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Nuclear Waste Management Competence Survey in Finland 2022

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Summary <p>This report aims to investigate the competences in Finnish nuclear waste management field. The results presented in this report are based on information provided by organisations in the field of nuclear waste management, based on an online survey. Answers were received from all key actors in the field, but in the case of industrial companies, the answers were scarce, and the results are therefore not comprehensive.</p> <p>In the survey, a total of 437 experts were reported. Responses to the report were received from thirteen organizations. A total of 342 (78%) people with a higher university degree were reported, 76 (18%) with a lower one, and 20 (4%) with a secondary degree. There is a significantly larger number of university graduates with long work experience, while employees in lower and secondary education are employed with less work experience.</p> <p>The trend for the near future would seem to be that the need for nuclear waste management experts will decrease. This in itself is understandable in the current situation where the construction of final disposal facility for nuclear waste management is to be completed and the actual final disposal begins. The need for personnel in 2035 is estimated to be 40% lower than the personnel in 2022. The need for personnel is estimated to decrease in the near future (386 in 2022) and after that (373 in 2030) and further (264 in 2035). The number of personnel at all levels of education is seen to drop significantly by 2035, especially people with secondary education would be less needed in the industry.</p>	
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Preface

In 2012, a working group investigated the long-term competence of the national nuclear energy sector, set up by the Ministry of Economic Affairs and Employment of Finland (MEAE), published a report in which the nuclear energy sector's human resources, research infrastructure, funding, international research, and competence development were examined extensively. The report was updated in 2017 regarding human resources in the nuclear energy sector.

However, nuclear waste management was not studied in detail in these surveys, leaving many open questions open on the subject. Additionally, a lot has happened in Finnish nuclear waste management since these surveys and the advancement of Posiva's project to operational license application phase.

This survey of the Finnish nuclear waste management competences was done within the Finnish Research Programme on Nuclear Waste Management (KYT2022) 2019–2022 at the initiative of the Ministry for Economic Affairs and Employment. The status of Finnish nuclear waste management experts was studied using an online survey template sent to various organisations in the field.

The survey focused on both current experts in the field, as well as seen future needs for experts. The results were divided into categories by competence area, educational degree, and organisation. Gender balance of nuclear waste management experts was also surveyed.

Espoo 13.3.2023

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1. Introduction

Nuclear energy has a stable and significant position in the basic production of electrical energy in Finland, and nuclear waste management is an essential part of the responsible production of nuclear energy. In Finland, nuclear waste management is based on the responsibility of the power companies – Teollisuuden Voima (TVO) and Fortum – for their operational waste (intermediate waste storage and disposal of low- and intermediate-level waste). The spent fuel is disposed by Posiva, jointly owned by the two nuclear energy companies, whose final disposal facility is under construction and the application for a license is under evaluation by the authority at the time of writing of this report.

The supervisory authority for nuclear waste management in Finland is the Radiation and Nuclear Safety Authority (STUK) and the governmental control of the nuclear energy industry is in Ministry of Economic Affairs and Employment, which also oversees the operation of the National Nuclear Waste Management Fund (VYR). One of the tasks of VYR is to fund research related to nuclear safety and waste as well as the development of research infrastructure, and this report is written as a part of the VYR funded Finnish Research Programme on Nuclear Waste Management (KYT2022) 2019–2022.

Together, TVO, Fortum, Posiva, STUK, and MEAE form the key players in nuclear waste management in the national reference framework. Additionally, nuclear safety related research is done at several Finnish universities and other research organisations, such as VTT Technical Research Centre of Finland, LUT University, Aalto University, Helsinki University and the Geological Survey of Finland. Other Finnish universities also have related research.

Considerable changes have taken place in the domestic operating environment of nuclear energy since the time of the previous reports. At the time of the first survey OTR2010 [1], there were plans to build three new reactors in Finland (Olkiluoto 3, Olkiluoto 4 and Hanhikivi 1). Of these, a construction permit was never applied for TVO's Olkiluoto 4, and Fennovoima's nuclear power plant project Hanhikivi 1 was cancelled during 2022. Olkiluoto 3 was in a test phase in 2022 and moving towards normal electricity production. In contrast to the nuclear power plant projects, Posiva's disposal project has progressed on schedule and is applying for an operational license to use the Olkiluoto bedrock for the spent fuel of all five domestic reactors. With Posiva's research and development phase ending and operational phase beginning, Finnish nuclear waste management competence needs can be expected to change in the coming years at least in consideration of domestic work and assignments. Fortum had also applied new permission for the life-time extension of Loviisa 1 and 2 power plants until 2050 and the decision was made in spring 2023.



1.1 Objectives and Methods of the Competence Survey

The aim of this study was to update and expand the results of previous studies [1,2] in regard to the human resources of nuclear waste management. The methodology of the survey was chosen in such a way that the results would be as comparable as possible with the previous surveys.

- In the first survey in 2010, current numbers of experts were surveyed and the need for experts was assessed for the years 2015, 2020 and 2025. [1]
- In the second survey in 2017, current numbers of experts were surveyed and the need for experts was assessed for the years 2020, 2025 and 2030. [2]
- In the survey being carried out now, current numbers of experts in 2022 was surveyed and the need for experts for the years 2025, 2030 and 2035 was assessed.

The competence survey was done with an online template made with the Webropol tool and sent to selected organizations. The main target groups of the survey were:

- Key actors in nuclear waste management
- Universities and universities of applied sciences
- Industry close to the power companies

In order to review and compare the results, the survey respondents were further divided into the following groups, which are the same as in previous surveys [1, 2]:

1. Power companies (TVO, Fortum) and Posiva
2. Authorities (STUK, MEAE and VYR)
3. Universities and research institutes (including universities of applied sciences)
4. Other industrial companies

The general goal of the expert survey was to find out the number of experts currently working in the various sectors of nuclear waste management and the need in the coming years.

1.2 Method of the Survey

VTT implemented the survey (Appendix 1) as an online survey via the Webropol tool. The KYT2022 director Suvi Karvonen, project specialist Aku Itälä and Webropol implementation assistant Jessica Vepsäläinen were responsible for the practical work. The contact person of the Ministry of Economic Affairs and Employment (MEAE) was Linda Kumpula.

The survey was sent to 71 recipients and the response period was May 25-September 1, 2022, extended until October 3, 2022. The recipients were:

- Key players in the nuclear power sector (6 organisations)
- Universities, universities of applied sciences and research institutes (27 organisations)
- Industry related to power companies and Posiva (36 organisations).

13 responses were received:

- Key players in the nuclear power sector (6 organisations)
- Universities, universities of applied sciences and research institutes (5 organisations)
- Industry related to power companies (3 organisations).



Answers were received from all significant players in the nuclear industry (power companies, Posiva, STUK, MEAE, VYR).

Very few answers were received from industrial companies and as a result, the survey was not comprehensive for industrial companies. Previous surveys had the same issue and were not been comprehensive for industrial companies [1,2].

Each survey target organisation had a designated contact person, who, if necessary, collected the organisation's answers from different subject areas and filled out the questionnaire electronically, whereupon it was saved in the Webropol database.

The survey was carried out confidentially and the survey responses have been reviewed and presented by result groups or for the entire response material. Responses from individual organizations are not identifiable.

The survey expanded the areas of expertise in nuclear waste management compared to previous surveys. The questionnaire used can be found as an appendix to the report (Appendix 1).

In the first part of the survey, the current human resources were mapped in such a way that the number of experts was determined on the one hand by educational background and on the other hand by years of experience in the field of nuclear waste management. The educational background was defined as a Master's degree, Bachelor's degree (university of applied sciences) or a secondary vocational degree suitable for the field. At the same time, the gender distribution of experts was mapped (the number of women and men among experts) as well as the number of doctors and licentiates.

The competence areas in the survey were (for university degrees):

- Safety case
- Groundwater and water chemistry
- Host rock and geology
- Site investigations
- Biosphere
- Packaging (release barriers)
- Materials (bentonite, cement,...)
- Spent fuel
- Low and intermediate level waste
- Packaging and decontamination
- Radiochemistry
- Radionuclide transport modeling
- Radiation safety
- Security
- Risk management and accidents
- Safeguards
- Decommissioning
- Equipment and machinery
- Manufacturing and inspection
- Quality management



- Project management
- Other

The competence areas in the survey were (for secondary vocational degrees):

- Electrical
- Automation
- Mechanical
- Construction
- Chemistry
- Materials (bentonite, cement, ...)
- Security
- Risk management and accidents
- Other

In the second part, the expert needs of the organisations were mapped in 2025, 2030 and 2035. When evaluating this, the organisations also had to take into account the departure of personnel, i.e. retirement.

It was also possible to attach verbal replies to the survey. The organisations were asked which other experts in nuclear waste management the organizations may need in the future and how many.



2. Nuclear Waste Management Competences in 2022

This chapter presents the nuclear waste management experts from the perspective of work experience, education and areas of expertise as well as compares the results with previous surveys [1,2].

Work experience is defined according to the years worked in the field of nuclear waste management. Educational background was defined based on completed degrees: secondary school degree, lower university degree and upper university degree. Among those who completed a Master's degree, the number of those who completed a post-graduate degree in different groups (doctorate or licentiate degree) was also examined.

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

2.1 All organisations

A total of 437 nuclear waste management experts were reported in the survey. Responses to the report were received from thirteen organizations, one of which answered all zero. In the 2017 survey [2], a total of 3,807 experts were reported for the entire nuclear energy sector, and in the 2010 survey, 3,285 [1]. Of these, nuclear waste management experts numbered 170 (year 2017) and 210 (year 2010). It is reasonable to assume that this larger number does not reflect a significant increase in nuclear waste management experts, but a matter related to the question formulation – in the previous survey, many experts in nuclear waste management were likely listed under one of the other category options, such as fuel, radiochemistry or construction technology.

A total of 342 (78%) experts with a Master's degree were reported, 76 (18%) with a lower university degree, and 19 (4%) with a secondary degree.

The distribution of years of experience of employees who have accumulated work experience in the field is different between those who have completed higher education and others. There is a significantly larger number of university graduates with long work experience, while employees with lower university degrees and secondary education are employed with less work experience. The distribution of experience of experts in nuclear waste management based on years of work in the field is shown in Figure 2.1.



Figure 2.1. Experience in the field for Nuclear waste management experts in 2022. The distribution is similar to the result reported in 2017 [2].



In total, 78% have a higher university degree, 17% have a lower degree and 4% have a secondary degree. The distribution is significantly weighted towards those with higher education, which is explained by the fact that industrial companies responded to the survey at a very low rate.

2.1.1 Master's degree

A total of 342 experts with a Master's degree were reported in the survey. The largest competence areas among those with a Master's degree are geology and bedrock, safety case, materials (e.g. bentonite clay and cement) and radiation protection and safety. The rarest area of expertise is radionuclide transport modelling, and all the experts in that area have a long experience in the field.

The competence areas of those with a Master's degree are shown in Figure 2.2.

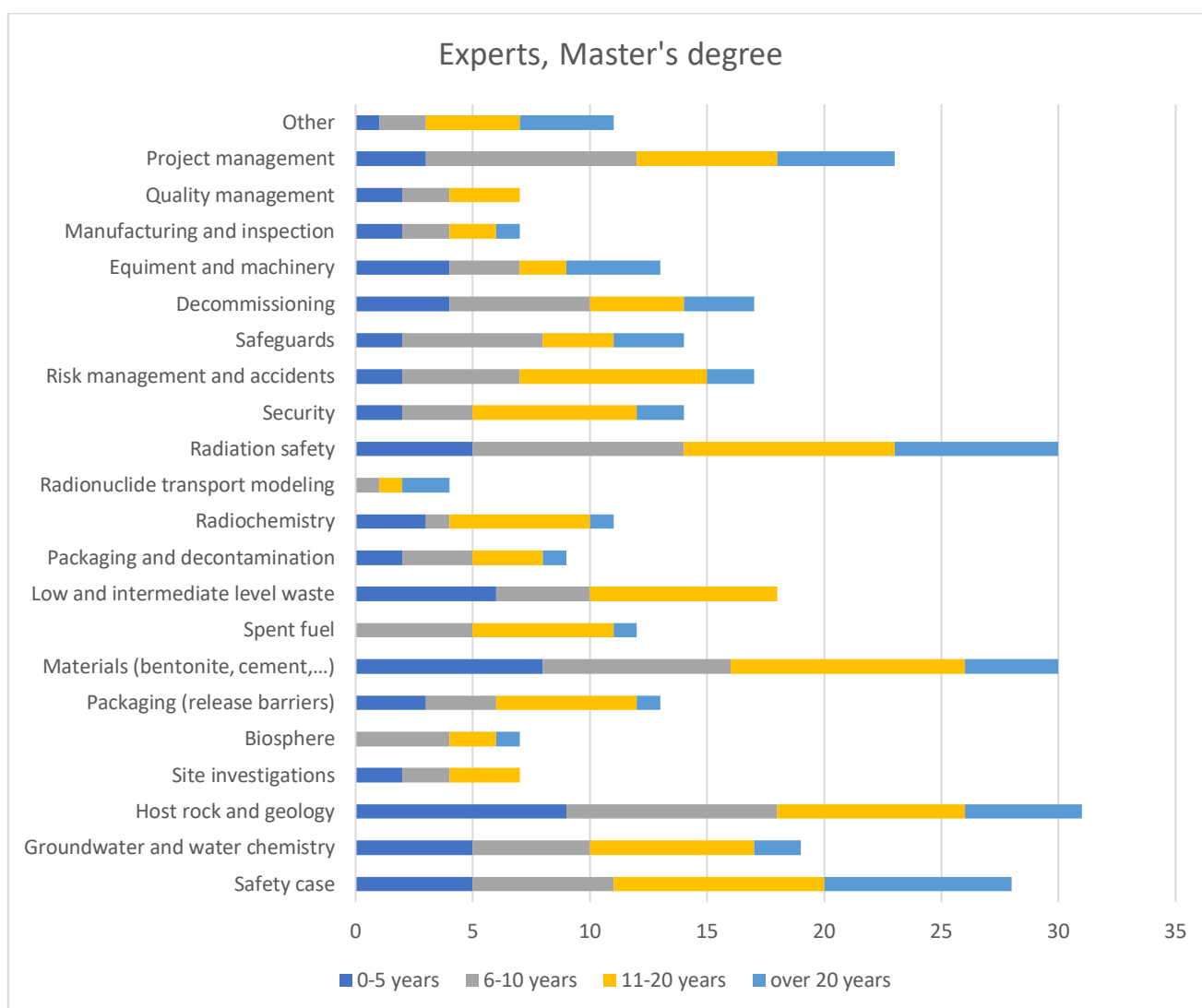


Figure 2.2. Master's degree experts in 2022, categorised according to work experience (years in the field).

Among the answers in the category "Other" were experts related to preparation for production, disposal facility technology, planning of disposal facilities, cost estimation, preparation of a nuclear waste program and selection of a disposal site, as well as supervision and authority expertise.



2.1.2 Bachelor's degree

A total of 76 experts with a Bachelor's degree were reported in the survey. The largest competence areas among those with Bachelor's degree are packaging and decontamination as well as low and intermediate level waste management. Several competence areas have no experts with Bachelor's degree; these include e.g. project management, safety case and quality and risk management topics. It can be also noted that whereas with higher university degree experts many had long careers in nuclear waste management (11–20 or more than 20 years in the field), this is less common with lower university degree experts, although still existent.

The competence areas of those with a Bachelor's degree are shown in Figure 2.3.

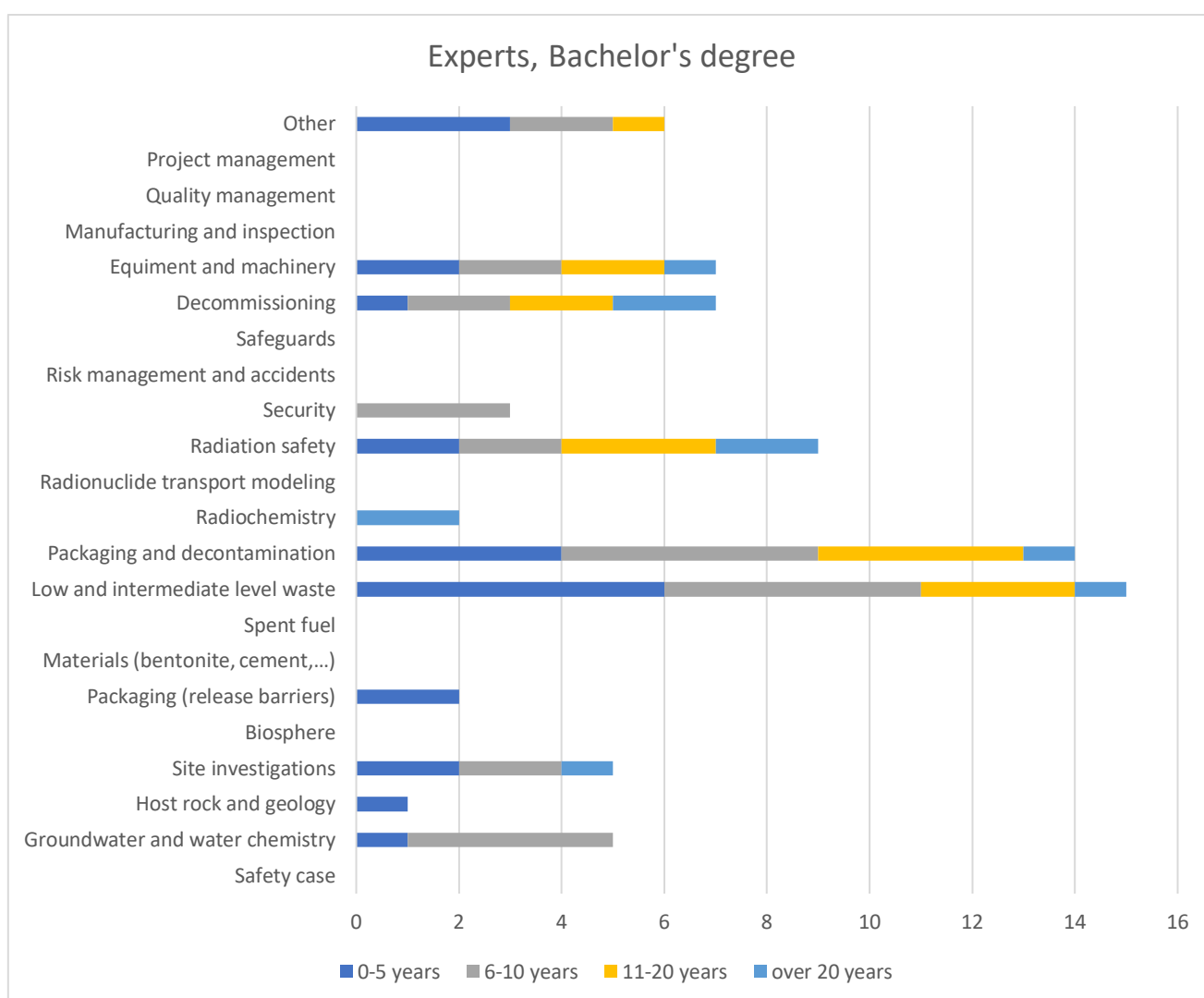


Figure 2.3. Bachelor's degree experts in 2022, categorised according to work experience (years in the field).

2.1.3 Secondary-level vocational qualifications

A total of 21 experts with secondary-level vocational qualifications were reported in the survey. This is a relatively low number and most likely reflects the fact that the survey was not comprehensive for industrial companies. Therefore, these results cannot be interpreted to accurately present the situation in Finland. It can, however, be observed that there are very few experts with long careers in nuclear waste management (11–20 or more than 20 years in the field) in this category.



The competence areas of those with secondary-level vocational qualifications are shown in Figure 2.4.

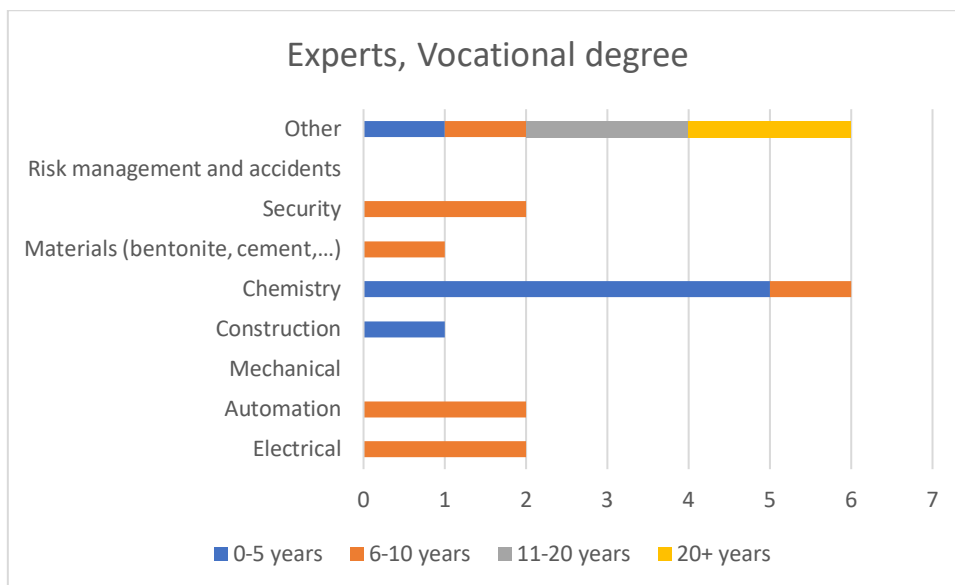


Figure 2.4. Vocational degree experts in 2022, categorised according to work experience (years in the field).

2.1.4 Summary of all experts by degree

The amounts of experts by degree in different categories is presented in Table 2.1 for all experts and by group. The groups are:

1. Power companies (TVO and Fortum) and Posiva
2. Public authorities (STUK, MEAE and VYR)
3. Universities and research organisations
4. Other industrial companies

Of the total 437 nuclear waste management experts reported in the survey, a total of 342 experts with a Master's degree were reported. Of these, 45% work at Posiva or the power companies, 6% at authorities, 45% at research organisations and 4% at other industrial companies. 58 experts with doctoral degrees were reported along with 5 licentiate degree holders.

Of the 76 experts with a Bachelor's degree, 46% work at Posiva or the power companies, 3% at authorities, 39% at research organisations and 12% at other industrial companies.

Of the 20 experts with vocational qualifications, 19 work at Posiva or the power companies, one at other industrial companies and the other groups do not report any experts in this category.



Table 2.1. Statistics for experts in different degree categories for each survey group. Group 1: Power companies (TVO and Fortum) and Posiva, Group 2: Authorities (STUK, MEAE and VYR), Group 3: Universities and research institutes Group 4: Other industrial companies.

Degree	All	Group 1	Group 2	Group 3	Group 4
Master's	342	155	19	153	15
Doctors	58	13	6	35	4
Licentiatees	5	3	0	0	2
Bachelor's	76	35	2	30	9
Vocational	20	19	0	0	1
Total	437	208	21	183	25

More detailed results for each group as presented in the following Chapters.

2.1.5 Gender ratio of experts in nuclear waste management field

As part of the survey, the gender balance, or ratio of men and women were reported. However, the reported numbers of men (158) and women (97) do not add up to the overall reported number of experts (255 vs. 437) so this data is not complete. The survey results show that some organisations did not report gender at all while others had only partial numbers and thus these statistics can only be viewed as indicative, not comprehensive.

The gender ratio on the different expert categories is 62% men and 38% women overall, closer to equal in Master's degree category and further in the other two categories. The gender balance in different expert categories is illustrated in Figure 2.5.

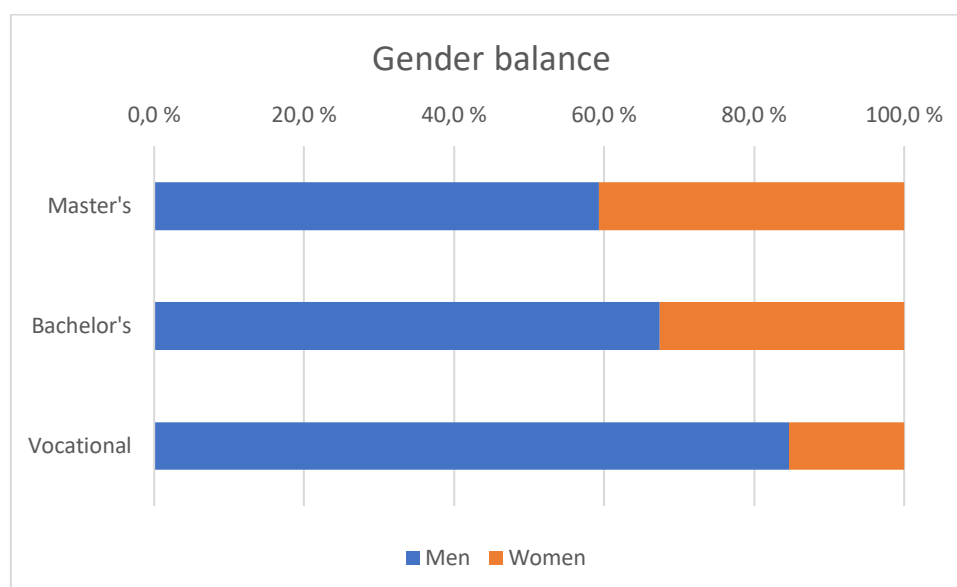


Figure 2.5. Gender balance in different expert categories for nuclear waste manage experts.



2.2 Power companies and Posiva

The power companies (TVO, Fortum) and Posiva reported a total of 208 experts. The majority of the experts have a Master's degree. The experience distribution of power companies and Posiva experts is illustrated in Figure 2.6.

The proportion of Bachelor's degree experts and vocational experts is highest among recent entrants to the sector and lowest among the most experienced personnel and no Bachelor's degree experts were reported in the 20+ years category. Master's degree-holders are more evenly spread across the different categories, but here also the proportion of 20+ year experience experts is lower than in the overall results.



Figure 2.6. Experience in the field for nuclear waste management experts for power companies and Posiva in 2022.



2.2.1 Master's degree

In total, there are 155 Master's degree-holders in Group 1 (power companies and Posiva). Radiation safety and low and intermediate waste management are the largest two competence area groups. No experts were reported in the manufacturing and inspection or categories or site inspections categories. The distribution of Master's degree experts in different competence areas is illustrated in Figure 2.7.

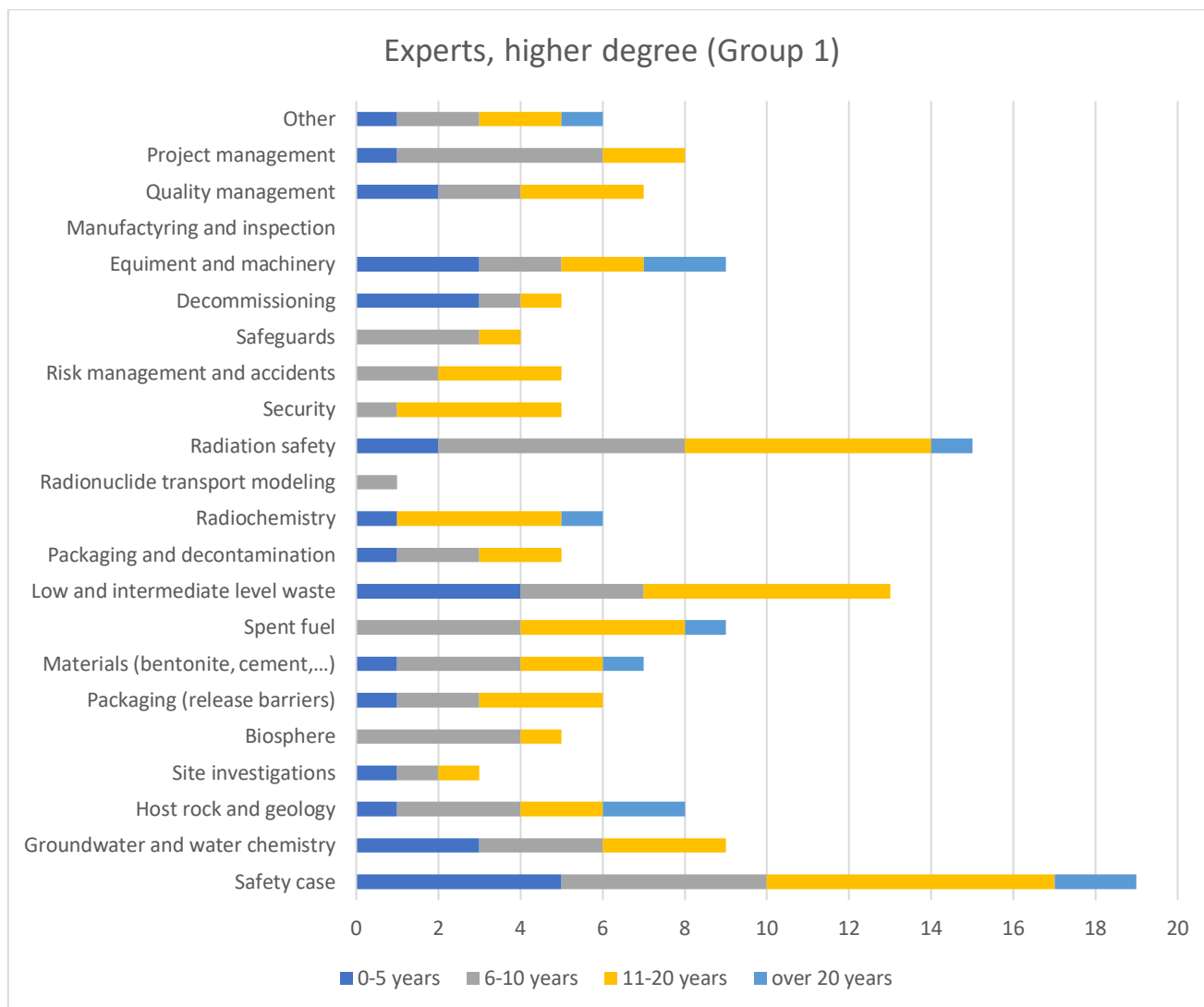


Figure 2.7. Master's degree experts in power companies and Posiva in 2022, categorised according to work experience (years in the field).



2.2.2 Bachelor's degree

In total, there are 35 Bachelor's degree-holders in Group 1 (power companies and Posiva). Equipment and machinery and low and intermediate waste management are the largest two competence area groups. No experts were reported in various categories, reflecting the fact that the overall number of Bachelor's level experts of 35 is not very high. The distribution of Bachelor's degree experts in different competence areas is illustrated in Figure 2.8.

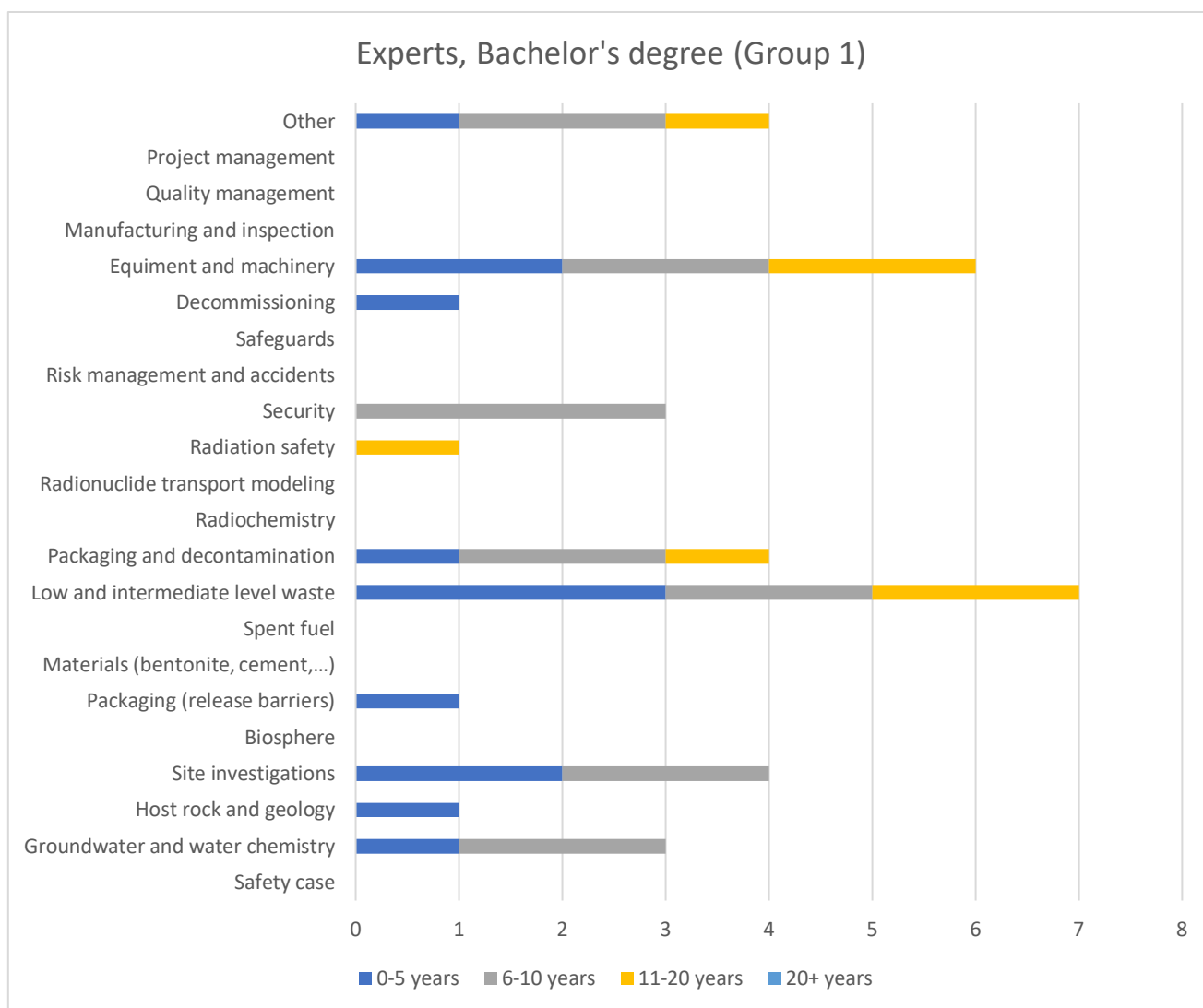


Figure 2.8. Bachelor's degree experts in power companies and Posiva in 2022, categorised according to work experience (years in the field).



2.2.3 Secondary-level vocational qualifications

In total, there are 20 vocational degree-holders in Group 1 (power companies and Posiva). The largest two competence area groups are Chemistry and “Other”, the latter consisting of operators, research assistants and technicians. No experts were reported in risk management and accidents or mechanical categories. The distribution of Bachelor’s degree experts in different competence areas is illustrated in Figure 2.9.

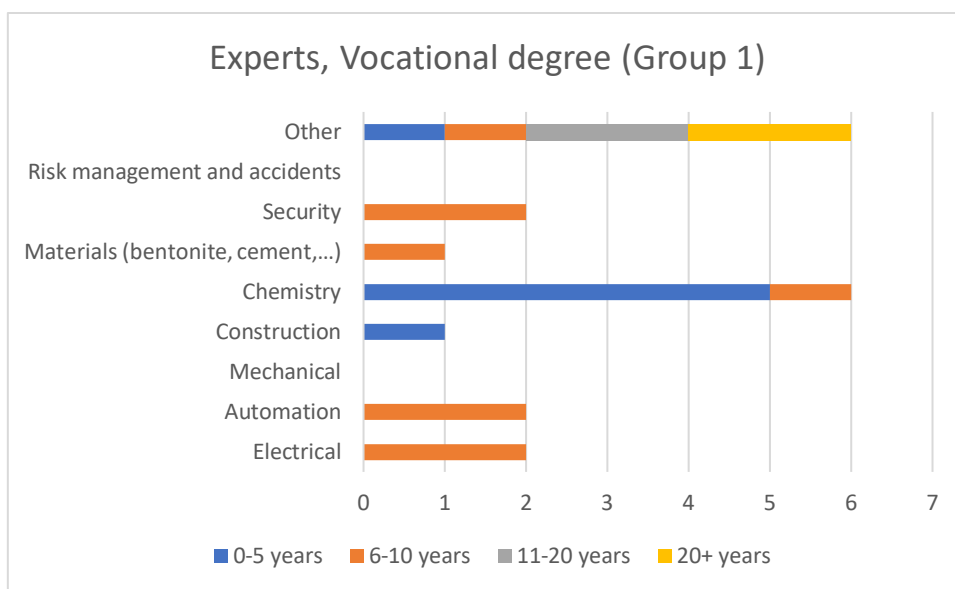


Figure 2.9. Vocational degree experts in power companies and Posiva in 2022, categorised according to work experience (years in the field).



2.3 Public authorities

The public authorities (STUK, MEAE and VYR) reported 21 experts in the survey. The majority of these (18 experts) are in STUK. Nearly all of experts have a Master's degree with only two Bachelor's expert reported, and no vocational experts. The experience distribution of public authorities' experts is illustrated in Figure 2.10.

In this group, the majority of the experts have long (20+ years) experience and the share of newcomers is the lowest in all the groups in this survey.

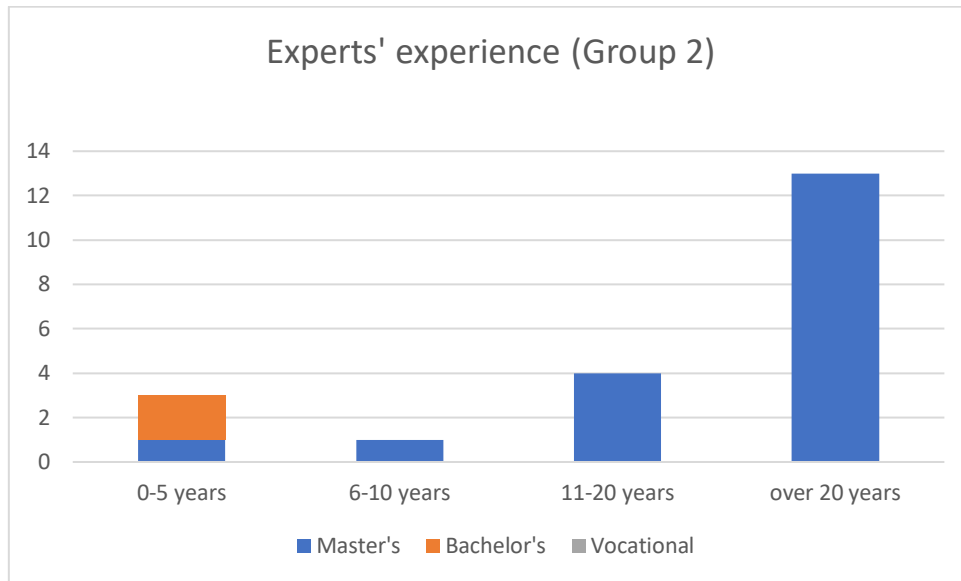


Figure 2.10. Experience in the field for nuclear waste management experts for public authorities in 2022.



2.3.1 Master's degree

In total, there are 19 Master's degree-holders in Group 2 (public authorities). Equipment and machinery and "Other" are the two largest competence areas, with the latter consisting of competences such as State Nuclear Waste Management Fund (VYR) expertise and nuclear waste management oversight expertise. Several categories had no reported experts; these can be seen to belong more to the license holder's domain.

The distribution of Master's degree experts in different competence areas in Group 2 is illustrated in Figure 2.11.

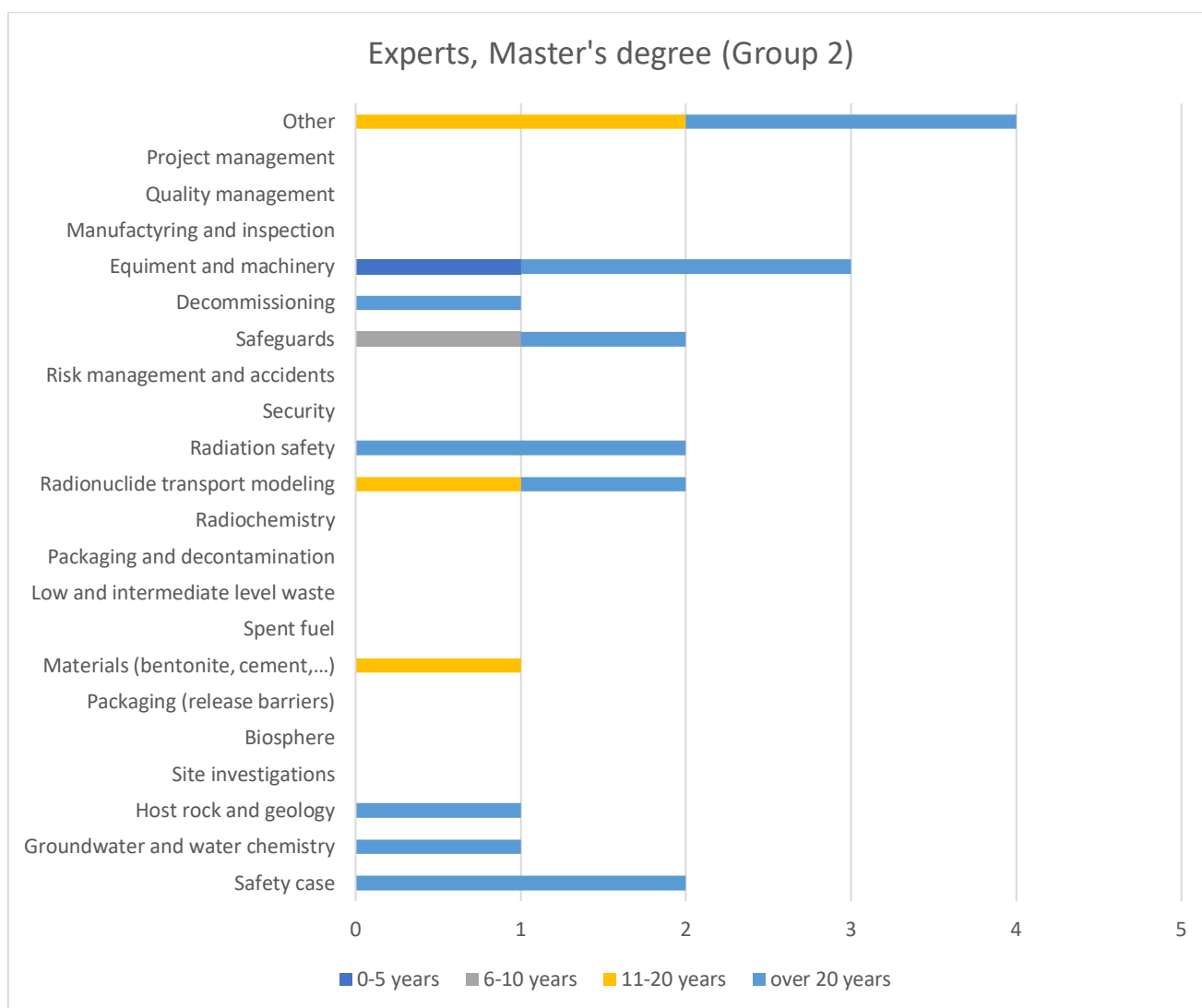


Figure 2.11. Master's degree experts for public authorities, categorised according to work experience (years in the field) in 2022.



2.3.2 Bachelor's degree

Only two Bachelor's degree experts were reported in this group, both in the "Other" category, not specified in more detail than oversight and control.

2.4 Research organisations and universities

Group 3 (research organisation and universities) reported 183 experts in the survey. The majority have Master's degrees, but there are also Bachelor's degree experts in each experience category. The experience distribution of public authorities' experts is illustrated in Figure 2.12.

In this group, the share of newcomers is higher than in the other groups, as is to be expected with the universities and research organisations, where students and doctoral students are trained in the field. However, there are also senior level experts with 10 or 20 years of experience, facilitating knowledge transfer.

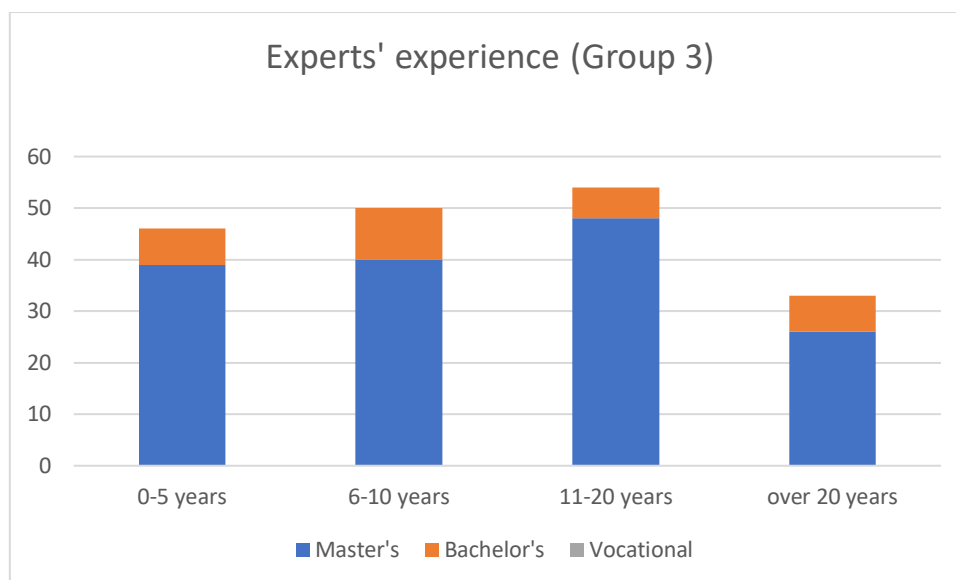


Figure 2.12. Experience in the field for nuclear waste management experts for research organisations and universities in 2022.



2.4.1 Master's degree

In total, there are 153 Master's degree-holders in Group 3 (research organisations and universities). The two largest competence areas are host rock and geology as well as materials, possibly reflecting the emphasis on basic science in many universities. Quality management, equipment and machinery and radionuclide transport modeling had no experts reported in this group.

The distribution of Master's degree experts in different competence areas in Group 3 is illustrated in Figure 2.13.

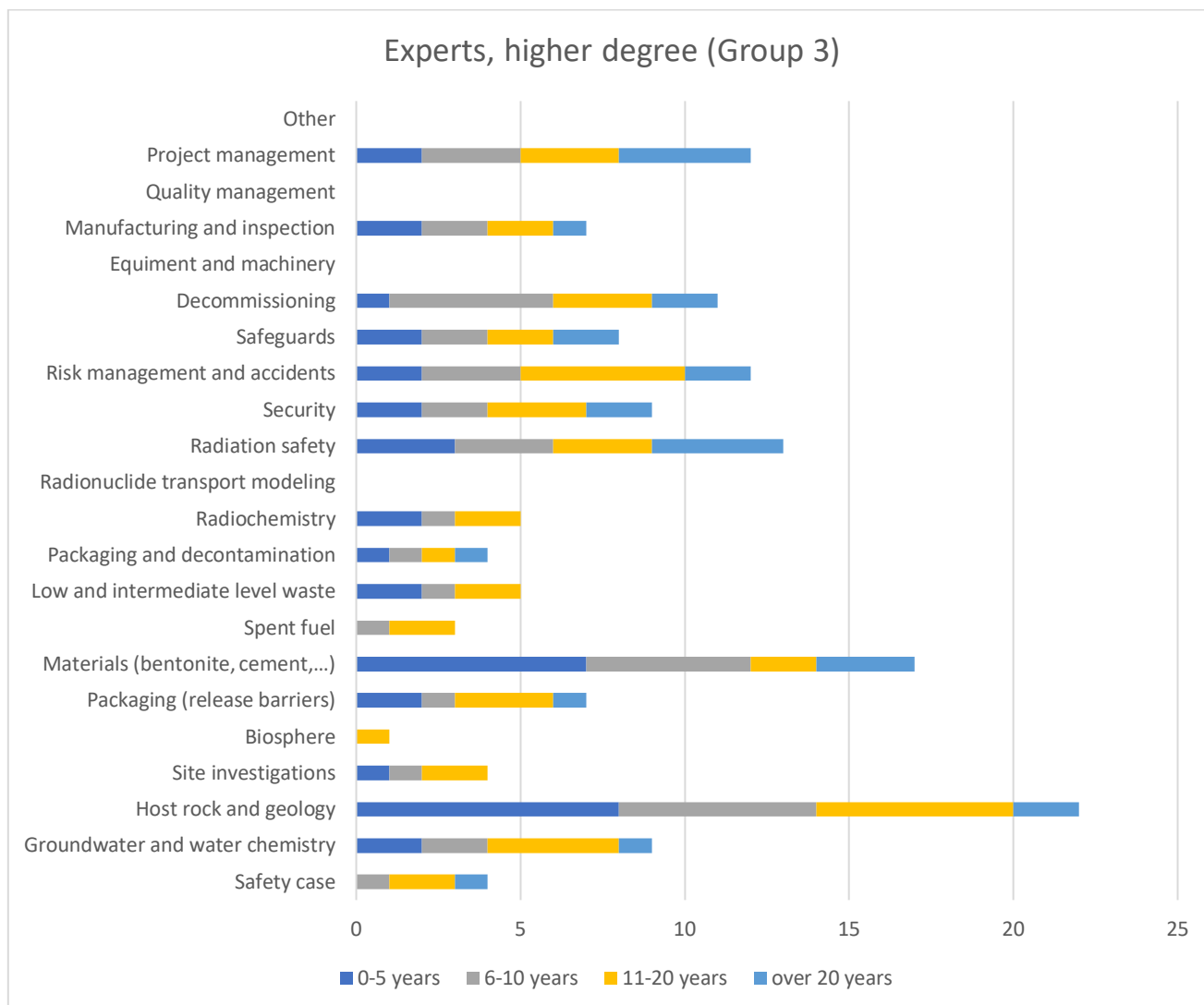


Figure 2.13. Master's degree experts for research organisations and universities, categorised according to work experience (years in the field) in 2022.



2.4.2 Bachelor's degree

In total, there are 30 Bachelor's degree-holders in Group 3 (research organisations and universities). The largest competence area is radiation safety. No experts were reported in various categories, reflecting the fact that the overall number of Bachelor's level experts of 30 is not very high.

The distribution of Bachelor's degree experts in different competence areas is illustrated in Figure 2.14.

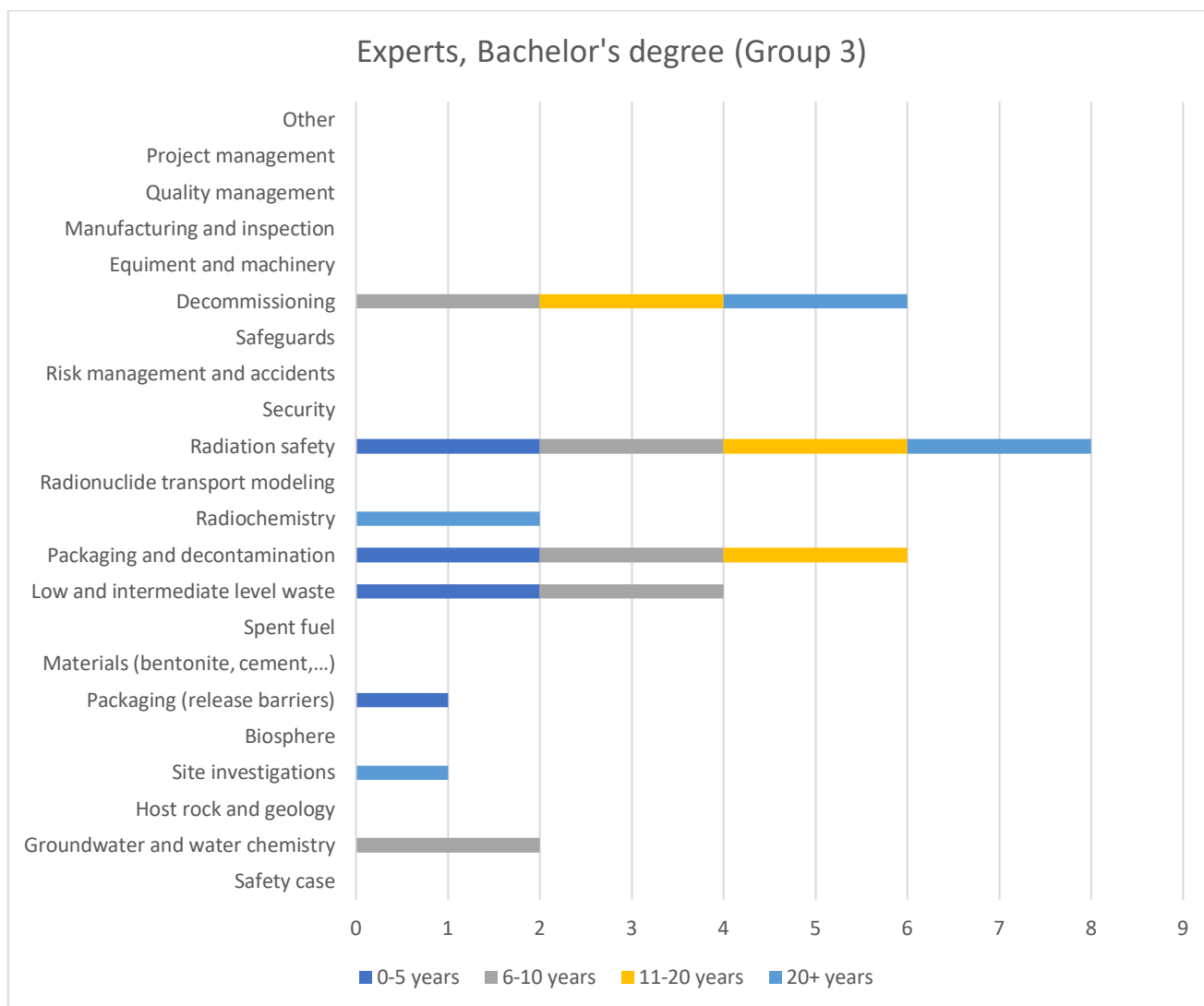


Figure 2.14. Bachelor's degree experts in research organisations and universities in 2022, categorised according to work experience (years in the field).



2.5 Other industrial companies

Group 4, other industrial companies, had a low response rate and only 3 companies responded to the survey. These results are therefore not comprehensive of the field but are reported as part of the survey.

The total number of experts in other industrial companies was 25 and the majority of the experts have a Master's degree. The experience distribution of Group 4 is illustrated in Figure 2.15.

Master's degree-holders are clearly on the more experienced end of the spectrum, whereas Bachelor's degree-holders are fairly equally distributed in all groups. Only one vocational expert was reported in the survey.

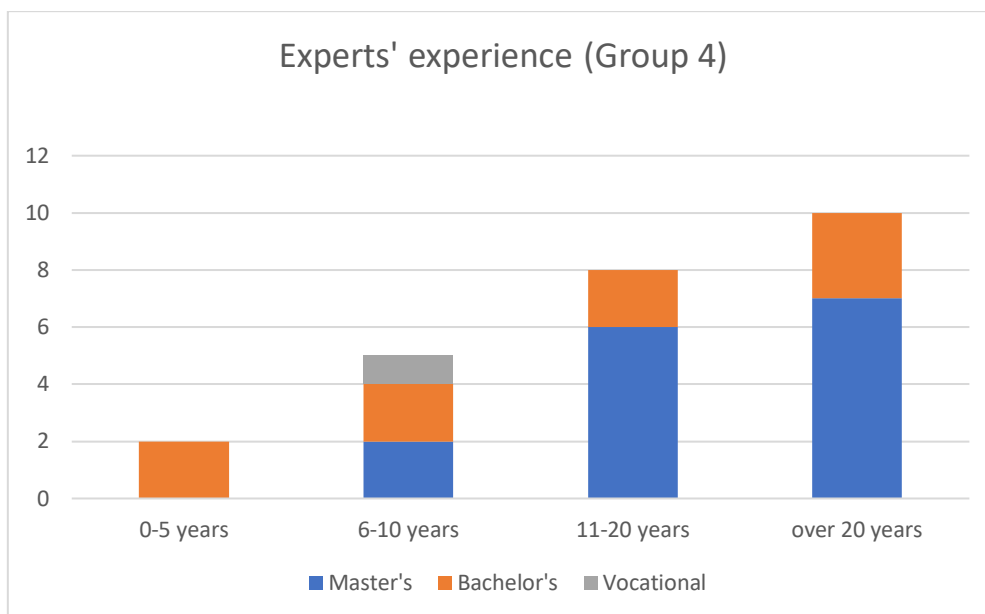


Figure 2.15. Experience in the field for nuclear waste management experts for other industrial companies in 2022.



2.5.1 Master's degree

In total, there are 15 Master's degree-holders in Group 4 (other industrial companies). The three largest competence areas are materials, safety case and project management. Various competences had no representation in this group.

The distribution of Master's degree experts in different competence areas in Group 4 is illustrated in Figure 2.16.

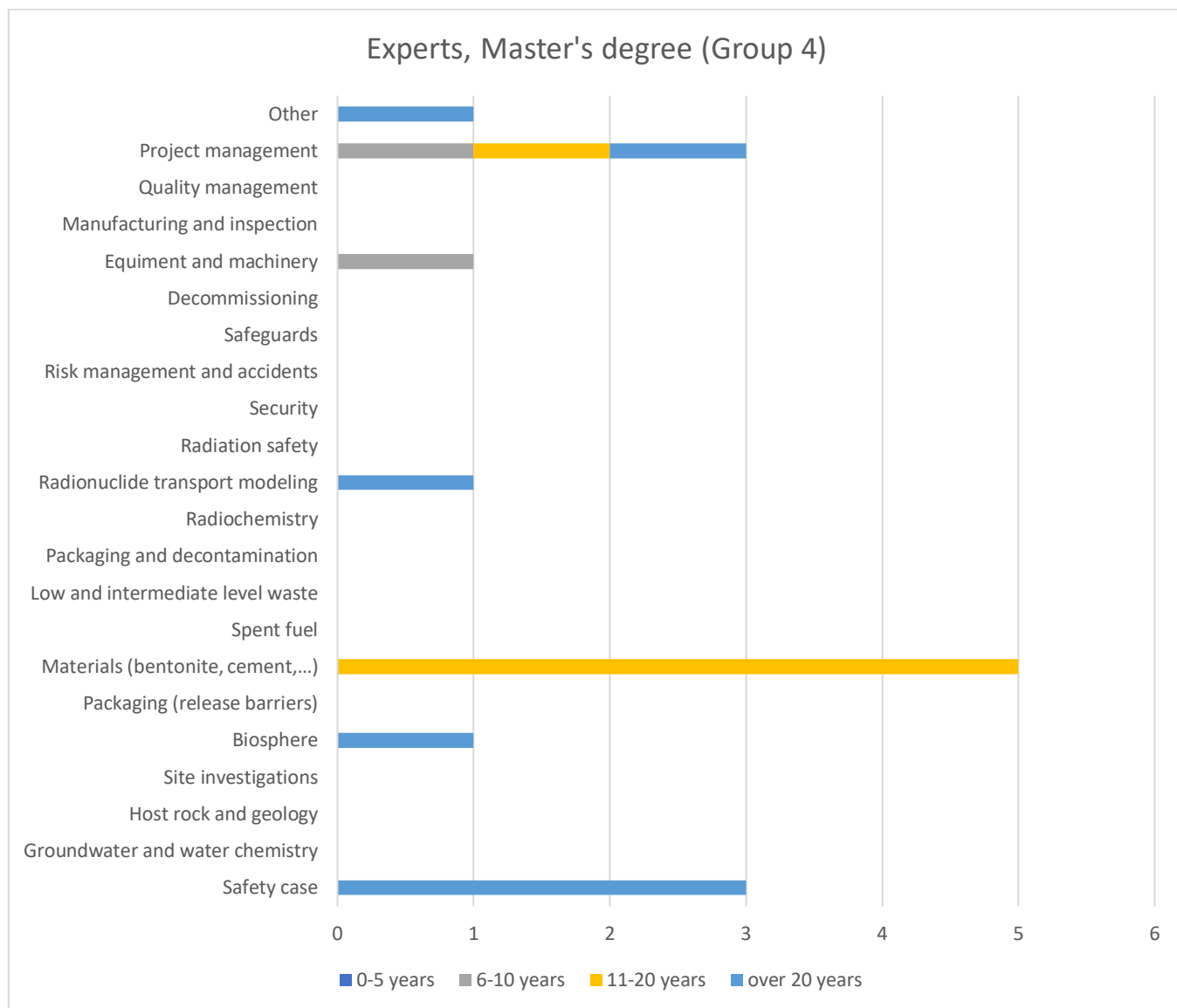


Figure 2.16. Master's degree experts for research organisations and universities, categorised according to work experience (years in the field) in 2022.



2.5.2 Bachelor's degree

In total, there are 9 Bachelor's degree-holders in Group 4 (other industrial companies). The largest competence areas are low and intermediate level waste and packaging and decontamination. No experts were reported in various categories, reflecting the fact that the overall number of Bachelor's level experts of 9 is low and the survey is not comprehensive on other industrial companies..

The distribution of Bachelor's degree experts in different competence areas is illustrated in Figure 2.17.

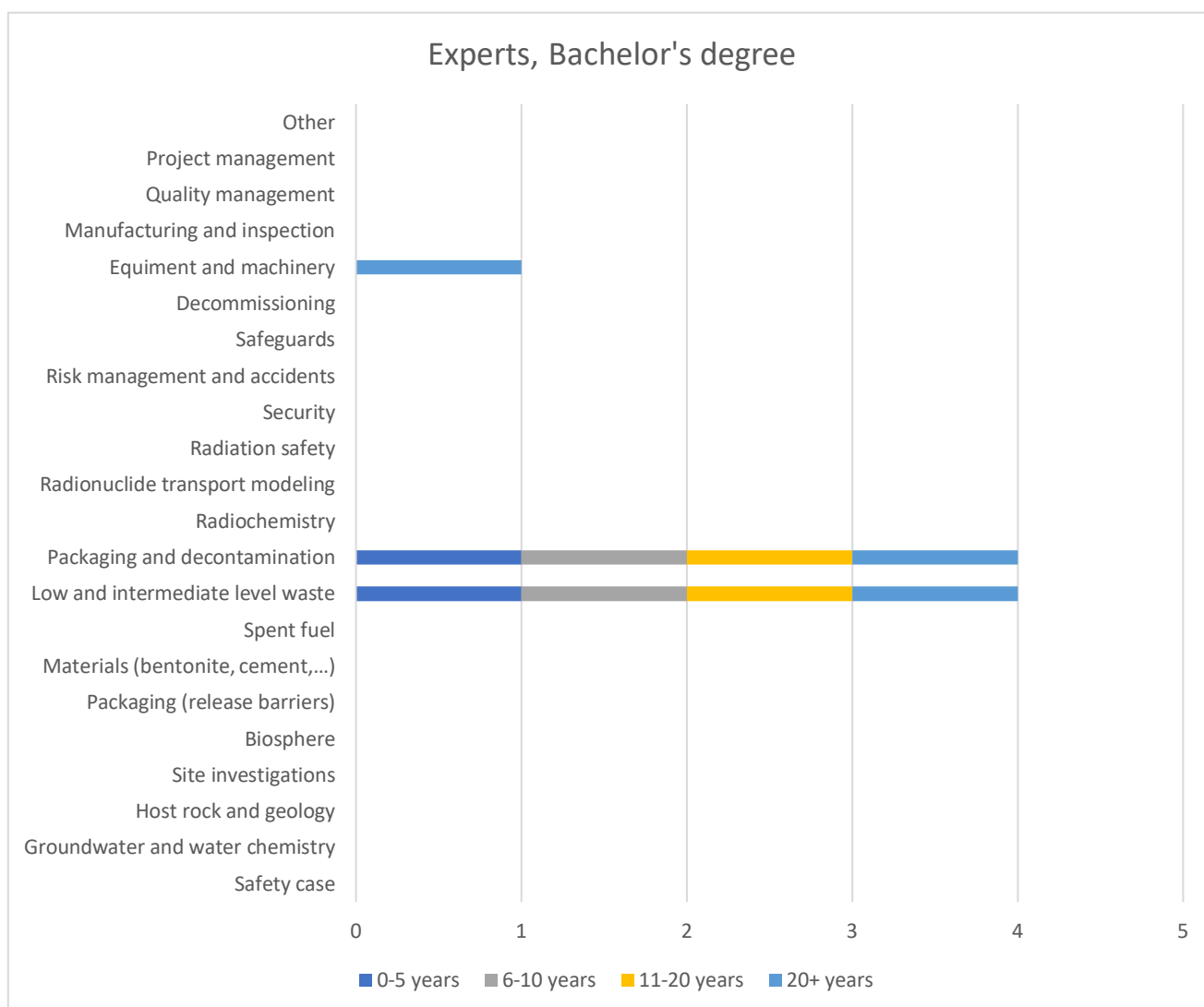


Figure 2.17. Bachelor's degree experts in other industrial companies in 2022, categorised according to work experience (years in the field).

2.5.3 Secondary-level vocational qualifications

In total, there is one vocational degree-holder in Group 4 (other industrial companies) in the competence area of materials (bentonite, cement).

3. Future personnel needs within the nuclear waste management field

3.1 All respondents

This chapter outlines the estimated demand for nuclear energy sector personnel for 2025, 2030 and 2035.

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. The result for all groups is illustrated in Figure 3.1.

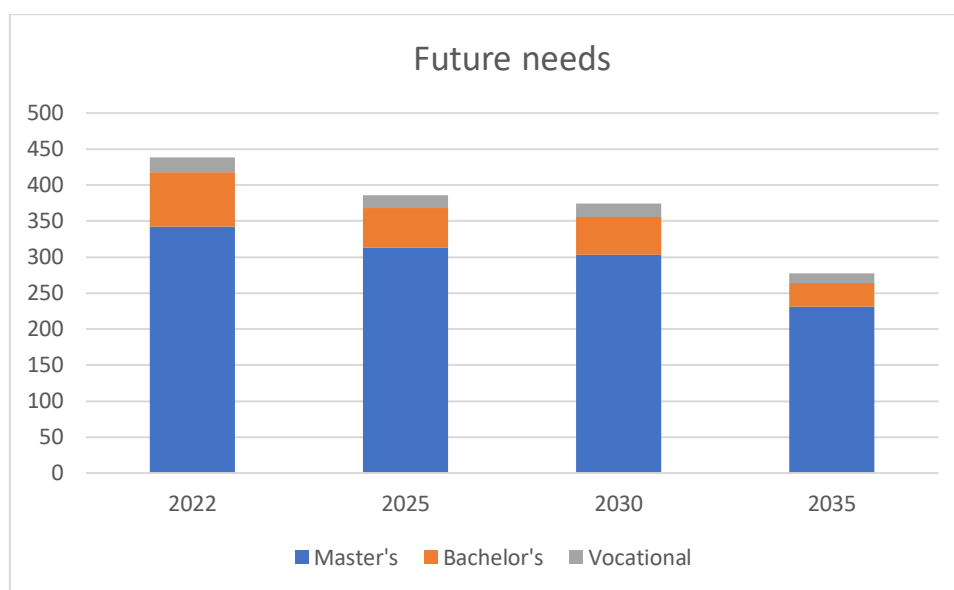


Figure 3.1. Reported future needs for experts in different degree categories for all respondents.

The demand for experts is estimated to decrease in the future to 60% of current number of experts. this may signal an intended shift due to the Posiva project moving to operational phase or simply a reflection of the expectation of the persons filling the survey template.

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.

Degree	2022	2025	2030	2035
Master's	342	313	303	231
Bachelor's	76	55	53	33
Vocational	20	18	18	13
Total	437	386	374	277



3.1.1 Master's degree

In the future, demand for experts holding a Master's degree is estimated to be lower in most categories as illustrated in Figure 3.2. The two exceptions to this are radiochemistry and lower and intermediate level waste where the need for experts is expected to rise. There are also many new experts expected to be needed in the "Other" category, specified as e.g. oversight and data management.

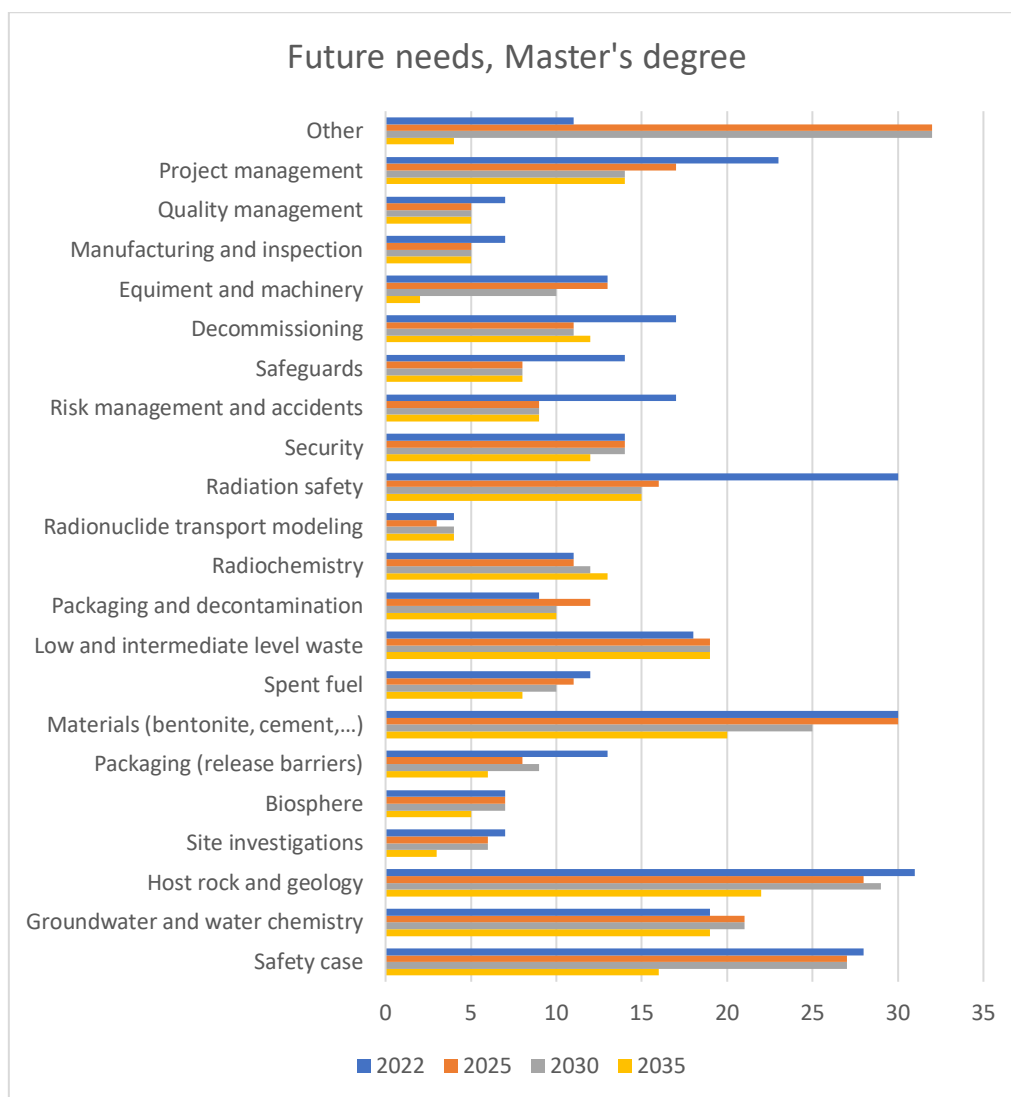


Figure 3.2. Expected future need for Master's degree holders in years 2025, 2030 and 2035 versus current year (2022).



3.1.2 Bachelor's degree

In the future, demand for experts holding a Bachelor's degree is estimated to be lower in most categories as illustrated in Figure 3.3. There are new experts expected to be needed mainly in the "Other" category, specified as e.g. operation, control and data management. Site investigations in possible domestic and foreign assignments might create a need for more experts in future.

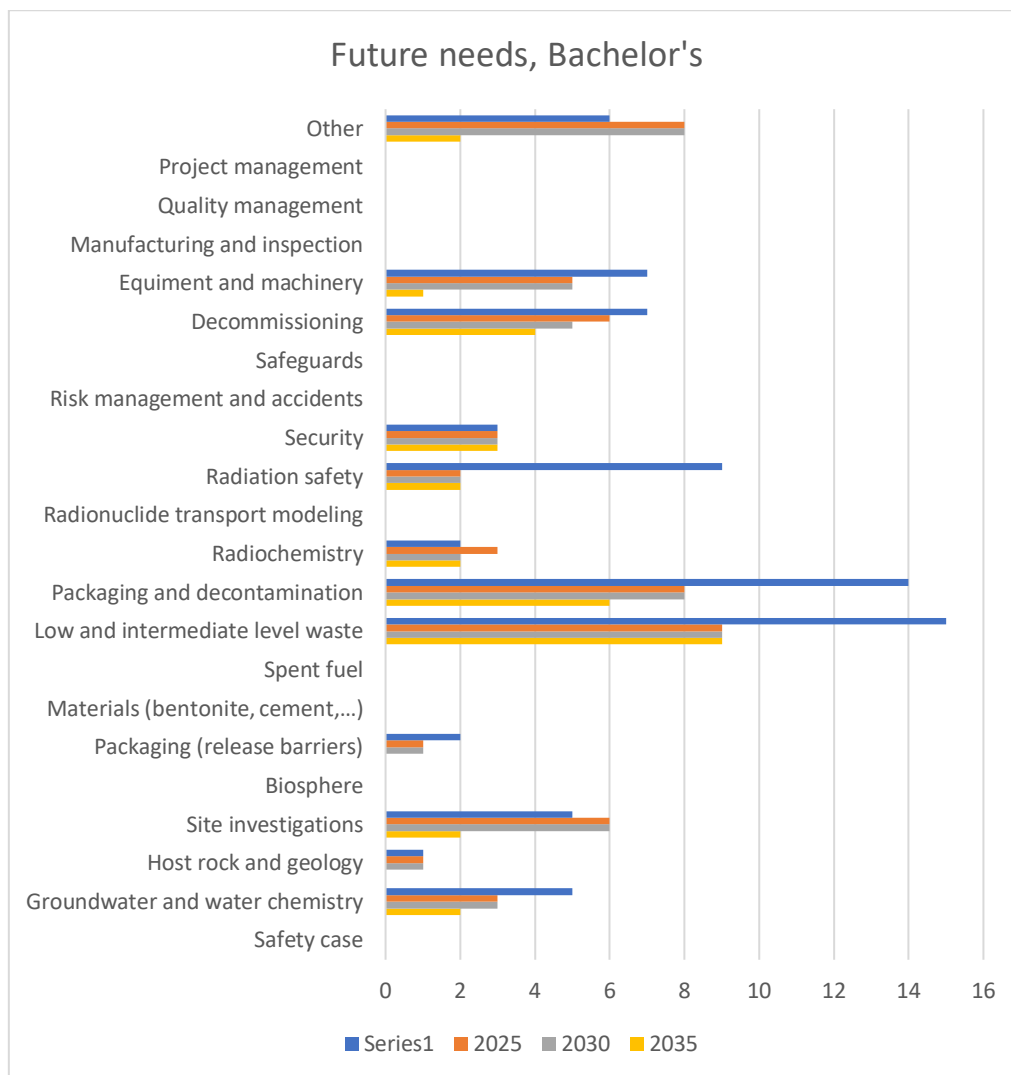


Figure 3.3. Expected future need for Bachelor's degree holders in years 2025, 2030 and 2035 versus current year (2022).



3.1.3 Secondary-level vocational qualifications

In the future, demand for experts holding a vocational degree is estimated to be lower in most categories as illustrated in Figure 3.4. However, at least one respondent specified that their organisation will need people in operation of the repository but that the specifics are not yet ready to be reported. This data is therefore not comprehensive.

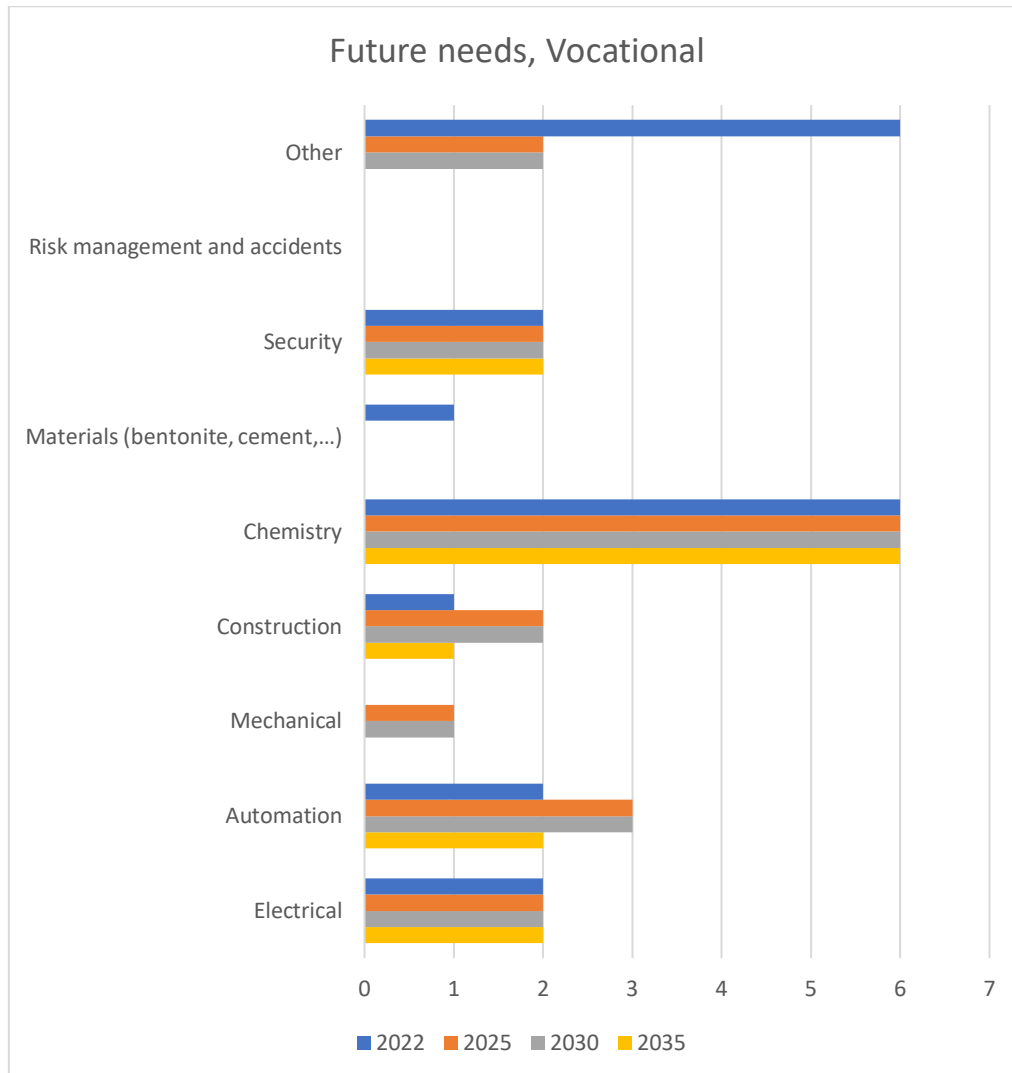


Figure 3.4. Expected future need for vocational degree holders in years 2025, 2030 and 2035 versus current year (2022).



3.2 Power companies and Posiva

The expected future needs for power companies and Posiva are illustrated in Figure 3.5. Based on the data, the three companies do not predict a similar development in their future needs as Posiva and TVO expects the number of experts to increase while Fortum expects it to decrease.

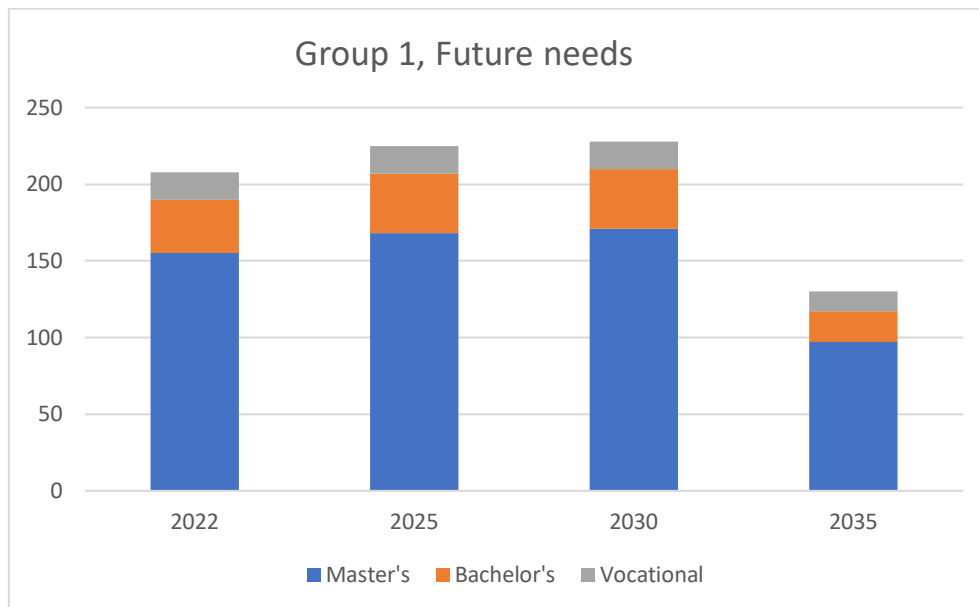


Figure 3.5. Reported future needs for experts in different degree categories for power companies and Posiva.



3.2.1 Master's degree

For Group 1, the expected demand for experts holding a Master's degree is illustrated in Figure 3.6. The demand is seen to be generally lower in future years, with the exception of low and intermediate level waste management where the need for experts is expected to rise. There are also many new experts expected to be needed in the "Other" category, specified as e.g. oversight and data management. Security area is also seen to slightly increase.

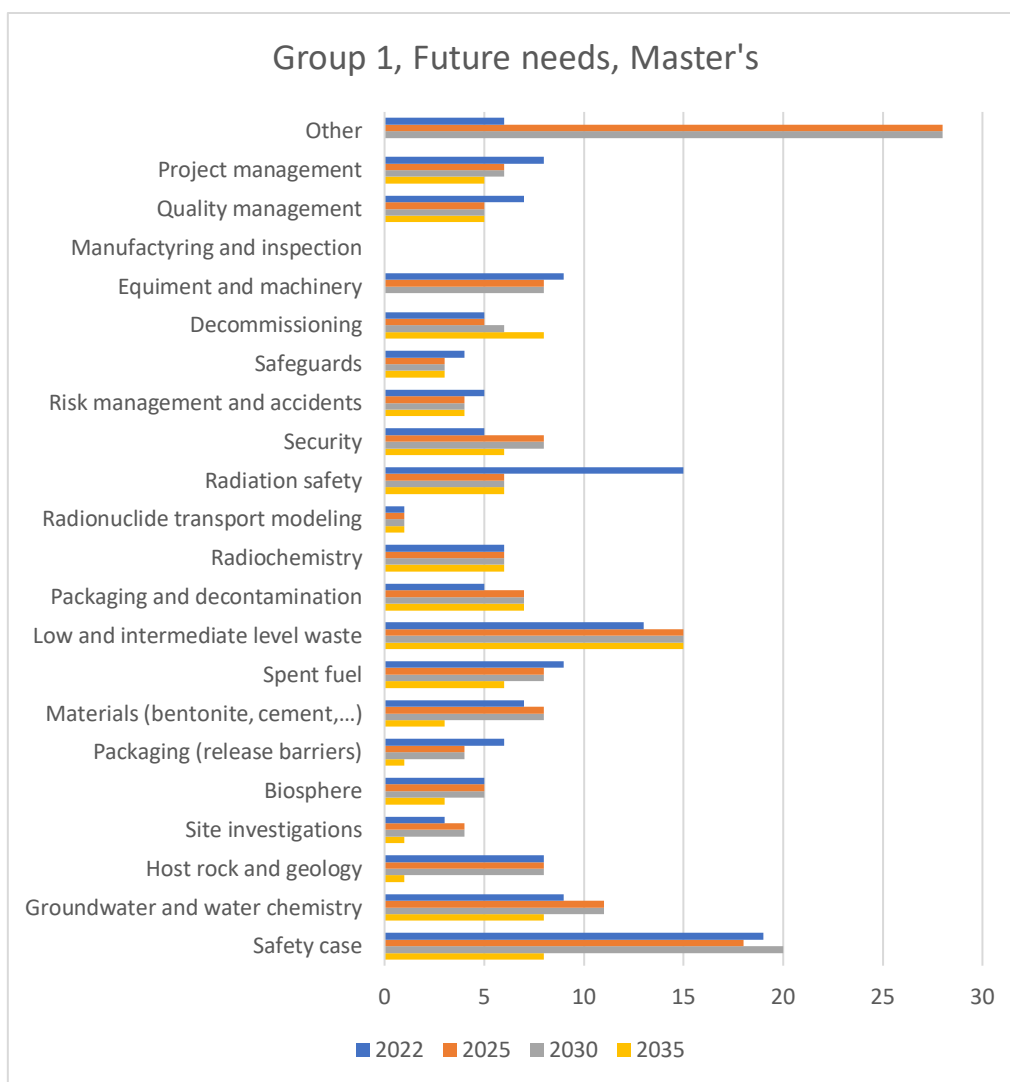


Figure 3.6. Expected future need for Master's degree holders for Group 1 in years 2025, 2030 and 2035 versus current year (2022).



3.2.2 Bachelor's degree

In the future, demand for experts holding a Bachelor's degree in Group 1 is estimated to be similar or lower in most categories as illustrated in Figure 3.7. There are new experts expected to be needed mainly in the "Other" category, specified as e.g. operation, control and data management, as well as low and intermediate level waste management.

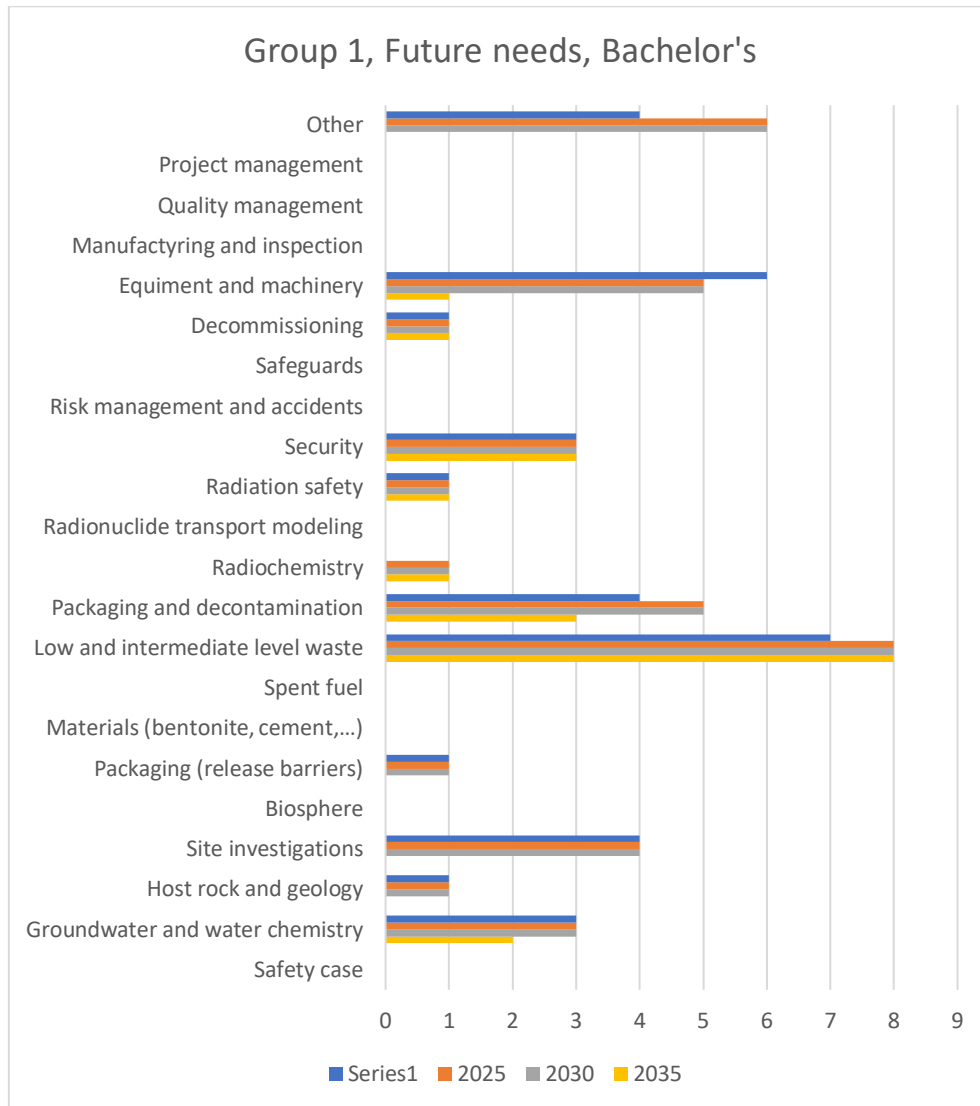


Figure 3.7. Expected future need for Bachelor's degree holders for Group 1 in years 2025, 2030 and 2035 versus current year (2022).



3.2.3 Secondary-level vocational qualifications

In the future, demand for experts holding a vocational degree is estimated to be lower in most categories as illustrated in Figure 3.8. However, at least one respondent specified that their organisation will need people in operation of the repository but that the specifics are not yet ready to be reported. This data is therefore not comprehensive.

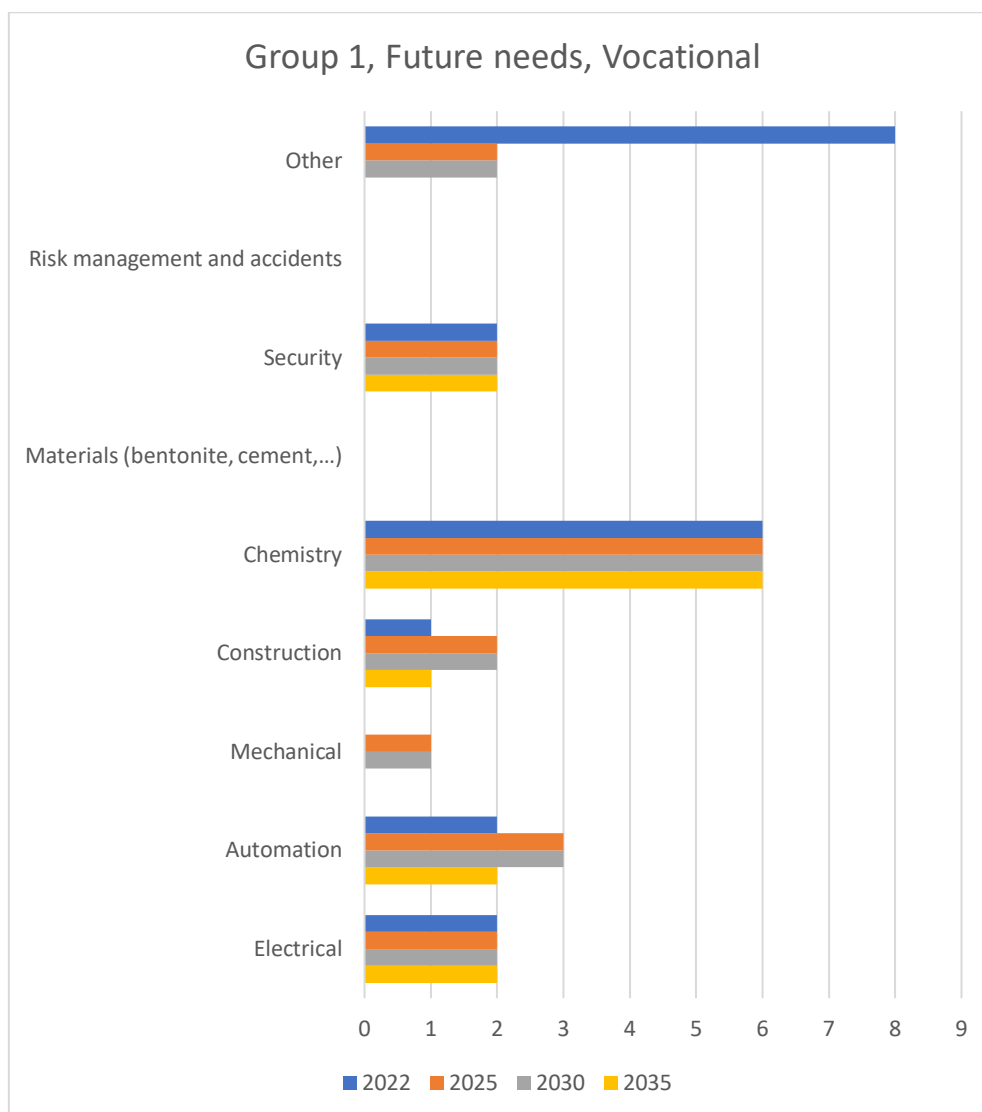


Figure 3.8. Expected future need for vocational degree holders for Group 1 in years 2025, 2030 and 2035 versus current year (2022).



3.3 Public authorities

The expected future needs for public authorities are illustrated in Figure 3.9. Based on the data, authorities see the situation as being fairly stable with no large changes but a slight decrease in number of experts.

No vocational experts are reported in Group 2 for current or future years.

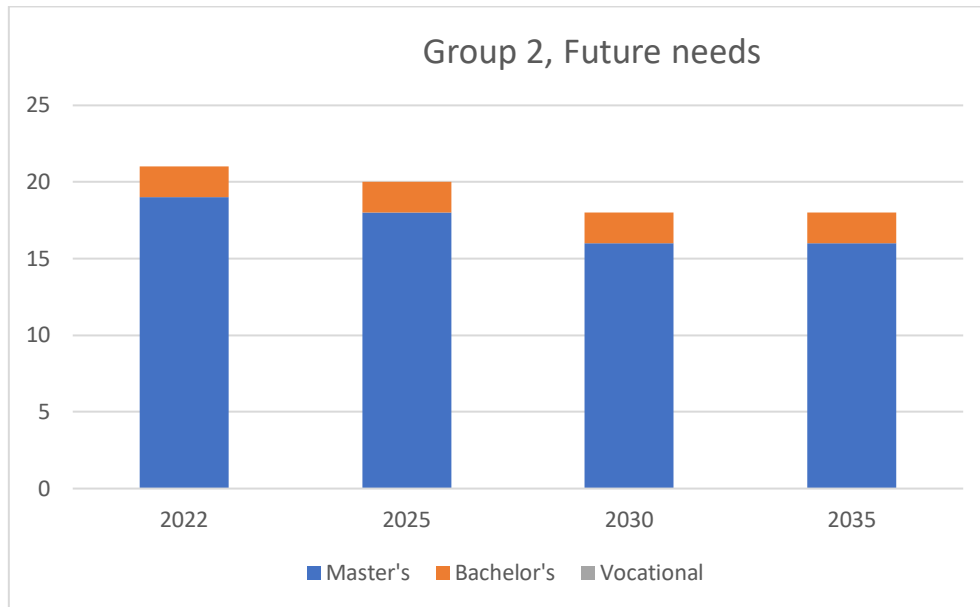


Figure 3.9. Reported future needs for experts in different degree categories for public authorities.

3.3.1 Master's degree

For Group 2, the expected demand for experts holding a Master's degree is illustrated in Figure 3.10. The demand is seen to be similar in future years for most categories, with the exception of radiation safety where the need for experts is expected to decrease.

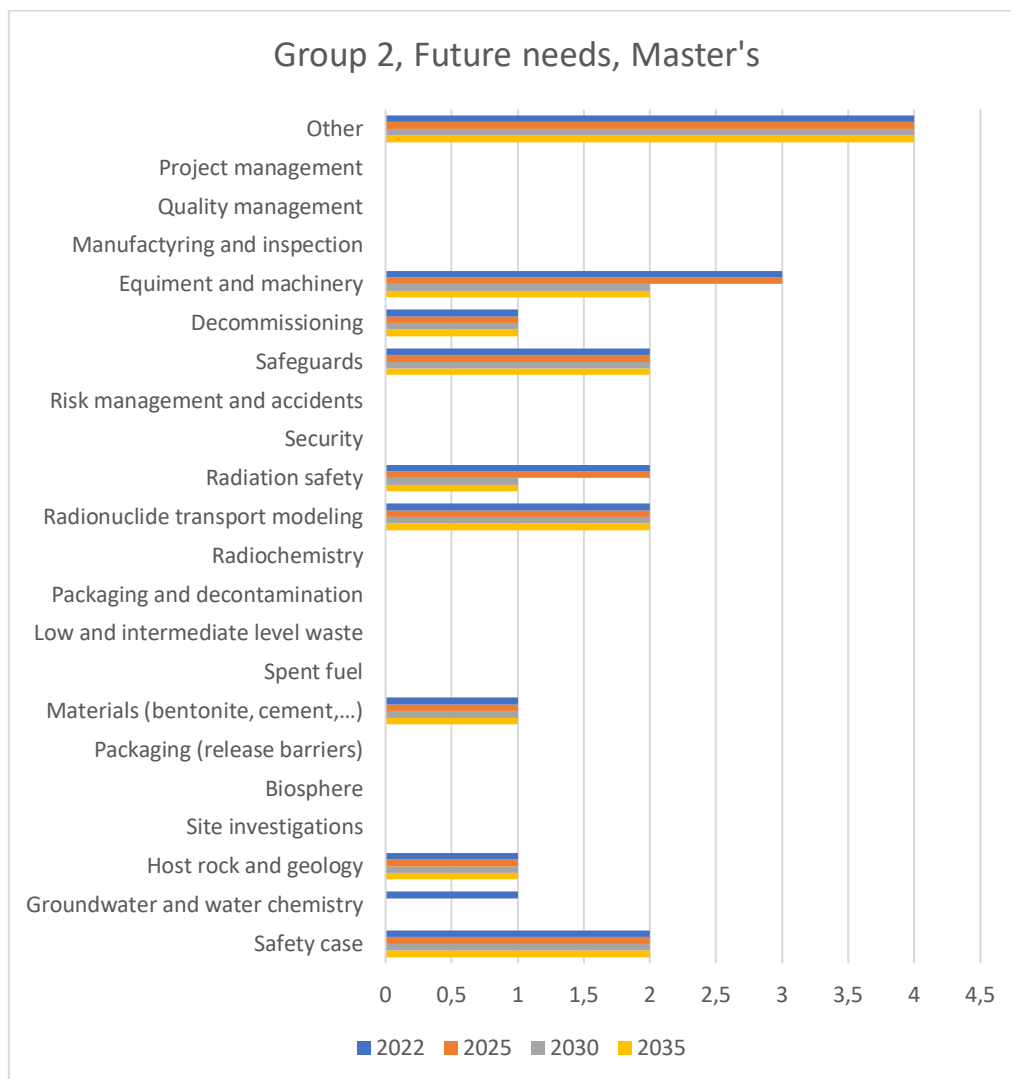


Figure 3.10. Expected future need for Master's degree holders for Group 2 in years 2025, 2030 and 2035 versus current year (2022).

3.3.2 Bachelor's degree

Only two experts in this category were reported for the public authorities in the "Other" category and the need is seen to remain the same for the upcoming years.



3.4 Universities and research institutes

The expected future needs for universities and research organisations are illustrated in Figure 3.11. Based on the data, the organisations see a rapid change in the next few years, followed by a stable situation with a decreased number of experts.

No vocational experts are reported in Group 3 for current or future years.

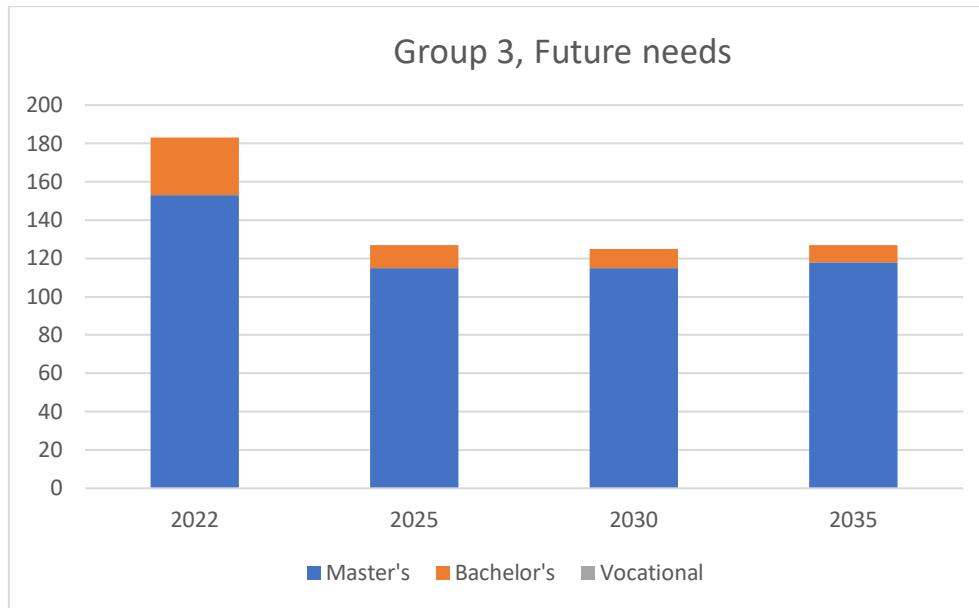


Figure 3.11. Reported future needs for experts in different degree categories for universities and research organisations.



3.4.1 Master's degree

For Group 3, the expected demand for experts holding a Master's degree is illustrated in Figure 3.12. The demand is seen to decrease in some categories and remain the same or have a slight increase in others. Especially decommissioning, safeguards risk management and accidents as well as radiation safety are seen to decrease in the future.

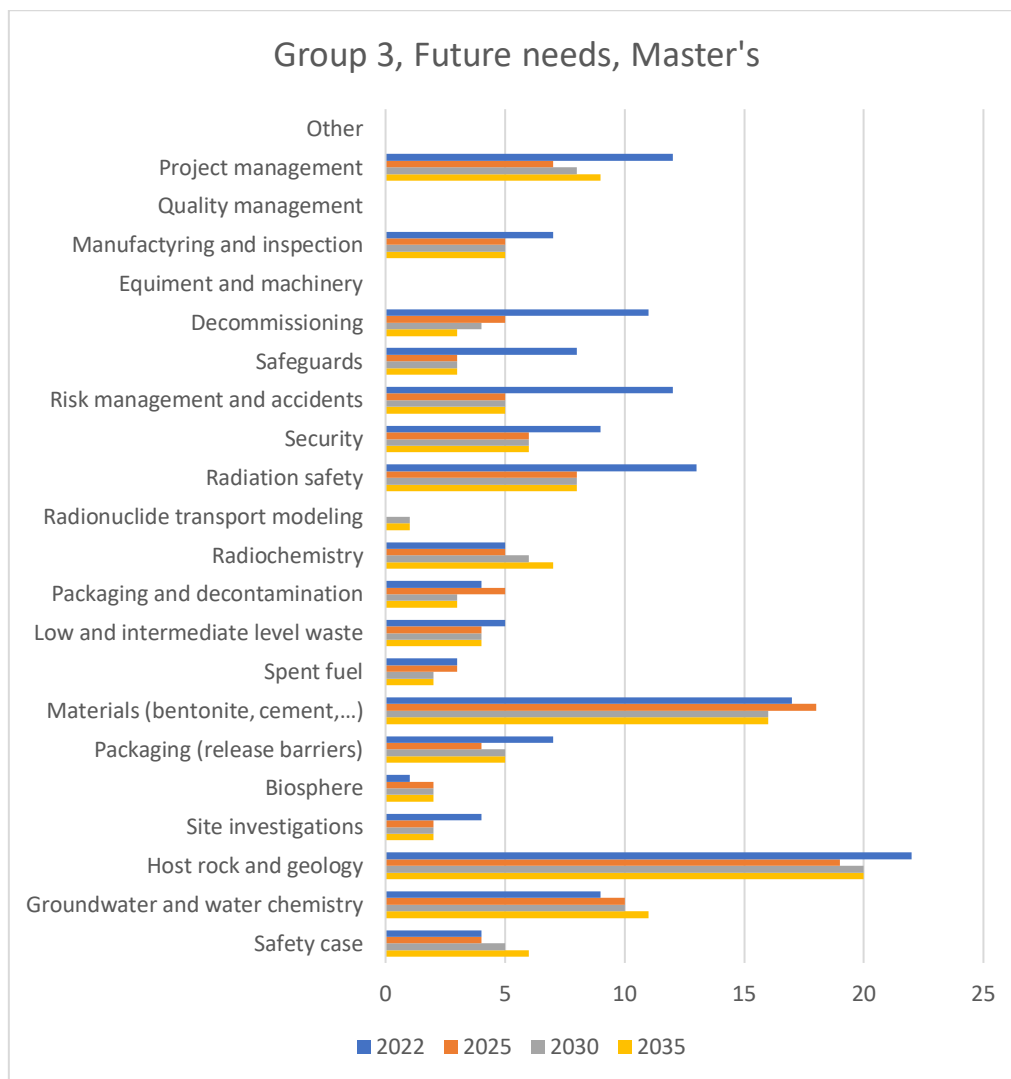


Figure 3.12. Expected future need for Master's degree holders for Group 3 in years 2025, 2030 and 2035 versus current year (2022).



3.4.2 Bachelor's degree

In the future, demand for experts holding a Bachelor's degree in Group 3 is estimated to decrease in most categories as illustrated in Figure 3.13. There are new experts expected to be needed mainly in site investigation category. As the overall numbers for future years in this category are fairly low, there is some question of whether the data is comprehensive.

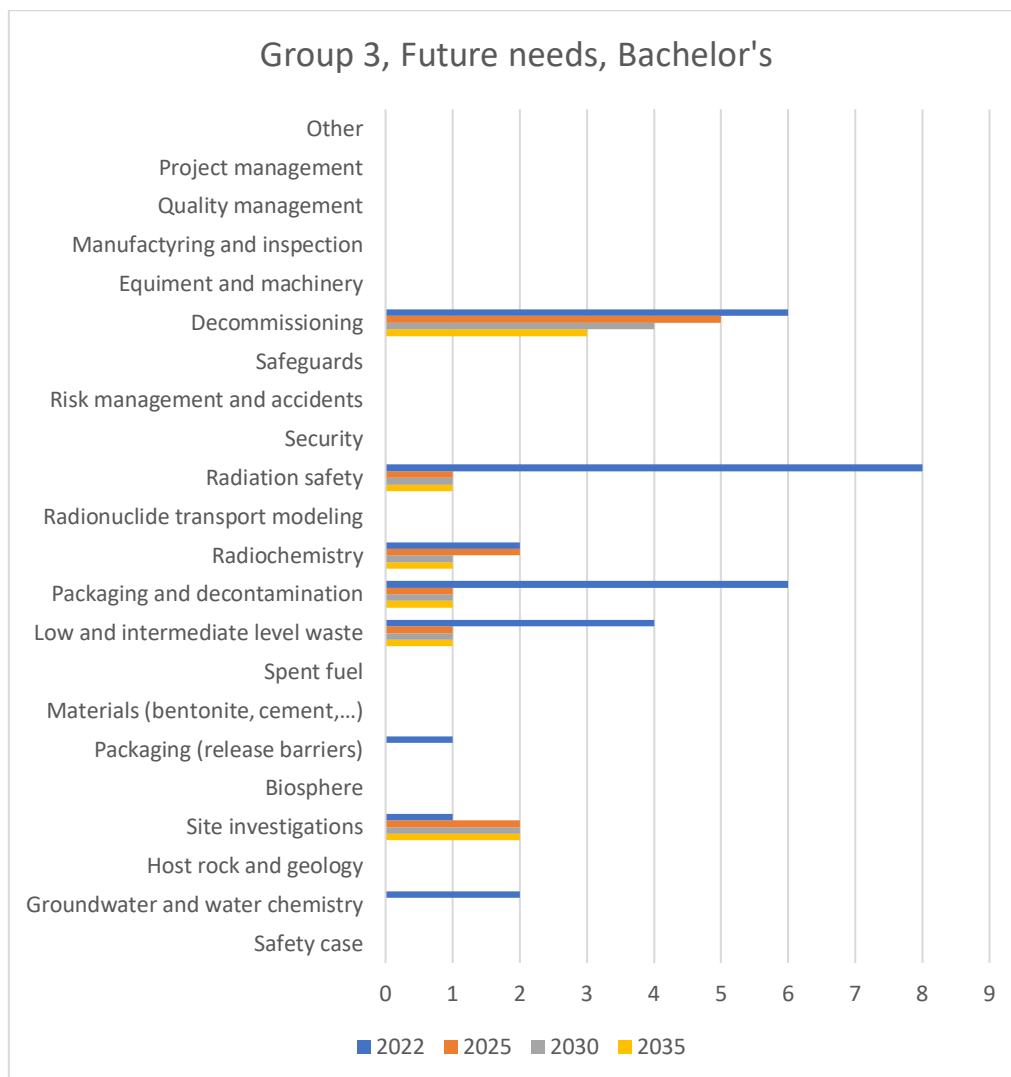


Figure 3.13. Expected future need for Bachelor's degree holders for Group 3 in years 2025, 2030 and 2035 versus current year (2022).

3.5 Other industrial companies

The expected future needs for other industrial companies were not comprehensively reported – some of the organisations gave no prediction of future numbers at all while others mentioned that they do not have a clear understanding of the needs for this timespan available. The incomprehensive results are therefore not reported here.



4. Summary and conclusions

The aim of this study was to update and expand the results of previous studies [1,2] in regard to the human resources of nuclear waste management. The competence survey was done with an online template made with the Webropol tool and sent to selected organizations as part of the KYT2022 research programme.

The main target groups of the survey were:

- key actors in nuclear waste management (TVO, Fortum, Posiva)
- authorities (STUK, MEAE, VYR)
- universities and universities of applied sciences
- industry close to the power companies.

The general goal of the expert survey was to find out the number of experts currently working in the various sectors of nuclear waste management and the need in the coming years.

13 organisations responded to the survey, including all key actors and authorities of the nuclear energy field. 437 experts were reported in total and the largest share of experts work at the power companies or Posiva. The results can be compared to the earlier reports for the nuclear energy field [1,2], where nuclear waste management experts numbered 170 (year 2017) and 210 (year 2010), however, they are not directly comparable due to different categories in the questionnaire (in the previous survey, many experts in nuclear waste management were likely to be listed under one of the other category options).

The reported distribution for years in the field for different experts was generally fairly even, with some outliers with senior experts on certain topics. An overall trend of more experienced experts employed by the public authorities can be distinguished, while the universities and research organisations have a larger share of newcomers, as can be expected.

The report covers the situation in summer 2022 and investigates the future predictions for 2025, 2030 and 2035. Some organisations expressed difficulties in predicting future needs and consequently, this data should be approached with some reservations.

As part of the survey, the gender balance, or ratio of men and women were also reported. However, the reported numbers of men (158) and women (97) do not add up to the overall reported number of experts (255 vs. 437) so this data is not complete. The gender ratio, as reported, on the different expert categories is 62% men and 38% women overall.



4.1 Summary for all respondents

A total of 437 nuclear waste management experts were reported in the survey.

A total of 342 (78%) experts with a Master's degree were reported, 76 (18%) with a lower university degree, and 120 (4%) with a secondary degree.

4.2 Summary for power companies and Posiva

The power companies (TVO, Fortum) and Posiva reported a total of 208 experts. All key actors responded to the survey in this group.

A total of 155 (74%) experts with a Master's degree were reported, 35 (17%) with a lower university degree, and 19 (9%) with a secondary degree.

4.3 Summary for public authorities

The public authorities reported a total of 21 experts. All key actors responded to the survey in this group.

A total of 19 (90%) experts with a Master's degree were reported and 2 (10%) with a lower university degree.

4.4 Summary for universities and research organisations

The universities and research organisations reported a total of 183 experts. Most, but not all, key actors responded to the survey in this group.

A total of 153 (84%) experts with a Master's degree were reported and 30 (16%) with a lower university degree.

4.5 Summary for other industrial companies

The universities and research organisations reported a total of 25 experts. The data for this group is not comprehensive, as only 3 organisations responded to the survey, in a similar manner to the previous reports [1,2].

A total of 15 (60%) experts with a Master's degree were reported, 9 (36%) with a lower university degree and 1 (4%) with a secondary degree.



4.6 Conclusions

The survey was submitted to 71 recipients that were identified as actors in the nuclear waste management field; of these 13 responded, including all of the key actors (Fortum, TVO, Posiva, STUK, MEAE and key research organisations). The data is most incomplete for other industrial organisations, where identifying the correct companies was challenging in itself and receiving responses from them turned out to be rare. This result is similar to the situation in the earlier surveys done for the field of nuclear safety [1,2]. For the future, if the survey is repeated or updated, it is recommended to consider alternative methods to reach a wider response from the different subcontractors and project organisations. The results reported here can be taken as indicative of the actual situation for the key actors.

The field of nuclear waste management appear in these results as one where experts generally have a university level degree, in most cases Master's, but also Doctor's degrees frequently reported. Many organisations have a large share of senior level experts (20+ years in the field), indicating commitment and longevity of the experts. However, the overall age distribution looks healthy for the field in general, with no sign of the potential problem that was observed in the first survey [1] of a large peak of soon-to-retire experts.

As a new feature compared to the earlier surveys, the gender balance of the experts in the field were investigated in this survey. Some actors reported that they did not have this data available and when checking the numbers of men and women it can be observed that they do not match the overall number of experts reported. There are hence some reservations that should be applied when drawing conclusions from this data, but based on what was reported, the gender balance (62% men – 38% women) seems fairly equal for a technical expertise field.

Future needs for each organisation were also included in the survey. While most (but not all) organisations did submit numbers for their anticipated future needs for experts in different categories, it should be noted that there were some factors that should be considered when considering the validity of these results. Firstly, during the reporting period, Fennovoima cancelled their application for construction license for the Hanhikivi power plant, and the effects of this on the field in general were not yet entirely clear during the creation of this report. Secondly, Finland was undergoing an energy crisis during 2022. Overall, predicting the future development of nuclear energy in the country, which has a direct impact on the nuclear waste management field, became more difficult during the reporting period than normally. It is also worth noting that especially those organisations that have less than 20 persons working on nuclear waste management related issues generally did not have a clear vision of their need for experts up to the year 2035, and some of them declined to answer to the future survey entirely. Overall, the reported numbers for future years are thus not entirely reliable, but they do highlight some expected changes in the topical areas, e.g., low and intermediate level waste management or data and knowledge management, gaining more importance and more experts needed in the upcoming decades.

Finally, for future reference if this work should be updated, it should be mentioned that many organisations expressed difficulties in replying to the survey due to the various categories required and no ready data at hand for the persons filling it. For future surveys it should be considered whether a simplified approach could produce more accurate, if less exact information on the situation in the nuclear waste management field.



References

- [1] 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. ISBN 978-952-227-600-1.
- [2] Hämäläinen, Suolanen; Survey of Competence in the Nuclear Energy Sector 2017–2018 in Finland, Publications of the Ministry of Economic Affairs and Employment, Energy 2019:22 (2019)

Appendices

Appendix 1 – Survey letter and template (in Finnish)

Ydinjätehuollon osaaminen Suomessa

YES-työn 2017 päivitys ydinjätehuollon henkilöresurssien osalta vuonna 2022

Työ- ja elinkeinoministeriölle tehtävä selvitys osana KYT2022 -tutkimusohjelmaa

10.5.2022

Saate

Työ- ja elinkeinoministeriö asetti lokakuussa 2010 kansallisen ydinenergia-alan pitkän aikavälin osaamista selvittävän työryhmän. Selvityksen tuloksena valmistui vuonna 2012 julkinen raportti, jossa on laajasti tarkasteltu ydinenergia-alan henkilöstöresursseja, tutkimusinfrastruktuuria, rahoitusta, kansainvälistä tutkimusta sekä koulutustarjontaa. Selvitystä päivitettiin vuonna 2017 tehdyllä kyselyllä vuosille 2020, 2025 ja 2030.

Nyt tehtävässä kyselyssä tarkoituksena on laajentaa ja päivittää vuoden 2017¹² selvitystä ydinjätehuollon osaajien osalta. Aiemmassa selvityksessä ydinjätehuolto oli mukana vain yhtenä kategoriana eikä tulos siis kerro ydinjätehuollon osaajiin liittyvistä tarpeista.

Ydinjätehuollon osaamiskartoituksen toteuttamista on suositeltu mm. kansallisen YETI -työryhmän toimesta³ sekä Valtion ydinjätehuoltorahaston (VYR) tutkimusohjelmien kansainvälisen arvioinnin loppuraportissa⁴. Osaamiskartoituksen tuloksia tullaan hyödyntämään uudessa SAFER2028 - tutkimusohjelman (National Nuclear Safety and Waste Management Research Programme) toteutuksessa sekä Suomen ydinjätehuollon ARTEMIS -arvioinnissa (Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation). Kyselyn tulosten hyödyntämisen osalta olisi tärkeää, että mahdollisimman moni organisaatio osallistuu kyselyyn.

Kysely on lähetetty valituille organisaatioille. Kyselyn kohderyhmät ovat:

1. Keskeiset ydinvoima-alan toimijat
2. Yliopistot ja korkeakoulut
3. Voimayhtiöiden lähipiiriin teollisuus

Kysely toteutetaan Webropol -työkalulla. Selvityksen toteutuksesta ja saaduista tuloksista laaditaan julkinen yhteenvetoraportti, josta ei kuitenkaan ilmene vastaajakohtaisia tietoja. Vastaajakohtaiset tiedot pidetään luottamuksellisina.

Tämä kysely on lähetetty kuhunkin organisaatioon vain yhdelle yhteyshenkilölle. Toivomme, että kyselyn saaja selvittää koko organisaation osajatilanteen tai tarvittaessa lähettää kyselyn eteenpäin valitsemaalleen oman organisaation edustajalle.

Kyselyn toteuttaa Teknologian tutkimuskeskus VTT Oy työ- ja elinkeinoministeriön toimeksiannosta.

Lisätietoja antavat tarvittaessa KYT2022-ohjelman johtaja Suvi Karvonen (suvi.karvonen@vtt.fi p. 040 356 2536) ja projektkoordinaattori Aku Itälä (aku.itala@vtt.fi, p. 040 833 6473). Työ- ja elinkeinoministeriön yhteyshenkilö on Linda Kumpula (linda.kumpula@gov.fi, p. 029 506 0125).

¹Hämäläinen, J. & Suolanen, V., 2017, Survey of Competence in the Nuclear Energy Sector 2017-2018 (Ydinenergia-alan osaamisselvitys 2017-2018; in Finnish). <https://www.vtt.fi/inf/pdf/technology/2018/T344.pdf>

²Hämäläinen, J. & Suolanen, V., 2019, Survey of Competence in the Nuclear Energy Sector 2017-2018 in Finland. Publications of the Ministry of Economic Affairs and Employment. <http://urn.fi/URN:ISBN:978-952-327-410-5>

³Kansallisen ydinjätehuollon yhteistyöryhmän (YETI) loppuraportti (2019), <http://urn.fi/URN:ISBN:978-952-327-435-8>

⁴36SAFIR2022 Program, KYT2022 Program and SAFER2028 Draft Framework External Evaluation Report (2022), <https://urn.fi/URN:ISBN:978-952-327-799-1>

Kyselylomake

TYÖ- JA ELINKEINOMINISTERIÖ – KYSELY YDINENERGIA-ALAN OSAAMISESTA SUOMESSA

REKISTERITIEDOT

Sähköpostiosoite:

Kohderyhmä (merkitse alle):

- Keskeiset ydinjätealan toimijat
- Yliopistot, korkeakoulut ja tutkimuslaitokset
- Voimayhtiöiden lähipiirin teollisuus

TAUSTATIEDOT

- Organisaation nimi
- Osoite
- Vastaajan nimi
- Puhelinnumero

HENKILÖSTÖRESURSSIT

1. Kuinka monta henkilöä, joilla on osaamista ydinenergia-alan erityispiirteistä on kesäkuussa 2022 organisaationne palveluksessa (työsuhde organisaatioon)? Merkitkää henkilöiden lukumäärä ydinenergia-alan kokemusvuosien mukaisesti (kukin henkilö vain kerran).

1.1 Ydinenergia-alan asiantuntijat (alalle soveltuva ylempi korkeakoulututkinto)	0-5 vuotta ydinalalla	6-10 vuotta ydinalalla	11-20 vuotta ydinalalla	yli 20 vuotta ydinalalla
Turvallisuusperustelu				
Pohjavesi ja vesikemia				
Geologia ja kallioperä				
Loppusijoituskenttätutkimukset				
Biosfääri				
Vapautumisesteenä toimivat ydinjätteen loppusijoituspakkaukset				
Materiaalitekniikka (mm. bentoniittisavi, sementti, komponentit...)				
Käytetty polttoaine				
Matala- ja keskiaktiivinen jäte				
Jätteiden pakkaaminen ja dekontaminointi				
Radiokemia				
Radionuklidien kulkeutumismallinnus				
Säteilysuojelu ja säteilyturvallisuus				
Turvallisuus (security, yritysturvallisuus, paloturvallisuus,...)				
Onnettomuudet ja riskienhallinta				
Ydinmateriaalivalvonta (safeguards)				
Käytöstäpoisto				
Koneet ja laitteet (jätteiden käsittely, loppusijoitus tilan rakentaminen)				
Komponenttien valmistus ja tarkastus				
Laadunhallinta ja tarkastustoiminta				
Projektihallinta				
Muu, mikä?				
1.1 A: Mitä nämä muut ovat?				
1.1 B: Kuinka monta edellisistä henkilöistä on -tohtoreita: _____ -lisenssiaatteja: _____				
1.1 C: Kuinka monta edellisistä henkilöistä on -naisia: _____ -miehiä: _____				

1.2 Ydinenergia-alan asiantuntijat (alalle soveltuva alempi korkeakoulututkinto tai vastaava)	0-5 vuotta ydinalalla	6-10 vuotta ydinalalla	11-20 vuotta ydinalalla	yli 20 vuotta ydinalalla
Turvallisuusperustelu				
Pohjavesi ja vesikemia				
Geologia ja kallioperä				
Loppusijoituskenttätutkimukset				
Biosfääri				
Vapautumisesteenä toimivat ydinjätteen loppusijoituspakkaukset				
Materiaalitekniikka (mm. bentoniittisavi, sementti, komponentit...)				
Käytetty polttoaine				
Matala- ja keskiaktiivinen jäte				
Jätteiden pakkaaminen ja dekontaminointi				
Radiokemia				
Radionuklidien kulkeutumismallinnus				
Säteilysuojelu ja säteilyturvallisuus				
Turvallisuus (security, yritysturvallisuus, paloturvallisuus,...)				
Onnettomuudet ja riskienhallinta				
Ydinmateriaalivalvonta (safeguards)				
Käytöstäpoisto				
Koneet ja laitteet (jätteiden käsittely, loppusijoitus tilan rakentaminen)				
Komponenttien valmistus ja tarkastus				
Laadunhallinta ja tarkastustoiminta				
Projektihallinta				
Muu, mikä?				
1.2 A: Mitä nämä muut ovat?				
1.2 B: Kuinka monta edellisistä henkilöistä on - naisia: _____ - miehiä: _____				
1.3 Ydinenergia-alan suorittajat (esim. toisen asteen ammatillinen tutkinto)	0-5 vuotta ydinalalla	6-10 vuotta ydinalalla	11-20 vuotta ydinalalla	yli 20 vuotta ydinalalla
Sähkötekniikka				
Automaatiotekniikka				
Mekaniikka / konetekniikka				
Rakennustekniikka				
Kemia / prosessitekniikka				
Materiaalitekniikka (mm. bentoniittisavi, sementti, komponentit...)				
Turvallisuus (security, yritysturvallisuus, paloturvallisuus,...)				
Onnettomuudet ja riskienhallinta				
Muu, mikä?				
1.3 A: Mitä nämä muut ovat?				
1.3 B: Kuinka monta edellisistä henkilöistä on - naisia: _____ - miehiä: _____				

2. Kuinka suuri tarve organisaatiollanne on ydinenergia-alan osaajille tulevaisuudessa, mukaan lukien nykyiset työntekijät? Merkitkää henkilöiden lukumäärä vuosikohtiin.

2.1 Ydinenergia-alan erityisasiantuntijat (ylempi korkeakoulututkinto)	v. 2025	v. 2030	v. 2035
Turvallisuusperustelu			
Pohjavesi ja vesikemia			
Geologia ja kallioperä			
Loppusijoituskenttätutkimukset			
Biosfääri			
Vapautumisesteenä toimivat ydinjätteen loppusijoituspakkaukset			
Materiaalitekniikka (mm. bentoniittisavi, sementti, komponentit...)			
Käytetty polttoaine			
Matala- ja keskiaktiivinen jäte			
Jätteiden pakkaaminen ja dekontaminointi			
Radiokemia			
Radionuklidien kulkeutumismallinnus			
Säteilysuojelu ja säteilyturvallisuus			
Turvallisuus (security, yritysturvallisuus, paloturvallisuus,...)			
Onnettomuudet ja riskienhallinta			
Ydinmateriaalivalvonta (safeguards)			
Käytöstäpoisto			
Koneet ja laitteet (jätteiden käsittely, loppusijoitus tilan rakentaminen)			
Komponenttien valmistus ja tarkastus			
Laadunhallinta ja tarkastustoiminta			
Projektihallinta			
Muu, mikä?			
2.1 A: Mitä nämä muut ovat?			
2.1 B: Kuinka monta edellisistä henkilöistä on -tohtoreita: -lisenssiaatteja:			
2.2 Ydinenergia-alan asiantuntijat (alalle soveltuva alempi korkeakoulututkinto tai vastaava)	v. 2025	v. 2030	v. 2035
Turvallisuusperustelu			
Pohjavesi ja vesikemia			
Geologia ja kallioperä			
Loppusijoituskenttätutkimukset			
Biosfääri			
Vapautumisesteenä toimivat ydinjätteen loppusijoituspakkaukset			
Materiaalitekniikka (mm. bentoniittisavi, sementti, komponentit...)			
Käytetty polttoaine			
Matala- ja keskiaktiivinen jäte			
Jätteiden pakkaaminen ja dekontaminointi			
Radiokemia			
Radionuklidien kulkeutumismallinnus			
Säteilysuojelu ja säteilyturvallisuus			
Turvallisuus (security, yritysturvallisuus, paloturvallisuus,...)			
Onnettomuudet ja riskienhallinta			
Ydinmateriaalivalvonta (safeguards)			
Käytöstäpoisto			
Koneet ja laitteet (jätteiden käsittely, loppusijoitus tilan rakentaminen)			
Komponenttien valmistus ja tarkastus			
Laadunhallinta ja tarkastustoiminta			
Projektihallinta			
Muu, mikä?			
2.2 A: Mitä nämä muut ovat?			
2.3 Ydinenergia-alan suorittajat (esim. toisen asteen ammatillinen tutkinto)	v. 2025	v. 2030	v. 2035

Sähkötekniikka			
Automaatiotekniikka			
Mekaniikka / konetekniikka			
Rakennustekniikka			
Kemia / prosessitekniikka			
Materiaalitekniikka (mm. bentoniittisavi, sementti, komponentit...)			
Turvallisuus (security, yritysturvallisuus, paloturvallisuus,...)			
Onnettomuudet ja riskienhallinta			
Muu, mikä?			
2.3 A: Mitä nämä muut ovat? _____			

3. Mitä muita ydinenergia-alan asiantuntijoita organisaationne voi tarvita tulevaisuudessa ja kuinka paljon?

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petri.kotiluoto@vtt.fi



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