Green Skills for the Youth

*The **Global Forum on Sustainable Energy (GFSE)** is a neutral multi-stakeholder platform, which is facilitating international dialogue on energy for sustainable development by taking into account the special interests and challenges of developing countries. GFSE aims at the establishment of a sustainable world energy system from a social, economic and environmental perspective.*

GFSE contributes to both international discourse and information dissemination on sustainable energy. The multi-stakeholder platform plays a crucial role in facilitating sustainable energy projects by bringing together donors, investors and project developers. Their interaction creates new opportunities and enhances existing initiatives in the field of sustainable energy.

1. Introduction

The energy transition will require the training of a more flexible, agile and diverse energy workforce. During this transition, new jobs are created, certain jobs may be eliminated and a number of jobs will be transformed. Strategic design of sustainable energy transitions can minimize negative employment disruptions and create opportunities for decent jobs, ensuring social and gender justice.[1] To harness new energy and mobility technologies, companies will need to transform their corporate structures and their approaches to work to reskill and upskill their workforce and incorporate new talent.

Increasing green skills at all levels contributes to growth and innovation as well as the creation of a more equitable and sustainable society. It is therefore critical to help young people acquire the market-relevant skills that support the energy transition. These green skills will help them integrate into the labor market generated by an increasingly sustainable energy system. The green transition will require technical and scientific skills but also soft skills such as adaptability, communication, teamwork and problem-solving. In addition, skills that develop our capacity to care for others and the environment and to educate about sustainability are central to the transition.[2]

In the renewable energy and energy efficiency value chains, a wide range of skills and educational levels are required. The types of skills are evolving as new technologies are introduced into the market. Meeting these evolving skill requirements is necessary to avoid a shortage of workforce that could slow down the achievement of renewable energy and energy efficiency targets.

It is also necessary to create local and regional value chains for renewable energy and energy efficiency. The creation and strengthening of local value chains is an important step for developing countries to actively participate in the sustainable energy transition. There are employment opportunities in different parts of the value chain. The local workforce should, at the very least be able to plan, install, maintain, repair and decommission these technologies.

The wide range of skills needed in renewable energy and energy efficiency requires access to a wide talent pool. Thus, we need to ensure that the workforce is diversified. This means that gender equity must be improved and minorities and marginalized groups included. Also, more training and jobs for

[1] IEA, 2021: Recommendations from the Global Commission on People-Centred Clean Energy Transitions. https://iea.blob.core.windows.net/assets/a01c5f4a-e833-42da-9387-830fcb024046/Recommendationsoftheglobalcommissiononpeople-centredcleanenergytransitions.pdf

[2] Kwauk, C., 2021: The road to a net-zero economy requires building girls' green skills for green jobs. https://www.brookings.edu/blog/education-plus-development/2021/03/01/the-road-to-a-net-zero-economy-requires-building-girls-green-skills-for-green-jobs/

young people are urgently needed.[3] Targeted education and training will play a key role in addressing disparities and promoting inclusion. Training helps workers access the skills and tools they need to maximize their labor market potential and provide employers with the skilled workers they need.[4]

As the green transition continues and technologies become more complex, the need for higher cognitive skills will grow. This encompasses, on the one hand, technical and digital skills and on the other hand, social and emotional skills. Technical Vocational Education and Training (TVET) institutions should move beyond building job-specific technical skills to building a broader set of specific capacities that include sustainability competencies and communication, negotiation and management skills.

Skills for Success program in Canada:

The new Skills for Success program in Canada launched in 2021 will deliver training to enhance skills in 9 different areas: Adaptability, collaboration, communication, creativity and innovation, digital, numeracy, problem-solving, reading and writing. Through the program, approximately 90,000 Canadians will be able to improve their skills to better prepare for a job. Additional funding will support the "Indigenous Skills and Employment Training Program", the "Foreign Credential Recognition Program", "the Opportunities Fund for Persons with Disabilities", and "the Women's Employment Readiness pilot project".[5]

Delivering a qualified workforce requires cooperation between companies, educational institutions, labor associations and governments. Cooperation encompasses anticipating skill demands, monitoring skill supply/demand, establishing a curricula design and delivering education and training as well as policy development. An integrated approach is necessary to ensure that the youth develop marketable skills and have access to training and education, making the match between demand and supply in the labor market easier. Many countries also need to build local professional capacity to develop, manage and execute renewable energy and energy efficiency projects to avoid supply chain disruptions. This capacity can only be built as a cooperative effort between stakeholders.

National Energy Skills Accelerator (NESA) in Scotland

The National Energy Skills Accelerator (NESA) is a collaborative initiative between Robert Gordon University (RGU), the University of Aberdeen (UoA) and North East Scotland College (NESCol), supported by regional partners, including Skills Development Scotland (SDS) and Energy Transition Zone Ltd (ETZ). As a collaborative umbrella organisation, the NESA will provide a 'one-stop shop' to access energy courses, skills development programes and R&D capabilities in the partner institutions to prepare the workforce for the energy transition. It also collaborates with other skills hubs and initiatives, nationally and internationally.[6] The NESA forms part of the Energy Transition Zone in Aberdeen. The Energy Transition Zone (ETZ Ltd.) is a private sector-led, not-for-profit company created to reposition the North East of Scotland as an integrated clean energy cluster that delivers sustainable jobs for the region while reducing its longstanding reliance on oil and gas. People in Aberdeen working in the oil and gas supply chain possess skills that are transferable to the offshore wind industry and other renewables, but require re-skilling and upskilling for doing so.[7]

[3] IRENA, 2021: Renewable Energy and Jobs. Annual Review 2021. Renewable Energy and Jobs - Annual Review 2021 (irena.org).

[6] North East Scotland College, 2021: New National Energy Skills Accelerator to be established in Aberdeen to support the UK energy transition. https://www.nescol.ac.uk/new-national-energy-skills-accelerator-to-be-established-in-aberdeen-to-support-the-uk-energy-transition

Governments need an integrated approach to labor and educational policy to guarantee that training leads to employment and synergies between workplace learning and classroom work make young people more employable. Enhanced policy coherence between labor, educational, energy and environmental policies and coordination among ministries and social partners is also needed.

Skill delivery pathways include on-the-job training, vocational training, university degrees and apprenticeships. Curricula may need to be adapted to meet emerging skills and the educational requirements in the energy sector have to be integrated with those of other sectors. Many jobs in the renewable energy value chain normally require up to medium-level technical skills and do not necessarily require a university degree. They can be acquired through vocational training, on-the-job training, re-skilling and upskilling of workers. This highlights the importance of technical and vocational education for the energy transition.

The FCHgo Vision project

The FCHgo project aims at spreading knowledge about fuel cells and hydrogen in schools by delivering a teaching toolkit, encouraging teachers to take up hydrogen in lessons and stimulating pupils' interest.

As part of FCHgo, materials for teachers and learners in different age groups have been developed. For the youngest pupils, an imaginative and narrative approach has been taken. The FCHgo school materials can be used to teach pupils from 8 to 18 years about the basic principles and applications of fuel cell and hydrogen technology. A text for primary school teachers (*Hydrogen and Fuel Cells —How, What for, and Why?*), who do not have a scientific background, has also been written. The FCHgo Toolkit can be found here.[8]

Green skills are important enablers for the green economic transformation, including the transition to a circular economy and a sustainable energy system. The availability of skills is critical to the establishment of a localized or regional renewable energy and energy efficiency industry. Companies, educational institutions, labour associations and governments would need to cooperate to anticipate the skills and competencies that are expected to play a role in a sustainable energy system, and implement the actions that are necessary to develop such skills. This requires the assessment of existing green skills and an understanding of the development of green technologies and markets. It also requires an examination of the domestic economic value added, associated with a given technology or sector.[9]

[5] Government of Canada, 2021: Skills for Success. https://www.canada.ca/en/services/jobs/training/initiatives/skills-success.html

[6] North East Scotland College, 2021: New National Energy Skills Accelerator to be established in Aberdeen to support the UK energy transition. https://www.nescol.ac.uk/new-national-energy-skills-accelerator-to-be-established-in-aberdeen-to-support-the-uk-energy-transition

[7] Barton Willmore, Invest Aberdeen and Opportunity North East, 2020: Aberdeen energy Transition Zone Feasibility Study. https://www.aberdeencity.gov.uk/sites/default/files/2020-04/ETZ%20Feasibility%20Study%20Report.pdf

[8] FCHgo, 2020: https://fchgo.eu/

[9] Vidican Auktor, G., 2020: Green Industrial Skills for a Sustainable Future. UNIDO. November, 2020. https://lkdfacility.org/wp-content/uploads/LKDForum-2020_Green-Skills-for-a-Sustainable-Future.pdf

2. Green skills in four subsectors

In what follows, we present some examples of green skills needed in four subsectors: mini-grids, energy-efficient buildings, heat pumps and e-mobility.

2.1 Mini-grids

In 2019, 759 million people did not yet have access to electricity and 2.6 million did not have access to clean cooking.[10] Mini-grids have considerable potential to accelerate the uptake of renewable energy, particularly in rural areas.[11] They can contribute to giving people decentralized access to electricity. They can also increase the resilience of electricity supply, given the fact that they are small, decentralised systems. However, the pace of their deployment has been slow due to a number of factors. Among others, regulatory barriers, a lack of technical capacities to install, operate and maintain the systems, a lack of sound business models, insufficient access to finance and inadequate community engagement hamper their development.[12] Scaling up mini-grid deployment and increasing the number of mini-grid developers is vital to achieve energy access targets and absorb capital available for rural electrification.

Mini-grid operators require a diverse set of skills to develop and run mini-grids, covering from project development and construction through to operation. Skills encompass, among others: [13]

- Project development includes site selection, demand estimation, technical systems design, development of business models, financial modelling and project management
- Project construction includes, among others, contracting, procurement and installation as well as project management
- Project operation and maintenance include marketing and sales, tariff setting, customer service, metering, demand stimulation and company management.

However, many mini-grid developers are missing core skills particularly related to project management, business models, financial modelling and risk assessment. There are many training programs but they tend to concentrate on technical skills and these have to be complemented with knowledge and skills in other subjects such as business models and finance, policy and regulation, health and safety and data analytics. Training support has to take into account the type (national, international) and level of experience of mini-grid developers. Developers with little experience require basic training covering the whole project development cycle of mini-grids.

[10] IEA, IRENA, UN Statistical Division, World Bank, World Health Organisation. Key Findings of the Tracking SDG7: The Energy Progress Report. https://trackingsdg7.esmap.org/data/files/download-documents/infographics-060221.pdf

[11] Brent, W., 2021: Minigrids could bring power to half a billion people in Africa and Asia. https://www.canarymedia.com/articles/grid-edge/minigrids-could-bring-power-to-half-a-billion-people-in-africa-and-asia

[12] Draeck, M., Kottasz, E., 2017: Renewable energy-based mini-grids: The UNIDO experience. UNIDO. https://www.unido.org/sites/default/files/2017-03/Minigrid_report_Jan2017.v19_FINAL29906_0.pdf

[13] Inensus and energy 4 impact, 2018: Mini-Grid Training Needs Assessment. Gap Analysis for Developers Report prepared by Energy 4 Impact and Inensus. September 2018. http://energyaccess.org/wp-content/uploads/2018/11/AFDB_Minigrid_Developer_Training_Needs_Assessment_September-2018.pdf

Micro-Grid Academy (MGA) of RES4Africa
The Micro-Grid Academy (MGA) based in Kenya is RES4Africa' capacity building and youth program that contributes to filling the gap of Micro-Grid capacitation. The MGA is implemented with local, regional and international partners from the public and private sectors such as AVSI Foundation, Strathmore University, St. kizito VTI, KPLC and EACREEE. The MGA also partners with women-led associations such as Aweef and EWiEn to increase women's participation in the renewables sector. The MGA provides courses developed by RES4Africa in collaboration with Strathmore University in Kenya. The training provides an overview of the mini-grids' value chain for rural electrification and practical training in labs. Economic, financial, managerial, and business development aspects, as well as technical topics and project management are covered. Topics include: Micro-grid pre-feasibility and feasibility studies, safety, environmental risks and hazards, Operation & Maintenance of mini-grids, business models for mini-grids and entrepreneurial skills.[14]

National accreditation of training organisations is necessary to increase the quality of training. Regional accreditation of training programs is useful to guarantee mutual recognition of participants across countries and harmonize curricula guaranteeing minimum standards of qualification. Peer-to-peer learning and knowledge exchange between equipment manufacturers, academia and practitioners would contribute to improving the quality of the training.

There is currently no widely recognized mini-grid industry training standard. Many vocational courses are locally certified, but there is no regional certification system for mini-grid training. Standardisation of curricula and accreditation of training programs can help ensuring that industry needs are met and also needs to be developed as a cooperative effort. Skill standards specifying contents and duration of the training, theoretical and practical parts of the training and the main outcomes of the training could help harmonizing training across technical and vocational education and training (TVET) institutions. Harmonization of curricula and training certification should also be pursued at the international level. Skill standards harmonized at the international level would also be beneficial for other sectors.

2.2 Energy efficient buildings

Buildings are a large energy consumer and still heavily rely on fossil fuels for their energy supply. Energy efficient buildings using renewable energy sources are needed to ensure affordability and sustainability of the built environment.[15]

The urban building stock in developing countries is expected to more than double by 2030, accompanied by a substantial rise in demand for energy services in buildings. An increase in the number of buildings is expected, together with a much greater use of appliances and air conditioning.

[14] EW SETA, SACREEE, SARETE, RES4Africa Foundation, Microgrid Academy, Enel foundation, 2021: 19th MICRO-GRID ACADEMY EDITION. Re-skilling Lab- Introduction to the Value Chain of the Renewable Energy Decentralized Systems. 20th – 24th of September 2021. Concept Note. https://static1.squarespace.com/static/609a53264723031eccc12e99/t/610170897ac16a22a230cc4d/1627484301554/MGA_Concept+Note+South+Africa+2021.07.28.pdf

[15] Lucon O., D. Ürge-Vorsatz, A. Zain Ahmed, H. Akbari, P. Bertoldi, L.F. Cabeza, N. Eyre, A. Gadgil, L.D.D. Harvey, Y. Jiang, E. Liphoto, S. Mirasgedis, S. Murakami, J. Parikh, C. Pyke, and M.V. Vilariño, 2014: Buildings. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

New buildings will have to meet rising demand for energy and housing while preventing the lock-in effect in unsustainable structures.

In addition, refurbishment of the existing building stock will also have to comply with more stringent energy efficiency and environmental standards. Due to the large number of trades involved in the refurbishment of buildings, complex demands are placed on the future skills of the specialists involved in this area and cross-craft skills, i.e. knowledge from other occupational fields, are becoming particularly important.

When demand for energy efficient buildings is created without planning for skills development, there will be a lag in the supply of skilled workers, which will cause a delay of implementation. It is therefore important to ensure that a skilled workforce is in place ahead of demand.[16] We need to ensure that the labor force possesses sufficient competencies relating to energy efficiency and the use of renewable energy technologies in buildings so that countries can advance the decarbonisation of buildings.

Achieving energy performance objectives in renovation and construction of new buildings requires building professionals to understand building's energy performance as a whole and to follow an integrated approach to building design, construction and operation as well as quality control.

The skills required encompass, among others:[17]

- Building management systems
- Energy efficiency: building envelope, heating, ventilation and air conditioning systems (HVAC), hot water systems, solar thermal systems, window systems, lighting systems, heat pumps etc.
- Sustainable architectural design
- Sustainable building materials
- Integrated design
- Micro climates
- Construction management
- Environmental quality
- Interdisciplinary skills: quality assurance, procurement, financial assessment

In many cases, however, a building-energy performance gap becomes apparent. That is, a disparity between the energy consumption predicted in the design stage of a building and the energy use in actual operations. This is the result of many factors, including the lack of integration between the different areas involved in building design, construction and operation and inadequate coordination between the different professionals. An integrated approach from design to construction helps securing a good building performance on the ground. For this purpose, cooperation between different sectors and professions is necessary.

In the future, nearly-zero energy buildings (nZEB) will play an increasing role. These are buildings that, over the year, consume a very low amount of energy covered to a very significant extent by renewable

[16] CITB, Building Skills for Net Zero. Report prepared by Eunomia for CITB. March 2021. https://www.citb.co.uk/media/kkpkwc42/building_skills_net_zero_full_report.pdf

[17] PROF/TRAC, 2018: D3.2 European Qualification Scheme and professional profile description about professions related to NZEB design, maintenance and refurbishment. Professional multi-disciplinary Training and Continuing Development in skills for NZEB principles.

energy sources. Building and operating nearly-zero energy buildings require innovative technologies and designs and an integrated approach facilitated by multidisciplinary work teams.

However, in practice, realizing nearly-zero energy buildings can be challenging. In Austria, for example, complex construction tasks are performed by semi-skilled workers. Although a number of certification and education schemes is available, there is a lack of skills in the workforce that makes the effective implementation of the nearly zero-energy building standard difficult.[18]

It is thus necessary to increase the supply of qualified workforce in the buildings sector, both by upskilling the current workforce through further education and training and by training of a new workforce. Effective training strategies should include at least the following elements:[19]

- Awareness-raising of the importance of skills and training and their market value in order to motivate companies and employees in the construction sector to improve their energy efficiency and renewable energy skills
- Adjust training courses to the needs of workers and make them flexible, for instance through micro-learning (small learning units)
- Involve target groups and other stakeholders from the beginning.
- Promote training courses to the target group and their companies
- Provide clear descriptions of competencies earned in the training
- Provide recognition of the skills obtained, if possible based on an international, comparable standard
- Create a register of companies that employ skilled workers
- Set a requirement for mandatory training courses
- Development of quality assurance systems for the training
- systematic skills upgrade in energy topics for teachers in the adult vocational training system

Example: Building Energy Savings Training Program (FEEBAT) in France

In 2007, EDF (Electricity of France), ADEME (Agency for Environment and Energy Management), the French Buildings Federation (FFB) and the CAPEB (Professional Federation of Craft Companies) together with several ministries, created FEEBAT “Energy saving training for construction craftsmen and enterprises”, a training program to train and upskill several kinds of professionals in the building sector to increase energy efficiency.

Public authorities, trade unions, and employers’ organizations were brought together to define the programs dedicated to vocational training. Financed by the EDF within the framework of the energy saving certificate scheme, the FEEBAT program has trained more than 175 000 active professionals. The program was initially dedicated to building contractors, but became accessible to apprentices, trainers, project designers, and construction supervisors later. The program offers each trainee an individualized and innovative skills development program, combining face-to-face and distance learning.

Training is to three different target groups:

[18] BUS League, 2021: D2.4 Qualification for the recognition of energy efficiency skills. https://busleague.eu/wp-content/uploads/2021/07/D2_4_full_version.pdf

[19] Trinomics and Visionary Analytics, 2018: Final report on the assessment of the BUILD UP Skills Pillar II. https://www.buildup.eu/sites/default/files/content/bus-d4.4finareport_on_assessment_april_2018_0.pdf

- building professionals, craftsmen, company managers or journeymen,
- architects, construction supervisors,
- teacher in the center of apprentice education, professor in the national school for architecture

The training for construction team leaders and craftsmen is divided into modules (electricity, heating, ventilation, carpentry, and building envelope). Modules on project management and energy audit are also offered.

Competences are evaluated through a multiple-choice test that, if approved, can bring a certificate or serve as one of the requirements for getting the formal recognition on the RGE label (Recognised Environmental Guarantor certification). In order to obtain the RGE label, professionals must satisfy a number of criteria to prove the quality of their work. Other criteria are evidence of technical resources, proof of insurance covering the professional's liability and checks on work carried out. Companies with quality labels are identifiable on a public website.[20]

2.3 Heat pumps

Heat pumps are an energy-efficient alternative for space heating and cooling. Heat pumps use electricity to transfer heat from a renewable source from a cool space to a warm space. Given that they harness heat from a renewable source, the heat output is greater than the electricity it consumes. Thus, heat pumps can substantially reduce the energy consumed for heating/cooling and/or domestic hot water and have the potential to become a key technology in the electrification of buildings.[21]

However, significant challenges have been identified for scaling up the use of heat pumps. One of the main obstacles is the lack of a qualified workforce (designers, planners and installers). Other barriers are low-consumer awareness, the complexity of the systems and high costs of installation. Training programs are required that increase skills along the heat pump value chain.

Heat pump installers, for example, must have, among others, the following competencies:[22]

1. Ability to provide advice to clients about the use of heat pumps and their economics
2. Specification and design of an efficient domestic heat pump installation
3. Capability to install a domestic heat pump in compliance with building regulations and other standards, including health and safety
4. Apply an integrated approach taking into account the interaction of the heat pump with the building envelope and other elements of the heating, ventilation and air conditioning system
5. Co-ordination of the domestic heat pump installation
6. Safe work practices concerning the installation of heat pump systems
7. Manage the commissioning of a domestic heat pump system
8. Maintain and repair domestic heat pump installations

Developing the installer base is essential to increase the deployment of energy efficient, renewable-based heat pumps. Qualified installers are fundamental to achieving renewable energy targets and

[20] European Commission, 2020: COMMISSION STAFF WORKING DOCUMENT. Preliminary analysis of the long-term renovation strategies of 13 Member States. Brussels, 25.3.2021. SWD(2021) 69 final
[21] Hitachi, 2021: Heat Pumps Explained - The Electrification of Heating. https://newsroom.hitachiaircon.com/ja/news/heat-pumps-explained-the-electrification-of-heating
[22] BUS League, 2021: D2.4 Qualification for the recognition of energy efficiency skills. https://busleague.eu/wp-content/uploads/2021/07/D2_4_full_version.pdf

reducing dependence on fossil heat. They are also an important contact with the homeowners and can promote heat pump technology while making sure that installations are efficient, cost-effective and safe.

In order to scale up the penetration of heat pumps with the required quality, training programs have to become more accessible, less costly and deliver up-to-date knowledge. The existing workforce, and in particular, installers and engineers dealing with natural gas heating systems can be upskilled to design and install renewable heating systems using heat pumps.[23]

Training has to include background information about the market, heat pump regulations and guidance, principles of heat pump operation and heat distribution, installation materials and methods, testing, commissioning, Heat pump servicing and fault finding.[24]

Training programs embedded in a wider policy framework can help to create an incentive for training and certification of installers. For example, if it is required that installations are made by certified professionals in order to access investment grants or other subsidies, this can act as an incentive to create a market for qualified installers. In addition, policies supporting the replacement of fossil fuel heating systems by renewable heat help create a market for heat pumps.

Attracting participants to training requires a considerable amount of time and marketing effort. The support of professional bodies and networks, if available, is necessary to reach the right target group. Training courses also have to be well-advertised and easy to access.

A sufficient number of well-trained educators is also essential to ensuring the quality of training for heat pump installers. 'Train the trainer' courses should also make sure that training is standardized across the industry.

Example: Training and certification of heat pump installers in Austria

The Austrian Institute of Technology (AIT) offers a basic training on heat pumps for trained heating installers who install and maintain heat pumps. The training provides theoretical and practical knowledge in the field of refrigeration and heat pump technology. Heating installers who are not only involved the installation and maintenance of heat pumps but also in the design and/or planning of heat pump heating systems and/or who provide customer advisory services can attend a more advanced education course on planning, installation and maintenance of heat pumps.

By participating in this comprehensive further training and passing the final course examination, heating installers meet the requirements for obtaining a so-called personal certificate in accordance with EU Regulations. After passing the examination, the installers can apply for a certificate of the Federal Guild for Sanitary, Heating and Ventilation Technicians. Certified heat pump installers are registered in an official list of certified professionals. The certification helps customers gain confidence in the quality of service and recognize competent professionals that design and build technically sound and well-functioning facilities. Certified installers can also become a so-called competence partner of

[23] Heat Pump Association, 2020: Building the installer base for net zero heating. June, 2020. https://www.heatpumps.org.uk/wp-content/uploads/2020/06/Building-the-Installer-Base-for-Net-Zero-Heating_02.06.pdf

[24] Logic4training, 2021: Heat Pump Training Courses. https://www.logic4training.co.uk/course/heat-pump-course/

klimaaktiv, the climate protection initiative of the Austrian Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK). As competence partners of klimaaktiv, the installers have access to a variety of training courses and profit from the recognition of the klimaaktiv brand at the national level in Austria.[25]

The certificates are valid for three calendar years. For a regular renewal of the certification, the certified persons have to prove continuous further education. In addition, quality controls are carried out on specific heat pump systems planned and constructed by certified heat pump installers and planners. Certification is personal, but also suggests the quality awareness of the employer. It makes a difference whether a company has certified employees or not.[26]

2.4 E-mobility

Sustainable mobility is required for both developed and developing countries alike. E-mobility is a powerful tool to shift towards more efficient and less polluting transportation modes.[27] E-mobility is also being combined with other key technological trends. In the long term, this combination of Autonomous driving, Connectivity through the Internet-of-Things (IoT), Electrification and Shared mobility (ACES) can accelerate the uptake of clean mobility solutions and lead to the creation of new business models.[28],[29] ACES will also require new sets of skills in various disciplines.

Maximizing the benefits of electric mobility requires collaboration and coherent policymaking across sectors. It also requires a qualified workforce. Without the capacity and skills to build and deploy electric mobility technologies and infrastructure, no significant progress can be achieved. E-mobility requires an interdisciplinary approach integrating a number of disciplines, some traditional and others that have not been involved so far in the transport sector. Substantial skilling efforts are needed with support from policymakers. Governments and companies will have to implement programs for education, training, upskilling and reskilling of the labor force to capitalize on new opportunities.

With the advance of electromobility, job profiles in the mobility industry will undergo substantial changes and a continuous evolution of skills of the workforce will have to take place. For instance, the skill sets of traditional automakers and suppliers will need to shift substantially, towards a new combination of traditional engineering skills, digital and soft skills. They will need to close up the resulting skills gap by reskilling, continuous education, and hiring new talent from non-traditional areas.[30]

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[25] Austrian Institute of Technology, 2021: PLANUNG, ERRICHTUNG UND WARTUNG VON WÄRMEPUMPEN. https://www.ait.ac.at/themen/training-education/weiterbildung-im-bereich-waermepumpen/certified-heat-pump-installer-n

[26] Austrian Institute of Technology, 2021: WÄRMEPUMPEN-FACHLEUTE. https://www.waermepumpen-fachleute.at/

[27] World Bank, 2021: Sustainable Electric Mobility: Building Blocks and Policy Recommendations. https://www.sum4all.org/data/files/buildingblocksandpolicyrecommendations_english.pdf

[28] McKinsey&Company, 2019: The future of mobility is at our doorstep. December 19, 2019. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-future-of-mobility-is-at-our-doorstep#

[29] Sanvicente, E., Kielmanowicz, D., Rodenbach, J., Chicco, A., Ramos, E., 2018: Key technology and social innovation drivers for car-sharing. H2020 STARS Project. http://stars-h2020.eu/wp-content/uploads/2019/06/STARS-D2.2.pdf

[30] McKinsey&Company, 2021: The irresistible momentum behind clean, electric, connected mobility: Four key trends. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-irresistible-momentum-behind-clean-electric-connected-mobility-four-key-trends

New skills include those in battery manufacturing, materials science and electric motors. But, they also include those in artificial intelligence, for instance to help detect objects around vehicles, and in human-machine interfaces, a growing area of focus to provide, among others, mobility assistance, vehicle control and infotainment.[31] The rising importance of in-vehicle software and connected and autonomous cars increase the need for digital talent. Qualified engineers and technicians with skills that bridge the traditional and digital domains are required. Developing new e-mobility solutions will also require interdisciplinary and transdisciplinary approaches. For instance, engineering and psychology approaches will have to be combined to design good and safe human-machine interfaces.

New skills in software and data analytics will also be needed for online sales and marketing channels. Social and emotional skills, especially communication and negotiation, leadership, management, and adaptability will also be necessary. A combination of these technical and soft skills will be necessary to make innovative business models successful.

The DRIVEN BY KIDS workshops at Volkswagen group

The DRIVEN BY KIDS workshops give children the opportunity to get to know about e-mobility as a technology of the future in a playful and creative way. Media educators work with the children at the VW Group's facilities. Among others, the topics of electric car charging and range are discussed. The workshops allow media educators to assess how the children react to electromobility and collect information about the type of questions that children pose. This helps them to evaluate the best ways to stimulate their interest and teach them the basics of e-mobility.[32]

The substantial changes brought about by the replacement of the internal combustion engine by electric motors and battery technology will force automotive companies and suppliers to change production and assembly lines. Electric motors, for example, have fewer parts overall than an internal combustion engine (ICE). An e-motor typically has only about 20 moving parts vs. 200 or more in an ICE. The manufacturing of electric drivetrains is also more suitable to automated assembly and the use of robots.[33] This will reduce the number of workers and change the profiles of the workers in assembly lines. Companies will have to conduct strategic workforce planning to identify requirements for up- and reskilling. It will be also essential to foster a lifelong learning culture.[34]

The transition will also encompass adjacent industries such as the deployment of infrastructure for charging stations and renewable electricity generation, which are expected to be a core provider of jobs. E-mobility brings together the sectors of energy production, transport infrastructure and vehicle technology, which so far were not connected to each other.[35]

[31] Fowlers, 2017: EVs and autonomy drive new skills requirements in the automotive industry. https://www.theengineer.co.uk/skill-requirements-in-the-automotive-industry/

[32] Cleantechnica, 2020: E-Mobility Through The Eyes Of A Child.https://cleantechnica.com/2019/12/09/e-mobility-through-the-eyes-of-a-child/

[33] Thibodeau, I., 2020: Shift to electric vehicles will radically change auto factories. https://eu.detroitnews.com/story/business/autos/2019/09/05/shift-electric-vehicles-radically-change-auto-factories/2208961001/

[34] Boston Consulting Group, 2021: Is E-mobility a Green Boost for European Automotive Jobs?. https://www.bcg.com/is-e-mobility-a-green-boost-for-european-automotive-jobs

[35] UNIDO, 2020: Best-practices in electromobility. https://www.unido.org/sites/default/files/files/2020-08/UNIDO_Electric_Mobility_Paper.pdf

The Austrian e-Mobility Check training program

In the e-Mobility Check project, a training program for electricians, electrical planners and other stakeholders has been developed to support them with planning and installing charging infrastructure in existing buildings. The training courses are developed in coordination between the industry and training institutions. The training addresses technical, legal and economic issues of the process of planning, testing and installing charging infrastructure in residential buildings. After the two-day training program, a personal certification can be obtained.[36] In addition, decision-making guidelines for owner associations, property managers and property developers for the construction of e-mobility charging infrastructure in existing residential buildings have been developed

In all parts of the value chain, there is a need for training and the establishment of a skills base. This requires cooperation between vocational schools, universities and businesses and setting up an exchange of knowledge and experience. Specifically, closer ties between vocational schools and universities are necessary, including joint training of engineers and technicians, so that they can learn to cooperate with each other.[37] Vocational training may include areas such as electric vehicle (EV) technology, basic electrical engineering, EV batteries, battery management systems, smart grids and renewable energy and safety for EV charging systems. Engineering curricula must be adapted to cover subjects such as battery design, charging station development, battery management systems, drivetrain and propulsion system, vehicle-to-grid integration, electric motor, energy storage and management.[38]

3. Concluding remarks

The sustainable energy transition will change the way we design, develop, produce, market and distribute energy technologies. It will lead to the replacement of fossil fuel energy technologies and the transformation of a number of economic sectors. During the transition, new jobs will be created, certain jobs may be eliminated and a number of jobs will be transformed. A successful energy transition will need to be underpinned by a workforce equipped with renewable energy, energy efficiency and sustainability skills and knowledge.[39] A transformation of the education and training systems is necessary to align them with the priorities at national and international levels and deliver the new skills that are needed.

One of the most pressing challenges for emerging economies is a shortage of jobs among the youth. Enhanced skills development and decent work opportunities for youth can be created in the sustainable energy and clean mobility sectors. Training on new energy technologies and the creation of local value chains will contribute to delivering decent jobs for youth and social justice while contributing to achieving renewable energy and energy efficiency targets.

[36] Austriatech, 2020: The e-Mobility Check training program. https://www.austriatech.at/en/e-mobility-check-stellt-schulungsprogramm-vor/

[37] BGZ, 2021: Learning e-Mobility Plus. https://www.bgz-berlin.de/en/projects-and-products/project-overview/learning-e-mobility-plus-learning-together-in-the-future-oriented-technology-field-of-electromobility/

[38] Mandal, S., 2020: Can India's Current Engineering, Tech Courses Cope With EV Skills Demand?. Inc42. India.

[39] Childs, E., 2021: Paving the way for a green society: Upskilling the workforce. Institution of Environmental Sciences. https://www.the-ies.org/analysis/paving-way-green-society

The skill-building needs (i.e. training and education) for emerging green jobs related to the energy transition are significant. New technologies and business models are leading to a shifting of the skill sets and companies will need to reskill and upskill their workforce. It is therefore critical to engage young people in reskilling and upskilling activities to let them develop and acquire the skills that the new, sustainable energy system requires.

Technical skills remain central but non-technical skills are becoming more and more important. Developing and deploying new renewable energy and energy efficiency solutions will also require interdisciplinary and transdisciplinary approaches. In addition, workers need to be aware of the wider context regarding business societal developments and sustainability. The changing energy landscape will require lifelong learning and a combination of different disciplines.

Strong skills partnerships between governments, companies, educational institutions and labor associations are necessary to develop and implement training strategies that deliver the skills required by the renewable energy and energy efficiency sectors.

In practice, there is a lack of skills in the workforce that makes the effective deployment of renewable energy and energy efficiency technologies difficult. Newly installed systems often do not have the required quality and there is not enough personnel to scale up penetration of clean energy technologies at a fast enough pace. Training programs need to be improved and extended to improve the quality of renewable energy installations and accelerate their deployment. This requires working closely with business and educational institutions to understand their needs and fostering private-public partnerships. Peer-to-peer learning and knowledge exchange between equipment manufacturers, academia and practitioners would contribute to improving the quality of the training.

Training programs should be embedded in a wider policy framework to create an incentive for training and certification of professionals. For example, if it is required that installations are made by certified professionals in order to access investment grants or other subsidies, this can act as an incentive to create a market for qualified installers. In addition, policies supporting the replacement of fossil fuel systems by renewable energy systems help create a market for a qualified workforce.

Skill standards specifying contents and duration of the training, theoretical and practical parts of the training and the main outcomes of the training could help harmonizing training across technical and vocational education and training (TVET) institutions. Harmonization of curricula and training certification should also be pursued at the international level. Regional accreditation of training programs is useful to guarantee mutual recognition of participants across countries and harmonize curricula guaranteeing minimum standards of qualification.

*The **Global Forum on Sustainable Energy (GFSE)** is a neutral multi-stakeholder platform, which is facilitating international dialogue on energy for sustainable development by taking into account the special interests and challenges of developing countries. GFSE aims at the establishment of a sustainable world energy system from a social, economic and environmental perspective.*

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E-Mail: gfse@energyagency.at

Internet: http://www.gfse.at