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BUSINESSES AND EDUCATION IN THE FACE OF THE GREEN SHIFT

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PREFACE

The project «Renergy» has investigated the possibilities for developing and implementing a new upper secondary vocational education to cater to «the green shift» (renewable energy). The research (a study) and the development work were carried out through interdisciplinary collaboration between an educational institution, company, municipality and researchers at the Norwegian University of Science and Technology (NTNU).

The overarching goal of the research was to secure a scientific approach in the planning, method, and implementation face of the study. The questions to be answered scientifically involve the demand for workforce and competence to cater to renewable energy approaching the green shift.

In the study, we have carried out a strategic review. We present a background to our study with research published by the Nordic Council of Ministers, Political Steering documents from Norway, European Union, and OECD, in addition to scientific articles and reports where the green shift is framed in a historical context. In addition, information from central web pages, as do newspaper articles, contributes to information. In-depth interviews with nine companies and one training office were carried out. The interview results bring insight into the demands and competence of the workforce for companies in their continuing work towards the green shift.

As part of the process, Selbu Upper Secondary School invited central stakeholders to a seminar on the 3rd of November, 2023, where the study's main findings were presented. An open discussion followed the presentation, where seminar participants gave valuable feedback.

We want to thank critical report readers who have contributed with comments underway. Thank you to Erik Widar Andersson, Arnstein Trøite and Arne Hårstad.

EN SPENNENDE VERDEN

Vi prøver jo hver gang når vi har ungdommer på besøk og prøver å beskrive hvor spennende verden vi egentlig lever i. For den er allsidig, voldsomt allsidig. Så jeg håper egentlig at det lykkes dette, du nevnte jo en videregående, det hadde hatt veldig mye å si for oss. Hele regionen. Hvis vi hadde fått det på stell. Det er jeg helt sikker på, for som jeg sa her i stad så er det korte avstander til vind, og det har jo både vannkraft og vindkraft her, og der kommer det også sol i tillegg, så du har alle 3 spektrene i nærheten av skolen faktisk. Og det ser jeg på som en fordel for regionen, at du kan bytte, du trenger egentlig ikke bestemme deg for så veldig mye bare du havner på rette sporet det første året på yrkesskole. Så kan du ta valgene etter hvert. Det er jo å få de interessert i løpet her som er inngangen til å lykkes, tror jeg da. (nr.4)

ABSTRACT

In Norway, the need for green transformation arises amid attention to climate change and the decline in the Norwegian oil industry from 2014-2017. Norway predicts that sun and wind will become available at a low cost in European and global energy systems during the 2020-2030 period. Green industrial investments require suitable land, infrastructure, raw materials, capital, and expertise. It is estimated that an employment need of 13.000 (low scenario), 64.000 (medium scenario), and 115.000 (high scenario), with a need for around 50 per cent of crafts and operators, 40 per cent of engineers, and ICT developers (Landsend-Henriksen, 2022). Incorporating more significant quantities of wind-solar energy with hydropower, geothermal energy (hydrogen), and biomass is challenging. Environmentally friendly production of batteries is emphasised, where the Nordic region is at the forefront of lithium-ion batteries and a circular economy. (Nordic Council of Ministers, 2021; Policy brief, 2022).

The results from the interviews with Norwegian and Swedish companies, along with their subsidiary companies involved in hydropower, thermal power, wind parks, and solar energy, indicate that they are actively engaged in cross-border activities for the green shift. They cooperate among others on skill development, cooperation for company growth, and education. The results also give at hand that in both Trøndelag and Jämtland, there are challenges in recruiting staff within several disciplines. In parallel, there are difficulties in finding skilled craftsmen/women to contribute to the demands of catering for the green shift. In Norway, a flexible educational system is expected to prevent centralisation and provide necessary skills to districts. County municipality has a central role through its responsibility for political directives involving competence both for the public and private sectors (Meld.St14, 2022-2023).

KEYWORDS:

» **Green shift**
» **Employment need**
» **Renewable energy**
» **Shortage of skills**

CONTENT

Green shift is a continuous ongoing irreversible, and unstoppable process.

The green shift involves reduced greenhouse gas emissions and improved resource productivity in all sectors of society, and at the same time offers new opportunities for value creation.

(Bjartnes, 2015)

1 INTRODUCTION

In Norway, the identified need for a green transformation arises against a backdrop of increased attention to climate change on the international and national scene and a temporary decline in the Norwegian oil industry in the 2014–2017 period. The perceived understanding of content and/or goal on what a change/transformation requires varies greatly among different policy actors, stretching from altering today's agenda to doing things a little greener or/and acting towards substantial changes. Regarding a green transformation, the terms sustainability, renewability, and circularity are relevant since they point to planetary limits as sustainability especially comprises environmental, social, and economic dimensions (Amundsen & Hermansen, 2021). As for the term green transformation, it is, to a large degree, interpreted in terms of green growth and, more commonly, as a green shift defined in 2015 by the Norwegian Bjartnes (2015).

In the ongoing continuous process of the green shift, the initial part of this report pays attention to expectations of meeting goals of sustainability, renewability, and circularity expressed through Norwegian, Nordic, and international policy documents. Documents bring forth environmental changes, for example, hydropower and the development of wind, sun power, and hydrogen gas. Ongoing changes also involve social/economic transformation, such as the demand for expansion of VET programs and how to work towards improved use of environmentally friendly resources. The economic dimensions refer to nations', as well as international interests', securing prolonged economic stability. The roadmap for a green shift and alternative/renewable circular development referred to in the Norwegian government document (2017) Veikart for grønn vekst i norsk fornybarnæring mot 2050, anticipates that sun and wind are to become available at a low cost within the European and the global energy system during the period 2020–2030. It is also found that regulated power without "climate gas-emission" based on hydropower is expected to become scarce. As for battery technology, it is under rapid change, aiming to support alternative forms of energy[1]. Along the line of change, The European Green Deal (2019) is a "green growth" strategy to secure a sustainable and competitive Europe. The "green deal" is a sector-wide plan across policy areas. It plays a vital role in the EU`s implementation of the UN`s 2030 agenda and the UN`s sustainability goals.

[1] Regeringen.no, p.10,2017.

The Norwegian government, in line with the European Union (EU), announced "the Green Deal" as part of the Norwegian agenda.[2] A green shift has a bearing on how Norway can become a low-emission country by 2050. To achieve low emissions by 2050, it is argued (in 2021) that Norway must transform itself into a society where growth and development occur within the tolerance and limits of nature. It is argued that society must alter products and services with fewer negative consequences for climate and the environment.[3]

1.1 Change and requirement

Regarding climate and environment, the Norwegian government (2022) finds that converting to green industrial change has consequences for both the economy and society. As part of a global climate and nature crisis, it is argued Norway must take its share of responsibility for cutting emissions and contributing to sustainable development. Green industrial investments require access to suitable land and infrastructure, raw materials, and, not least, capital and labour.

Sufficient access to the right expertise is crucial for companyes' ability to operate efficiently. Thus, competent labor from all levels of education is required to create values in supporting the green shift.

Sufficient access to the right expertise is crucial for a company's ability to operate efficiently. Thus, competent labour from all levels of education is required to create values that support the green shift. One aim is to be a leading nation (Norway) in offshore wind with an industry that develops and builds top-class wind power solutions. By 2040, Norway has the ambition to allocate areas with the potential for 30 GW offshore wind production on the continental shelf. Other areas of concern are the development of battery production for transport use on both land and sea.[4]

The ambitions to work towards a green shift and the continued establishment of new industries (for example, battery production, sun, and wind power) indicate different scenarios for the development of green value chains. For example, it is estimated an employment need of 13.000 (low scenario), 64.000 (medium scenario), and 115.000 (high scenario) within selected occupational groups where there is a need for around 50 per cent of crafts and operators, 40 per cent of engineers, and ICT developers. Vis-à-vis today`s skills shortage (for example, skilled workers within wind power), there is a struggle to find solutions (gap of competence/resources) that can contribute to realising the ambitions for a green shift by 2030 (Landsend-Henriksen, 2022, p.40). A report from Norderegio (2023:9) underlines the importance of local involvement and trust when working towards a green shift in Nordic rural areas. The report, based on a project, points out challenges and strategies correlating to the importance of nurturing social acceptance and a sense of justice, referring to a green shift. Top-down decision-making neglecting local opinion might lead to feelings of powerlessness and resistance at the local level. The report suggests that early engagement, transparent communication, and ensuring local benefit are vital. A blend of community engagement, environmental benefits, and

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[2] https://www.regjeringen.no/no/dokumentarkiv/regjeringen-solberg/aktuelt-regjeringen-solberg/ud/nyheter/2021/norges-posisjonsnotat-om-europas-gronne-giv/id2845272/

[3] https://www.regjeringen.no/no/tema/klima-og-miljo/innsiktsartikler-klima-miljo/det-gronne-skiftet/id2879075/?expand=factbox2879090

[4] https://www.regjeringen.no/contentassets/1c3d3319e6a946f2b57633c0c5fcc25b/veikart-for-gront-industriloft.pdf

local ownership of the project will foster trust and a deepened sense of justice concerning a green shift (Salonen & Tomrèn, 2023).

Lack of labour is an encounter for the Nordic countries. Companyes find it difficult to recruit within several disciplines parallel with increasing challenges in finding skilled craft.

The Nordic Council's report (2022) Attraktive erhvervsuddannelser I Norden[5] finds that the lack of labour is an encounter for the Nordic countries. Companies find it difficult to recruit within several disciplines, parallel with increasing challenges in finding skilled craft.

The Nordic region is estimated to lack several hundred thousand skilled workers in 10-15 years (Nordic Council, 2022). Stortingsmelding Utsyn over Kompetansebehovet i Norgefinds in line with the Nordic Council that skills shortages can inhibit the emergence of green companies and industry, delay digitisation in working life and slow down productivity. It can also lead to difficulties in providing good services throughout Norway (2022-2023).

As for educational skills and the labour shortage at the upper secondary level, the counties in Norway have a regional political assignment allocating responsibility for VET and contributing to a better match between the demand for labour and the supplies of education and skills in their county. In Stortingsmelding *Utsyn over Kompetansebehovet i Norge,* it is argued that the provision of studies/subjects at the upper secondary level ought to be set in proportion to a workforce demand – meaning that there ought to be a need for this or that kind of skilled workforce (2022-2023)[6].

Trøndelag fylkeskommune, in their economic forecast for the period 2024-2027, pinpoints challenges, possibilities, and development expected (lying ahead). The document intends to give politicians a knowledge base for setting political priorities and enabling steering signals to the county council`s work. In addition, the county council has adopted and prioritised investment areas in the regional planning strategy, and these are as follows: a) Trøndelag responds to the climate challenge; b) innovative solutions so that everyone can work and live throughout Trøndelag; c) a sustainable company life throughout Trøndelag; d) competence to meet a changing working life; e) culture as a driving force in community building; f) collaboration in new structures; g) sustainable finances in the county council; h) further develop the Norwegian model (2024-2027)[7].

[5] The Nordic Council's report (2022). Attraktive erhvervsuddannelser I Norden https://pub.norden.org/nord2022-028.
[6] Stortingsmelding (2022-2023). Utsyn over Kompetansebehovet i Norge. Meld.14 2022-2023.
[7] Trøndelag fylkeskommune (2023). Utfordringsdokument. Økonomisk plan 2024-2027.

Grønt hjerte AS was founded in 2020 by Trøndelag County Council to reach adopted climate targets and contribute to increased industrialisation linked to the implementation of energy and environmental measures. Trøndelag County councils' company *Grønt hjerte AS* will invest 160 million in renewable energy over the next five years. *Grønt hjerte AS* will harvest, store, produce, and distribute electrical and thermal energy to all the county buildings (2020)[8].

1.2 The study

The report pinpoints a green shift and meeting goals of sustainability, renewability, and circularity expressed through Norwegian, Nordic, and international policy. Vis-à-vis the backdrop of the green shift, the report contains a study based on interviews with energy-producing companies. In the result of the study, we present the interviewed Companies' concerns and their demand for labour and competence in Trøndelag, Norway and Jämtland, Sweden.[9]

Towards the background of expressed demand for labour and competence to meet the green shift, we look further into how the educational field and vocational education and training (VET) in *a local region/municipality of Trøndelag* could cater to and/or develop a VET program(s) to meet market demands.

[8] Trøndelag County Council (2020). Grønt hjerte AS. https://www.trondelagfylke.no/nyhetsarkiv oker-satsingen-pa-fornybar-energi-i-trondelag.

[9] Since companyes within the water, wind, and sun sector is working across the Nordic "green belt" (Trøndelag – Jämtland), the report will to some extent involve the company's demands independent of the existing National border.

2 BACKGROUND

2.1 Agendas for a Green Shift

Towards the background of the United Nations (UN) treaty on Climate Change, the Kyoto Protocol (1997) operationalised intended climate change, committing industrialised countries to limit and reduce greenhouse gases. In 1997, the European Union (EU) also published the white paper Energy for the Future, formulating ambitious indicative targets of doubling the overall share of renewables in the EU by 2010. The purpose of the directive was to create a framework to facilitate a significant increase in renewable generated electricity within the European Union (EU, 1997). The leaders of the EU in 2007 agreed that 20% of energy production by 2020 should come from renewable energy. In achieving this national binding target goal, the EU implemented the Renewable Energy Directive (RED). Target goals aimed at reducing emissions of greenhouse gases, promoting the security of energy supply, accelerating technological innovation, and stimulating regional development (Skjærseth & Rosendal, 2023).

The 2009 United Nations Climate Change Conference (Copenhagen Climate Summit) concluded with a political declaration of the need to limit the global average temperature rise to no more than two °C above pre-industrial levels (year 1750). There was no agreement on how to accomplish the declaration in practice. Since then, the declaration of a "climate change emergency" by the United Kingdom parliament, the Green New Deal in the United States, and the summoning of world leaders by the UN General Secretary illustrate the urgent worldwide transformation towards green-friendly change (Ytterstad & Henrik Bødker, 2022).

There are several understandings of what a green shift holds in store-on the one hand decreasing use of fossils fuels on the other multiple tranformations intersecting.

In Norway, the perception of state authorities and organisations of the primary industries agree that all sectors need to contribute to a green shift. There are several understandings of what a green shift holds in store. It seems, on the one hand, to be acknowledged that there is a need to decrease the use of fossil fuels, but on the other, there is no consensus on the impact/scale of economic growth. A green shift transformation is also referred to as multiple transformations intersecting, overlapping, and even conflicting in unpredictable ways. Apropos transformation, it is recognised that different actors apply the same concept, such as the" green shift", to fit "their" agenda. Amundson and Hermansen (2021) find that the concept of "green shift" is flexible enough and can be used by disparate actors for diverse purposes, for example, company interest, climate policy, ethics, and/or caring for nature. As mentioned earlier, a transformation also involves the discourse on sustainability as part of the discussion. Even if economic sustainability is given more weight in the discussion, it is found that emphasis is also given to social sustainability. It is argued that vital local communities, local livelihood, and long-term perpetual environmental sustainability refer to a deeper transformational approach contained by

long-term planetary boundaries and simultaneously sustaining local communities (Amundsen & Hermansen, 2021).

Through the European Economic Area (EEA) agreement, Norway's contribution to achieving the overall EU RED target (2009) hinged on an increase in its renewable energy consumption from 58.2% in 2005 to 67.5% by 2020. We are reminded that the energy-economic arena in Norway parted from other European states since hydropower already provided almost 100% of Norway's on-land electrical production. Norway by far accomplished their EU binding quote of renewable energy target by 2020, and together with Sweden, Norway also lived up to the electricity certificate system target ensuring financial liability for market investment. RED thus linked the EU binding renewable energy target and electricity certificate system of Norway with Sweden. The certificate system was technology-neutral, with hydro and wind power being the cheapest options in Norway. The capacity in each country (Norway, Sweden) was to be regulated by the market, and powerplants could obtain certificates for up to 15 years with a deadline for new installations within the certificate system by 2021. Renewables would be funded regardless of production in Norway or Sweden. In parallel, it pointed towards increasing the profitability of wind power and recommended that it should be subject to value distribution principles to ensure that local communities would receive their share of investments (Skjærseth & Rosendal, 2023).

The Nordic Conference on Climate Change Adaptation (NOCCA 2023) took place in Reykjavík, Iceland, on April 17-18, 2023. The Nordic Council of Ministers policy brief from the conference reports that the Nordic countries have gathered considerable knowledge individually in the field of climate change.

A Nordic network of municipalities would offer the potential to support local authorities in strengthening adaptation responses and creating climate-resilient communities

The conference concludes that the Nordic countries could accelerate climate alteration by establishing sharing platforms as well as guidelines and tools on adaption across regions a Nordic network of municipalities would offer the potential to support local authorities in strengthening adaptation responses and creating climate-resilient communities (2023, p.20). The Nordic Council of Ministers are interested in assisting the establishment of networks expediting progress at the local level.[10]

[10] Nordic Council of Ministers (2023)a. Policy brief: Stronger together for a climate resilient north – Mainstreaming adaptation to climate change at the local level in the Nordic Countries. Copenhagen.

2.2 Progress and Renewable Energy Sources

Electricity was produced on a lesser scale from hydropower already in the early 19th century, and a breakthrough came in the late stage of the 20th century when the construction of large power plants and reservoirs began.

Hydropower has been the core of the nation-building processes such as in Sweden where currently (2017) 50 % is supplied by electricity and in Norway where almost all electricity is generated from hydropower.

Hydropower has been the core of the nation-building processes, such as in Sweden, where currently (2017) 50 % is supplied by electricity, and in Norway, where almost all electricity is generated from hydropower. Historically, in these countries, the provision of hydroelectricity enabled urban and rural development, as well as industrialisation, and other primary value-added activities such as electricity to light up family homes. Although positive in many ways, hydropower was realised with significant environmental costs, particularly at the local level, where citizens counteracted in the name of democracy (for example, protesting the ruining of natural water flow/rivers). Traditionally, there has been a divide in perceptions of hydropower production, in which stakeholders tend to box it either as an environmental hazard or as a socio-economic benefit. In Norway, a plan for hydropower development came to the fore in the 1980s, with protection plans limiting opportunities for hydropower development. Further revisions of watercourse regulation were made in 1992 and again in 2009, significantly influencing watercourses available for further hydropower exploitation (Lindström & Ruud, 2017).

2.2.1 Wind and Solar Energy

Wind power was introduced into Norwegian energy policies in 1998, and its development represents the main technological change in Norway's energy mix. Wind power is described as a potential, renewable energy source to support Norway's future energy production. Norwegian wind power policies have constantly been (re)constructed during the past decades, in parallel with climate policies, technological development, and the materialisation of wind turbines. The enhancement of wind power has provoked local and national protests as well as public debates related to a range of socioenvironmental, procedural, and distributional concerns. Research on Norwegian wind power has addressed disputed discourses such as energy justice and perceptions of fairness in wind-power-hosting municipalities. During the 2010s, wind power was connected to the debate on climate and market commitments and became increasingly linked to climate policy goals, international commitments to renewable energy production, and the electrification of industry and society. Foreign capital investing in Norwegian wind power increased in 2010 with about 58% foreign ownership. In 2016, there was a focus on an increase in renewable energy and energy security requirements, as well as efforts to fulfil climate policies (Vasstrøm & Lysgård, 2021). Gabrielsen & Grue (2012) find that uneven sources such as wind and sun power might allow higher access if operating in synergy with hydropower, and as such, combined technologies can offer higher reliability than each technology on its own (Gabrielsen and Grue, 2012).

In the Nordic countries, three-quarters of electricity consumption is renewable versus the EU`s one-third share. The most notable change between 2018 and 2019 in the Nordic was in the consumption of solar-generated electricity, which increased by more than 24 per cent. Wind energy share rose 14 per cent and biomass 6 per cent while hydropower share remained about the same – and as mentioned earlier, hydropower is a key component of the Nordic electricity system. Out of the Nordic countries, Denmark consumes nearly half of the Nordic region's solar-generated electricity (1TWh) and Finland, with its forest industry, accounts for 44 per cent of biomass consumption (12TWh). Iceland, in turn, leans on geothermal sources (6TWh), and Norway consumes 60 per cent of hydropower (140TWh). Sweden consumes the most wind power (21TWh), or 43% of the Nordic region's total. In comparison with a European and global context, the Nordic countries access high levels of renewables in the electricity mix (2021).[11]

There is a need to combine larger amounts of wind and solar energy with hydropower, geothermal energy (hydrogen), and biomass to support a stable and cost-effective energy system for the Nordic countries in the future.

The Nordic Program for Co-operation on Energy Policy (2022-24) finds there is a need to combine larger amounts of wind and solar energy with hydropower, geothermal energy (hydrogen), and biomass to support a stable and cost-effective energy system for the Nordic countries in the future (2022-24).[12] Even with a reported increase in the use of solar energy, the lower use of solar technology solutions in the Nordic countries has earlier partially been the result of the misconception that irradiation is much lower in the Nordic than in central European countries.[13]

In identifying barriers and challenges to the adoption of solar systems in the Nordic countries, Formolli, Lobaccaro and Kanters (2021) found that municipalities play a crucial role. They play a role in facilitating and adopting solar energy solutions (in cities), embracing vision, and being financially involved as owners or by subsiding projects. It is concluded that the Scandinavian legislation on solar energy utilisation in the urban context is still vulnerable, and the authors, therefore, suggest guidelines as a pressing need to move the solar energy market forward (Formolli et al., 2021). In a review of solar energy, Kannan & Vakesan (2016) report several barriers to solar energy. Solar energy is complex and requires advanced technology for manufacturing and installation. Solar cells often contain various chemicals that are environmentally toxic; thus, disposal is a challenge for manufacturers and consumers. The heat exchangers in the collectors also contain toxic fluids. Managing the collectors after use is a challenging task. Next to this fact, large amounts of water are used to clean and cool turbine generators for better efficiency, leading to the wastage of water and the release of wastewater, which leads to water pollution (Kannan & Vakesan, 2016). In Norway, Solar power can be divided into solar power connected to the power grid and stand-alone, such as solar panels/cells, which we find in the mountains supporting a cabin owner with electricity at the cabin site. Facilities linked to the power grid are found to be increasing in Norway. Still, solar power only makes up a small part of power production in Norway, and at the end of 2022, just under 300 MW of solar power was connected to the grid in Norway.[14]

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[11] Nordic Energy Research (2021). Renewable energy in the Nordics. Oslo: Nordic Energy Research.

[12] Nordic Council of Ministers (2021). Nordic Programme for Co-operation on Energy Policy 2022–24. Copenhagen

[13] Nordic Energy Research (2021). Renewable energy in the Nordics. Oslo: Nordic energy research

[14] Et solcelleanlegg på et tak i Norge produserer mellom 650-1000kWh/kWp i året. For en enebolig med 20000 kWh i strømforbruk/år betyr dette at et solcelleanlegg bestående av 20 paneler vil kunne produsere nok strøm til å dekke 25 prosent av strømforbruket til boligen(https://www.nve.no/energi/energisystem/solkraft/).

Around 5 % of the solar cell plants in Norway are larger plants of more than 50 kW. Most of these 5 % facilities are mounted on private and industrial roofs and primarily cover their consumption. There are currently no dedicated solar power plants in Norway, but this is expected to change as more solar power initiatives receive licenses and build solar power.[15]

2.2.2 Hydrogen

Hydrogen gas is an energy carrier produced from a source of energy. In the process of production, some of the energy will be "lost", meaning that the source carrying the energy contains less energy than the energy source had from the start. It does not mean that energy has been lost, but it means that a certain part of the energy has been transferred to a lower energy form, for example, heath. The positive side of energy carriers is that we can use the energy stored in them for certain purposes at certain places. Sun and wind are not energy carriers since we cannot control them or store them as they are; we can only enjoy the sun while it shines and sail while there is wind. If we want to "catch" the energy from the sun and wind, we produce electricity, which in turn becomes carriers of sun and wind energy. We transport the electricity in cables where we make use of the electricity. If we do not want to transport the electricity in cables, we can store it in batteries or as hydrogen gas. Cables, batteries, and hydrogen gas will entail a loss of energy since we, as a result, will receive less electricity than what was sent into the cable, battery, or used to split water to hydrogen gas. Petrol and diesel are also examples of carriers of energy where the source is oil. The energy stored in hydrogen gas is simply explained as found in the electrons the hydrogen atoms share. The electrons can be supplied through electrolysis, where electricity is passed through water via two electrodes, causing the water molecules to split into hydrogen gas and oxygen gas. Another way to produce hydrogen gas is via steam-methane reforming, or the splitting of methane gas and water molecules at high temperatures. If the electricity for the electrolysis of the methane gas comes from renewable energy, we can say that hydrogen gas is renewable.

In the Nordic countries, the Nordic Hydrogen Partnership (NHP) is a collaboration between the Nordic hydrogen associations. In addition to functioning as a platform to communicate between the Nordic countries. NHP experts from the Nordic countries cooperate intending to boost their cross-sector implementation of hydrogen and fuel cell technologies.

(NHF, 2023).[16] In the Nordic countries, the Nordic Hydrogen Partnership (NHP) is a collaboration between the Nordic hydrogen associations, in addition to functioning as a platform to communicate between the Nordic countries. NHP experts from the Nordic countries cooperate, intending to boost their cross-sector implementation of hydrogen and fuel cell technologies in the Nordics in close cooperation with several industry representatives. In 2019, the Next Wave was established through NHP partnership (NHP, 2023). In a report from the Nordic Council of Ministers on batteries, energy, circular economy, and sustainable environment (Policy Brief, 2022), it is concluded that environmental pressure will be reduced with the increased use of batteries. In the policy brief, the Council also addresses environmentally friendly production of batteries as it wants to promote the Nordic as forerunners within lithium-ion batteries and a circular economy. Lithium-ion battery production

[15] NVE (2023) Norges Vassdrag og Energidirektorat https://www.nve.no/energi/energisystem/solkraft/.
[16] Norsk Hydrogenforum (NHF) 2023. Norwegian Hydrogen Forum. https://www.hydrogen.no/en

is complex, involving several steps. Metals are extracted in different parts of the world, where China currently dominates cell production, including cathode and anode production. Metals are mined for the cathode, which then are refined to sulfates or, as with lithium, sometimes used as hydroxide. When mined and refined cathode material is produced, the extraction of metal is highly impacting the environment as well as people living and working near these sites. Inclinations in the coming years for battery chemistries concern not only the raw material for production but also volumes of batteries up for recycling. Research on new chemistries is of high priority, where the main driver is energy density to increase the range for use on cars, reduce costs, and reduce the need for materials such as cobalt (Nordic Council of Ministers 2022)[17].

2.3 Workforce and Demand

In Norway, the building of additional value chains (green shift) and restructuring of existing ones involve a great need for labour with technical expertise, as well as a demand for labour within construction. Furthermore, it will require technical workers, vocational school graduates, and people with university and college education in construction and technical subjects. Digitisation and automation are also mentioned as areas of expertise. In addition, the competence is tied to producing goods in the building and construction sector, especially new expertise related to high-tech building materials, security, and advanced electrical systems. The situation largely involves a technical vocational school education workforce and people with university and college education in digitisation and technology (Landsend-Henriksen, 2022). In a study carried out by Sintef in 2014 on the required labour to maintain installed wind power at Fosen Trøndelag, it was found that there is a need for a machine and electrical workforce (VET). It was estimated that around 90 % of the workforce in the operating organisations would be electrical and mechanical workers. In addition, the workforce would need training at a power company or turbine supplier to handle turbines, as well as requirements for training in EHS[18] (Skarsholt, 2014).

It will require technical workers, vocational school graduates, and people with university and college education in construction and technical subjects. In addition, their competence is tied to the production of goods in the building and construction sector especially new expertise related to high-tech building materials, security, and advanced electrical systems.

For education providers in Norway (upper secondary education, higher vocational education/vocational school, university, college education), the green shift implies a need to keep pace with development and demands. Dialogue and cooperation with industries are expected to be necessary – not least for vocational education and training schools. A green shift places demand not only on pupils and students but also on teachers, where trade-offs within technological education can link to the need for competence across several subjects versus a need for completely new subjects. The changes related to education require cooperation between authorities, educational institutions, and industries, with a particular focus on vocational training and vocational schools. New adaptions to the green shift are expected to

[17] Nordic Council of Ministers (2022). Policy Brief: Batteries in the Nordics – Changing for Circularity. Copenhagen.
[18] EHS: Helse, miljø, sikkerhet

occur gradually and will require long-term planning and dialogue at various levels (Landsend-Henriksen, 2022).

The green shift involving renewability, sustainability, and circularity indicates variations in skills requirements between industries. As mentioned, there is an expected increased demand within several fields to secure competence. Also, companies are pointing out that to meet future competence demands, they will make sure to enhance workplace competence. Across working life, citizens will need to understand the consequences climate and environmental changes have on society.

It may be wise to look further into how education can include knowledge of sustainability taking into account environmental, economic, and social aspects.

It may be wise to look further into how education can include knowledge of sustainability considering environmental, economic, and social aspects (NIFU, 2023). In addressing a green shift and gender studies, it is pointed out that climate change seems to have a positive impact, particularly on male-dominated sectors such as energy, industrial, and agricultural sectors. The gender perspective on ways to include women ought to be considered when discussing a fair and socially sustainable green transition (Nordic Council of Ministers, 2023c).

2.3.1 Challenges – Keeping up to date

In NOU Fremtidige kompetansebehov III Læring og kompetanse i alle ledd (2020:2), it is found that in Norway, there are persistent structural shortfalls over time in professions that are important to take care of the population, to build the country and to develop technology (health, building, ICT). Concerning upper secondary schools' vocational training, the labour market needs do not have high priority in the counties dimensioning/planning – at least not in competition with other objectives/responsibilities of counties. In addition, it is also pointed out that climate changes and demographic development are key factors indicating future skills needs. As mentioned, climate change and the green shift signal job changes and new competence requirements for certain work categories along with new competence requirements (NOU, 2020:2).

In Stortingsmelding Utsyn over Kompetansebehovet i Norge) it is, on the one hand concluded county municipalities weigh various parameters (students' wishes, access to apprenticeships, working life need for competence). On the other, the Norwegian government has the intent to collaborate with parties in working life and consider possibilities for structural changes to better meet working life and society's need for competence.

The Norwegian government proclaims it will stand behind flexible education throughout the country and take measures to ensure education and training will be accessible to all.

The Norwegian government proclaims it will stand behind flexible education throughout the country and take measures to ensure education and training will be accessible to all. Another goal mentioned is to preserve professional environments throughout Norway. Considering the shortage of labour (in certain fields), the educational system must be accessible and flexible so that residence does not become

an obstacle to getting education and/or updating skills throughout life. The flexible education system should counteract centralisation and ensure the districts have access to the skills needed. It is pointed out that the county municipalities have a central role through their responsibility for skills policy in their region, both public and private sector (Meld.St14, 2022-2023).[19]

The Nordic Council of Ministers report on Recognition of Educational and Vocational Qualifications (2023) declares that Europe's Green and digital shift is expected to demand skilled workers in all sectors in Nordic countries. In the Nordic countries, there are differences as to whether (or not) qualifications in the same trade are regulated by the EU Professional Qualification Directive (2005/36/EEC). The Professional Directive was designed to allow EU citizens to transfer their qualifications and skills between member states. The report concludes that the same qualifications do not exist in all Nordic countries. Additionally, educational qualifications are not placed at levels corresponding to the same EQF[20] levels in the various Nordic countries' educational systems. As for Norway, an obstacle to mobility is that there is a lack of knowledge regarding Vocational and Technical Vocational education systems in the other Nordic countries. The mutual recognition of levels of VET qualification could strengthen opportunities to access further vocational or higher studies within Nordic regions. Mutual recognition could also provide trust in Nordic qualifications in the Nordic labour market without altering employers' professional autonomy (Nordic Council of Ministers, 2023b).[21] In a review from OECD (2023) on building future-ready vocational education and training systems, it is argued, among others, that skills needs are changing due to factors such as the green and digital transition as well as population ageing. Furthermore, structural changes indicate a need to re-engineer part of VET systems to keep them up to date, ensuring VET can keep pace with the ongoing present changes. The OECD report concludes there are four key dimensions of importance for VET to be future-ready: responsiveness to changing skills needs, the flexibility to make VET work for all, the ability to support transitions into a changing labour market and further learning, the potential of digital technology to innovate VET design and delivery (OECD, 2023).

The mutual recognition of levels of VET qualification could strengthen opportunities to access further vocational or higher studies within Nordic regions. Mutual recognition could also provide trust in Nordic qualifications in the Nordic labour market without altering employers' professional autonomy.

2.4 Locally Situated Vocational Education and Training

Norwegian VET is organised in several ways. The "standard model" is two years in school and two years as an apprentice in a company where the cooperation between the school and the company is regulated through policy (Simonsson, 2022).

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[19] Kunnskapsdepartementet (2022-2023). Utsyn over kompetansebehov i Norge. Meld. st.14 Melding til Stortinget.

[20] The study connects to the European Union's European Qualification Framework (EQF) learning outcomes-based framework. The EQF serves as a translation tool linking nations' qualifications frameworks, supporting transparency, comparability, and portability of people's qualifications from different countries and institutions.

[21] Nordic Council of Ministers (2023)b. Recognition of vocational education and training in the Nordic countries. Tema Nord 2023:516 Copenhagen.

Education and work have historically developed independently of each other – each field with its purpose such as a school rationale and a production rationale.

Education and work have historically developed independently of each other – each field with its purpose, such as a school rationale and a production rationale. However, in VET, both the school and the workplace expect an interaction between education and work. Vocational education's main goal is to equip students with the necessary skills to succeed in future work roles. Companies want qualified labour for a job that the educational system cannot completely overlook. Still, they depend on external training to increase knowledge internally and improve efficiency (Jørgensen, 2004). In Norway, education in a local community is an important aspect of justice. Still, the difference between access to education in urban and rural areas is significant. When it comes to supporting an educational structure for individuals interested in pursuing VET, rural areas are not structurally prioritised (Balfour et al., 2008; Cedefop, 2017; Milmeister et al., 2022). A locally rooted VET in a rural area is central to the local community, and it is found that VET in the district contributes to local culture and welfare (Gristy & Hargreaves, 2020). A rural school also contributes to economic and social development as VET has the potential to develop mutually beneficial partnerships between schools, local companies, and regional industries. Local knowledge and experiences are translated into practice in vocational education through continuous ongoing organising. Rapp and Knutas (2023) find that the loosely coupled organisation of VET in a rural area is characterised by continuous dialogue regarding challenges. Loosely coupled organising provides flexibility and solutions for VET students and companies. A driving force in a rural community and a mutual interest to engage in a local rural VET is the preoccupation to reconstruct a thriving local community, its economy, culture, and workforce (Rapp & Knutas, 2023).

3 INTEREST ANALYSIS

An interest analysis is built on a process that aims to achieve increased understanding and knowledge of chosen actors in the environment. Following Freemans (1984) there is for example a two-way relationship between a company and its interest. A company is affected by the achievement of its corporation's purpose (Freeman, 1984) such as in our case companies of electricity production and their solutions/ purpose to meet the green shift.

Towards the background of the green shift the primary interest of our study was companies working with the production of energy for the grid. The secondary interest (our study on companies' energy/green shift) was to look further into actors who indirectly influence company achievement. In our case, we link actors' competence in Vocational and further education (VET and higher education) and the company's achievements toward a green shift. The aim was to acquire knowledge of the sector(s) in which the companies were engaged, their cooperating partners, their educational demand on the workforce correlating to the green shift, and the company's cooperation with educational pathways, mainly Vocational competence and to some degree further education.

Interviews over the Internet (Teams) and telephone were carried out with 9 companies and one public cross-disciplinary training office (VET). The informants represent hydropower plants and production some involved with solar and battery, one thermal powerplant, electric distribution company and as mentioned one cross-disciplinary training office.

The interviews lasted between 35-45 minutes and were based on questions sent ahead to the person to be interviewed (see attachment). The persons interviewed were informed that the participation was voluntary and that they could request not to participate at any point. They were informed the material would be treated according to the guidelines for research ethics, including a guarantee of both confidentiality and anonymity. All the interviews were audio-taped and transcribed in full. The data material was encoded so that no person was identifiable (NESH, 2021). From the transcribed material, we assembled an overview of the companies and their diverse fields. We also looked closer at their foci and collaboration with others. In the next step, we pinpointed VET, and the attention was laid on reporting/matching the demands across the companies that were overlapping/mutual indicating a priority on the VET workforce and required qualifications and to some extent continued education. In addition, the interest analysis suggests strategies to support dialogue and cooperation that can lead to action and improve educational strategies for a locally situated VET.

4 RESULT

4.1 Overwiev of Companies Interviewed

There are a total of 9 company representatives were interviewed in addition to representatives of one cross-disciplinary training office. Four of the companies are active in hydropower production/hydroelectric plants. Out of the four, one is also involved in solar energy, yet another of the four is in addition involved in wind power and a cooperative solution for solar power. Three of the companies work with wind power, where one builds and constructs wind parks in addition to contracting maintenance. One company is a thermal power plant, one delivers electricity to the grid based on electricity from a hydropower company.

Company	Electric distribution	Solar	Wind	District heating	Cooperative solution solar	Mainten-ance	External maintenance	Cooperation internal/ external
Hydropower Plant nr 1	X	X				X	X	
Wind/build Construct nr 2	X		X			X	X	X
Wind Park nr3	X					X		X
Hydropower Plant nr 4	X	X				X		X
Wind Park nr 5	X						X	
Electrical Distribution nr 6	X	X				X	Private solar/ grid Charging stations cars	Hydropower plant delivers electricity
Hydropower Plant nr 7	X	X	X			X		X
Thermal power plant nr 8	X			X	X	X		X
Hydropower Plant nr 9	X					X		X
Cross-disciplinary Training A. VET nr 10								X

As shown in Table 4.1 one of the main tasks for the companies interviewed is to produce and deliver electricity to the grid. They also work with maintaining their power plants and wind parks alongside carrying out maintenance for other companies within their field.

Hydropower Plant (nr.1). The plant has four operative employees who work with high and low voltage; they have a certificate of apprenticeship as energy installers in combination with a certificate as energy operator with competence in wind power. To participate/contribute to solar technology, the company has installed

solar panels on their buildings. The company is situated near a wind power park and sees bit-by-bit possibilities for developing synergies with the wind park.

> *Our focus is hydropower, and we have the energy operator profession as priority on (nr. 1)*

Wind Power Company (nr. 2). The company works with constructing and building wind parks. When a new park is up and running, they often enter into a service agreement (with the owner of the newly built wind park), where they support the conditioning of wind turbines and continuing operation and maintenance. The company is dependent on technicians with wide professional knowledge.

> *We are dependent on having access to technicians with a wide professional knowledge [...] we do not only recruit personnel with an electrical certificate since we are bound to have access to staff with a mechanical certificate as well. If we do not educate employees ourselves, we choose to hire personnel with technical diplomas (nr.2)*

The Wind Park (nr.3) is one out of seven wind parks owned by the company. The park produces wind power, and they also continually work with maintenance servicing all the wind parks owned by the company. The wind park hires electricians (high voltage) and mechanicians- energy operators are also useful. In addition, they hire staff with IT competence. The wind park is one of the oldest in the area and they feel they have a lot of experience to share.

> *So, we are in a special situation [...] when they build new wind parks involving big operations and they need assistance we line up with staff and help out (nr. 3).*

Hydropower Plant (nr. 4). The hydropower plant is one out of 17 plants spread out and owned by a company in the county. The main company owning 17 plants also deals with both solar and wind power. In addition, the main company has a Swedish branch owning hydropower plants and wind power park(s). The subsidiary hydropower plant in focus here produces hydropower which is delivered to a grid company. The subsidiary plant hires mechanics and energy operators. Next to running the plant, the focus lies on carrying out the maintenance of the plant. At the plant, there is an interest in health, environment, and safety.

> *For the main company, number one is good health, environment, and safety, [...] so in line with the top management it is decided there should not be any limits about money and time [...]so we have gathered a network of people from Norway and Sweden consisting of the subsidiary companyes of the main company and branch in Sweden. The goal for us is to learn from each other and work out the same written routines to secure security (nr. 4)*

Wind Park (nr. 5). The company is a subsidiary wind power company owned by a larger energy company in the county (Trøndelag). As the subsidiary company operates with wind power, an important partner that they cooperate with is the company that has delivered their turbines as well as the company that has built the wind park infrastructure. The company hires electricians with competence in automation and mechanical profession.

> *The professional training is traditional and to a large degree angled towards other companyes than the wind power company. So, there is only one professional training program that as of today has wind power as part of the education and that is energy operator based on an upper secondary electrical education degree (nr. 5).*

Electrical Distribution (nr. 6). The company is mainly engaged in electrical distribution to customers on the grid (electricity to the company is delivered by a hydropower plant). The company is also involved in customer-related support, such as installing chargers for electric cars and/or cabin owners who want to install solar panels on their roofs. In addition, they engage in projects such as new customers connecting to the grid or different kinds of new structures in the pipeline, such as those mentioned charges for electric cars. The company works tightly with "hands-on" entrepreneurs (for example, electricians), and they hire project leaders to run "new structure" projects. They have staff with the competence to write contracts.

> *As to what kind of competence I would say there are needs on all levels, within the company there are developers and project leaders needed to run projects and to be able to count and figure out dimensions for the grid. Working closely with entrepreneurs, we have staff who sign contracts and prepare both for project leaders and electrical installers (nr. 6).*

Hydropower Plant (nr. 7). The subsidiary hydropower plant is one of the main companies 18 plants producing and delivering electricity to the grid. Hydropower plants having been a very technical-oriented profession nowadays include the environment and economy as part of the green shift. The main company is engaged in wind and solar power with other partners and has installed solar on their cooperate buildings. The company expects that solar power as an energy source will increase. The subsidiary plant is involved in a cooperative society-owned solar park that delivers electricity to the grid.

> *If we go back 20 years then the matter was to keep the plants running, it was a matter of keeping them running at the right time and such. Now the matter of running a plant is much broader and consequently, more, and varied competence is involved in the process (nr. 7)*

Thermal Power Plant (nr. 8). The thermal power plant delivers electricity to the grid. In addition, they distribute thermal heating to housing and public institutions (to the town where they are situated, in addition to smaller villages where they also have facilities). The plant is the sponsor of a smaller thermopower facility at a local upper secondary school to support students with better educational material/understanding of thermal energy. They hire students with upper secondary education from the electricity and energy program, and preferably the students take an additional two years of schooling.

> *You choose electricity and energy at upper secondary school, and we prefer minimum higher education such that almost 90% of those that work with us today they have in addition taken two years higher education, energy, and heat production (nr. 8).*

Hydropower Plant (nr. 9). The subsidiary hydropower plant is one of the main companies owning 20 hydropower plants. The main company is a part developer in a hydrogen gas project which is slowly working its way forward. The subsidiary hydropower plant runs/maintains and services three plants in their nearby area and delivers electricity to grid partners. They hire staff with competence in fibre and remote control of the plant. They are also in dear need of staff who have both electrical and mechanical competence.

> *That is, a good electro machinist and those are not easy to find. Now, the professional title is energy operator but still, you need to be skilled at handling both me-*

chanics and electro. In addition, there is a demand for digital and remote control of plants (nr. 9).

Cross-disciplinary Training Office VET (nr. 10). The cross-disciplinary training office is responsible for apprentices with placement within several fields for example energy operators, car mechanics, and industrial mechanics. The training office works closely with the nearby upper secondary school in recruiting apprentices for es nearby. In their work with students and companies, they focus on the curriculum – that is, what the students need to learn and what the company needs to cater to make sure the student can follow their course and end up with their exam. The training office also works as a go-between when taking responsibility for giving signals from the companies on demands in the future and in what ways the upper secondary school ought to think in terms of dimensions of attractive occupations for companies.

We try to give signals back from the companyes [...] So we cooperate with the local upper secondary school and inform them on the demand for professions in VET during the coming years (nr. 10).

4.2 Examples of Company Foci

The hydropower plants in the study, next to producing and selling energy to grid companies, all work with continuing maintenance and service of their plants. Some of the plants have additional contracts with hydropower plants to carry out their maintenance and service. One company engaged in hydro production in an area where the Sami herd their reindeer finds that dialogue is the best way to cooperate and come to mutual agreements on matters of health, environment, and security.

We are in contact with reindeer owners on both Norwegian and Swedish side of the border, we find it works out very well and we have found out that dialogue is the best tool we have (nr. 4).

One of the Swedish plants in the study is involved in a mix of energy sources (nr.7). Solar power is still only a smaller part, but wind power is where they own wind parks together with other partners/companies. In Norway, they are also part owner of a hydropower plant in addition to three additional hydropower companies with which they cooperate.

We share experiences with colleagues on the Norwegian side [...] we have cooperated on topics such as infrastructure for the electrical load (grid) and we have a lot of contact with the northern part of Trøndelag (nr. 7).

Considering the mix of energies, a topic for the hydropower plants is the variation in the market on a 24-hour basis. There may be more hour resolution with the prices in the power market, and soon there will be quarter-hour resolution, which brings large variations.

AND since the more wind power that comes into the market the more "noise" it will create for us with up and down-regulation of the waterways [...] yes, you `ll suddenly get an extra 500 megawatts from the coast (wind power) – then we `ll have to regulate up and down in the power plants wherever we can (nr. 9).

The wind park companies represented in the study produce wind power, which they sell to grid companies. One of the subsidiary wind parks (nr.3) is owned by one

large company involved in a mix of energy sources and with branches in several countries. The subsidiary park informs that their turbines' lifespan is coming to an end, and hopefully, the company will renew and replace their turbines. For the time being, the wind park continues to carry out maintenance and produce wind power.

> *68 wind turbines are now coming towards the end of their lifespan, so we hope or at least we look at renewing us and replace these turbines (nr. 3).*

Yet, another main energy company (nr.5) involved in both wind and hydropower is represented through its subsidiary wind park. The main company has recently bought two wind parks across the border in Sweden. The subsidiary wind park works closely with its suppliers, both deliverers of wind turbines and the infrastructure builders of the wind park.

> *But at the same time, the suppliers, in turn have their suppliers to some of the components and part of the wind turbine, and it could just be as good for us to cooperate with the supplier of a component instead of being in a go-between situation with the deliverer of the turbine.[...] It could be considered a kind of conflict of interest where the deliverer of the turbine wants to keep as much of its delivers into the running cost (maintenance contract) while we focus on delivering a good service to the owner of the wind park [...] including concern on costs of keeping the wind park running (nr. 5).*

The Wind power company constructing and building wind parks (nr.2) are also engaged in shorter and longer contracted maintenance with the owner(s) once a wind park is up and running. Even after a wind park company`s maintenance contract has run out, they can get support with troubleshooting wind turbines. Since Norway, during a period, has slowed down on building wind parks, the company cooperates internally with their branches in Sweden and Finland.

> *Sweden and Finland have had an enormous development so there we cooperate [...] the projects need technicians to mount and get the turbines up and running (nr. 2.)*

The electrical distribution company (nr.6) is also engaged in projects, both reinvestments to update the grid and new connections of various kinds. "It is both reinvestment with renewing the electricity grid, new connections, yes all kinds of new structures that are showing up, for example, an electrical charging post (vehicle) or solar cell to be connected to the grid" (nr.6).

The thermal power plant produces and sells electricity to the grid and delivers thermal power to housing and public buildings. They have no competition in their area as they also own the smaller thermal power plants in several municipalities in the region.

> *There are no others [...] and this is an advantage but still, it puts a big demand on us that we have to be sensitive to what people think, we can't just come up with whatever we want (nr. 8).*

The cross-disciplinary training agency next to catering apprentices in companies (for two years) cooperates with vocational upper-secondary education. They recruit apprentices from a nearby upper secondary vocational school, either energy installers or energy operators "We have apprentices in two companies, and we have/are responsible for the upper secondary education in a vocational subject/final qualification/exam" (nr.10).

4.2.1 The Green Belt – Knowledge and Resources

It is not the case that the energy market is "special" when it comes to companies cooperating across countries. Rather, in today's globalized world, companies independent of size along with their subsidiaries operate in countries where there is a market of interest. What is highlighted in this report is the fact that there are cross-border interests in the Nordic Green Belt[22]. Through the interviews, it is found that both Norwegian and Swedish companies in addition to their subsidiary companies (hydropower, wind parks, solar energy), are cross-border active within the green shift. In this framework, it is observed that skills development and cooperation regarding company development, in addition to education, are focal points.

An example is a Norwegian subsidiary wind park (nr.3), where the main company owns wind parks in Sweden. The subsidiary park exchanges staff between Trøndelag and Jämtland to promote knowledge. The company seek to switch a bit between Norway and Sweden "just simply to exchange knowledge, get a slightly broader understanding of the different wind turbines we have in the loop" (nr.3). They also set up meetings with staff from Trøndelag and Jämtland, and when there is need for an extra hand, personnel will have the opportunity to widen their competence "so then we exchange staff for a while". It is found that the competence is similar. Still, Sweden has their wind park school, which Norway does not. It is concluded that Norway's similarity is the vocational energy operator.

> *But we could have called our apprentice's wind power technicians if such a certificate of apprenticeship had existed. And we have had a good deal of Swedes taking their educational practice with us – not just a few – but actually quite a few (nr. 3).*

Another area of cross-border cooperation is the hydropower plant situated on the Swedish-Norwegian border where the Sami herd their reindeer (nr.4). The cooperation with the Sami involves nature conservation and environmental legislation. Yet another example is a main Swedish hydropower plant (nr.7), which cooperates with a Norwegian company since they share ownership of a wind park. The Swedish company is also part owner of a hydropower plant in Northern Norway. The companies mentioned (Swedish-Norwegian) cooperate on matters of infrastructure (grid), electric capacity and distribution to the grid as well as expansions of hydropower plants.

We are told by the wind power building company (nr.2) that there are some obstacles to sending personnel across the border. It works fine to send staff from Norway to Sweden to build wind parks, but it is more difficult the other way around, depending on the definition of a turbine. What is a bit odd is that a turbine is a machine. In Sweden, the authorities have taken a stand. They say that a turbine is a machine, and when it is put into operation, it is an electrical facility. There has been no clear statement in Norway from the Norwegian Labour Inspection Authority or the Directorate for Civil Protection (DSB).

> *So that is a grey area you could say [...] the problem is that in Norway there is no regulation regarding the electrical vocational employee and the qualification regulation. There is also the matter of who has supervisory authority. It is the Norwegian Labour Inspection Authority, but they may not have expertise on the electrical side, so they want DSB which has the expertise to take it. However, DSB does not have the authority since it is not an electrical facility. Then the challenge becomes ours with the overall responsibility for making the right choices (nr. 2).*

[22] Trøndelag, Jämtland, Västernorrland.

4.3 The Energy field and rapid Development

From having been technically oriented, the production of energy such as a hydropower plant vis-à-vis the green shift is still a matter of technology. As for technology, 20 years ago, the major focus was laid on keeping the hydropower plants running at the right time. Additionally, the environmental perspective was added as an important perspective early on. As for the green shift, an added value to consider with marketisation is the economy where hydropower plants work towards optimising production and distribution. Understanding the market is, in turn, connected to the demand of keeping up with a rapid and continuously changing new technology. One example is the connections of hydropower plants with batteries. The battery is built together with the hydropower plant so that the resources can "work together". The battery supports the fast requirements on the grid whereas the hydropower supports the slower. With sun and wind power contributing to the grid's energy distribution, complexity increases. And with production capacity being monitored, there is a request for IT knowledge. Above all, in approaching the green shift, there is an expressed demand for understanding the complexity of production and distribution.

> *Next to the environment and such there is considerable focus on market analysis, forecasting and such. These are areas that we earlier did not have much of at all. Back then we produced and then the price was what it was. Now it's a matter of optimisation. Thus, we carry out additional services, and support services such for example power regulation to the grid. Regarding the topic of optimisation and services, there is a fairly large market – a market that appears quite quickly, and which perhaps disappears quite quickly. The situation affects us in how we plan and not least when it comes to our investigations on how to proceed on the market. Earlier when we had to build some kind of production capacity, we could carry out a study for around three years. You cannot do that now, because we are building for a market that may not be around in three years, so there are completely new ways of thinking (nr. 7).*

The findings from the interviews point out the rapid changes and demands which make parallel with the 2023 report from DNV.[23] Balancing climate change and renewable energy expansion is at the core of the report, and countries have committed to promoting electricity from variable renewable energies (vRE). vRE, such as wind and solar power, entails concerns for electricity system operators. As pointed out by the interviewed informants, wind and solar generation contribute to real-time variations, which tend to increase the need for balancing by the system operator. DNV finds that off-grid renewable energy production will be driving green hydrogen production and its scale-up. Producing almost no carbon emissions, hydrogen produced from off-grid renewables has significant environmental benefits compared to grid-based or fossil-based hydrogen (DNV 2023)

As mentioned, experts from the Nordic countries cooperate to boost the cross-sector implementation of hydrogen and fuel cell technologies in the green shift (NHP, 2023). An example of the ongoing changes in the renewable energy market (hydrogen gas) is represented by Alfa Laval more known for introducing the milk separator in 1880$^{th.}$ Alfa Laval will, through a subsidiary company, start a new company unit to develop hydrogen gas in combination with fuel cells to produce electricity for the industry and/or for running car engines.

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[23] Det Norske Veritas (DNV) was founded as a membership organisation in Oslo, Norway, in 1864. In 1951, new rules based on an analytical and theoretical scientific approach were introduced, and significant step was taken towards establishing a dedicated research department. In 1977, wind energy was introduced as a new company segment. This and other climate-friendly service areas represented new opportunities. In 2035, more than 80% of Europe's grid electricity will be generated by DNV, which is estimated to come from renewable sources.

14 Nyheter

Dagens industri
Fredag 3 november 2023

Grön energi • Industrikoncernen startar ny affärsenhet

Vätgas ska lyfta Alfa Laval

Alfa Laval storsatsar på vätgas och startar en ny affärsenhet.

Verkstadskoncernens vd Tom Erixon har gott självförtroende och tror att bolaget kan bli ledande på området.

I samband med Alfa Lavals digitala kapitalmarknadsdag på torsdagseftermiddagen lanserade den skånska industrikoncernen en helt ny affärsenhet med inriktning mot vätgassektorn.

Vätgas, som ses som viktigt i omställningen mot förnybara energisystem, kan i kombination med en bränslecell användas till elproduktion, i industrier eller för att driva fram fordon.

"Som ofta pågår de här utvecklingsarbetena lite i skymundan innan de mognar fram. Nu kom vi till en punkt där vi skulle bestämma om vi ska göra allvar av detta eller om det ska bli en sidofråga, men vi har valt att kraftsamla kring det", säger Alfa Lavals vd Tom Erixon.

För Alfa Laval, som är inriktat på värmeöverföring, separering och flödeshantering inom energi, marin, livsmedel och vatten, har steget till vätgas inte varit så långt som man kan tro.

Alfa Lavals vd Tom Erixon. FOTO: LARS JANSSON

Strukturen i de elektrolysörer och bränsleceller som används i vätgassektorn är i sin struktur inte så annorlunda från innehållet i de värmeväxlare som Alfa Laval utvecklar.

"Vi sitter på en massa tekniskt kunnande i våra traditionella verksamheter. Utvecklingstakten är väldigt hög på det här området, så vi kände att vi behöver få rätt struktur på plats för att vara drivande."

Tom Erixon vill inte gå in i detalj på vilka kunder Alfa Laval har hunnit skaffa sig, men säger att bolaget redan nu har samarbeten med flera av de runt tio företag som är ledande på området.

Hur ser konkurrensen ut?

"Det återstår att se och är ett skäl till att vi har bråttom. Om vi går på halvfart i några år så har tåget lämnat stationen."

Vätgasmarknaden är fortfarande ung, men vd:n ser affärsmöjligheter "som överstiger många miljarder kronor" framför sig.

En utmaning blir att hitta rätt segment att rikta sig mot. Tom Erixon tror att bolaget kommer att fokusera på mer komplicerade applikationer snarare än att verka över hela marknaden. Inledningsvis kommer runt 50 personer att arbeta inom den nya affärsenheten. Alfa Laval kommer också att bygga ett nytt innovationscenter vid huvudkontoret i Lund.

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Alfa Laval kommer att starta ett nytt innovationscenter vid huvudkontoret i Lund. FOTO: LARS JANSSON

FAKTA

■ Elektrolysörer: En enhet som använder förnybar energi för att dela vatten till väte och syrgas genom en elektrolytisk process.

■ Bränsleceller: Omvandlar den kemiska energin hos ett bränsle, vanligtvis vätgas, och ett oxidationsmedel (vanligtvis syre från luften) till elektrisk energi genom en elektrokemisk reaktion.

Källa: Alfa Laval

Source: Dagens Industri Friday 3 november 2023

4.4 The Green shift – Shortage and complexity of Competence

As mentioned, sufficient access to the right expertise is crucial for a company's ability to operate competently. Capable labour from all education levels is crucial for supporting the green shift. The shift to sustainable energy and eco-friendly industries, such as battery production, solar, wind power and hydrogen, present several scenarios for advancing green value chains. It is projected that there will be a demand for 13,000 (in the low scenario), 64,000 (in the medium scenario), and 115,000 (in the high scenario) employment needs. Work categories required are estimated at 50 per cent of craftspeople and operators, 40 per cent of engineers, and ICT developers. Currently, there is a struggle to find solutions (for example, skilled workers within wind power) to achieve the ambitions for a green shift by 2030 due to a skills shortage. (Landsend-Henriksen, 2022).

In line with predictions by Landsend-Henriksen (2022), the struggle to employ skilled workers is expressed by the informants.

> *I am more worried about that potato. The one with both mechanics and electricity "in the same", meaning that you have a good electrical mechanic, there aren't that many of them. Now the vocational certificate is labeled energy operator, but the situation requires that you be skilled in both mechanical and electrical engineering. And then there is the knowledge required on digital and communication equipment such as between central and remote-control systems of a hydropower plant – what we will struggle with in the long run is that a lot of staff with long-time experience are retiring. It is not just to bring in an electrician from the street to run a power plant – it is not (nr. 9)*

On the topic of structure and the complexity which has consequences for finding staff. One informant at a hydropower plant says it is time to worry about

cross-disciplinary competence, which there is demand for, especially with new techniques and more complex digital equipment. It is not only a matter of complexity, but competence is becoming scarce in certain areas since staff either have retired or passed away.

> *The industrial mechanic has proven to be more important lately since the supplier industry is not there to the same extent as before, such that it is difficult to find "good" turbine smiths – there are about 10 to 15 available in the country (Norway) who can manage big and heavy revisions. Thus, we are dependent on external support, we had a lot of competence in our ranks, and now all of them are either dead or have retired (nr. 9).*

Along the vein of demanding workforce in the future, an informant says that with the workforce shortage, they need to plan to make sure they continuously have educated staff to keep the power plant running – especially since the educational system cannot cater to companies' demand.

> *Since 2019, we have more specifically focused on steering our interns in a certain direction. We see a great need; many of us are going to retire soon, and then we have to ensure we have the right competence [...] look at the south of Sweden, they have been forced to initiate internal training since companies fight over staff, and there is no education either to talk of (nr. 8).*

Besides the agenda of right competence, an informant at a hydropower plant (nr.9) concludes that electrical VET education has shortages since the whole market has changed and new demands are required. The VET apprentice does not get access to the wide platform of chores compared to 20 years ago. Consequently, they do not get enough experience to work with either new demands or hands-on maintenance to solve problems.

> *We do not run the power plant as we did 20 years ago when I began. Then we operated the plant and line network with the same people. Their tasks were more varied as they got experience for example in assembly work. Nowadays when you run operations, maintenance and solve error correction you do not get the wide platform as in the earlier days. Also, as we replace old power plants the employee does not have to solve problems through hands-on maintenance. And when you do not get to practice then it becomes difficult (nr. 9)*

> *The apprentice is with us for 2,5 years, and as an apprenticeship with us – well you may get to "skim a bit on the tip of the iceberg" but not learn anything in-depth. So, when you leave upper secondary school without any kind of experience, I think that this vocational certificate should have been a slightly longer apprenticeship. If you have a vocational certificate at the bottom, either as an industrial electrician, mining electrician or something along that line then it might be good to take it over a 1.5-year apprenticeship. However, if you don't have any previous experience, then I do not know if it is worthwhile since they do not have the right competence (nr.9)*

The informant's conclusions (nr.9) align with what is underscored in several published sources (NOU 2020:2; Landsend-Henriksen, 2022; NIFU, 2023). As pointed out, the green shift brings demands on additional kinds of knowledge. The changes related to education require cooperation between authorities, educational institutions, and industries, with a particular focus on vocational training and vocational schools. The shortage of competence, in addition to a need for a mix of workforce, is emphasised by yet another informant from a hydropower plant (nr.7). In line

with Landsend-Henriksen (2022), it is highlighted that the demand they have for craftspeople includes operators, engineers, and ICT developers. The informant also stresses the agenda of the male and female workforce where it is concluded that hydropower is a conservative field, and to keep women employed, they have work to do in catching up.

> *Informant: You should know that the industry is crying out loud to find a skilled workforce. People often talk about us needing more technicians and engineers, and that is true to some extent, but I see that we need those who have the market side with them (new techniques - different power sources), preferably in combination, of course, there is also a category that we have become better at recruiting, worse at retaining and that is, unfortunately, the women. So there, too, I think there is a job to be done. I have been involved in some such work at the national level, but we have not managed it.*
>
> *Researcher: At upper-level education, are there any women looking for practice?*
>
> *Informant: Yes absolutely, and as said we receive more women when recruiting, but we do not get to keep them. They often transfer over the chemistry and such. There is also a vague understanding that water and wind power is hard work, tiresome work. That is not the case today. I think that the wind power industry, being a younger company, succeeds better. Hydropower, is very traditional (conservative), and we have work to do in catching up (nr. 7).*

The findings align with the report from the Nordic Council *Attraktive erhvervsuddannelser I Norden,* which finds that a lack of labour is an encounter for the Nordic countries. Several of the people we interviewed informed us of the challenges in recruiting and finding skilled crafts. Attention to the shortage of workforce is also fronted by the Stortingsmelding *Utsyn over Kompetansebehovet i Norge* (2022-2023). It is reckoned that the skills shortages will interfere with materialising the green shift, thus inhibiting the emergence of green companies and industry, delaying digitisation in working life and slowing down productivity (2022-2023). From a study on gender, it is pointed out that sectors such as energy, industry and agricultural sectors are male-dominated. In the report, it is concluded that ways to include women in male-dominated sectors are part of upholding a fair and socially sustainable green transition. (Nordic Council of Ministers, 2023c).

4.5 Company and Education

The hydropower company cooperates with an upper secondary vocational electricity program. They take on the practice placement of students whenever the school asks, both during 1st and 2nd year. To find apprentices, they advertise in the press, and as they take on practice placement from the vocational program, they often choose apprentices in cooperation with teachers from the upper secondary vocational school. Once hired as an apprentice, effort is given to incorporate the young person into the work environment. The company emphasises fostering workplace-appropriate behaviour among apprentices.

The apprentice carries out daily chores closely supervised by one person on the side, and as time goes by, the apprentice switches to other workfellows. Through the procedure, the apprentice gets to socialise with all employees. The company works closely with the disciplinary training agency as they have the educational responsibility for the apprentice. The company has excellent contact with teachers at the upper secondary school towards the background of taking on the practice placement of students during both the first and 2nd school year. As for promoting future carriers, the company does not have a strategy – the argument given is that the hydropower field is conservative, and the employees want to work with practical chores.

The wind park building company took on its first apprentice in 2022. They got in contact with a training agency in Trøndelag (electro) to find apprentices and were forwarded to Dalene Upper Secondary School in Egersund. The company only takes on apprentices who have taken the energy operator course VG3. They do not have any possibility of taking on apprentices from the energy operator course who aim to work with hydropower. As for apprentices in the loop, they cooperate with the closest training agency (electro) since the agency caters for the theory and follow-up of the apprentice. In the coming period, they will evaluate their first experience with taking on an apprentice. In the longer run, they wish to take on 2-4 apprentices per year and to achieve this goal, they would like to work closer with additional upper secondary educational schools that cater to their demands.

When they take on apprentices, they emphasise environmental circumstances so that the apprentice feels welcome and gets a good impression of the workplace. In addition, the focus is laid on security as they work with high voltage. Once the apprentice has received their certificate, the company's strategy is to provide additional certificates to boost the employee's career. Until next year (2024), they plan for a praxis candidate education – dependent on the kind of certificate of apprentice they can offer to build on the student's competence towards becoming an energy operator. The company expresses that there are challenges in finding a certificate of apprentice that completely covers the demands that they have on a wind power technician – as for now the closest they can find is an energy operator.

Foto: Colorbox

Nr.3

The wind power company has a demand for both electricians (high voltage) and mechanics for maintenance. They also demand IT competence and energy operators. They cooperate with a training agency in Trøndelag to find apprentices they advertise, and they participate in educational fairs arranged by the upper secondary schools. The company says they feel they need to take on apprentices and contribute to the continuation of educating the new workforce. They take on two apprentices a year.

The apprentice relates to one designated person in the company who follows up on work chores and progression. They also send the apprentice to other locations owned by the company so that they become involved in major operations. They also have good relations with the training agency since they cater for the apprentice in reaching their certificate, not only on a skills level but also on social and environmental matters. If there are job openings, they can offer an apprentice a steady position once they have their certificate. The company says that if there was additional education in the area, such as the one in Egersund (energy operator), it would be highly appreciated especially if such an education had a bit of mechanics added. As for continuing education, they have offered employees courses in electrical certificates; they are also demanding additional mechanical knowledge and as mentioned, if the combination of electrical and mechanical knowledge was catered through a certificate of educational system, it would have been appreciated.

Nr.4

The hydropower company finds it a bit difficult to find apprentices locally. They try to give information to the surrounding area, but still, it is a bit slow to get a dialogue going. All in all, they continuously have four apprentices in the loop. The company finds there is competition in hiring the “best” students finishing their two years of upper secondary education. Personality is considered when interviewing before taking on an apprentice. Cooperation with the training agency works out well, and they visit to ensure proper documentation and cooperation. As for competence, the company borrows staff from the company Trondheim location whenever needed – mainly engineers since they are dependent on qualified engineers. Having engineers and skilled workers cooperate is found to create a win-win situation in developing and finding good solutions for hydropower plants.

The company concludes that employees who build on their certificate with technical college become good at finding solutions for challenging tasks at the plant. They have, throughout the years, had trainee programs to cater for employees to take on courses at a technical college. It is also concluded that today, the operators hired need both electro and mechanics to be able to run and maintain the hydropower plant.

Nr.5

The wind power company concludes they do not have enough cooperation with Upper Secondary Education. They are aware that they need to engage more in this area to become more visible and express their demand for educational skills. As of today, there is only one upper secondary education course that caters towards wind power (VG3), and the company wishes that this course was folded in as part of VG2. It would contribute to a broader base of youth who would apply for an apprentice with basic competence in wind power already after VG2. As of today, the young person must travel to Egersund to take the VG.3 course (energy operator). As underscored, if the course was part of VG2. It would be of great value to the wind power industry.

The company emphasises that renewable energy is more than wind power – it is a mix of renewable sources that need to be folded into the education catered by the school system (sun power, hydrogen, battery). The company takes on apprentices (energy operators), and this year they made direct contact with two upper secondary schools, and two apprentices were assigned. The apprentice works daily with an experienced employee, and the company works well with the nearest training agency for the apprentice to attain their certificate. The company offers module courses aimed at increasing competence in different types of turbines in use within the wind power field.

Nr.6

The electrical distribution company finds there is a lack of competence along the whole chain catering to the green shift. They hire project leaders to run projects, and they need staff to calculate dimensions for the electrical grid. As for upper secondary education, they look for students who have a technical background as it gives them access to higher education. The more practical educational paths are also interesting since they also need workers with electrical knowledge when there is assembling work to be carried out. The informant says the company has been invited to a group of company people representing installation, hydropower, and distribution of electricity. They meet a couple of times a year to receive information from educational programs, the number of people applying for education, and the amount of placement for practice the educational system would like to receive for their students.

The company caters to practice for higher education students, and they are also involved in an intern program with a hydropower plant for adult staff who are in apprenticeship programs. The company is also involved in a higher education program where they take part in deciding the content of courses. The program is set up so that the adults can take distance courses; now and then, there are physical gatherings at a study centre. In between courses, the students are out in practice at a company. The company, through a seven-year contract, sponsor one higher education institution within the electrical field where two Universities are involved.

Nr.7

The hydropower company cooperates with the local upper secondary electrical program, mainly concerning practice placement of youth. When a youth comes to practice, they are set up with a general introduction for about six months – that is, an introduction to the company and getting to know the additional plants owned. What has occurred to the company during later years is that the student in practice expects to "learn the job" quicker than, say, 10 or 15 years ago. The company thought they were being considerate when they did not demand too much too early, but what happens is that the students become bored and want to learn more during a shorter period. They also cooperate with the nearby University on planning/developing electrical engineering education. In addition, they take on students from a vocational school who need practice and carrying out exam work. Several of the students return for practice during their educational period. The priority when taking on a student is, first and foremost, security since there is high voltage involved. They also try to ensure the student is given access to a wide range of work chores so that they can later choose what they would like to focus on more in-depth. The students get to work with single persons and in teams, depending on the situation.

Nr.8

The thermopower company employs youth from the electrical/energy program at upper secondary education who have taken an additional two years of higher education. Almost 90 % of their staff has a combination of 3+2 years. The higher education students enrol in is directed towards power-heating production. During upper secondary education (second year), the students already carry out practice at the company – three weeks during the fall and three weeks during the spring. The same routine is repeated during the third year. When the students from the upper secondary electrical/energy program attend for the first time, they are introduced to four different departments during their first period. This way, they get to know what it means to run a thermopower plant. When they come back during their second year, they usually know a bit more about what they would like to immerse themselves in. This way, the company can steer their practice in the direction the student wants to take. If an upper secondary student does not know how to behave (no interest in keeping up, asking questions, or arriving in time for work) when taking their practice with us, we send them back to the school.

The company meets with the teachers from upper secondary during fall and spring, and then they share information on practice and how things are coming along with students. Occasionally, they have had a student from upper secondary who did not care to take higher education. Then they bought external education for the person (for example, operating technicians) so they had the opportunity to increase their work competence. The students taking higher education also carry out practice along the same line – during their first year, they attend three weeks during the fall and three weeks during the spring; in the second year, they attend for six weeks in both fall and spring. The company says they have a demand for continuous education since the branch is under constant change/development, among others, with new environmental demands when it comes to burning biofuel.

Foto: Colorbox

Nr.9

The hydropower company takes in two or three apprentices a year. They have one employee taking continued adult education, adding on knowledge with a second certificate as an energy operator. The company cooperates with the training office, which caters to their apprentices in reaching their goals. As for the theory, the company finds that if you do not have any certificate of apprenticeship within the field from before, then it is "pretty thin" knowledge they receive taking residual theory. It could have been extended to one or two extra sessions with focus given to generators and magnetising. The training agency visits the company to follow up on the apprentice's progress, and the cooperation with the agency works out well. When recruiting apprentices, they cooperate with an upper secondary school on the coast. At times, they also take placement of students, and when recruiting an apprentice, it might turn out that the students, having had placement during their two first years, come back for their apprenticeship. The company finds recruiting challenges since the hydropower industry (often) is not a student's first choice. The matter is also whether they have anything to win recruiting from upper secondary education – maybe they are better off recruiting a person with some work experience from before. The field is such that after 2.5 years as an apprentice, the person might not have the competence they need. It takes five to ten years until an employee has gathered enough experience to be able to carry out most of the demanded chores. Before taking in an apprentice, they look at grades and absence, and if they do not do well in Norwegian and English, it does not have much to say, but they do look at the electro subjects. Once hired they make sure the apprentice is introduced to the different departments and also make sure that the person can reach the educational goals stated in the curriculum. The company is involved in modules of education for its staff where they turn to a competence centre in Geilo for hydraulic courses and bearing courses. A typical course runs over two weeks.

Nr.10

The cross-disciplinary training agency partaking in the study is responsible for following up with apprentices in their area given the subject and directives of the curriculum. They are in contact with the companies to ensure that the apprentices have the basics to accomplish their certificate. Challenges mentioned by the training agency are to motivate students and to "get them to understand the importance of their role and the shoe they are to fill". The companies demand that the apprentice has finished the two first years of upper secondary education before entering apprenticeship. Parallel, there are options to adjust and take on an apprentice if the student is missing a grade (for example, English), thus supporting the student to reach their goal and giving options to pick up the missing grade underway. The cross-disciplinary training agency works closely with the nearest upper secondary school and gives signals back from companies regarding future demand for the workforce. The new curriculum 2020 catering for electro-education (upper secondary) was given a wider entrance to the field as some knowledge of the green shift was added. Still, there might not be enough attention given to the green shift. The Ministry of Education always seems to be behind the market developments. As for the "rest theory" demanded for apprentices (0.5 years), the training agency finds that its (rest theory) ought to be revalued. Considering the green shift, the theory is too narrow, and it might be a good idea to widen the course and complement it with additional knowledge of renewable energy.

5 EDUCATIONAL STRATEGIES FOR VET

As the results point out, technical development within renewable energy is progressing at a fast pace. Environmental requirements are increasing, and the production and distribution systems in the energy market are complex, with several mixed energy sources. Companies interviewed underscore that there is a shortage of knowledge on the complexity of the distribution systems; for example, several energy sources are merged and work in different capacities. With the fluctuation and regulation of mixed energy sources, there is a demand for knowledge and competence on how to calculate stable transfer of energy to the grid. It is not only a matter of stable transfer of energy but also of economising renewable sources. In a broad sense, the goal is to minimise environmental impact. With the green shift, the interviews give at hand that knowledge of health, environment, and security (HSE) is at the forefront for companies. Not only job security for each employee but dialogue with the surrounding society is accounted for when considering ways forward to enhance renewable energy.

From the study, it is concluded that there is a demand for VET education to become broader than it is today (2023). With the rapid development in the energy field, it is concluded that VET education must lay a good foundation for further studies, especially since the renewable energy market is on the verge of finding new and improved solutions. One example of constant improvement is wind power, which is a so-called unregulated power that is consumed immediately. As reported earlier, companies are working intensely with both hydrogen and batteries to find ways to store unregulated energy (wind and solar). Thus, sources such as hydrogen and batteries will become central when developing a broader VET education to cater for the energy market.

As reported through the interviews, the educational system ought to take note that companies have a demand for mechanics, knowledge of hydraulic with cooling systems and electricians as well as technicians with broad professional expertise. There is also a shortage of IT competence, competence to operate control systems and remote control, as well as competence in fibre, knowledge of automation, electromechanics and industrial mechanics.

Referring to renewable energy, there is a demand for experienced workers with basic VET education. Being experienced, they have hands-on and analytical knowledge from the energy field. Referring to further studies, they are attractive candidates to contribute to the renewing energy market (green shift). There is a demand for project leaders and for knowledge on calculating energy dimensions to balance the energy onto the grid. There is also a demand for analysing the electrical market resources (looking ahead) as well as a demand for knowledge on writing agreements whenever an energy project is in its initial face. Energy companies are in dire need of experienced VET workers with hands-on and analytical competence who have continued to build on their knowledge and/or would consider taking the step and continuing to other positions in the energy market. Considering the background of interviewed companies' demands, it is concluded there is an educational gap to fill.

In line with OECD, structural changes require a re-engineer of VET systems to keep them up to date and ensure that VET keeps pace with ongoing changes. Four key dimensions for VET to be future-ready are mentioned; responsiveness to changing skills needs, the flexibility to make VET work for all, the ability to support transitions into a changing labour market and further learning, the potential of digital technology to innovate VET design and delivery (OECD, 2023). Cooperation between VET, vocational schools, higher education, and Universities is crucial such that there is a red thread throughout the educational systems.

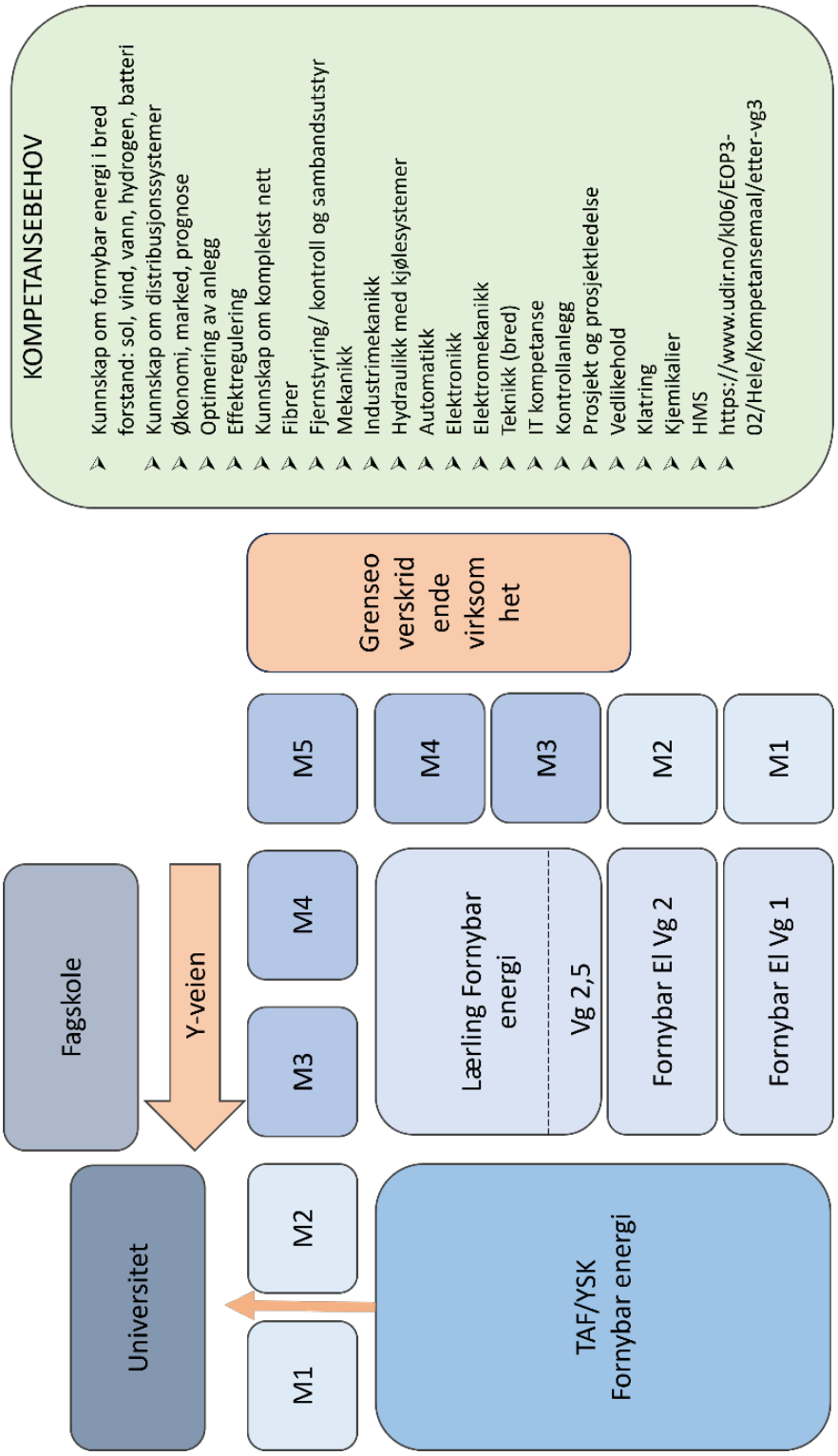
With the results, it is found VET education directed toward new demands on competence in renewable energy is running behind. With the amount of hydropower and wind power in the region of *the green belt* it is significant for the companies to ensure they have staff with the competence and skills to contribute to the continued development of the green shift. The situation is excellent for future development considering the amount of hydropower, wind power, solar and hydrogen development, and cross-border collaboration that has been fronted in the interviews with companies in this report. Considering the results from the interviews of the extensive cross-border exchange (renewable energy), it would be possible to enhance the comprehensive cooperation in the green belt through a VET program. As mentioned earlier, mutual recognition of levels of VET qualification could strengthen opportunities to access further vocational or higher studies within Nordic regions (Nordic Council of Ministers, 2023b).

The companies interviewed (2023) express they have good relations with the Educational VET systems with which they collaborate on matters of apprentices. As stated, some of them collaborate with both VET and higher education as they are in urgent need of increasing competence to keep up with the fast paste in the renewable energy market. As of today, companies are taking responsibility for continued education to make sure they have trained, skilled workers. Companies are interested in a higher degree of cooperation with the educational system (at all levels) to ensure the right competence – a competence that is estimated to be under constant change in the future. The companies purchase external education with distance studies to raise competence, and there is a potential for continued education to combine module-based training with basic education. Offering module-based education to companies will increase cooperation between companies and education. Furthermore, when promoting modules catering for both students in basic education and skilled workers, the socialising between students in their educational face and skilled workers will increase.

The future VET Education ought to be designed as flexible and mobile regarding working lives need for competence and learning at the workplace – parallel reflecting students' preferences. According to the training agency interviewed, it is found that education is constantly lagging in relating to developments in renewable energy (green shift). Cooperation with the local community is essential to support flexible education. The significance of dialogue with the surrounding society (including education and companies) is essential – as we are reminded that a specific need or demand arises at a certain place and time considering being flexible in training, practice and learning situations.

On the topic of the green shift: If the educational system does not reconstruct VET education and targeted competence to support the green shift, the consequence will impede companies' possibilities to keep up. Further, the consequence will affect society at large since companies will not manage to match market competition (Expert and critical reader).

Figure 1. A new education in renewable energy



We provide an example of a new vocational education and training program and demonstrate how to create pathways from it.

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