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# Summary of mapping and analysis of skills needs for electrification



## Introduction

Skills provision is crucial to Sweden’s competitiveness, welfare and green transition. Many industries, including the energy sector, bear witness to the difficulties of recruiting people with the right skills. Sweden intends to be in the vanguard of the global green transition of industry, transport and society to achieve net zero emissions.

This is a summary of a report prepared as part of the Swedish Energy Agency’s **government assignment to coordinate a national mobilisation** to secure short-term (5 years) skills provision for electrification. Our analysis is a snapshot of the present situation within the limitations of the analytical framework. It will provide a foundation for continued efforts to analyse obstacles and challenges, and for proposing measures and collaborations.

Figure 1 shows the analytical framework of the study. The analysis focuses on a selection of major industrial investments, as well as electricity production, infrastructure and support services. These objects have been chosen (step 1) for the analysis based on where the greatest skills needs are likely to arise as a result of electrification.

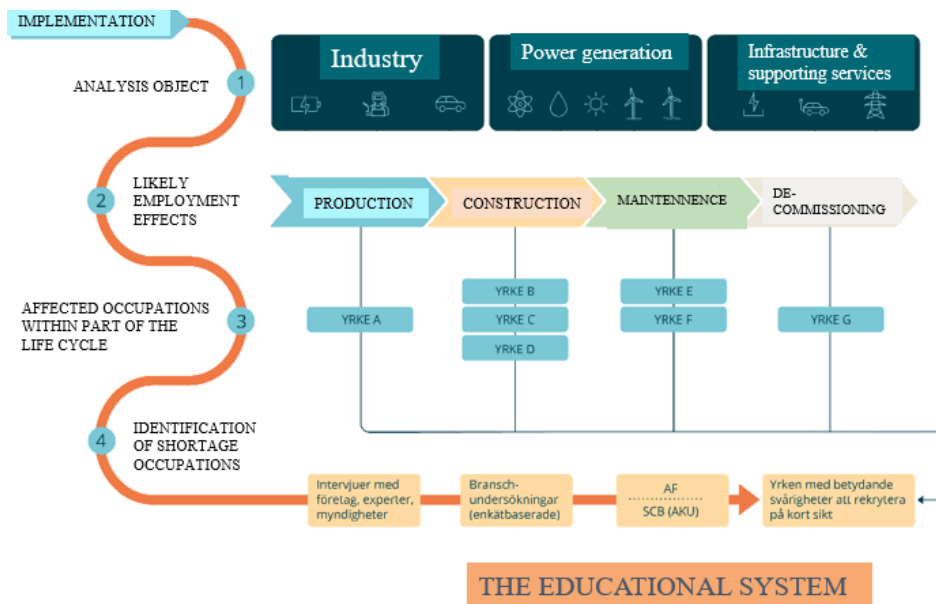


Figure 1 Illustration of the analytical framework used for the study.

The analysis identifies where employment effects will arise in the object’s lifecycle (step 2) and, based on this, which occupations are likely to be affected (step 3). The analysis has focused on identifying the specific occupations that will make the planned transition possible. These include occupations that employ a large workforce, as well as others that, while they employ few people, are considered likely to constitute significant bottlenecks in the planned transition, with concomitant delays and cost overruns (step 4).

## Summary of our main conclusions

Our main conclusions are:

### **The electrification of society affects a large number of occupations and skills.**

- There are already significant skills gaps.

### **A skewed gender balance with few women is adversely affecting skills provision.**

- Many of the occupations facing labour shortages, and many of the education pathways that lead to them, are dominated by men.

### **Electrification affects transport and industries in various ways and gives rise to different skills needs.**

- How electrification affects the dynamic in a given industry, branch or sector is crucial to how skills needs will change.

### **Additional skills needs arise hand in hand with planned investments.**

- The true scope of societal transition becomes apparent when subcontractors, accompanying family members and public-sector recruitment needs are included in the calculation.

### **Many of the occupations identified as suffering from a shortage of labour can create bottlenecks in the electrification of society.**

- The report has identified 35 occupations of particular importance to electrification.

### **Increased demand for both traditional and new skills profiles.**

- The skills gap associated with society's electrification is comprised of broad, combined and niche skills.

### **Relevant educational pathways for many occupations with a labour shortage are unattractive and have low graduation rates.**

- Regardless of the level of education, many of the study programmes associated with occupations with a labour shortage are unattractive and have low graduation rates.

**Generally speaking, large employers find it easier to find, recruit and train staff than small employers.**

- By virtue of their visibility, attractiveness and strategic HR resources, large employers are better placed to recruit people with in-demand skills, or to train their own staff internally, than small employers.

**Fierce competition between industries for labour affects the conditions for successful electrification.**

- The report suggests that recruitment largely takes place within an industry, while the flow of new skills into an industry is limited.

## The employment effects of electrification in Sweden

The employment effects of electrification have been mapped to clarify during which phases – production, establishment, operation and maintenance, and/or decommissioning – short-term skills needs will arise in Sweden for each analysis object.

A significant expansion of **wind power** is anticipated in the coming years. The main employment effects will be felt in the establishment, operation, maintenance and development phases. Construction and civil engineering services for off-shore wind farms are not as tied to local labour as those for onshore wind farms, opening the possibility of engaging specialist teams from other countries. Offshore wind farms will also demand large operating organisation and create the need to expand ports and secure access to specialist infrastructure.

**Solar energy** is expected to expand in Sweden in both the short and long term. The main employment effects will be felt during the establishment of photovoltaic power stations, or solar parks, including project design, grid connection, installation and inspection. While an initial workforce will be required to install solar panels, once in place solar parks require minimal maintenance.

The main challenges facing **hydroelectric power** are environmental adaption and increasing the efficiency of existing plants. The employment effects of electrification on the industry will be relatively minor and, while it remains uncertain exactly what these will be, there is likely to be increased demand for maintenance and operational personnel as power outages become more common and the role of hydroelectric plants in providing balancing power is further reinforced.

While the decommissioning and dismantling of Sweden's nuclear reactors has been underway for some time now, it appears that **nuclear power** will account for a significant percentage of the country's future electricity production. As no decision on expansion has yet been reached, the short-term employment effects will be minor. There will however be long-term employment effects with regard to operation, decommissioning and waste management. In the slightly longer term, the nuclear industry is facing a significant skills gap with regard to both the potential development of new plants and the operation of Sweden's existing nuclear power plants. As Sweden has had a policy of decommissioning nuclear reactors, there has been limited training in the relevant skills.

The **national grid** requires major upgrades and expansion. There is a significant skills gap at local, regional and national level, but the most pressing need is in the production and establishment of new power lines. Large-scale recruitment for the expansion of the national grid may have the knock-on effect of making it harder to recruit operational and maintenance staff, as they are largely recruited from the same skill pool. Changes to the sector mean that there will be an overall need to recruit a large number of people with knowledge of electricity and energy systems, who are also likely to increasingly need IT skills.

**Energy storage** will become an increasingly important part of our electricity system, especially pumped storage hydropower and batteries. In Sweden, the short-term employment effects will largely be felt in the manufacture of batteries as new factories are built. There will also be some employment effects in the installation of batteries and the operation and maintenance of energy storage solutions. Hydrogen is an important piece of the green transition puzzle in terms of making energy systems more flexible and it is expected to play an important role in the coming years. However, as this is likely to be in the somewhat longer term, the employment effects of hydrogen have been excluded from the present analysis.

**Charging infrastructure** is crucial to the successful electrification of the vehicle fleet. The employment effects of expanding charging infrastructure will largely be felt in establishment, project design, installation and maintenance. Some jobs will also be created in the production of charging infrastructure in Sweden.

**Industry** is undergoing a transformation involving the electrification of processes, while at the same time small and medium-sized manufacturers are meeting the demand for the products the electrified society will need. The analysis in this report is based on selected investments in the industry sector.

The **iron and steel industry** are facing a major transition involving the electrification of processes. To manage this transition, the industry is making enormous investments focused on northern Sweden. Building, operating and developing the planned plants will demand the recruitment and retention of a

significant workforce. That said, a number of existing plants will be decommissioned, creating a large demand for retraining and continuing professional development. Various industries are competing for labour and skills.

The **battery industry** is characterised by the rapidly emerging battery value chain, leading to a rapid build-up of production capacity. Sweden has stakeholders at all stages of the battery value chain. Sweden and Europe as a whole need to train and retrain a significant number of people to meet the anticipated demand. With a number of plants planned around Europe, the industry is expected to create close to 100,000 jobs, making it the fastest growing industry in the region. Consequently, competition for skilled workers in Europe is fierce.

As a key player in the electrification of society, the green transition is placing enormous demands of the **automotive industry**. Electrification is increasing demand for specialised technical knowledge and engineering skills in fields such as battery management systems, energy management, electrical grids and electric vehicle communication systems. The automotive industry is also dependent on a great many products from adjacent industries, including batteries and charging infrastructure.

**The permit processes administered by supervisory authorities and analytical agencies** fulfil a crucial function in the establishment and development of the national grid, power plants and industrial plants. Any skills gap and increased workload at this stage risks creating bottlenecks in the permit process or undermining the quality of the documentation prepared before assessments.

## Occupations with a labour shortage affecting the electrification of society

Our analysis has identified 35 occupations with a labour shortage of particular importance to electrification. One thing these have in common is that in one way or another they are important for ensuring that the electrification of society is not delayed. Other issues shared by many of these occupations is that the average age of the existing workforce is high, that they are often not the first choice of students and that its gender balance is heavily skewed towards men.

There are also at least four important differences between the occupations. Firstly, the number of people employed in each occupation varies significantly, from tens of thousands to a couple of hundred. Secondly, the level of education required to enter the occupation varies; in some, the majority of employees have at most an upper-secondary education, while in others the majority have a university education. Thirdly, employees in some occupations tend to have general qualifications, such as a BSc or MSc in engineering, which qualify them for many different occupations, while in others many employees have niche qualifications, such as wind turbine technician. Fourthly, recruitment patterns differ, with certain occupations commonly recruiting from abroad while others tend to recruit from the local workforce.

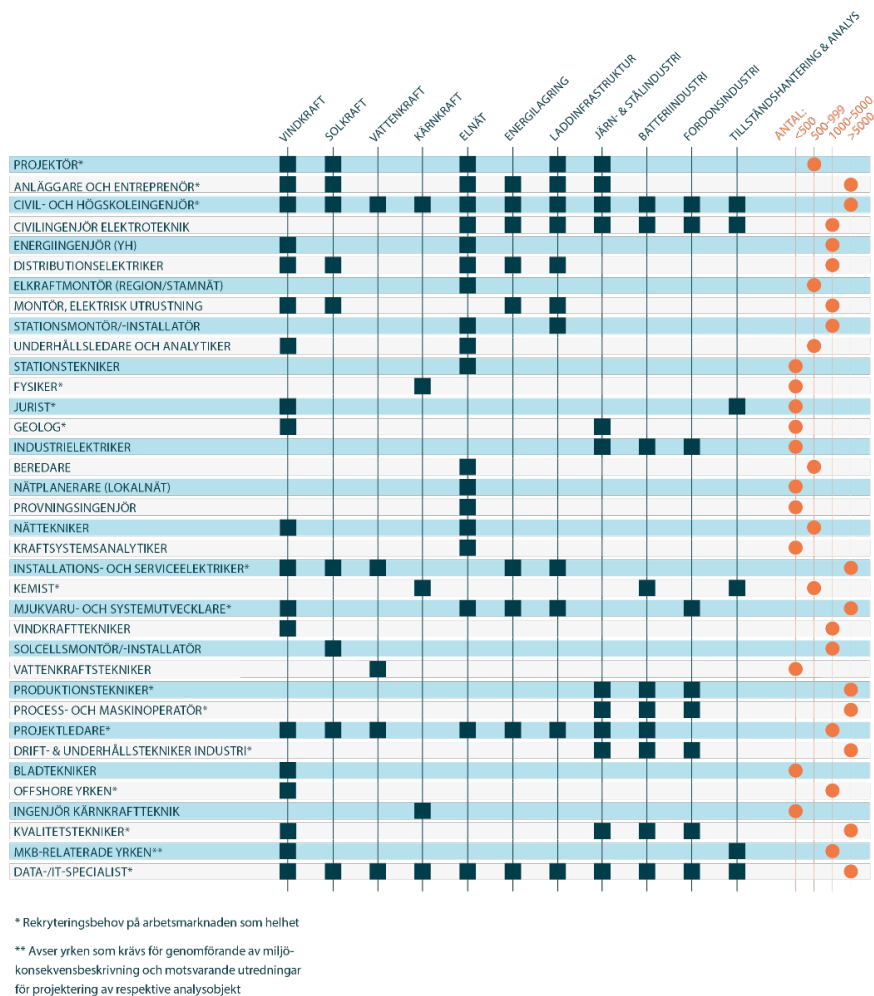


Figure 2 List of occupations with a labour shortage by analysis object

Figure 2 lists the 35 occupations with a labour shortage identified in the analysis. It also shows which analysis object – for example, the national grid – the shortage of a given skill is expected to arise in. On the right-hand side, there is also an estimate of the number of people that will be needed in the coming years. The national grid, for example, face labour shortages in many different occupations, as does the wind power sector. For other analysis objects, the skills



gap may relate to only a couple of occupations. As far as possible, the names of occupations follow the Swedish Standard Classification of Occupations (SSYK). In some cases, however, the established job title in the industry in question is used.

## Relevant study programmes, courses and initiatives for meeting skills needs

A large number of study programmes and training courses are associated with occupations with labour shortages. There is also informal training courses and certificates arranged and financed by employers themselves.

The majority of employees in the identified occupations fall into a category comprising those whose highest level of education is an upper-secondary programme with a relevant specialisation or, to a lesser extent, a higher vocational education programme, as opposed to a university education. This is particularly noticeable in industry. The programmes offered by upper-secondary schools and through municipal adult education at upper-secondary level do not correspond adequately to present and future skills needs.

At **lower-secondary level** the proportion of applicants to college preparatory economics programs at upper-secondary level has almost doubled over the past ten years, while applicants to natural sciences and technology have significantly decreased. Reasons for this development are still unclear, the low share of qualified teachers in these subjects at the lower-secondary level resulting in lower quality in and lack of inspiration for these subjects can be a contributing factor, while also the increasing share of private institutions at upper-secondary level, which focus more on less cost-intensive programmes – labs and equipment require capital investment, could contribute to this shift in choice of study programme. Further analysis is required to establish a better understanding.

At **upper-secondary level**, the school vocational programmes *Electricity and Energy* and *Industrial Technology*, and the equivalent programmes offered in municipal adult education, are most relevant to occupations with a labour shortage. The number of upper-secondary students applying for and admitted to vocational programmes, including *Electricity and Energy* and *Industrial Technology*, has gradually declined since the reform of the Swedish Education Act in 2011, after which vocational programmes no longer qualified students for higher education.

At **higher vocational level**, there is a wide range of programmes associated with occupations with a labour shortage. A large percentage of places in energy-related programmes are unfilled and in many cases the graduation rate is significantly lower than the average for higher vocational education programmes. The lack of applicants means that half of places in operations technician

programmes and almost two-thirds of places in wind turbine technician programmes stand empty. For the programmes identified as especially relevant to occupations with labour shortages and the electrification of society, the graduation rate is generally lower than the average for all higher vocational education programmes.

At **post-secondary level**, programmes for the Degree of Bachelor of Science in Engineering and Degree of Master of Science in Engineering provide the most relevant educational background for working in electrification and the green transition of energy systems. The trend over the last ten years has been towards more applicants and more places made available on engineering programmes, however, the programs most pertinent to electrification—specifically energy and electrical engineering—have experienced a slight decrease in interest during the same timeframe. Nonetheless, there remains a significant lack of engineers and there is fierce competition for their services. The graduation rate for engineering programmes is approximately 50 per cent. Graduates from third-cycle programmes are an important part of securing skills provision for electrification. The number of doctoral students has declined over recent years as fewer men enter third-cycle studies.

To ensure that relevant programmes and courses are offered and to secure skills provision, a number of mainly large companies have committed to cofinancing and supporting programmes at upper-secondary, higher vocational and university level. At university level, there are an increasing number of programmes and research-oriented centres of excellence related to occupations with an identified labour shortage.

There are a number of initiatives and investments underway to improve the conditions for Sweden to secure the necessary skills for the electrification of society. Some of these have the stated purpose of addressing the electrification skills gap, while others have a broader purpose, such as encouraging more young people to apply for science and engineering programmes.

## Conclusions

**The electrification of society affects a large number of occupations and skills.** Electrification generates a broad and extensive need for relevant skills for everything from permit processing to the construction and operation of various types of power plants, infrastructure and industrial plants. The electrification of society is also expected to contribute to the development of completely new industries that will demand skills profiles that are new to Sweden, such as hydrogen energy storage or large-scale offshore wind farms. The report demonstrates that we are already in great need of these skills, making the skills gap an urgent challenge.

**A skewed gender balance with few women is adversely affecting skills provision.**

The report reveals that many occupations with labour shortages, and the study programmes that lead to them, are dominated by men. There is a low percentage of female students enrolled in relevant upper-secondary programmes, such as the *Technology Programme*, *Industrial Technology Programme* and *Electricity and Energy Programme*. This is for example reflected in the number of certificates issued to electricians. This is a long-standing gender imbalance. However, the girls and women who apply for these programmes at various levels tend to perform better and are more likely to graduate than their male classmates. We have more chance of securing skills provision if there is a more even gender balance in the energy sector. It is important that further analyses are performed of how the study programmes, occupations and skills that Swedish society's electrification demands can be made more attractive to girls and women.

**Electrification affects transport and industries in various ways and gives rise to different skills needs.** In industry, fossil fuels are being replaced with both electricity and indirect electrification in the form of greater use of hydrogen and other electrofuels. The transport sector is gradually moving towards electrified, digitised and complex systems with electric vehicles and electric roads. New industries such as battery, electrolyser and fuel cell manufacture are emerging and traditional industries, such as cable, transformer and heat-pump production have to scale up in order to meet demand for grid extension and electrification targets in the heating sector. So, electrification affects different industries in different ways. How electrification affects the dynamic in a given sector, industry or individual company will decide how skills needs will develop.

**Additional skills needs arise hand in hand with planned investments.** The principle focus of our analysis has been the primary employment effects of electrification, i.e., the labour that will be required to build and operate the chosen objects of analysis. The true scope of societal transition only becomes apparent when the secondary effects on subcontractors, accompanying family members and public-sector recruitment needs are included in the calculation. Areas of Sweden face exponential population growth if they succeed in attracting planned new green investment and attracting and retaining the workforce that goes with them. It is vital to identify area-specific and industry-specific challenges and solutions in both the short and long term, including secondary employment effects.

**Many of the occupations identified as suffering from a shortage of labour can create bottlenecks in the electrification of society.** The report has identified 35 occupations of particular importance to the electrification of society in which the demand for skilled workers will outstrip supply. When many investments are made at the same time and the same skills are in demand in different areas of the country, there is a risk that the shortage of workers in

certain occupations will create bottlenecks. As we continue this work, it is important to investigate where these bottlenecks will occur and propose measures to minimise them.

**Increased demand for both traditional and new skills profiles.** The skills gap associated with society's electrification is comprised of broad, combined and niche skills. Those with traditional skills will need to broaden and deepen their competence but brand-new skills will also be needed as new technical solutions are developed and deployed and the demand for holistic solutions increases. Expertise in information technology and digitisation is one skills profile that is in demand in more and more occupational categories.

**Relevant educational pathways for many occupations with a labour shortage are unattractive and have low graduation rates.** Many of the study programmes associated with occupations with a labour shortage are unattractive and have low graduation rates. This is true regardless of the level of education. The number of places available on attractive courses with high student completion rates is crucial to closing the skills gap for electrifying society.

**Generally speaking, large employers find it easier to find, recruit and train staff than small employers.** Aside from the lack of qualified applicants, potential recruitment challenges include individual employers not being visible or attractive to jobseekers or being unable to adequately formulate their skills needs. The ability to rectify these deficiencies will differ. By virtue of their visibility, attractiveness and strategic HR resources, large employers and public authorities are better placed to recruit people with in-demand skills, or to train their own staff internally, than smaller employers, municipalities and government agencies. Further analysis of how small and medium-sized companies and authorities can acquire the skills they need is therefore required.

**Fierce competition between industries for labour affects the conditions for successful electrification.**

The report suggests that recruitment largely takes place within an industry, while the flow of new skills into an industry is limited. The annual supply of newly educated staff is limited and the pool of reserve labour with an upper-secondary education from which employers can reinforce their workforce is very small. Initiatives to make the study programmes and occupations that are essential to the electrification of society more attractive need to be viewed in light of the fact that almost all industries are taking similar initiatives to the same ends, which in itself creates competition between industries.