Advancing VET Institutions' Capacities for Building Electrical Engineering Skills and Sustainable Future "ADVENTURE"

Comparative General Report - Summary

SES Foundation

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1. Introduction

Nowadays, the relevance of Vocational Education and Training (VET) in electrical engineering and other technical areas is indisputable due to the rapid evolution of technology and the increasing demand for specialised skills in the global labour market. The ADVENTURE (Advancing VET Institutions' Capacities for Building Electrical Engineering Skills and Sustainable Future) arises as a strategic response to these needs, focused on improving the capacity of VET and technical education institutions to deliver quality education relevantly aligned with contemporary industry and sustainability challenges.

The overall objective of the ADVENTURE project is therefore to:

To improve the capacity of VET institutions to provide up-to-date and relevant education in electrical engineering, with a focus on the skills demanded by the labour market and environmental sustainability.

Addressing these issues is developed through a collaborative and transnational approach, incorporating partners from different sectors and regions, including Argentina, Ecuador, El Salvador, Belgium, France, Italy, and Poland.

The transnational dimension of the project not only broadens the scope and depth of shared educational practices, but also fosters a collaborative network between VET institutions in Latin America and Europe. This network facilitates the exchange of knowledge and resources and promotes continuous improvement in teaching and learning standards across geographical and cultural borders.

However, the main objective of this report is to document the development and findings of the three investigations in El Salvador, Argentina and Ecuador during 2024 on the existing gaps between the skills, capacities and competences demanded by the labour market in the energy sector (with a major focus on the electricity sector) and the training provided by VET institutions and to encourage the use of sustainable practices in teaching and learning.

Project Context

The project aims to have a significant impact in the region, not only in terms of improving the employability of graduates, but also in promoting sustainable practices in the electricity industry, which makes it a key initiative for the socio-economic development of the participating countries.

This is a first phase of diagnosis and needs analysis in which valuable information is collected through surveys, interviews and focus groups to identify gaps and needs in current training. At this stage, stakeholder participation is key to understanding the labour market demands and challenges in the sector.

- Therefore, in this first stage of diagnosis, the research sets as its general objective:

Identify and describe the gaps between the educational offer of Vocational Training institutions and the demands of the energy sector in El Salvador, Argentina, and Ecuador in 2024.

2.2. Methodological strategy

To understand the capacity of VET institutions in Ecuador, El Salvador, and Argentina to provide up-to-date and relevant education in the energy/electricity sector, a mixed approach is used, combining qualitative and quantitative research techniques to obtain primary and secondary sources of analysis. A desk review of the regulatory and policy framework regulating technical and technological education, as well as labour market trends in the energy sector, is also carried out.

For the initial or diagnostic phase information gathering, structured surveys addressed to students, teachers and employers in the electricity sector, semi-structured interviews with key industry representatives, and the organisation of focus groups to discuss and validate training needs and intervention proposals were included.

The stakeholders selected for the data collection included a representative sample of students, graduates, and teachers from TVET institutions, as well as employers and experts from the electricity industry. The selection was based on criteria of relevance in terms of their participation in technical education or in the labour market, ensuring diversity in terms of levels of experience and areas of specialisation. They can be grouped into four broad groups:

1. *educational and vocational training institutions:* teachers, researchers, and administrators in an academic, university or vocational training institution;

2. *employer sector:* practising professionals (self-employed), company representatives/employers;

3. *public sector and regulatory bodies:* public sector and regulatory bodies: member of a governmental organisation/civil servant, staff, or technicians of regulatory bodies in the sector;

4. *professionals in training or recent graduates:* students, direct beneficiaries of the professional training and new practices implemented; graduates: recently incorporated into the labour market or in the process of incorporation.

Regarding the tools used: a structured survey was conducted and distributed in online format on a representative sample of the various stakeholders, as well as in-depth interviews and focus groups. These tools were used to collect qualitative and quantitative data on the perceptions and experiences of key stakeholders on the quality of training and employability in the sector, as well as to identify trends, gaps, and projections in the training of electrical engineering professionals.

In total, seventy-four surveys were completed with different stakeholder groups, six focus groups with a scope of twenty-eight people and sixteen individual semi-structured in-depth interviews were conducted to obtain qualitative and detailed information.

On the other hand, at the level of secondary sources, curricula, study plans and current teaching guides in the region were reviewed, as well as regulatory frameworks that account for the context of electricity consumption in LAC (Latin America and the Caribbean) and academic documentation was reviewed that gave an account of the labour situation in the industry.

3. Regional Context: Electricity Sector Labour Market in Latin America

From the ILO Report *'Employment in a Net Zero Emissions Future in Latin America and the Caribbean'* it is suggested that carbon-free prosperity can be achieved through immediate and parallel actions around five pillars (IDB and DDPLAC, 2019):

i) phase out fossil fuel-based electricity generation and replace it with carbon-free sources, such as wind and solar power;

ii) use electricity instead of fossil fuels for transport, food preparation and heating;

iii) increase public and non-motorised transport;

iv) halting deforestation and planting trees, which will require a change in diets, replacing animal foods with plant foods; and

v) reduce waste in all sectors, recycle materials and start using sustainable building materials, such as wood or bamboo.

The road to a net zero carbon world is full of obstacles. One of the challenges is to ensure a just transition, i.e. to make sure that the change is as equitable as possible and based on a participatory approach (ILO, 2018). Despite more than a decade of steady progress, the region continues to struggle with ethnic and gender inequalities, labour skills gaps, insufficient social protection, and a large informal sector (Alaimo et al., 2015).

Jointly promoting social and environmental goals means ensuring that both workers and companies have the labour skills needed for a zero net emissions future, and enjoy decent working conditions: fair income, workplace safety, workers' rights, social protection, and

social dialogue. A just transition also means supporting workers, businesses and communities that will be negatively affected by the downsizing of the most polluting industries, such as fossil fuel extraction or livestock grazing. Education and public information are essential to achieving a zero net emissions economy.

For these reasons, it is extremely important to characterise and analyse the energy sector in Latin America to determine what skills and capacities are demanded in terms of training supply and what knowledge and competences are requested by the labour market.

The energy sector covers all industries involved in the production and sale of energy, including the extraction, manufacture, refining and distribution of fuels. People consume large amounts of fuel, and the energy industry is a crucial part of the infrastructure and maintenance of society in every country in the world. Thus, the energy industry comprises the liquid fossil fuel industries, the coal industries, the natural gas industries, the electric power industry (generation, transmission, distribution, and marketing of electric power). Within this, there are industries not mentioned above, such as clean renewable energies (hydroelectric, wind and solar, and the manufacture, distribution, and sale of alternative fuels). The nuclear energy industry.

The traditional energy industry is based on the collection and distribution of fuelwood (biomass), the use of which for cooking and heating is particularly relevant and common in lower income countries.

There is a clear dependence on energy sources globally and in the region. This trend has been marked during the 20th century, particularly for those energy sources that emit carbon dioxide (CO2), such as fossil fuels and traditional energy. Today, fossil fuels continue to be the world's main source of energy and are a major contributor to global warming and air pollution.

The global and local context, as well as the growing demand for energy, poses challenges for the energy sector in general and the electricity sector in particular and the sustainable economic development of society, which requires a skilled workforce to lead the countries'

energy transition and to be able to face both the technical and environmental challenges of the countries.

Given the heterogeneity of the three countries covered in this report and given the different availability of public data available, the treatment and depth of the analysis varies from country to country.

At the regional level, it is observed that oil continues to lead the consideration when looking at the total primary energy supply of the countries in the region, accounting for more than 40% of the total. It is followed by renewable energy and natural gas with 27% and 26%, respectively. (Source: International Renewable Energy Agency (IRENA), year 2018).

Ecuador is highly dependent on oil, which accounts for 77% of its total primary energy supply. This is followed by renewable energies with 19% and natural gas with 4% of the supply.

Argentina is one of the countries in the region whose primary energy supply comes mainly from natural gas. Of its total primary energy supply, 54% comes from natural gas, 33% from oil and 10% from renewable sources. Of the renewables, 52% is bioenergy, 41% is hydropower, 5% wind and 1% solar.

In 2020, imported fossil fuels accounted for the largest share of El Salvador's total energy supply. It was followed by smaller contributions from biofuels, hydropower, geothermal and solar.

In terms of the electricity sector, Latin America and the Caribbean is characterised as one of the regions with clean electricity systems, with low carbon dioxide (CO_2) emissions, since 61% is generated from renewable energies, with hydropower being the most frequent, with a share of 45% of the total generation. Likewise, 8% comes from wind, 4% from solar panels, 4% from bioenergy, 2% from nuclear energy and 36% from fossil fuels - gas, oil, and coal (IEA, 2023).

This scenario highlights the need to diversify the country's electricity sources to reduce dependence on water sources in the context of climate change, as well as to reduce dependence on energy imports and the burning of fuels as emergency measures in the face of a lack of water resources.

The electrification of specific sectors of the economy (transport, household appliances, etc.) is one such trend that can be key to achieving the decarbonisation targets required to meet the climate objectives of the SDGs (Sustainable Development Goals). For several years now, some activities have been shifting the use of polluting energy sources towards electric power (e.g. electric cooking and heating). Electrification in transport, via private vehicles or public transport vehicles, is less widespread, but offers great opportunities to optimise the use of the grid (especially if the possibility of distributed storage is included) and to accelerate environmental benefits.

The trend towards digitalisation in the electricity sector is transforming the operation of systems through automation and communication between the different segments of the production chain (generation, transmission, distribution, and marketing). For example, modern technologies are already being used for sector scheduling and execution and for fault identification and resolution, among other technical uses. However, the most important impact of digitalisation is not in the improvements it brings to the current functioning of the sector, but in the changes brought about in its industrial organisation, specifically in the configuration of electricity markets and the way in which transactions are carried out.

Because of all transformations and innovations, it is essential to discuss what the electricity market is demanding and, in turn, what teaching practices are being put forward by VET and TVET institutions, particularly those offering programmes focused on electrical engineering, to accompany the changes in the sector.

Considering the reports of the three countries, it is possible to characterise the electricity market in each one in the following manner:

1. El Salvador

- The country has diversified its energy matrix to include hydroelectric, solar, biomass, geothermal, and natural gas, with an installed capacity of 2,600 MW.
- This diversification allows it to export and import energy in the Central American region.
- There is a low proportion of workers in the sector, mostly men in technical and operational areas, which requires adequate training to handle new technologies and growing demands in the sector.

2. Ecuador

- Although only 0.2% of the employed population works in electricity and energy, the country relies heavily on renewable sources, with 69.1% of its generation capacity coming from hydropower.
- Growth in energy demand and decreasing rainfall due to climate change has led to an increase in energy imports, highlighting the need to diversify generation sources.
- Technical training in renewable energy and other alternative technologies becomes crucial to meet these challenges.

3. Argentina

- It is a global energy power, standing out in the production of gas, oil, and electricity, with significant growth in renewable energy generation.
- The sector employs more than 100,000 workers, and the renewable energy boom will further boost job creation.
- However, professionals face barriers such as a lack of prior work experience and cross-cutting skills, as well as a need to deepen the link between academic training and practice.

In summary, in all cases, the energy industries are undergoing major transformations, requiring an update of technical and transversal competences. Training should focus on the use of renewable technologies and more sustainable practices, while at the same time improving the educational offer and creating opportunities for internships and apprenticeships to facilitate students' labour market insertion.

Based on the research conducted in the diagnostic phase, which is covered in this report, the aim was to survey the perception of the different stakeholders regarding the challenges for labour market insertion in the electricity sector.

The most frequently selected variable was lack of previous work experience. Out of the seventy-four respondents in the first stage, 17.42% of the respondents highlighted this variable.

The 'lack of transversal skills' and the 'outdatedness of acquired technical knowledge' appear as the next most important difficulties in terms of labour market insertion.

Another significant barrier is the 'limited availability of internship opportunities during training. This obstacle is mentioned by all actors, especially by students, teachers and researchers, and self-employed professionals, who see the lack of practical experience during academic training as an important challenge. 11.7% think this is an issue.

Insufficient professional networking' is also a notable difficulty for 8.71%. This problem is particularly pointed out by teachers, self-employed professionals, and employees, underlining the importance of networking for job search.

In summary, job placement in the electric power sector faces several challenges, including lack of prior experience, little practical connection during training, and the need for both technical and transversal skills. Addressing these problems could facilitate a smoother transition of professionals into the labour market.

4. Technical and Vocational Education in LAC: Characterisation, Supply and Challenges in the Energy Sector

The Technical Vocational Education (TVE) sector can be defined as the set of educational modalities that combine theoretical and practical learning relevant to a specific occupation or occupational field, distinguishing between initial and continuing TVE. The former includes formal programmes at secondary and higher levels, designed to be provided to young people at the beginning of their professional careers and prior to entering the labour market. Continuing education, on the other hand, comprises all other programmes, including in-company training for employees and training specifically targeted at the unemployed[1].

The author María Paola Sevilla B for ECLAC emphasises that in the countries of Latin America and the Caribbean, TVE, despite its growing strategic importance and the recognition of the structural problems it faces in the region, has been scarcely studied and put into comparative perspective. The generation of studies at the regional level has been limited by the absence of national diagnoses and the scarce production and publication of information on TVET in the countries.

Hence the importance of the three documents from Argentina, El Salvador, and Ecuador, which study the links between vocational training institutions and the electricity employer sector.

In relation to training in the field of electrical engineering, respondents were asked about the role of educational and academic institutions. According to the results, 25.31% considered that their key role is to provide high quality technical and vocational education. Some 13.47% highlighted the importance of fostering collaboration between educational institutions and the industry/employer sector; 12.65% mentioned promoting the use of emerging and advanced technologies in education; and 11.02% stressed the need to support research and innovation in the sector.

[1] Taken from the document *"Panorama de la educación técnica profesional en América Latina y el Caribe"* by María Paola Sevilla B for ECLAC # and the Norwegian Ministry of Foreign Affairs

In addition, 8.57% indicated that it is essential to update curricula and teaching resources according to the demands of the labour market, while 7.35% emphasised the importance of providing guidance and support to students in their transition to the labour market. On the other hand, 6.94% highlighted the need to develop continuous training programmes for teachers, 5.31% advocated facilitating the development of soft (transversal) skills in students and 4.49% suggested integrating environmental sustainability in all areas of learning.

In turn, in relation to the academic offer and the needs of the energy sector, the survey included new areas of performance that are appearing in the market for the profession.

In all three countries, the highest percentage of respondents answered various updates. In Argentina 65.21% replied this; while in Ecuador 81.81% and in El Salvador 79.31%.

Other variables of considerable interest that emerged are related to the emergence of the revolution known as Electricity 4.0. In this context, the management of data collected at different points in a system is carried out and analysed using artificial intelligence. This situation represents an opportunity to acquire knowledge about energy management systems or to specialise in other areas, as the data analysis will be interpreted by artificial intelligence.

The link to sustainability and the management of transversal skills were also considered as new areas of performance in the electricity market.

The above-mentioned ECLAC article anticipates that, unlike academic education, the provision of which is well structured and homogeneous across countries, the organisational and management patterns of TVE are widely diverse. It is not possible to speak of a single model of TVET provision and the LAC region is no exception. Nevertheless, it has been identified that, despite its high regional heterogeneity, TVET has certain logics and characteristics that are transversal between countries, among them that of accommodating a population with a lower socio-economic level and that has traditionally been excluded from the formal education system or has been unable to reach advanced levels in it. Notwithstanding this, its extension

at the tertiary level is still limited in most countries, so it is seen as a space to be developed to advance in the expansion and democratisation of higher education.

Regarding these issues, the country reports characterised the educational context in technical and vocational training as follows.

Ecuador:

- The Technical and Vocational Education and Training (TVET) System is comprehensive, encompassing formal, non-formal and informal training.
- It includes technical secondary education and productive technical high school, as well as technical and technological programmes at tertiary and postgraduate levels.
- Non-formal training offers courses and certifications of labour skills.
- Leading institutions such as the Salesian Polytechnic University (UPS) and the Polytechnic Superior School of Litoral (ESPOL) stand out in electrical engineering for their practical approach and collaborations with the productive sector.

El Salvador

- The education system is organised in formal and non-formal education, with vocational technical programmes from middle and higher education.
- Energy areas are growing, with an increasing demand for professionals trained in renewable energy.
- The country faces challenges in educational innovation and the connection between academia and the energy industry, which demands greater alignment with market needs.

Argentina

- The TVE Law regulates technical education at the middle and higher non-university level, with a focus on professionalising practices.

- There are more than 1,600 TVET institutions, offering specialisations in electricity and electromechanics, preparing students for work in the electricity sector.

- Vocational training includes initial and continuing training, with specific pathways in electricity.

In the region, technical and vocational education (TVET) has emerged in a fragmented manner, both temporally and institutionally. This fragmentation has not favoured the development of a coherent system of training for work, nor the creation of training pathways that effectively connect secondary and higher education levels, nor between these and vocational training provided outside the formal education system.

5.4. Results

6. Gaps between Vocational Education and Training and the Labour Market: Perceptions, Challenges at Regional Level

Today, there is consensus on the need to invest in young people's skills to boost economic growth and build a solid foundation for future progress. In particular, globalisation and technological transformations are rapidly changing the skills demanded, so that vocational education and training policies increasingly need to anticipate and adapt to new demands.

This is why there is a renewed and widespread global interest in technical and vocational education and training (TVET[2]), recognising its potential to respond to the challenges of equity, productivity, and sustainability of nations. Various international agencies are deploying efforts and resources to assist countries in strengthening their vocational training systems to make them more relevant to the demands of the productive sector and society at large.

Reading the research from Ecuador, El Salvador and Argentina allows us to distinguish that vocational training in the electricity sector in Latin America is characterised by its diversity

[2] It is important to clarify, once again, that depending on the country, education and vocational training related to electrical engineering or electricity covers various levels of training.

and the need to adapt to a constantly changing context. Addressing existing challenges and taking advantage of opportunities for improvement will be crucial to ensure quality education that responds to the demands of the labour market and contributes to the sustainable development of the region.

From the perspective of the different stakeholders in relation to how they perceive electrical engineering training, 59.46% highlighted that the training was adequate, only 24.32% rated it as outstanding and 16.22% considered it unsatisfactory.

However, if this question is broken down by key actors, we obtain that for 74.3% of the graduates the training in the profession is adequate; for 18.9% outstanding; for 4.1% unsatisfactory and for 2.7% (do not know what the system means).

On the other hand, 63.5% of the educators perceive the training in electrical engineering as adequate, and 28.4% consider it excellent. Only 5.4% considered it unsatisfactory and 2.7% (I do not know what system means).

Finally, 58.1% of the employers/self-employed answered that they consider the training in the profession adequate, 24.3% as outstanding and 14.9% as unsatisfactory.

According to these results, the most unfavourable perception of training comes from employers.

It is therefore essential to invest in improving existing initiatives and addressing the bottlenecks that limit their impact.

A bottleneck that cuts across all levels of training is the poor articulation between the productive sector and the training and education sector. Articulation is necessary to promote education that is coherent with the needs of the labour market.

In reference to this, 63.5% of the total number of respondents in the diagnostic stage answered that they perceive a 'partial linkage' between academic and vocational training institutions and the employer sector.

Only 21.6% of the respondents report that there is a 'seamless linkage' between education and work.

7. Gaps between vocational education and training and the labour market. Challenges and prospects

One of the most pressing challenges facing education systems in the 21st century is how to prepare students for successful integration into the labour market, especially in a context where the simultaneous forces of globalisation and technology are rapidly redefining the skills and knowledge that students must acquire.

The transition from education to employment is fraught with challenges, mainly related to lack of practical experience, disconnection between academic training and market demands, and lack of transversal skills. In addition, factors such as insufficient preparation for selection processes, lack of professional networks, and low demand in certain sectors further complicate this transition. Educational institutions and policy makers should consider these areas to improve the employability of new professionals, possibly through more robust internship programmes, mentoring, and better alignment between training and market needs.

The current situation in Latin America shows the existence of important gaps in knowledge and skills acquired in the different vocational training institutions and the labour market.

On the other hand, considering the perspective of the actors is precisely one of the most valuable aspects of this project, as it allows for a more precise definition of their needs and demands regarding labour market insertion.

As common point, the actors pointed out the following demands:

Needs for curricular updating and methodologies of vocational training and trainers:

1. Updating of Contents

- In Ecuador, students highlight the lack of focus on industrial and commercial areas, suggesting including electrical engineering, industrial automation, programmable control systems (PLC) and maintenance of electric motors.

- In Argentina, experts insist on the need to update electrical engineering curricula, incorporating digitalisation, IoT and renewable energies, reflecting current market demands.

2. Practical training

- Students in Ecuador perceive that practical training is insufficient due to the lack of modern equipment and limited practical experience in real conditions, affecting their work readiness.

- There is a need to improve the relationship between theory and practice, as class times do not allow for a solid understanding before applying knowledge.

3. Energy Transition and Automation

- Training should focus on the ability to work with renewable energy and automation, key competences to face the transition towards more sustainable and smarter electricity systems.

4. Digitalisation and New Technologies

- The integration of digital technologies, such as artificial intelligence, simulators, and data analysis tools (Python, Power BI), is essential to prepare students in the face of the evolution of the electricity industry.

5. Innovative Pedagogical Methods

- Project Based Learning (PBL) and interactive methods are key to develop technical, analytical, and managerial competences, connecting theory with real problem solving.

- The use of specialised software and collaborative platforms is encouraged to facilitate hands-on learning and teamwork.

6. Development of Transversal Skills

- Graduates lack socio-emotional skills such as communication and leadership, necessary to work in teams and manage projects.

7. Preparation for the Labour World and Self-Employment

- A lack of preparation is identified in skills for interviews and selection processes, as well as in competences for self-employment, crucial in contexts of high labour informality.

In short, there is a need for a comprehensive updating that combines advanced technologies, real practices, and soft skills to better prepare graduates for the labour market.

In line with what was mentioned in the previous paragraphs, graduates, employers, and self-employed workers were consulted on the existence of a significant gap between the competences acquired during the training process and the skills required in the labour market.

47.4% of graduates, 50% of employers and 33.3% of the self-employed agreed that this gap exists.

The survey went deeper into the graduates' answers, asking those who had pointed out the existence of gaps between the skills developed during training and the needs that arise in the workplace to expand their comments.

Among the graduates who recognise the existence of a gap, 57.2% relate it to curricular aspects, highlighting the need to update academic content. On the other hand, 42.8% indicated that the gap is linked to the development of transversal skills, such as effective

communication skills, project management, budgeting, interpersonal skills, leadership and empathy.

Stakeholders were also asked about what kind of additional or specific training students should receive before entering the labour market.

Students (15.38%), graduates (18.09%), practising professionals (15.79%) and academics (14.96%) all agreed that students should have internships in companies in the sector.

Another relevant aspect to consider is the role of women in the energy sector. Although this role has evolved positively in the last decades, showing the important progress achieved, there are still barriers that prevent gender equity in the sector from being achieved.

Related to this issue, the report from Ecuador highlights the need to promote greater inclusion of women in the electricity sector. Existing barriers for women in the field need to be addressed to tap the full potential of the available talent. A more inclusive work environment will not only promote diversity but will also contribute to greater innovation and development in the sector.

Women study specialisations that are lower paid in the labour market, while the labour market pays less to women who specialise in higher paid areas (ECLAC, 2016b).

In sum, there are a variety of initiatives in the countries of the region to improve the relevance of technical education and vocational training and to ensure that they respond to the economic needs of the country. However, several bottlenecks limit their impact: low scales of operation, little evaluation, weak articulation between sectors, poor integration of women, and information gaps to guide the design of effective programmes. Progress in these areas will be of critical importance to improve human capital formation in the region.

Another line of challenges is related to the lack of data to guide the supply and demand of vocational education and training; to the lack of understanding of the level of socio-

emotional skills (transversal skills) that young people currently possess; and to the lack of linkages between companies and academia.

Therefore, an opportunity lies in gathering more and better information on training offers and needs, including data on the impact of different forms of training, the type of skills and professional profiles that will be needed in the short and medium term, among other inputs.

Precisely, this report aims to improve professional training in electrical engineering and to promote sustainable practices in education, responding to the growing demands of the labour market. It recognises that, in an ever-changing market, educational programmes must evolve to offer practical, not just theoretical, experiences.

The report highlights the importance of internships, which allow students to apply their knowledge in controlled environments, familiarise themselves with the dynamics of the productive sector and develop skills such as teamwork and problem solving.

Internships also benefit employers by providing young talent and the possibility to evaluate students before they are hired. They also strengthen the links between educational institutions and industry, ensuring alignment between educational programmes and market needs.

Finally, the report underlines that internships not only improve employability, but also have a positive impact on students' personal development, fostering confidence, resilience, and a problem-solving mindset. This contributes to narrowing the gaps between academic training and labour market requirements, improving long-term career prospects.

In summary, the integration of practical components in training is key to face the current and future challenges of the electricity sector, ensuring a better alignment between the acquired competences and the demands of the industry.

8.5. RECOMMENDATIONS

As mentioned at the beginning of this document, the ADVENTURE project (Strengthening the Capacities of Vocational Training Institutions to Develop Electrical Engineering Skills and a Sustainable Future) emerges as a strategic response to the growing need to improve vocational training in the field of electrical engineering and to promote sustainable practices in education. This project focuses on strengthening the capacities of vocational education and training (VET) institutions to offer relevant education aligned with the demands of the contemporary labour market.

In consideration of this objective, this document gathered the perceptions of different actors from both the educational and energy labour fields and focused on three key aspects that allow for a broader understanding of the current situation and challenges of Vocational Education and Training (VET) in Latin America and the Caribbean, specifically in relation to the energy sector.

1. Technical-professional education in LAC, Supply, and challenges in the energy sector: in relation to this axis, TVET in the region was characterised, analysing its institutional structure, its capacity to respond to sectoral demands and its evolution in recent years. The educational offer in the energy sector in the three participating countries was addressed and the challenges inherent to the adaptation of contents and methodologies in the face of an increasingly demanding and specialised labour market were identified.

2. Analysis of the link between vocational training and the labour market: perceptions and challenges at regional level. This second axis explored the link between the training received by students in VET and the real needs of the labour market. Through a regional analysis, the perceptions of graduates, employers, and other key actors on the effectiveness of the training received in preparing them for work were captured. Here, we highlighted the difficulties faced by graduates when entering the energy sector, the profiles most in demand by companies and the challenges faced by institutions in training professionals who can quickly adapt to the demands of a rapidly changing industry.

3. Training gaps and labour market demands: challenges and expectations of the energy sector. In this segment, the aim was to identify the existing gaps between the competencies acquired during training and the skills demanded by the labour market. In the energy sector, some significant gaps were observed in key areas such as automation, PLC control and home automation.

These analyses made it possible to outline critical areas for intervention and propose evidence-based recommendations to try to reduce training disparities and improve the relevance of vocational-technical education in the region to the energy labour market.

The following are some of the recommendations with benefits:

➢ Educational Benefit

a. Improved Educational Quality

- Updated curricula: according to ECLAC, the rapid technological transformation in the electricity sector requires that educational programmes be constantly being revised. The integration of modern technologies, such as artificial intelligence and smart grid management, into curricula is recommended. This should be accompanied by international certifications that allow graduates to access opportunities in wider markets. These recommendations take place in regional contexts of deep social and economic inequalities, which mark constant urges and challenges for education policies. However, prioritising innovation and quality training has greater medium and long-term benefits for productivity, development, and skilled employment opportunities in the region.

- Improved learning resources: UNESCO stresses the importance of up-to-date materials to enhance technical education. To this end, it recommends the creation of digital learning platforms, virtual laboratories and interactive simulations that facilitate access to modern practices and emerging technologies, providing a flexible and modern approach to electrical engineering education. The present study is developed in the framework of an exchange project between the Latin American region and Europe, which constitutes a pilot experience with potential in the process of exchanging experiences on training models that incorporate these

technologies. Its application in the region, and even in the institutions that are part of this project, requires support from different spheres within each country and institution.

b. Effectiveness of teaching and learning processes

- Professional development of educators. The updating of educational programmes must go hand in hand with the continuous training of teachers in new teaching methodologies and technologies. Intensive training programmes, as suggested by UNESCO, should focus on improving the pedagogical and technical competencies of educators, and promote the use of active teaching methodologies, such as project-based learning, simulation, case analysis, etc.

- Professional exchanges. Encouraging the exchange of knowledge with other regions and international institutions is key to improving teaching competences. The shared space between teachers or professionals in the area to exchange, discuss and reflect on those practices that due to their relevance, their characteristics, their results deserve to be shared among colleagues to analyse them, to inspire, to enhance and rethink them, allows innovations in the teaching of electrical engineering.

➢ Socio-economic benefits

c. Improved Employability

- Alignment with the labour market. Both ECLAC and the International Labour Organisation (ILO) Highlight the need to systematically address the connection between training and market needs. It is crucial that VET institutions carry out periodic studies of labour demand and adjust their programmes according to the most required profiles. This includes specialisations in areas such as renewable energy and industrial automation, which increase the employability of graduates.

- Industry-education links. To reduce the gap between education and employment, it is necessary to strengthen partnerships between educational institutions and companies in the

electricity sector. These alliances allow for the creation of work placements, internships and joint projects that provide direct experience to students, ensuring that their training is relevant and applicable in the work environment.

d. Economic Development

Contribution to the electricity and energy sector. From the present diagnosis it is evident that professional training needs to be deepened and kept up to date and its relationship with the increase of innovation and efficiency in the electricity industry was established, which in turn contributes to the economic growth of a country. ECLAC recommends promoting applied research and the development of energy technologies, not only to modernise the sector, but also to generate quality employment in areas related to renewable energies.

Promotion and sustainability. Professionals need to be trained to implement sustainable energy technologies, aligned with the Sustainable Development Goals (SDGs). This includes training in energy efficiency, clean energy, and environmental impact reduction, resulting in long-term environmental and socio-economic benefits.

e. Increasing Women's Participation in the Sector

Gender Equality and Opportunities for Women

- Measures in the academic sphere. To promote gender equality, ECLAC and UNESCO recommend increasing the number of scholarships aimed at women in electrical engineering careers, as well as raising awareness of gender stereotypes. They also suggest training teachers and curriculum designers to incorporate a gender perspective in teaching and promote women's participation from the most basic levels. The diagnoses elaborated by the countries that are part of this research, to a greater or lesser extent, suggest the relevance of deepening the approach, at the level of education policy from an early age, initiatives aimed at fostering the participation of women in STEM careers.

- Measures in the workplace. Implement affirmative action to eliminate gender inequalities and promote equal treatment and opportunities. This includes internal company policies that promote gender equality, such as the prevention of harassment and the promotion of an inclusive work environment. In addition to other labour and social policies in general, such as more equitable regulatory frameworks for care work.

9.6. CONCLUSIONS

The diagnosis developed in El Salvador, Ecuador and Argentina shows that the challenges for improving the relevance of TVET and VET in Latin America are numerous and varied among the different countries. However, the reality is that the nations of the region recognise the magnitude of these challenges and are promoting various initiatives to address them. The problem lies not in a lack of awareness or interest on the part of policy makers, but in the difficulty of implementing transformative programmes and policies on a large scale and with quality. The review of ongoing experiences suggests that, despite regional diversity, there are certain common elements that present opportunities with high transformative potential.

The transformation of the electricity sector and its growing role in the energy transition require a profound adaptation of vocational training and talent management. The analysis of the proposed axes shows that to meet the current and future challenges of this sector, it is essential to implement a dynamic educational offer that responds to both immediate needs and emerging competences. Regrouping and optimising training programmes, as well as facilitating access to continuous training for SMEs, is crucial to ensure that both current and future professionals are prepared to lead these changes.

Attracting young people, employees and jobseekers to a sector that offers skilled and sustainable jobs also requires specific strategies, such as promoting apprenticeships and strengthening ambassador networks that connect with the younger generation. It is essential to show the strategic value of the electricity sector in the energy transition, not only to ensure its relevance, but also to boost its long-term growth.

Finally, collaboration with other regions and anticipation of employment and skills needs will strengthen the sector's ability to efficiently manage career paths, driving the creation of high-demand jobs. Supporting SMEs in their development and adaptation to this new context will be a key pillar to ensure a balanced and resilient ecosystem that drives both innovation and sustainability in the Latin American electricity sector.