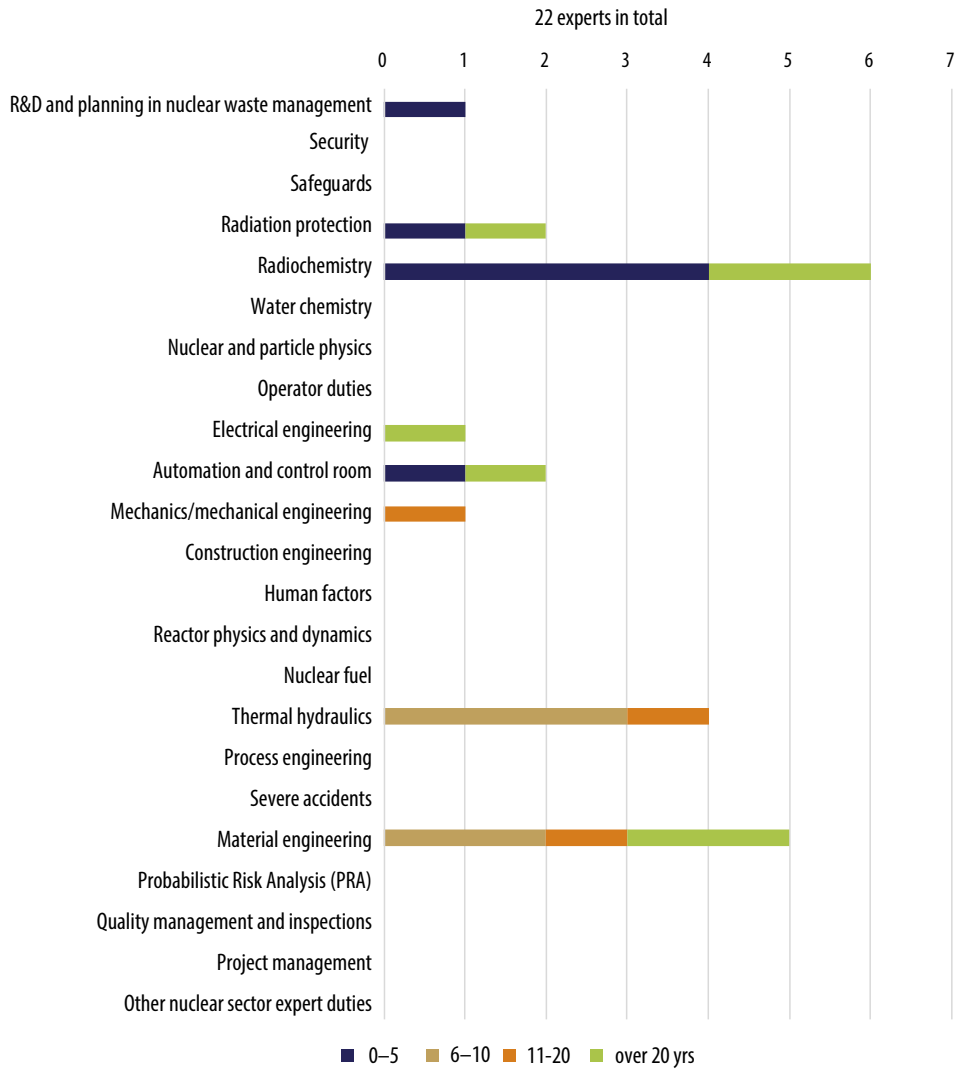

Figure 2.24 Number of experts with Bachelor's degree by area of competence and years of experience (0–5 years, 6–10 years, 11–20 years and over 20 years in the nuclear energy sector). Group 3: universities and research institutes.

2.4.4 Secondary-level vocational qualifications

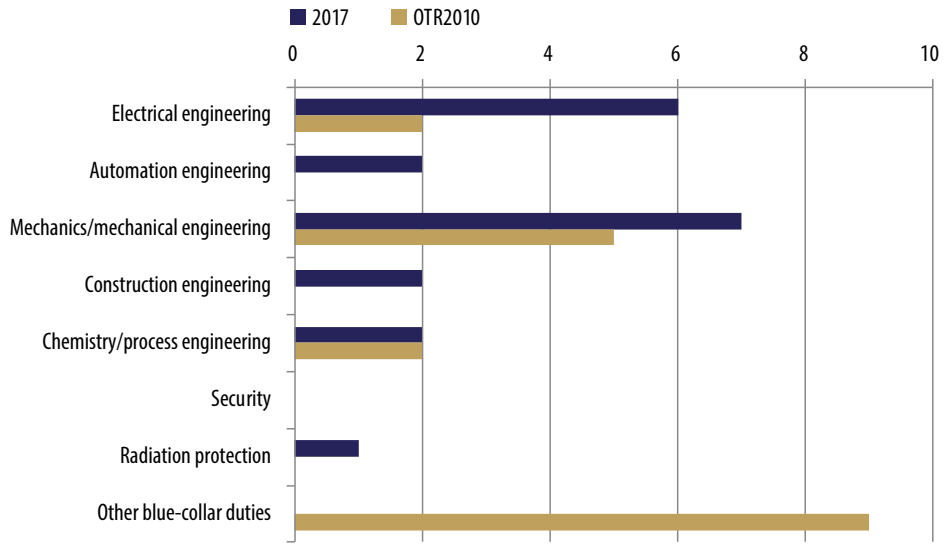

Figure 2.25 Number of experts with secondary-level vocational qualifications by area of competence in 2017 and 2010. Group 3: universities and research institutes.

In total, there are only 20 secondary-level vocational qualification-holders, which amounts to 2 individuals (11%) more than in 2010 (18), and they are distributed into a larger number of competence areas (Figures 2.25 and 2.26).

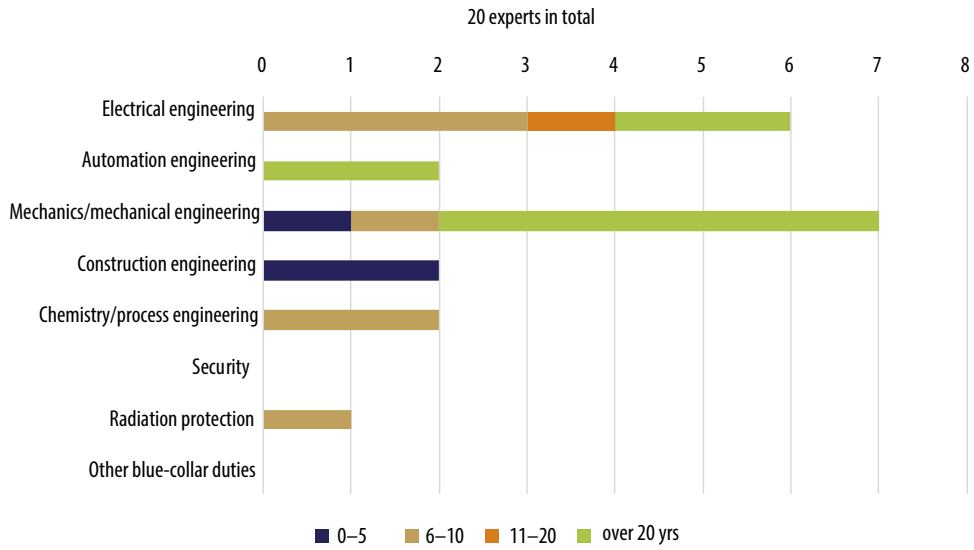

Figure 2.26 Number of experts with secondary-level vocational qualifications by area of competence and years of experience (0–5 years, 6–10 years, 11–20 years and over 20 years in the nuclear energy sector). Group 3: universities and research institute.

2.5 Other industrial companies

2.5.1 Distribution by experience

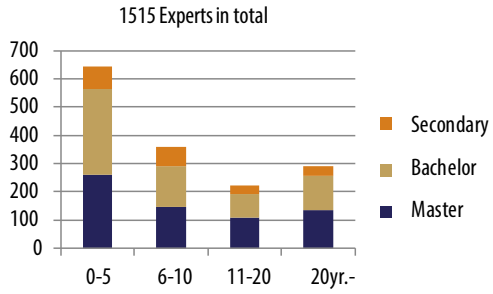

Figure 2.27 Number of experts by years of experience (0–5 years, 6–10 years, 11–20 years and over 20 years in the nuclear energy sector) and by educational qualification (secondary-level vocational qualification, Bachelor's degree and Master's degree) in 2017. Group 4: other industrial companies.

Other industrial companies reported a total of 1,515 experts, amounting to 576 (29%) more than in the 2010 survey (939, calculated from the results of the report [1]). As the report of the OTR2010 competence survey [1] did not cover detailed data on group 4, a more specific comparison with the results of the previous survey will not be provided. In the same vein as the above-mentioned report, it should be noted here that not all companies operating in the sector responded to the 2017 survey, which means that the results are not fully comprehensive in terms of these companies.

The distribution by years of experience is slightly bimodal, concentrating around younger experts (Figure 2.27).

The proportion of Bachelor's degree-holders is highest among recent entrants to the sector (47% with 0–5 years of experience).

Of the whole, Master's and Bachelor's degree-holders account for 43% each, while the remaining 14% have a secondary-level vocational qualification. The number of both Master's and Bachelor's degree-holders reported in the survey was 651 (see Table 2.1). The figure was derived as a result of two different addition operations, and both sums were checked against the responses using two computing methods.

2.5.2 Master's degree

In total, there are 651 Master's degree-holders. The number of experts holding a Master's degree is highest in the following areas (Figure 2.28): construction engineering; mechanics and mechanical engineering; other duties; project management; quality management and inspections.

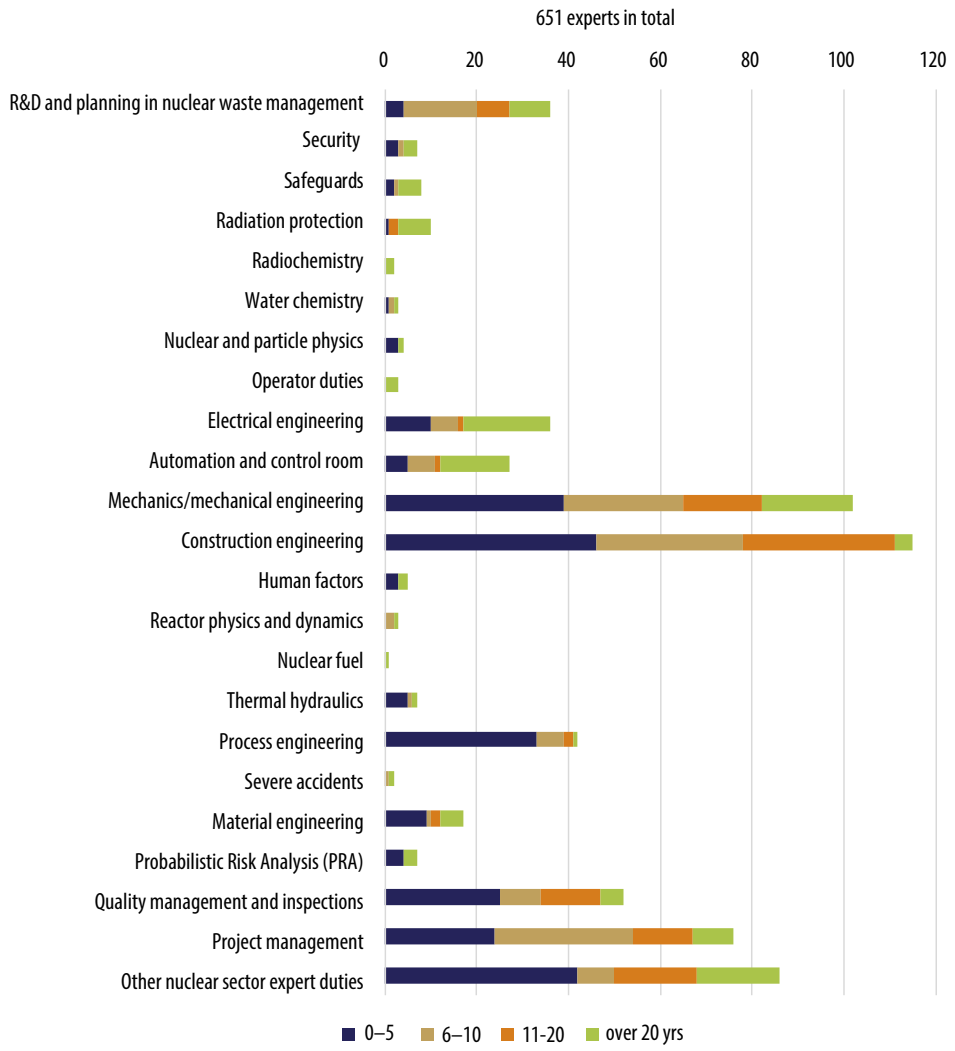

Figure 2.28 Number of experts with Master's degree by area of competence and years of experience (0–5 years, 6–10 years, 11–20 years and over 20 years in the nuclear energy sector). Group 4: other industrial companies.

2.5.3 Bachelor's degree

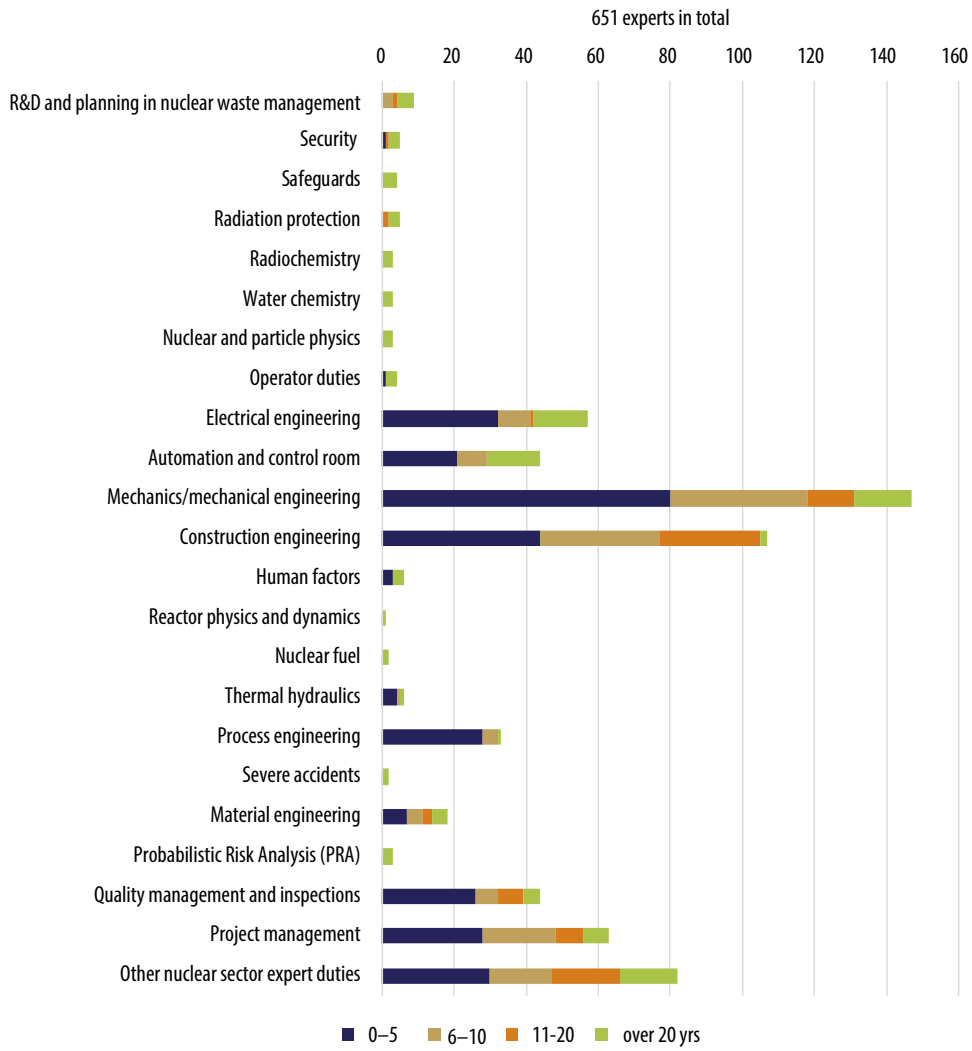

Figure 2.29 Number of experts with Bachelor's degree by area of competence and years of experience (0–5 years, 6–10 years, 11–20 years and over 20 years in the nuclear energy sector). Group 4: other industrial companies.

In total, there are 651 Bachelor's degree-holders. The number of experts holding a Bachelor's degree is highest in the following areas (Figure 2.29): mechanics and mechanical engineering; construction engineering; other duties; project management.

2.5.4 Secondary-level vocational qualifications

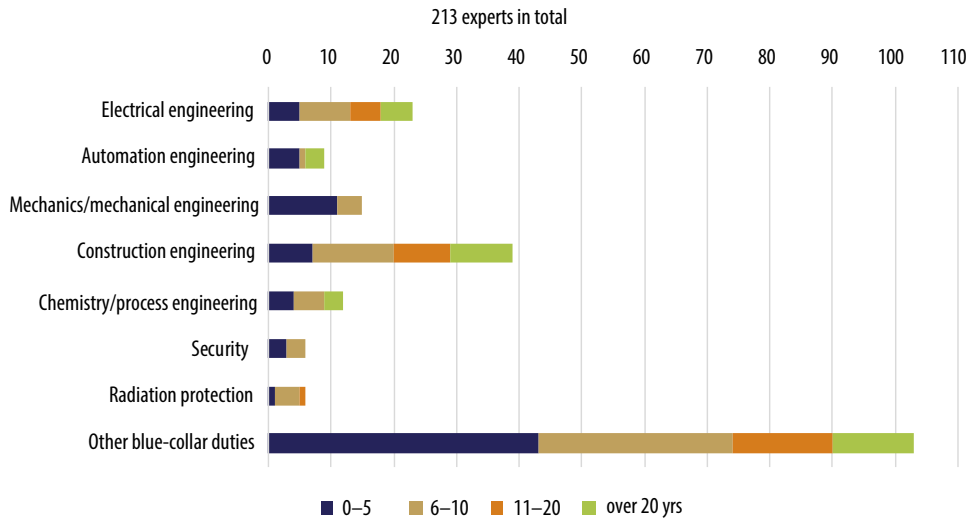

Figure 2.30 Number of experts with secondary-level vocational qualifications by area of competence and years of experience (0–5 years, 6–10 years, 11–20 years and over 20 years in the nuclear energy sector). Group 4: other industrial companies.

In total, there are 213 secondary-level vocational qualification-holders. The number of secondary-level vocational qualification-holders is highest in the following areas (Figure 2.30): other duties; construction engineering.

3 Future personnel needs within the nuclear energy sector

This chapter outlines the estimated demand for nuclear energy sector personnel for 2020, 2025 and 2030 and compares the estimates with those of the OTR2010 survey conducted in 2010 [1].

Personnel needs are analysed as a whole (all respondents) and by group (groups 1–4). The estimates take account of the relevant educational and competence requirements.

3.1 All respondents

3.1.1 Future personnel needs and comparison with the 2010 estimate

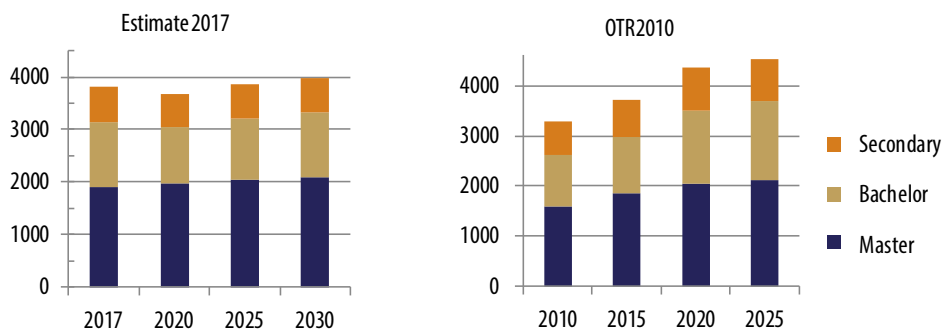

Figure 3.1 Number of experts in 2017 (left) and 2010 (right) and estimated demand for future years by educational qualification (secondary-level vocational qualification, Bachelor's degree and Master's degree). All respondents.

Demand for experts is estimated to decrease slightly in the near future, followed by a slight upturn (Figure 3.1). The previous survey (OTR2010) predicted a clear growth. Table 3.1 shows the results of the 2017 survey in numerical terms.

Table 3.1 Breakdown of estimated demand for nuclear energy sector personnel by educational qualification required (secondary-level vocational qualification, Bachelor's degree and Master's degree). All respondents.

Qualification	2017	2020	2025	2030
Master	1895	1967	2032	2085
Bachelor	1232	1083	1183	1231
Secondary	680	622	656	665
Total	3807	3672	3871	3981

Demand for personnel is estimated to be 3,981 in 2030, which is 5% higher than the number of personnel in 2017 (Table 3.1). The current experts with Bachelor's degree and secondary-level vocational qualifications are expected to suffice, while additional demand consists of Master's degree-holders. The number of Master's degree-holders should increase by 190 individuals, i.e., 10% on the current level.

The number of experts in 2017 (3,807) was 90 individuals (2%) more than the previous OTR2010 survey predicted for 2015 (3,717; Figure 3.1). The 2010 survey estimated that personnel needs would amount to 4,353 in 2020 and 4,522 in 2025 [1]. The equivalent figures in this survey are 3,672 and 3,871, i.e., 16% and 14% lower, respectively.

In particular, future demand for employees with Bachelor's degree and secondary-level vocational qualifications has now been estimated to be clearly lower than in 2010. In 2010, demand for Bachelor's degree-holders was expected to be 1,573 in 2025, whereas the 2017 estimate puts the figure at 1,183, i.e., 25% lower. In 2010, demand for secondary-level vocational qualification-holders was expected to be 832 in 2025, whereas the 2017 estimate puts the figure at 656, i.e., 21% lower.

The 2010 survey predicted that demand for Master's degree-holders would be 2,047 in 2020 and 2,117 in 2025. The present estimates for the same years are 1,967 and 2,032, i.e., 4% lower in both cases.

3.1.2 Master's degree

In the future, additional demand for experts holding a Master's degree is estimated to be highest in the following areas (Figure 3.2): R&D and planning in nuclear waste management; nuclear and particle physics; automation and control room; electrical engineering; process engineering; operator duties.

Most of the operators currently working at plants hold a Bachelor's degree (see Sections 2.1.3 and 3.1.3). According to the results, demand for operators with Master's degree has been estimated to increase (but not for those with Bachelor's degree, contrary to the 2010 estimate). Most of the new operators will be required for the plants currently being planned and constructed, and their qualification requirements will be confirmed when it is time for recruitment.

Demand for experts is estimated to decrease the most in the following areas: mechanics and mechanical engineering; other duties.

Other duties mentioned included the following areas: licensing; systems engineering; information security; extensive expert duties; management duties; administration; communications; HPAC; geology; fusion.

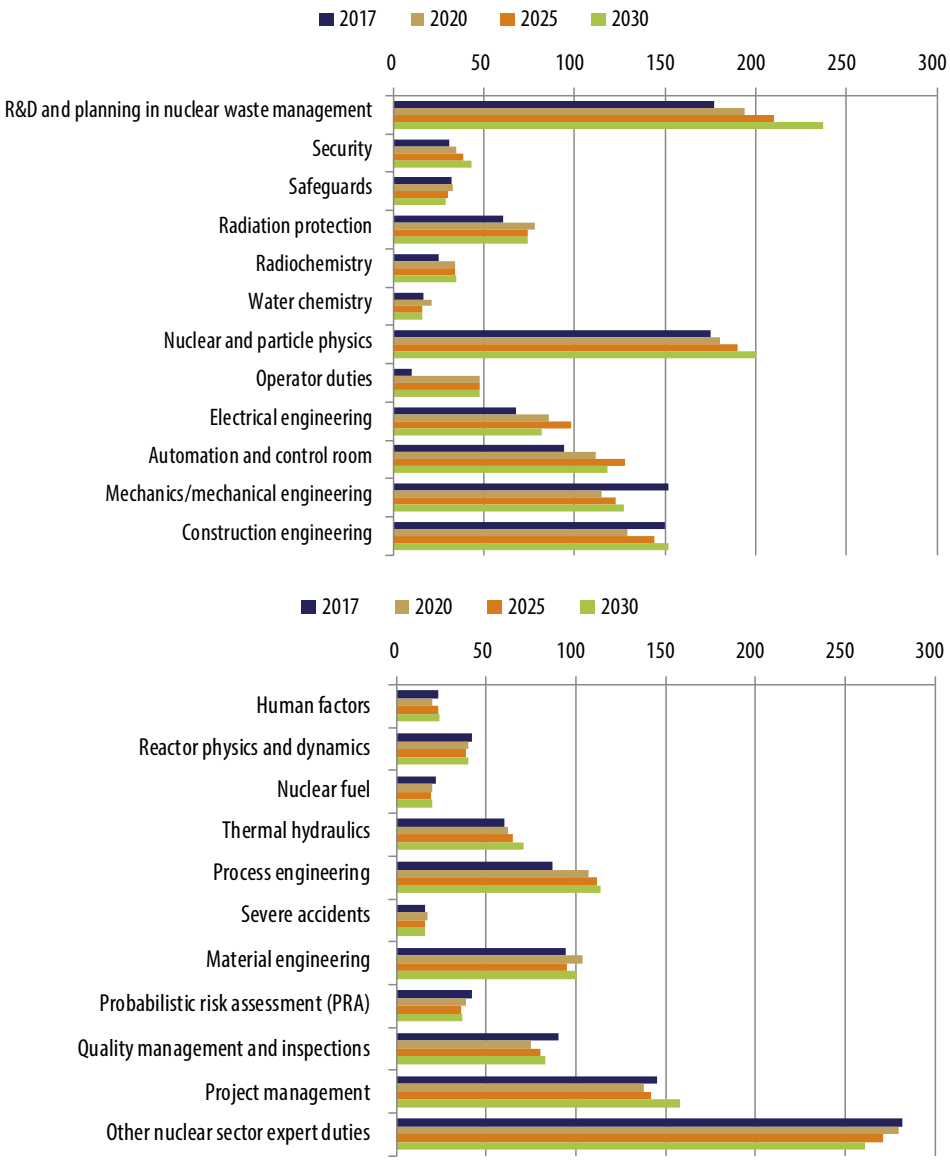

Figure 3.2 Number of experts with Master's degree in 2017 and estimated future demand in 2020, 2025 and 2030 by area of competence. All respondents.

3.1.3 Bachelor's degree

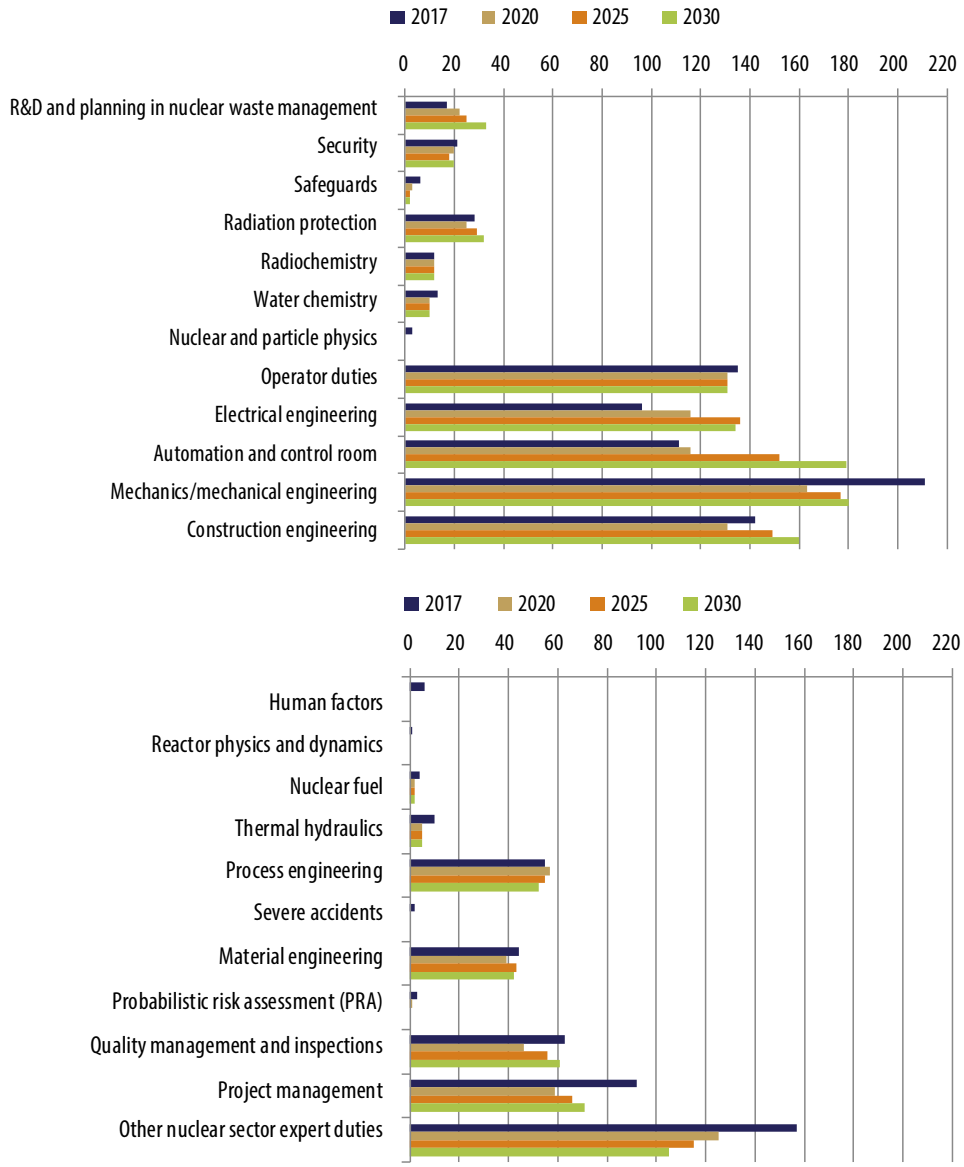

Figure 3.3 Number of experts with Bachelor's degree in 2017 and estimated future demand in 2020, 2025 and 2030 by area of competence. All respondents.

In the future, additional demand for experts holding a Bachelor's degree is estimated to be highest in the following areas (Figure 3.3): electrical engineering; automation and control room. The following areas are expected to face declining demand: mechanics and mechanical engineering; project management; and other duties. With regard to demand for operators, please refer to Section 3.1.2.

Other duties mentioned included the following areas: maintenance; information technology; HR duties; communications; procurement; ancillary administrative and management support duties; official duties; environmental engineering; construction. The responses indicated that a Bachelor's degree is suitable for many of the other duties described in Section 3.1.2.

3.1.4 Secondary-level vocational qualifications

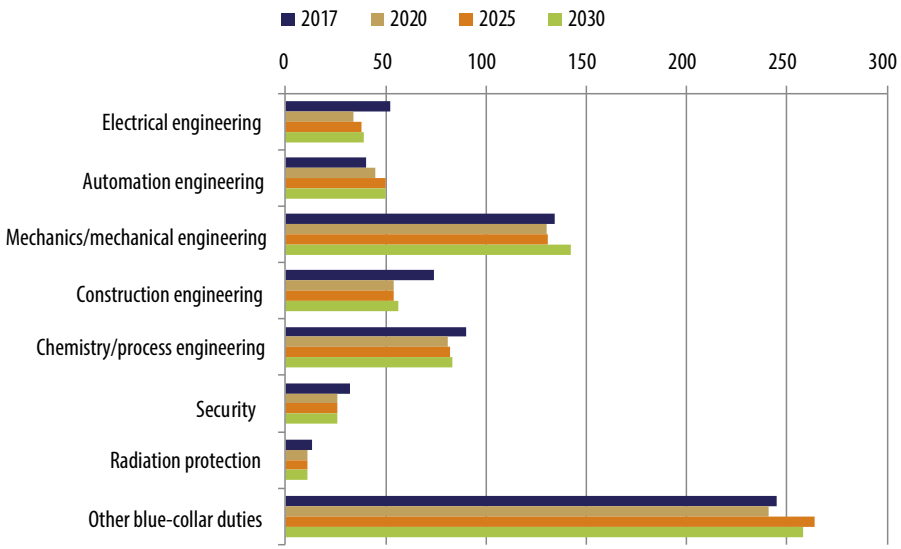

Figure 3.4 Number of experts with secondary-level vocational qualifications in 2017 and estimated future demand in 2020, 2025 and 2030 by area of competence. All respondents.

With regard to secondary-level vocational qualification-holders, none of the competence areas is expected to see any major changes in personnel needs by 2030 (Figure 3.4). Demand for experts in construction engineering is estimated to decrease the most.

Other duties mentioned included the following areas: project management; maintenance; HPAC; installation duties; operator functions; inspections; document management; technical documentation; material engineering.

3.2 Power companies and Posiva

3.2.1 Future personnel needs and comparison with the 2010 estimate

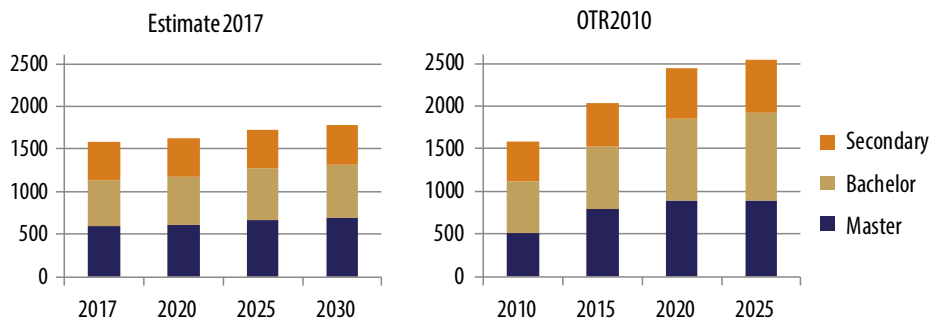

Figure 3.5 Number of experts in 2017 (left) and 2010 (right) and estimated demand for future years by educational qualification (secondary-level vocational qualification, Bachelor's degree and Master's degree). Group 1: power companies and Posiva.

Demand for experts is estimated to increase in the near future (Figure 3.5). The previous survey (OTR2010) predicted a clearly higher growth. Table 3.2 shows the results of the 2017 survey in numerical terms.

Table 3.2 Breakdown of estimated demand for nuclear energy sector personnel by educational qualification required (secondary-level vocational qualification, Bachelor's degree and Master's degree). Group 1: power companies and Posiva.

Qualification	2017	2020	2025	2030
Master	597	617	670	701
Bachelor	535	553	599	621
Secondary	447	458	463	463
Total	1579	1628	1732	1785

Demand for personnel is estimated to be 1,785 in 2030, which is 13% higher than the number of personnel in 2017 (Table 3.2). The current number of personnel with secondary-level vocational qualifications is expected to be almost sufficient, while additional demand mainly consists of Bachelor's and Master's degree-holders. The number of Master's and Bachelor's degree-holders should increase by 104 individuals (17%) and 86 individuals (16%), respectively, on the current levels.

The number of experts in 2017 (1,579) was 454 individuals (22%) fewer than the previous OTR2010 survey predicted for 2015 (2,033; Figure 3.5). The 2010 survey estimated that personnel needs would amount to 2,451 in 2020 and 2,540 in 2025 [1]. The equivalent figures in this survey are 1,628 and 1,732, i.e., 34% and 32% lower, respectively.

In particular, future demand for employees with Bachelor's degree has now been estimated to be clearly lower than in 2010. In 2010, demand for Bachelor's degree-holders was expected to be 1,032 in 2025, whereas the 2017 estimate puts the figure at 599, which is 42% lower. In 2010, demand for secondary-level vocational qualification-holders was expected to be 618 in 2025, whereas the 2017 estimate puts the figure at 463, which is 25% lower.

The 2010 survey estimated that demand for Master's degree-holders would be 895 in 2020 and 890 in 2025. The present estimates for the same years are 617 and 670, i.e., 31% and 25% lower, respectively.

3.2.2 Master's degree

In the future, additional demand for experts holding a Master's degree is estimated to be highest in the following areas (Figure 3.6): automation and control room; R&D and planning in nuclear waste management; operator duties. With regard to the relatively high additional demand for operators, please refer to Section 3.1.2.

While demand for experts is estimated to decrease in some areas, no single area is expected to see any particularly considerable decline.

3.2.3 Bachelor's degree

In the future, additional demand for experts holding a Bachelor's degree is estimated to be highest in the following areas (Figure 3.7): automation and control room; radiation protection; project management.

The area of other duties is expected to face declining demand. With regard to demand for operators, please refer to Figures 3.2 and 3.6 and to Section 3.1.2.

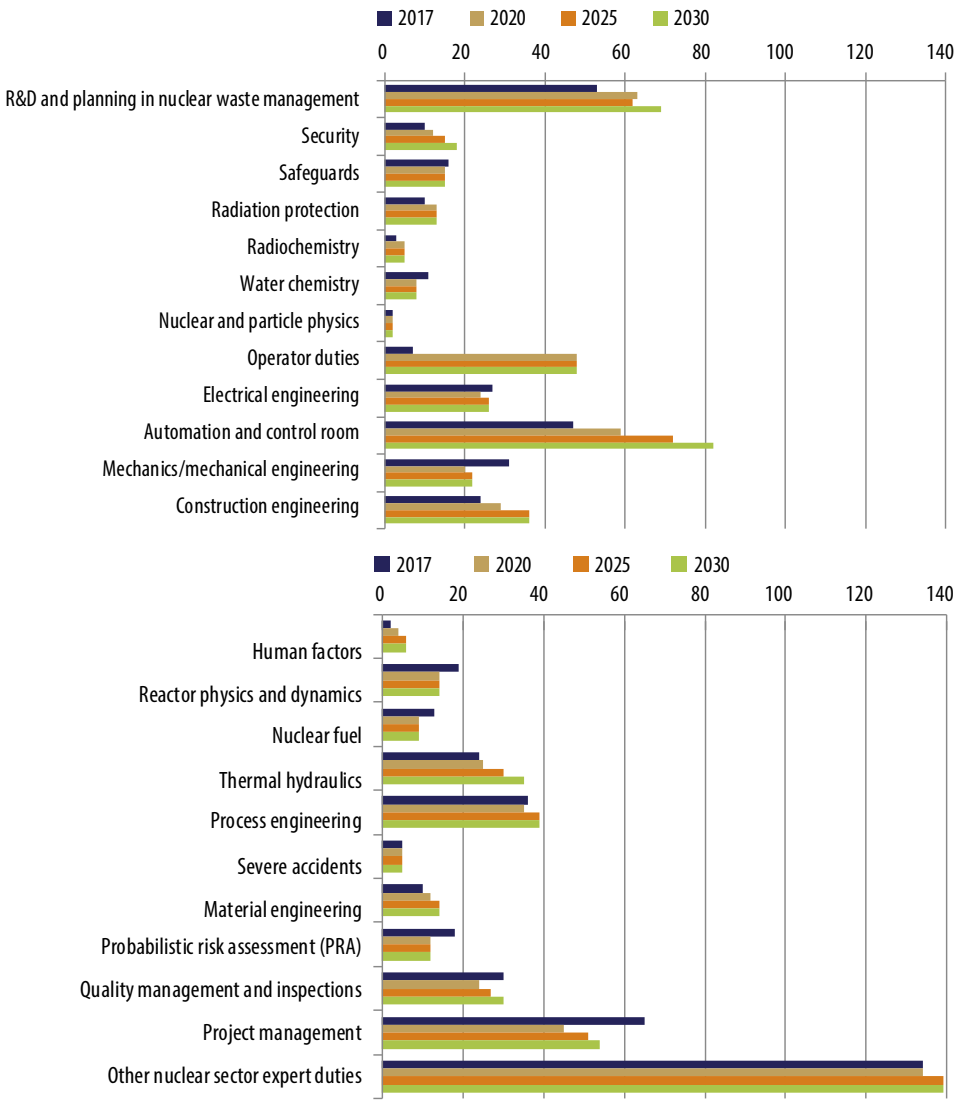

Figure 3.6 Number of experts with Master's degree in 2017 and estimated future demand in 2020, 2025 and 2030 by area of competence. Group 1: power companies and Posiva.

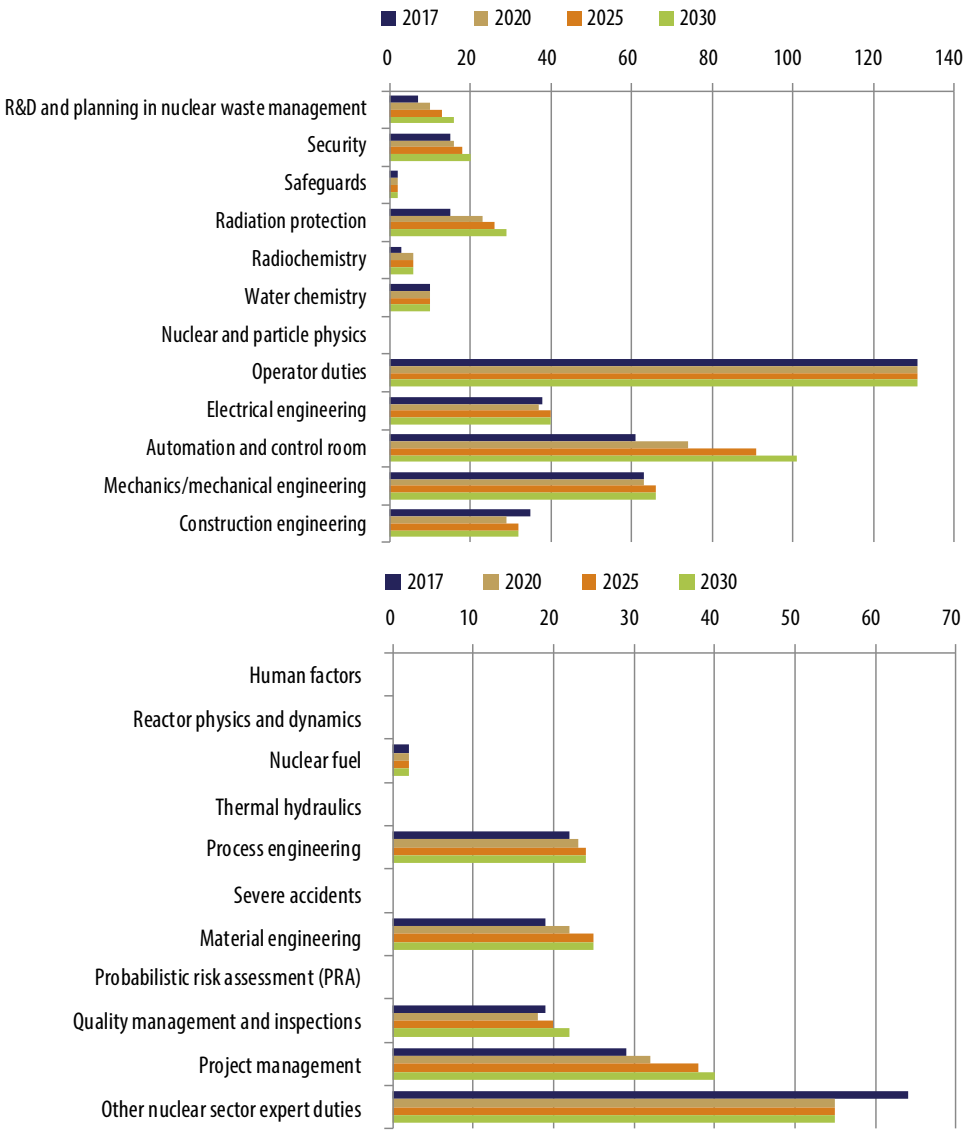

Figure 3.7 Number of experts with Bachelor's degree in 2017 and estimated future demand in 2020, 2025 and 2030 by area of competence. The scale in the top figure (max 140) is twice as large as the scale in the bottom figure (max 70). Group 1: power companies and Posiva.

3.2.4 Secondary-level vocational qualifications

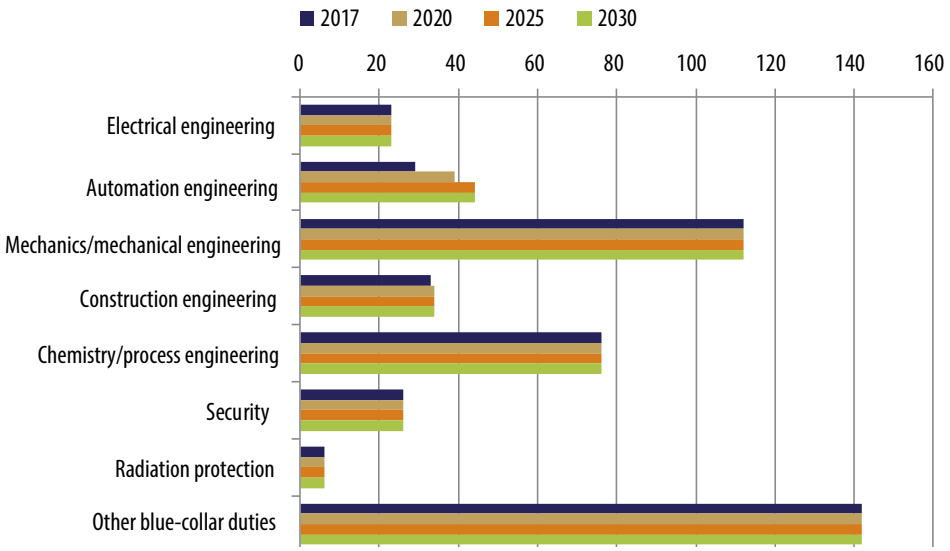

Figure 3.8 Number of experts with secondary-level vocational qualifications in 2017 and estimated future demand in 2020, 2025 and 2030 by area of competence. Group 1: power companies and Posiva.

In the future, additional demand for experts holding a secondary-level vocational qualification is estimated to be highest in the area of automation engineering (Figure 3.8). With regard to the other areas, the current personnel levels are expected to be adequate in the future as well.

3.3 Public authorities (STUK and MEAE)

3.3.1 Future personnel needs and comparison with the 2010 estimate

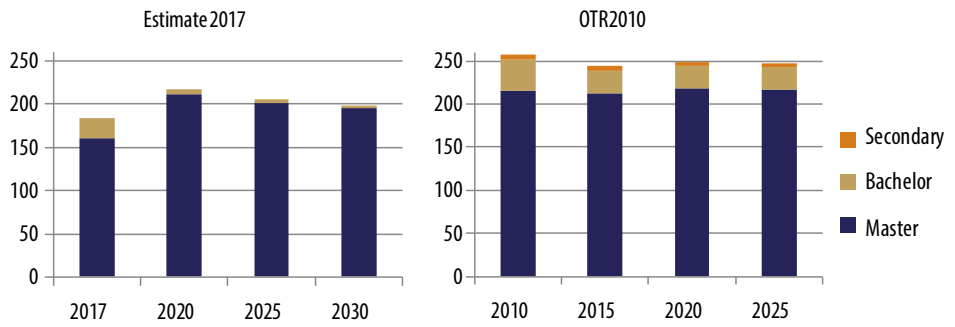

Figure 3.9 Number of experts in 2017 (left) and 2010 (right) and estimated demand for future years by educational qualification (secondary-level vocational qualification, Bachelor's degree and Master's degree). Group 2: public authorities (STUK and MEAE).

Demand for experts is estimated to increase slightly in the near future (Figure 3.9). The previous survey (OTR2010) estimated that the number of experts would remain more or less unchanged in the near future, but at a higher level than the current personnel number (see Section 2.3.1). Table 3.3 shows the results of the 2017 survey in numerical terms.

Table 3.3 Breakdown of estimated demand for nuclear energy sector personnel by educational qualification required (secondary-level vocational qualification, Bachelor's degree and Master's degree). Group 2: public authorities (STUK and MEAE).

Qualification	2017	2020	2025	2030
Master	160	212	201	195
Bachelor	24	5	5	4
Secondary	0	0	0	0
Total	184	217	206	199

Demand for personnel is estimated to be 199 in 2030, which is 8% higher than the number of personnel in 2017 (Table 3.3). There are no employees with secondary-level vocational qualifications in group 2; nor is it expected to see any demand for them in the future. Demand for Bachelor's degree-holders is estimated to decline. The number of Master's degree-holders should increase by 35 individuals, i.e., 22% on the current level.

Demand for Master's degree-holders is estimated to be 212 in 2020, followed by a slight decline. When compared with the number of personnel in 2017, additional demand amounts to 52 individuals (33%), which means that recruitment needs will be relatively high over the three-year period.

The number of experts in 2017 (184) was 60 individuals (25%) fewer than the previous OTR2010 survey predicted for 2015 (244; Figure 3.9). The 2010 survey estimated that personnel needs would amount to 249 in 2020 and 248 in 2025 [1]. The equivalent figures in this survey are 217 and 206, i.e., 13% and 17% lower, respectively.

In particular, future demand for employees with Bachelor's degree and secondary-level vocational qualifications has now been estimated to be clearly lower than it was estimated in 2010. In 2010, demand for Bachelor's degree-holders was expected to be 26 in 2025, whereas the 2017 estimate puts the figure at only 5 individuals. In 2010, demand for secondary-level vocational qualification-holders was expected to be 5 in 2025, whereas the 2017 estimate does not project any further demand.

The 2010 survey estimated that demand for Master's degree-holders would be 218 in 2020 and 217 in 2025. The present estimates for the same years are 212 and 201, i.e., 3% and 7% lower, respectively.

3.3.2 Master's degree

In the future, additional demand for experts holding a Master's degree is estimated to be highest in the following areas (Figure 3.10): radiation protection; other duties. No single area is expected to see any significant decline.

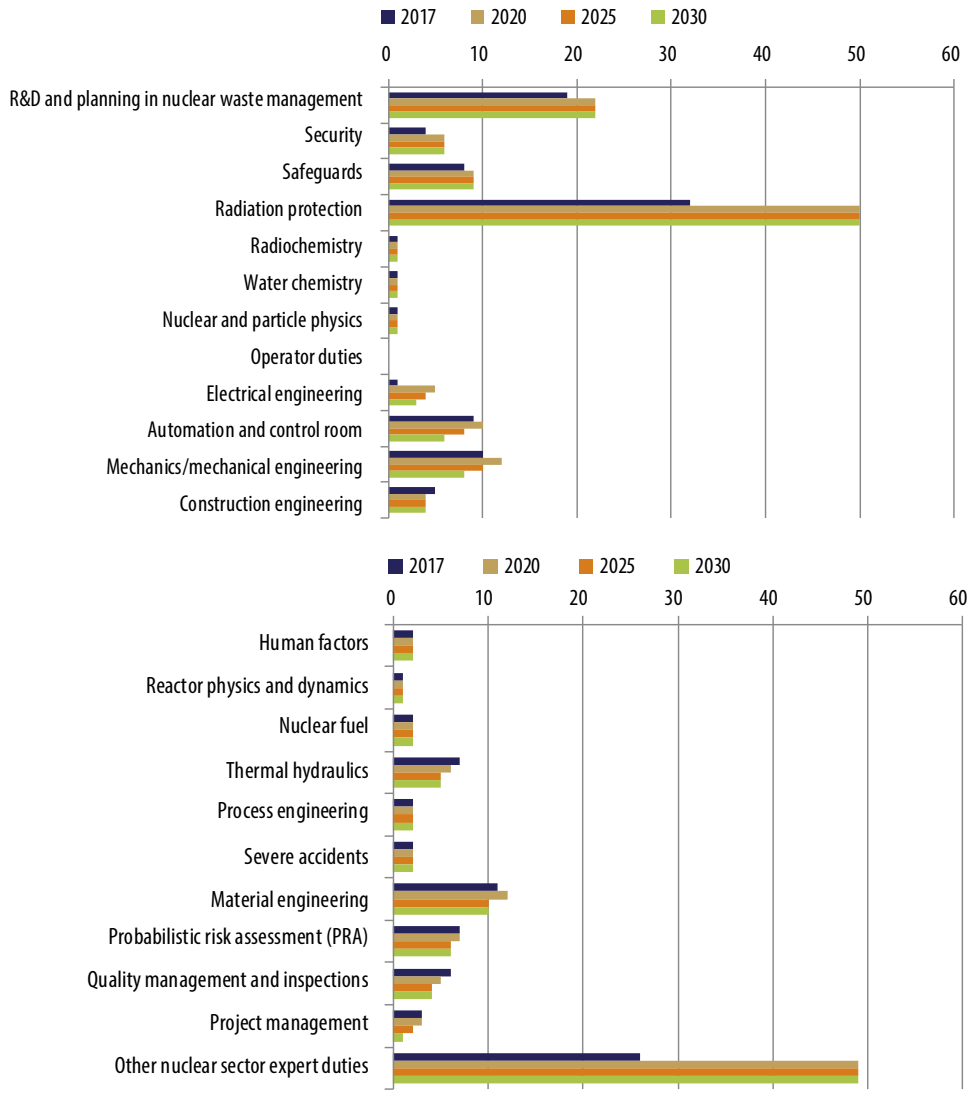

Figure 3.10 Number of experts with Master's degree in 2017 and estimated future demand in 2020, 2025 and 2030 by area of competence. Group 2: public authorities (STUK and MEAE).

3.4 Universities and research institutes

3.4.1 Future personnel needs and comparison with the 2010 estimate

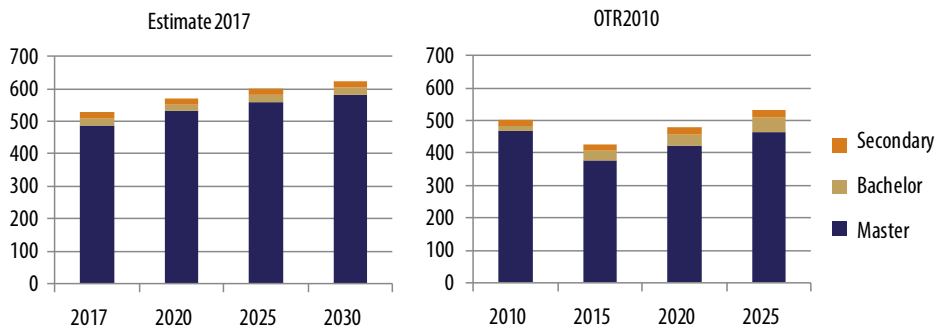

Figure 3.11 Number of experts in 2017 (left) and 2010 (right) and estimated demand for future years by educational qualification (secondary-level vocational qualification, Bachelor's degree and Master's degree). Group 3: universities and research institutes.

Demand for experts is estimated to increase in the near future (Figure 3.11). The previous survey (OTR2010) predicted clearly lower demand for experts. Table 3.4 shows the results of the 2017 survey in numerical terms.

Demand for personnel is estimated to be 625 in 2030, which is 18% higher than the number of personnel in 2017 (Table 3.4). The current experts with secondary-level vocational qualifications and Bachelor's degree are expected to suffice, while additional demand consists of Master's degree-holders. The number of Master's degree-holders should increase by 97 individuals (20%) on the current level.

Table 3.4 Breakdown of estimated demand for nuclear energy sector personnel by educational qualification required (secondary-level vocational qualification, Bachelor's degree and Master's degree). Group 3: universities and research institutes.

Qualification	2017	2020	2025	2030
Master	487	531	560	584
Bachelor	22	22	22	22
Secondary	20	19	19	19
Total	529	572	601	625

The number of experts in 2017 (529) was 104 individuals (24%) more than the previous OTR2010 survey predicted for 2015 (425; Figure 3.12). The 2010 survey estimated that personnel needs would amount to 479 in 2020 and 534 in 2025 [1]. The equivalent figures in this survey are 572 and 601, i.e., 19% and 13% higher, respectively.

While the experts with Bachelor's degree and secondary-level vocational qualifications are already few, future demand for employees in both groups has now been estimated to be even lower than in 2010. In 2010, demand for Bachelor's degree-holders was expected to be 46 in 2025, whereas the 2017 estimate puts the figure at 22, which is 52% lower. In 2010, demand for secondary-level vocational qualification-holders was expected to be 25 in 2025, whereas the 2017 estimate puts the figure at 19, which is 24% lower.

The 2010 survey estimated that demand for Master's degree-holders would be 424 in 2020 and 463 in 2025. The present estimates for the same years are 531 and 560, i.e., 25% and 21% higher, respectively

3.4.2 Master's degree

In the future, additional demand for experts holding a Master's degree is estimated to be highest in the following areas (Figure 3.12): nuclear and particle physics; material engineering; radiochemistry. None of the areas is expected to see any significant decline.

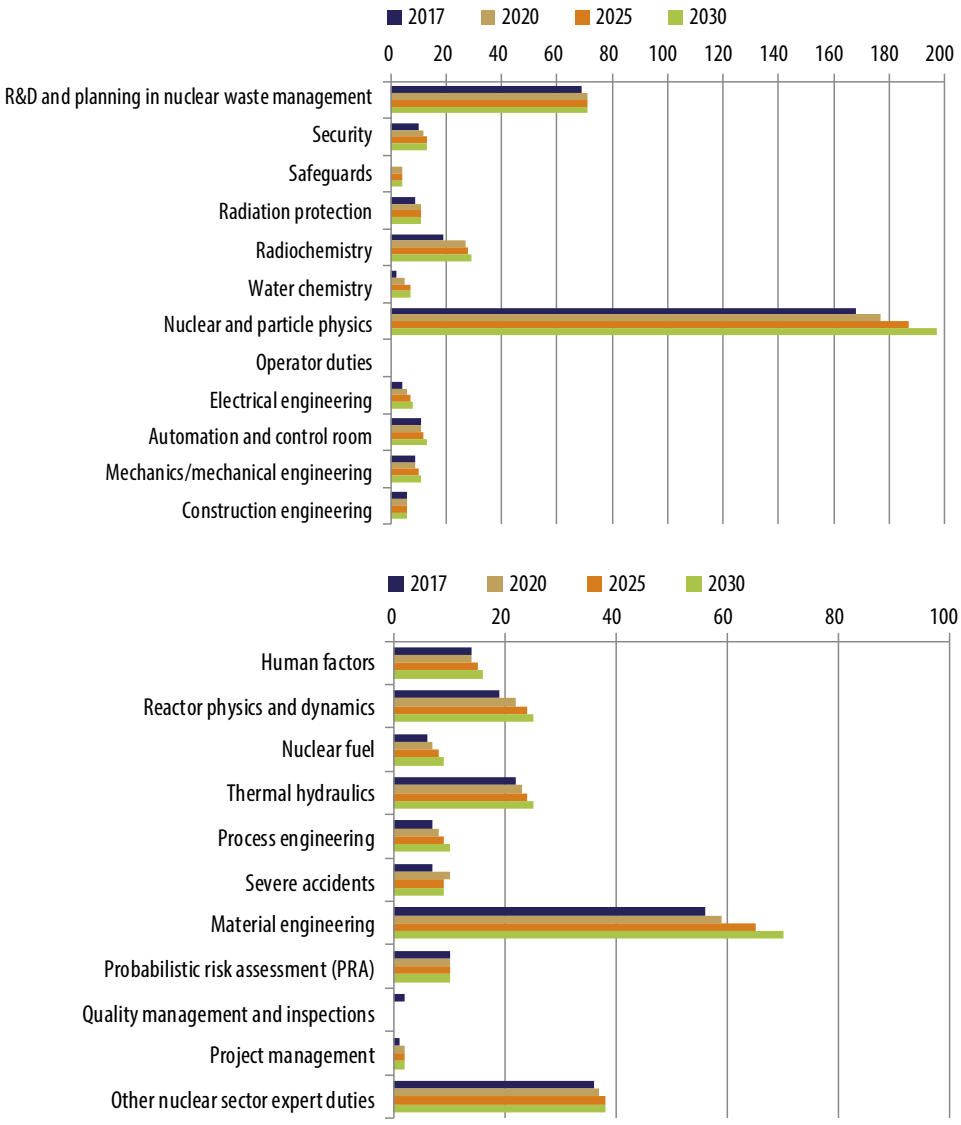

Figure 3.12 Number of experts with Master's degree in 2017 and estimated future demand in 2020, 2025 and 2030 by area of competence. The scale in the top figure (max 200) is twice as large as the scale in the bottom figure (max 100). Group 3: universities and research institutes.

3.5 Other industrial companies

3.5.1 Future personnel needs

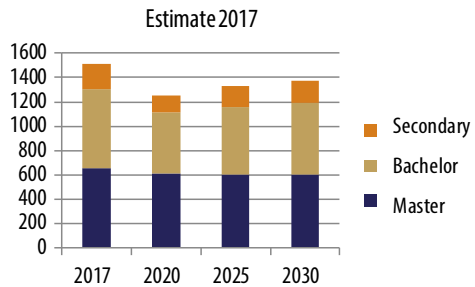

Figure 3.13 Number of experts in 2017 and estimated demand for future years by educational qualification (secondary-level vocational qualification, Bachelor's degree and Master's degree). Group 4: other industrial companies.

Demand for experts is estimated to decrease in the near future (Figure 3.13). Table 3.5 shows the results of the 2017 survey in numerical terms.

Table 3.5 Breakdown of estimated demand for nuclear energy sector personnel by educational qualification required (secondary-level vocational qualification, Bachelor's degree and Master's degree). Group 4: other industrial companies.

Qualification	2017	2020	2025	2030
Master	651	607	601	605
Bachelor	651	503	557	584
Secondary	213	145	174	183
Total	1515	1255	1332	1372

Demand for personnel is estimated to be 1,372 in 2030, which is 9% lower than the number of personnel in 2017 (Table 3.5). Estimated demand for holders of secondary-level vocational qualifications, Bachelor's degree and Master's degree will be 14%, 10% and 7% lower, respectively.

3.5.2 Master's degree

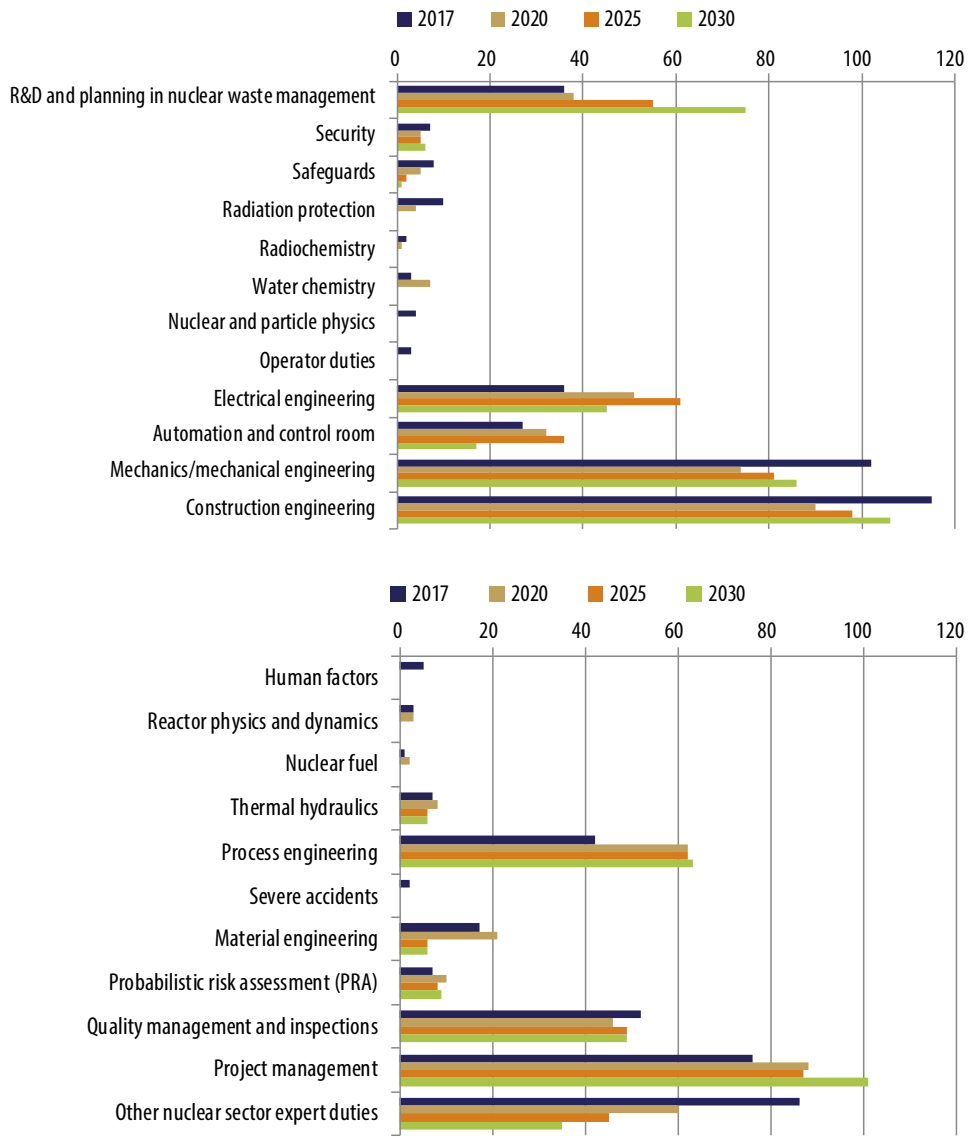

Figure 3.14 Number of experts with Master's degree in 2017 and estimated future demand in 2020, 2025 and 2030 by area of competence. Group 4: other industrial companies.

In the future, additional demand for experts holding a Master's degree is estimated to be highest in the following areas (Figure 3.14): R&D and planning in nuclear waste management; project management; electrical engineering; process engineering.

Demand for experts is estimated to decrease the most in the following areas: other duties; mechanics and mechanical engineering.

3.5.3 Bachelor's degree

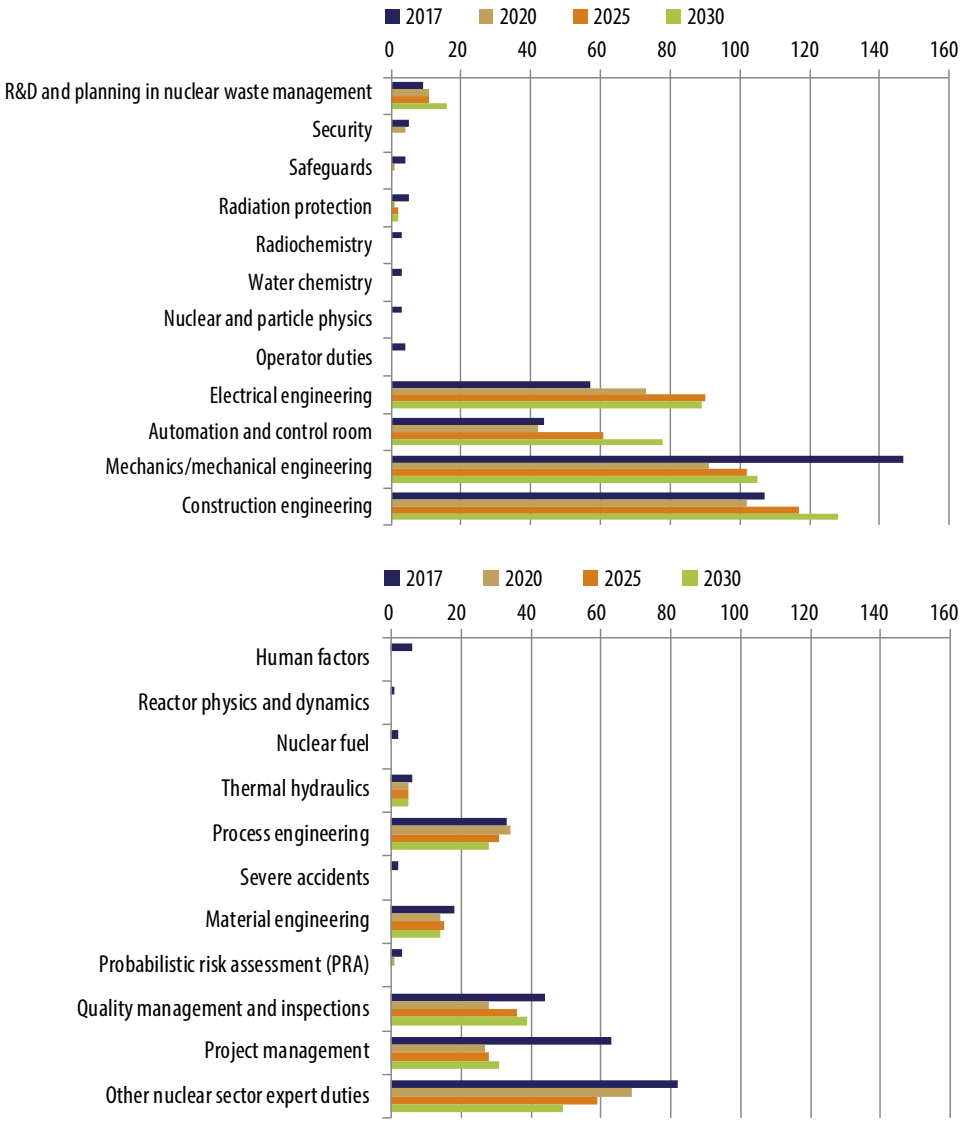

Figure 3.15 Number of experts with Bachelor's degree in 2017 and estimated future demand in 2020, 2025 and 2030 by area of competence. Group 4: other industrial companies.

In the future, additional demand for experts holding a Bachelor's degree is estimated to be highest in the following areas (Figure 3.15): automation and control room; electrical engineering; construction engineering.

Demand for experts is estimated to decrease the most in the following areas: mechanics and mechanical engineering; other duties; project management.

3.5.4 Secondary-level vocational qualifications

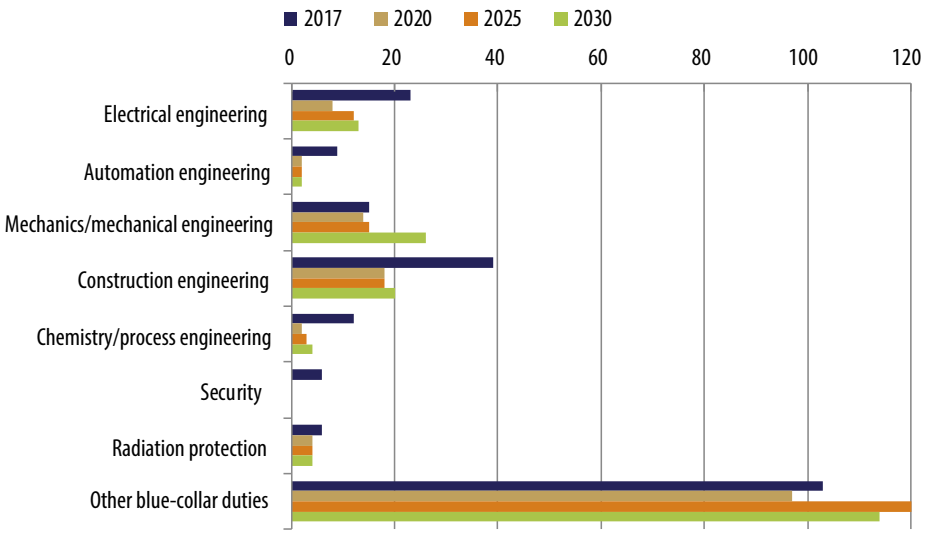

Figure 3.16 Number of experts with secondary-level vocational qualifications in 2017 and estimated future demand in 2020, 2025 and 2030 by area of competence. Group 4: other industrial companies.

It is estimated that there will be some increase in demand for experts holding a secondary-level vocational qualification in the area of other duties (Figure 3.16).

Demand for experts is estimated to decrease the most in the area of construction engineering.

4 Summary

The results of this report are based on data that selected nuclear energy sector organisations were asked to provide through an online survey. Based on its implementation method, the results obtained from the survey are comparable with those reported by the Committee for Nuclear Energy Competence in Finland (OTR2010) set up by the Ministry of Economic Affairs and Employment (MEAE) in October 2010 [1]. Responses were submitted by all key actors operating in the sector. Industrial companies submitted fewer responses than expected, which means that the survey was not fully comprehensive in this respect. The OTR2010 survey was also not comprehensive with regard to these companies.

The OTR2010 survey identified experts in 2010 and estimated personnel needs for 2015, 2020 and 2025. The present analysis covers the situation in autumn 2017 while also extending its scope further into 2020, 2025 and 2030. The responses for 2020 and 2025 provided in the two surveys reflect changes in the operating environment.

In 2010, the distribution of experts by years of experience in the sector was bimodal in all groups for which the relevant data was reported, concentrating around recent entrants to the sector (with 0–5 years of experience) and experts already nearing retirement (with over 20 years of experience). The present results only show a mild bimodal pattern in the group consisting of industrial companies, whereas the distributions in all other groups concentrate around younger experts, while the peak previously made up of experienced experts has disappeared.

In total, the number of experts reported in 2017 was 3,807, which is slightly (+2%) above the 2010 estimate for 2015. However, near-term demand has now been estimated to be clearly lower for 2020 (-16%) and 2025 (-14%).

The most significant change in the operating environment when compared with the situation predicted in 2010 is the suspension of the Olkiluoto 4 project. In the autumn of 2017, the number of experts in the group including the power companies was clearly below the 2010 prediction. Likewise, the number of experts within the public authorities' group in 2017 fell short of the estimate for 2015, albeit the decrease can mostly be attributed to the considerable drop in the number of radiation protection experts since 2010 (40 out of 60 individuals).

The key results are presented below by respondent group.

4.1 All respondents

In all, the total number of experts reported was 3,807, which is 16% higher than in 2010 (3,285). In 2017, Master's and Bachelor's degree-holders accounted for 50% and 32%, respectively, while the remaining 18% had a secondary-level vocational qualification. The distribution by years of experience has changed from the previous bimodal pattern (OTR2010), now concentrating around younger experts. The proportion of Bachelor's degree-holders is highest among recent entrants to the sector and lowest among the most experienced personnel, whereas the opposite is true for secondary-level vocational qualification-holders.

In 2017, the total number of Master's degree-holders was 1,895, 32% of whom worked for power companies or Posiva, while those employed by public authorities, universities or research institutes, and other industrial companies accounted for 8%, 26% and 34%, respectively. The relative proportion of those holding a postgraduate – i.e., a Doctor's or Licentiate's – degree (18% of Master's degree-holders) has remained the same as in the previous survey.

The total number of Bachelor's degree-holders was 1,232, 43% of whom worked for power companies or Posiva, while those employed by public authorities and universities or research institutes accounted for 2% each, and the remaining 53% worked for other industrial companies.

The total number of secondary-level vocational qualification-holders was 680, 66% of whom worked for power companies or Posiva, while those employed by public authorities, universities or research institutes, and other industrial companies accounted for 0%, 3% and 31%, respectively.

The number of experts reported in 2017 was 3,807, while personnel needs are estimated to decrease slightly in the near future (3,672 in 2020), followed by an upturn (3,981 in 2030).

Demand for personnel in 2030 is estimated to be 5% higher than the number of personnel in 2017. The current experts with Bachelor's degree and secondary-level vocational qualifications are expected to suffice, whereas the number of Master's degree-holders should increase by 10% on the current level.

When compared with the OTR2010 survey, i.e., over a seven-year period, the number of experts has grown by a total of 522 individuals (16%). Additional demand currently estimated by 2030, i.e., within a period of 13 years, amounts to 174 individuals (5%). Among employees with experience in the sector, the distribution by years of experience now concentrates around younger experts, which indicates that many new, young experts have entered the sector to accumulate their experience while the recently retired experts have not, on the whole, caused any personnel shortages. Consequently, based on the results obtained and actual developments in previous years, the required levels of personnel resources will also be achieved in the future.

As many duties in the nuclear energy sector require in-depth knowledge and long-term experience, the highest future demand for new experts will focus specifically on Master's degree-holders. Based on the results, recruitments have been made quite comprehensively in almost all competence areas in recent years. However, the recent entrants to the sector are relatively few in some areas of competence, which means that their experience distributions concentrate around older experts. In those competence areas, special attention should be paid to provision of training and induction for younger people.

4.2 Power companies and Posiva

Power companies and Posiva reported a total of 1,579 experts, which is 1% below the 2010 level. In 2017, Master's and Bachelor's degree-holders accounted for 38% and 34%, respectively, while the remaining 28% had a secondary-level vocational qualification.

The distribution by years of experience has changed from the previous highly bimodal pattern (OTR2010), concentrating around younger experts. The proportions of Master's and Bachelor's degree-holders are highest among recent entrants to the sector and lowest among the most experienced personnel. The proportion of secondary-level vocational qualification-holders is lowest among recent entrants to the sector and highest among the most experienced personnel.

Demand for personnel in 2030 is estimated to be 13% higher than the number of personnel in 2017. The current number of personnel with secondary-level vocational qualifications is expected to be almost sufficient, whereas the numbers of Master's and Bachelor's degree-holders should increase by 17% and 16%, respectively, on the current levels. The areas of competence estimated to grow include automation and control room, R&D and planning in nuclear waste management, operator duties, and radiation protection.

4.3 Public authorities (STUK and MEAE)

The group consisting of public authorities reported a total of 184 experts, which is 28% below the 2010 level. In 2017, Master's and Bachelor's degree-holders accounted for 87% and 13%, respectively. No secondary-level vocational qualification-holders were reported in this group. The distribution by years of experience has changed from the previous bimodal pattern (OTR2010), concentrating around experts who have worked in the sector for some time (6–10 years).

Demand for personnel in 2030 is estimated to be 8% higher than the number of personnel in 2017. Moreover, no demand for secondary-level vocational

qualification-holders is expected in the future either, while demand for Bachelor's degree-holders is estimated to decline. The number of Master's degree-holders should increase by 22% on the current level. The area of competence expected to see growth is radiation protection.

4.4 Universities and research institutes

The group consisting of universities and research institutes (incl. three universities of applied sciences) reported a total of 529 experts, which is 5% above the 2010 level. In 2017, the proportion of Master's degree-holders was 92%, while holders of Bachelor's degree and secondary-level vocational qualifications accounted for 4% each. The distribution by years of experience has almost levelled off from the previous bimodal pattern (OTR2010), concentrating around younger experts to a lesser extent than before.

Demand for personnel in 2030 is estimated to be 18% higher than the number of personnel in 2017. The current experts with secondary-level vocational qualifications and Bachelor's degree are expected to suffice. The number of Master's degree-holders should increase by 20% on the current level. The areas of competence expected to see growth include nuclear and particle physics, material engineering, and radiochemistry.

4.5 Other industrial companies

The group consisting of other industrial companies reported a total of 1,515 experts, which is 29% above the 2010 level. Master's and Bachelor's degree-holders account for 43% each, while the remaining 14% have a secondary-level vocational qualification. The numbers of Master's and Bachelor's degree-holders reported in the survey were the same (651). The distribution by years of experience is slightly bimodal, clearly concentrating around younger experts.

Demand for personnel in 2030 is estimated to be 9% lower than the number of personnel in 2017. Estimated demand for holders of secondary-level vocational qualifications, Bachelor's degree and Master's degree will be 14%, 10% and 7% lower, respectively. The areas of competence estimated to grow include R&D and planning in nuclear waste management, project management, electrical engineering, and process engineering. The areas expected to face the largest decline include other nuclear sector expert duties, and mechanics and mechanical engineering.

References

[1] Kansallisen ydinenergia-alan osaamistyöryhmän raportti. Työ- ja elinkeinoministeriön julkaisuja. Energia ja ilmasto 2/2012. Sähköinen versio: ISBN 978-952-227-623-0.

English version available:

Report of the Committee for Nuclear Energy Competence in Finland. Publications of the Ministry of Employment and the Economy. Energy and the Climate 14/2012. Electronic version: ISBN 978-952-227-600-1.

Appendix A: Survey questionnaire

Nuclear energy competence in Finland

Update of the OTR2010 survey with regard to personnel resources in 2017

Survey conducted for the Ministry of Economic Affairs and Employment
6 September 2017

Covering letter

In October 2010, the Ministry of Economic Affairs and Employment (MEAE) set up a national committee to examine long-term competence needs within the nuclear energy sector. As a result of the survey, a public report was completed in 2012, presenting an extensive review of personnel resources, research infrastructure, funding, international research and education in the nuclear energy sector. The data was obtained by a questionnaire sent to nuclear sector organisations.

The present survey updates the above-mentioned previous report with regard to nuclear sector personnel resources. The results obtained will be comparable with those of the previous survey. The previous survey looked into demand for experts in 2010 for 2015, 2020 and 2025, and this new survey covers the situation in autumn 2017 while also extending the analysis further into 2020, 2025 and 2030. The change in the operating environment is described by the responses for 2020 and 2025 provided in the two surveys.

The link to the survey has been sent to selected organisations. The organisations have been selected with a view to keeping the validity of the survey as high as possible when compared with the previous survey. The target groups of the survey include:

1. key nuclear sector actors;
2. universities and other higher education institutions;
3. industries closely associated with power companies.

The survey is implemented using the Webropol tool. The implementation of the survey and the results obtained will be documented in a public summary report, however, without disclosing any data specific to individual respondents. Any respondent-specific data will remain confidential.

The link to this survey has only been sent to a single contact person in each organisation. We hope that the recipient will determine the expert situation within the entire organisation or, if required, will forward the survey to their selected representative in the organisation.

The survey is being carried out by VTT Technical Research Centre of Finland Ltd, as commissioned by the Ministry of Economic Affairs and Employment. Should you require any further information, please contact Jari Hämäläinen, SAFIR2018 Programme Director (jari.hamalainen@vtt.fi, tel. 040 735 4382) and Vesa Suolanen, Project Coordinator (vesa.suolanen@vtt.fi, tel. 040 550 6052). The contact person for the Ministry of Economic Affairs and Employment is Jorma Aurela, Chief Engineer (jorma.aurela@tem.fi, tel. 050 592 2109).

Survey questionnaire

MINISTRY OF ECONOMIC AFFAIRS AND EMPLOYMENT – SURVEY OF COMPETENCE IN THE NUCLEAR ENERGY SECTOR IN FINLAND

REGISTER INFORMATION	
Email address:	
Target group (please tick below):	
1. ❑ Key nuclear sector actors	3. ❑ Industries closely associated with power companies
2. ❑ Universities and other higher education institutions	
BACKGROUND INFORMATION	
1. Name of organisation	
2. Address	
3. Name of respondent	
4. Telephone number	

PERSONNEL RESOURCES				
1. How many individuals with competence in the special features of the nuclear energy sector are employed by your organisation (in an employment relationship with the organisation) in September 2017? Please give the number of these individuals according to years of experience in the nuclear energy sector (only counting each individual once).				
1.1 Nuclear energy experts (Master's degree suitable for the sector)	0–5 years in the nuclear sector	6–10 years in the nuclear sector	11–20 years in the nuclear sector	Over 20 years in the nuclear sector
R&D and planning in nuclear waste management				
Security (incl. business security and fire safety)				
Safeguards				
Radiation protection				
Radiochemistry				
Water chemistry				
Nuclear and particle physics				
Operator duties (power plant shift supervisors, simulator instructors, etc.)				
Electrical engineering				
Automation and control room				
Mechanics/mechanical engineering				
Construction engineering				
Human factors				
Reactor physics and dynamics				

Nuclear fuel				
Thermal hydraulics				
Process engineering				
Severe accidents				
Material engineering (nuclear facility materials, failures, component manufacturing, inspection and lifetime management)				
Probabilistic risk assessment (PRA)				
Quality management and inspections				
Project management				
Other nuclear sector expert duties				

1.1 A: Please specify:

1.1 B: How many of those listed above hold a:
- Doctor's degree: _____
- Licentiate's degree: _____

1.2 Nuclear energy experts (Bachelor's degree suitable for the sector or equivalent)	0–5 years in the nuclear sector	6–10 years in the nuclear sector	11–20 years in the nuclear sector	Over 20 years in the nuclear sector
R&D and planning in nuclear waste management				
Security (incl. business security and fire safety)				
Safeguards				
Radiation protection				
Radiochemistry				
Water chemistry				
Nuclear and particle physics				
Operator duties (nuclear plant shift supervisors, simulator instructors, etc.)				
Electrical engineering				
Automation and control room				
Mechanics/mechanical engineering				
Construction engineering				
Human factors				
Reactor physics and dynamics				
Nuclear fuel				
Thermal hydraulics				
Process engineering				

Severe accidents				
Material engineering (nuclear facility materials, failures, component manufacturing, inspection and lifetime management)				
Probabilistic risk assessment (PRA)				
Quality management and inspections				
Project management				
Other nuclear sector expert duties				

1.2 A: Please specify:

1.3 Blue-collar employees in the nuclear energy sector (e.g. secondary-level vocational qualification)	0–5 years in the nuclear sector	6–10 years in the nuclear sector	11–20 years in the nuclear sector	Over 20 years in the nuclear sector
Electrical engineering				
Automation engineering				
Mechanics/mechanical engineering				
Construction engineering				
Chemistry/process engineering				
Security (incl. business security and fire safety)				
Radiation protection				
Other blue-collar duties				

1.3 A: Please specify:

2. How many nuclear energy experts would your organisation need in the future, including existing employees? Please enter the number of individuals under the appropriate year.

2.1 Specialist nuclear energy experts (Master's degree suitable for the sector)	2020	2025	2030
R&D and planning in nuclear waste management			
Security (incl. business security and fire safety)			
Safeguards			
Radiation protection			
Radiochemistry			
Water chemistry			
Nuclear and particle physics			
Operator duties (nuclear plant shift supervisors, simulator instructors, etc.)			
Electrical engineering			
Automation and control room			

Mechanics/mechanical engineering			
Construction engineering			
Human factors			
Reactor physics and dynamics			
Nuclear fuel			
Thermal hydraulics			
Process engineering			
Severe accidents			
Material engineering (nuclear facility materials, failures, component manufacturing, inspection and lifetime management)			
Probabilistic risk assessment (PRA)			
Quality management and inspections			
Project management			
Other nuclear sector expert duties			
2.1 A: Please specify:			
2.1 B: How many of those listed above hold a: - Doctor's degree: - Licentiate's degree:			
2.2 Nuclear energy experts (Bachelor's degree suitable for the sector or equivalent)	2020	2025	2030
R&D and planning in nuclear waste management			
Security (incl. business security and fire safety)			
Safeguards			
Radiation protection			
Radiochemistry			
Water chemistry			
Nuclear and particle physics			
Operator duties (nuclear plant shift supervisors, simulator instructors, etc.)			
Electrical engineering			
Automation and control room			
Mechanics/mechanical engineering			
Construction engineering			
Human factors			
Reactor physics and dynamics			
Nuclear fuel			
Thermal hydraulics			
Process engineering			

Severe accidents			
Material engineering (nuclear facility materials, failures, component manufacturing, inspection and lifetime management)			
Probabilistic risk assessment (PRA)			
Quality management and inspections			
Project management			
Other nuclear sector expert duties			

2.2 A: Please specify:

2.3 Blue-collar employees in the nuclear energy sector (e.g. secondary-level vocational qualification)	2020	2025	2030
Electrical engineering			
Automation engineering			
Mechanics/mechanical engineering			
Construction engineering			
Chemistry/process engineering			
Security (incl. business security and fire safety)			
Radiation protection			
Other blue-collar duties			

2.3 A: Please specify:

_____

3. What other nuclear energy experts might your organisation need in the future and how many?

Survey of Competence in the Nuclear Energy Sector 2017–2018 in Finland

Survey of the Competence is describing the status of the Competencies and Resources in the Finnish Nuclear Energy Sector in 2017–2018. It also compares these results with previous results from 2010 when in 2012 an extensive report was published by a Working Group examining long-term Competence Development in the National Nuclear Energy Sector.

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