adventure
Educational journey to sustainable innovation

Co-funded by the European Union

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

"ADVENTURE"

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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 project (Advancing VET Institutions' Capacities for Building Electrical Engineering Skills and Sustainable Future) emerges as a strategic response to these needs, focused on improving the capacity of vocational and technical education institutions[1] 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 vocational education 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 possible through a collaborative and transnational approach, involving 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 breadth and depth of shared educational practices, but also supports a network of cooperation between VET institutions in Latin America and Europe. This network facilitates the exchange of knowledge and resources and promotes the continuous improvement of teaching and learning standards across geographical and cultural boundaries.

The main objective of this report is to document the conduct and results of three studies carried out in El Salvador, Argentina and Ecuador in 2024. The study was carried out on the

[1] It is important to clarify that the reference to VET institutions covers different levels of training in each country. This report explains in detail what is implied in every context.

existing gaps between the skills, abilities and competences required by the labour market in the energy sector (with a particular focus on the electricity sector) and the training provided by technical vocational education and training institutions, and to encourage sustainable practices in teaching and learning.

2. Project Context

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

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

- For this reason, in the first stage of the diagnosis, the overall objective of the research is as follows:

To identify and describe the gaps between the educational offer of vocational training institutions and the requirements of the energy sector in El Salvador, Argentina, and Ecuador in 2024.

The specific objectives proposed are:

- to describe sector requirements: to analyse the specific needs of the energy sector in each country, including technical skills, theoretical knowledge and transversal skills;

- to compare national contexts: to explore how the socio-economic and cultural characteristics of each country influence the educational offer and needs of the energy sector;

- to propose recommendations: to propose improvements to VET curricula to better align educational provision with the needs of the energy sector labour market.

3. METHODOLOGICAL STRATEGY

The methodological aspects of the research refer to the way in which the subject under study is approached. That is, they refer to the task that the researcher must perform in relation to 'the choice of paths (of research), given the nature of the possible paths' (Marradi, Archenti and Piovani, 2007:53).

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

To achieve the objective, three phases of action were defined:

1. phase 1: diagnosis and needs analysis: in this phase, information was collected through surveys, interviews and focus groups to identify gaps in current training. The participation of stakeholders such as students, educators and employers were fundamental to understanding the labour market requirements and challenges of the electricity sector;

2. phase 2: curriculum development and update: with expert support, curricula and pilot courses were developed based on the findings of phase 1. Training spaces were also created for teachers on new technological tools and pedagogical methodologies;

3. phase 3: implementation and evaluation: the final phase introduces the updated content in the participating institutions and measured the impact of the intervention, ensuring the active participation of stakeholders to improve the programme.

To capture perspectives and experiences on the quality of training and employability, tools such as structured surveys (seventy-four questionnaires), in-depth interviews (16 interviews) and focus groups (6 groups with twenty-eight people) were used for the diagnosis. In addition, documents such as curricula, study plans and regulatory frameworks were reviewed to contextualise training in the electricity sector in Latin America and the Caribbean.

4. Regional Context: The Labour Market in the Electricity Sector in Latin America

The impact of the COVID-19 pandemic has forced households, businesses, and governments to reconsider how the environment is linked to their economies and societies. Currently, decent work deficits, inequality and dependence on fossil fuel exports make Latin America and the Caribbean particularly vulnerable to the social and economic impacts of the pandemic. These same issues will make the region more vulnerable to the effects of climate change in the future. In response to the pandemic, an equitable transition to net-zero emissions can address the negative economic and social impacts of the global crisis, while providing opportunities to create jobs, fight inequality and boost inclusive growth.

Stabilising climate change below 2°C and as close to 1.5°C as possible, as set out in the Paris Agreement[2], requires achieving net zero carbon emissions by 2050 (Intergovernmental Panel on Climate Change, 2018). Decarbonising the economy, or achieving net zero carbon emissions, means reducing carbon emissions from human activities, such as the use of fossil fuels, and offsetting other emissions, for example by planting trees on a large scale.

The ILO report '*Jobs in a Net-Zero Emissions Future in Latin America and the Caribbean*' shows that carbon-free prosperity can be achieved through immediate and parallel actions

[2] On 12 December 2015, at COP21 in Paris, Parties to the UNFCCC (United Nations Framework Convention on Climate Change) reached a historic agreement to combat climate change and to accelerate and intensify the actions and investments needed for a sustainable low-carbon future. The Paris Agreement builds on the Convention and, for the first time, brings all countries together in common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to help developing countries do so. As such, it charts a new course in the global climate effort.
The central objective of the Paris Agreement is to strengthen the global response to the threat of climate change by keeping the global temperature increase this century well below 2 degrees Celsius above pre-industrial levels, and to continue efforts to further limit the temperature increase to 1.5 degrees Celsius. In addition, the agreement aims to enhance the ability of countries to cope with the impacts of climate change and to ensure that funding flows are consistent with a low greenhouse gas (GHG) emissions level and a climate-resilient pathway. To achieve these ambitious goals, a new technology framework and enhanced capacity building are needed to support action by developing countries and the most vulnerable countries, consistent with their own national targets, and to mobilise and provide the necessary financial resources. The Agreement also provides for an improved transparency framework for action and support.

around five pillars (Inter-American Development Bank and Pathways for Deep Decarbonisation in Latin America and the Caribbean, 2019):

i. phasing out fossil fuel-based electricity generation and replacing it with zero-emission sources such as wind and solar power;
ii. using electricity instead of fossil fuels for transport, food preparation and heating;
iii. increasing public and non-motorised transport;
iv. stopping deforestation and planting trees, which will require a change in diet from animal to plant-based;
v. reducing waste in all sectors, recycling materials and starting to use sustainable building materials such as wood or bamboo.

The path to achieving net zero carbon is fraught with obstacles. One of the challenges is to ensure a just transition, i.e. making 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 still faces ethnic and gender inequalities, gaps in labour skills, insufficient social protection, and a large informal economy (Alaimo et al., 2015).

Promoting social and environmental goals together means ensuring that both workers and companies have the skills needed to achieve a net zero emissions future and enjoy decent working conditions: decent incomes, workplace security, labour rights, social protection, and social dialogue. A just transition also means supporting workers, businesses and communities that will be negatively impacted by reductions in the most polluting industries, such as fossil fuel extraction or livestock grazing. Social dialogue, from the simple exchange of information between the private sector, trade unions and governments to negotiating solutions, can help to develop climate-friendly solutions that are compatible with sustainable development goals and widely accepted by local stakeholders. Education and public information are essential to achieving a net-zero emissions economy.

Therefore, it is extremely important to characterise and analyse the energy sector in Latin America to identify what skills and capacities are required in terms of training supply and what knowledge and competencies are required by the labour market.

The energy sector includes all industries involved in the production and sale of energy, including the extraction, production, refining and distribution of fuels. People consume substantial amounts of fuel, and the energy industry is a key part of the infrastructure and livelihood of society in almost every country in the world. The energy industry therefore includes:

- the liquid fossil fuel industry, which includes the oil industry (oil extraction companies and related gas companies, oil refineries, fuel transportation and end-user sales at gas stations);
- coal industry (mining and processing);
- natural gas industry (natural gas extraction and coal gas production, as well as distribution and sales);
- the electricity industry includes the generation, transmission, distribution, and sale of electricity. It includes industries not mentioned above, such as the clean renewable energy industry, which includes sustainable alternative energy sources, e.g. hydro, wind and solar power, as well as the production, distribution, and sale of alternative fuels (e.g. biofuels);
- the nuclear energy industry, which, although it may have other alternative uses, for Latin America should be considered a subset of the electricity industry;
- the traditional energy industry is based on the collection and distribution of firewood (biomass), the use of which for cooking and heating is particularly important and widespread in lower-income countries.

There is a clear dependence on energy sources. This trend has intensified in the 20th century, particularly for carbon dioxide (CO_2) emitting energy sources such as fossil fuels and

traditional energy. This meant that the energy industry was often a major contributor to pollution and the environmental impact of the economy. Today, fossil fuels are still 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 increasing demand for energy, poses a challenge for the energy sector in general and the electricity sector in particular. It also creates a problem for the sustainable economic development of society, which requires a skilled workforce to lead the energy transition and be able to meet both the technical and environmental challenges of countries.

Given the heterogeneity of the three countries covered in this report, and particularly the different availability of public data, the approach and depth of analysis vary from country to country.

To study the energy sector of the Latin American and Caribbean economies, it is necessary to understand how much energy is produced and consumed in each country of the region, distinguishing, as far as possible, the different energy sources that participate in these processes. For this reason, we will start by analysing the primary energy sources, which include fossil fuels such as oil, natural gas, and coal, but also nuclear energy and renewable energy sources. This is followed by electricity generation, which is undoubtedly the main source of secondary energy and is logically generated from the above-mentioned primary energy sources.

At the regional level, it has been observed that oil still plays a leading role in terms of total primary energy supply in the countries of the region, accounting for more than 40% of the total. Renewable energy and natural gas are second with 27% and 26% respectively (source: International Renewable Energy Agency, IRENA, 2018).

Ecuador is heavily dependent on oil, which accounts for 77% of total primary energy supply. This is followed by renewables with 19% and natural gas with 4%.

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

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

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

This panorama highlights the need to diversify the country's electricity sources to reduce dependence on water in the context of climate change. It is also important to reduce dependence on energy imports and fuel combustion as emergency measures in the face of a lack of water resources. This will allow the transformation of the energy system towards a more sustainable and balanced one, while contributing to decarbonisation, mainly of the transport system and the industrial sector.

The electrification of specific sectors of the economy (transport, household appliances, etc.) is one such trend that could be key to achieving the decarbonisation goals required to meet the climate targets of the Sustainable Development Goals (SDG). For several years, some activities have been switching from polluting energy sources to electricity (e.g. electric

cookers and heating). The electrification of transport, through private cars 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 considered) and to accelerate environmental benefits.

The drive towards digitalisation in the electricity sector is transforming the operation of systems through automation and communication between different segments of the production chain (generation, transmission, distribution, and marketing). For example, modern technologies are already being used, among other things, for scheduling and execution of tasks in the sector and for identifying and rectifying faults. However, the most important impact of digitalisation is not in improving the day-to-day operation of the sector, but in the changes introduced in its industrial organisation, particularly in the configuration of electricity markets and the way transactions are carried out.

Given these problems, the concept of smart grids, which refers to a system consisting of elements of the traditional electricity system: generation, transmission, distribution, and commercialisation of electricity, as well as the communications system, has emerged worldwide with the arrival of the new millennium.

The smart grid architecture must be integrated (in addition to generation, transmission, and distribution) by customers and a service provider that oversees products offered by third parties, such as online portals offering electricity to customers, installation, and maintenance.

Other systems included in smart grids are the operating system (which manages the flow of electricity from the different grid domains) and the market (which coordinates those involved in trading energy services within the smart grid).

All the above elements together can bring greater benefits to smart grids in terms of operation, cost, and efficiency. They are also expected to be able to add the use of renewable energy (such as solar, wind, hydro) to their development.

In the technical paper 'Redes eléctricas inteligentes: situación en el mundo y en Argentina' (Smart grids: situation en el mundo y en Argentina)3by Dr Patricio G. Donato and Marcos A. Funes. The authors report report that smart grid development is uneven across the world. In developed countries, mass deployments of smart meters have already been completed or are underway, representing a first step towards the implementation of true smart grids. In countries such as Italy, Finland, Spain and Sweden, smart meters have been installed at more than 93% of customers. Furthermore, in Italy and Sweden, a second meter roll-out is underway, i.e. the renewal of a fleet of meters already installed almost a decade ago by a new batch of equipment. In addition to Europe, other countries such as South Korea, China and the United States are also well advanced in this area.

Both Latin America and Oceania will remain relatively small markets over the next few years, although the former region is expected to see an upturn as the economy improves in countries such as Brazil, Mexico, Colombia, and Argentina.

Due to all the transformations and innovations, it is necessary to discuss the requirements of the electricity market. Consequently, it is necessary to define what teaching practices are proposed by vocational and professional technical education institutions, especially those offering programmes focused on electrical engineering, to accompany the changes in the sector.

Considering the reports of the three countries, the electricity market of each country can be characterised as shown below.

[3] This article is part of a series entitled 'Redes eléctricas inteligentes: el camino a la eficiencia energética' (Smart grids: the road to energy efficiency) prepared by the same authors specifically for AADECA and Editores SRL based on the presentation they gave at the AADECA 2023 meeting. The series consists of the following articles: • *Redes eléctricas inteligentes en contexto* (Smart grids in context), • *Medidores y funciones de las redes eléctricas inteligentes* (Meters and functions of smart electrical grids), • *Redes eléctricas inteligentes: situación en el mundo y en Argentina* (Smart electrical grids: situation in the world and in Argentina), • *Redes eléctricas inteligentes: ¿qué hacer?* (Smart electrical grids: what to do?).

El Salvador has diversified its energy base to include a significant share of hydro, solar, biomass, geothermal and, more recently, natural gas. This shows that the country has diversified its energy base, thereby strengthening its competitiveness in the Regional Electricity Market. In 2023, the structure and capacity of the electricity sector in El Salvador is characterised by an installed capacity reaching approximately 2,600 megawatts (MW).

This allows for the export and import of energy in the Central American region, thus optimising the dispatch of energy in an economical and efficient manner. This approach has strengthened the competitiveness of El Salvador's energy sector, guaranteeing a reliable and stable energy supply that not only covers domestic needs, but also allows regional demand to be met.

In terms of human resources, the sector still employs a small proportion of the population, with a predominance of men in technical and operational areas. It is essential that staff are well-trained to meet the growing demands of the energy sector and the modern technologies being implemented.

The demand and skills needed in the energy sector in El Salvador are evolving as the industry moves towards greater energy efficiency and diversification of sources. According to the latest data on the country's energy sector, the industry has experienced a significant increase in investment and employment generation.

The energy sector, with the increase in geothermal and solar energy projects, has created new employment opportunities. However, detailed statistics on employment and underemployment rates in the energy sector are not clearly separated in the latest reports. It was mentioned that projects such as the Third February hydroelectric plant and the Talnique solar plant have increased employment opportunities in the sector.

In Ecuador, 0.2% of the employed population is concentrated in electricity and energy-related activities, below the regional average, where 2% of the workforce in LAC is employed

in the energy sector, energy supply, electricity sector, energy efficiency and vehicles. However, in line with the professional field of electrical engineering, professionals in this field may be represented in other sectors.

The low percentage of people employed in the electrical and energy sector occurs despite the key role it plays in the economy. According to the report on Latin America Energy Outlook (2023) by the International Energy Agency, the sector is an important source of job generation.

Installed capacity for electricity generation reflects the fact that Ecuador has relied mainly on renewable sources over the past 10 years, with an average of 58.1% of electricity generation coming from hydropower, 38.6% from thermal sources and 3.3 % from other renewable energy sources (Ministry of Energy and Mines, 2023). By 2023. 69.1% will come from hydropower, 25.6% from thermal sources and 1.7% from other sources such as biomass, biogas, wind, solar and imports.

However, electricity imports increase by 183.9% in 2023 compared to 2022. As of 2022, Ecuador went from being an exporter of electricity to being an importer again to meet domestic electricity demand, which increased by 6.8% in 2023 compared to 2022, with the highest demand in the provinces of Guayas and Pichincha. From 2023 onwards Ecuador is facing several electricity rationalisation measures, partly due to the lack of rainfall, which is crucial for the operation of hydropower plants. This is closely linked to the negative effects of climate change, as similar situations are occurring in other countries in the region, such as Colombia, which has even restricted electricity exports to Ecuador to secure demand in its country.

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 fuel combustion as emergency measures in the event of a lack of water resources. This will allow the transformation of the energy system towards

a more sustainable and balanced one, while also contributing to decarbonisation, mainly of the transport system and the industrial sector.

These challenges in the sector are also transferable to the education system, as it will have to adapt to strengthen training in electricity generation from alternative sources and provide the human talent required to drive the transformation and innovation of the national energy system.

In terms of the electricity market, Argentina is a global energy powerhouse and ranks among the 29 largest energy-producing countries, 18th in terms of gas production, 24th in terms of oil production, 30th in terms of electricity production, 23rd in terms of installed nuclear energy, 19th in terms of installed hydropower and 26th in terms of attractiveness for investment in renewable energy sources.

In terms of employment, according to 2022 data from the Ministry of Labour, Employment and Social Security, the energy supply sector employed an average of 103,020 workers in the private sector, distributed among various positions in generation, transmission and distribution, and related industries and services. The dynamism of Argentina's renewable energy projects will create new jobs. According to the International Renewable Energy Agency (IRENA), it is estimated that forty-two million jobs will be created worldwide in the renewable energy sector by 2050 to meet the greenhouse gas reduction targets set by the Paris Agreement.

Argentina's energy base has undergone a transformation over the past fifteen years, moving from a predominance of hydropower to a 60% reliance on natural gas. The new generation incorporated into the system was mainly conventional thermal energy, increasing the share of this source in total energy production. However, renewable generation has been implemented, with well-defined targets for 2025 of 20% supply and the possibility of reaching an extended target of 30% of national electricity consumption by 2030. The aim is to continue this positive path to the technical and economic limits of an integrated system,

SADI + SIEEE (Integrated Electricity Export System, in Spanish *Sistema Integrado Exportador de Energía Eléctrica*), in which renewable resources and natural gas in the South American region are optimised in an integrated and efficient manner.

In addition to efforts to diversify the energy base and reduce dependence on fossil fuels, special attention should be paid to large-scale hydroelectric projects that can reduce the need for thermal power plants. Although renewable energy sources, including conventional hydropower, will play a key role in the country's future energy base, thermal, gas and nuclear generation will still be needed to meet user demand and provide the system with the required level of reliability and quality. Argentina has significant reserves of shale gas in the Vaca Muerta fields[4], which will allow the system to be maintained with security and quality of electricity, as well as enabling this abundant primary energy to be converted into a secondary value-added export resource.

The Argentine electricity market is potentially competitive at two stages of electricity generation, transmission, and monopoly distribution. However, in the distribution area, it has been proposed to gradually introduce a competitive mode by allowing large users to contract supply directly with generators. Consequently, the demand for services in the wholesale (generation) and retail (distribution) markets also varies according to the type of user (Azpiazu, 2003).

The report *'Informe sectorial para inversores internacionales Energía / Energía Eléctrica'* (Sector Report for International Investors Energy / Electricity) highlights that the Argentine electricity sector is the third largest electricity market in Latin America, after Brazil and Mexico, and ranks 29th in the world.

[4] Vaca Muerta is Argentina's main shale coal formation, which is changing the country's energy reality through unconventional oil and gas production. Its reserves are estimated at 16 billion barrels of oil and 308 trillion cubic feet of gas, which means that if tapped, it will increase the country's proven reserves by more than eight times and we will be assured of gas and oil consumption for the next 150 and 85 years respectively.

The same document mentions that Argentina's electricity generation base depends on thermal (mostly natural gas) and hydroelectric plants: 56% and 21% respectively in 2022. It is characterised by a lower share, above the Latin American average, of hydroelectricity, a higher share of fossil fuels, although with a low share of coal and liquid fuels, the use of nuclear energy based on its own technological development and an increasing share of renewables. The main generation hubs (thermal and nuclear) are located around the large cities and the hydroelectric plants of Yacyretá, Salto Grande and Comahue. There is an increasing geographical spread around solar and wind farms.

It was also highlighted that Argentina's renewable electricity generation has seen a historic increase of 477% over the last four years. In 2022, 13.9% of the country's electricity demand came from renewable sources. The highest level, with 31.3% of demand covered by this type of energy, was recorded on 8 October 2022. Last year, three new photovoltaic parks, two small hydroelectric plants, two biogas thermal power plants and one wind farm were opened in the provinces of Mendoza, Buenos Aires, Catamarca, Córdoba, San Juan, and San Luis. According to the Compañía Administradora del Mercado Mayorista Eléctrico Sociedad Anónima (CAMMESA), the installed capacity from renewable sources added in 2022 represented 78% of the total new capacity installed in Argentina during the year.

Based on the research conducted in the diagnostic phase referred to in this report, the perceptions of different stakeholders regarding entry into the electricity sector were explored.

The most frequently selected variable was 'no previous work experience'. Of the seventy-four respondents in the first stage, 17.42% of respondents indicated this variable.

'Lack of transversal skills' and "outdatedness of acquired technical knowledge" emerge as the next most important difficulties in terms of entering the labour market.

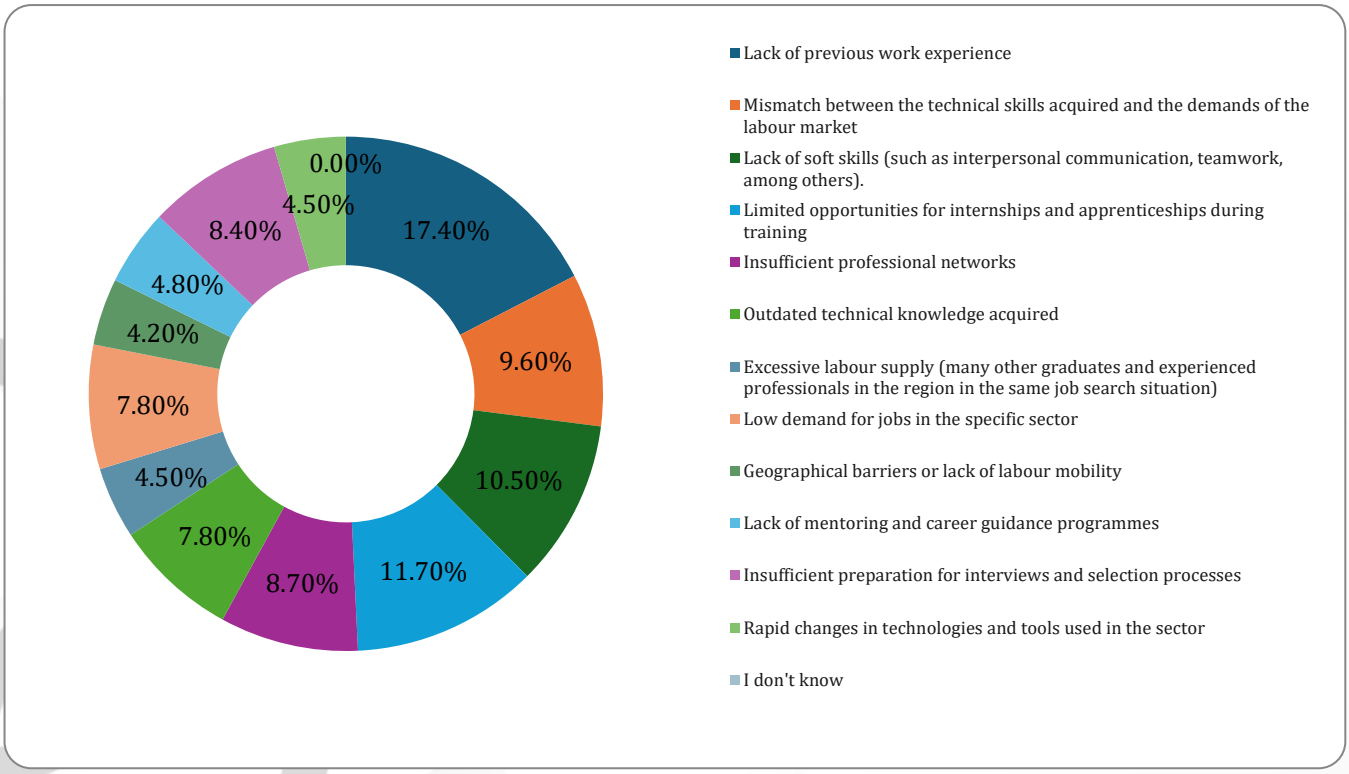
Another important barrier is 'limited availability of internships during training'. This obstacle is mentioned by all actors, especially by students, teachers and researchers and self-employed professionals, who see the lack of practical experience during academic training as an important challenge. 11.7% consider this to be a problem.

'Insufficient professional network' is also an important difficulty for 8.71%. Teachers, self-employed professionals, and employees particularly indicate this problem, emphasising the importance of networking in the job search.

In summary, finding a job in the electricity sector presents several challenges, including a lack of prior experience, little practical contact during training and the need for both technical and cross-cutting skills. Addressing these issues could facilitate smoother entry into the labour market for professionals.

Below is a chart that allows us to identify the actors' opinion on entering the electricity labour market.

Chart 1: Main difficulties encountered when entering the electricity sector labour market



Source: own compilation based on surveys conducted with seventy-four key actors

5. Technical- Vocational Education in Latin American and Caribbean Countries: Characteristics, Supply and Challenges in the Energy Sector

Defining the technical-vocational education sector within the education system is complex, as its boundaries with academic or general education are imprecise. However, a frequently used definition is the one that refers to educational methods that combine theoretical and practical learning related to a specific occupation or professional field, distinguishing between initial and continuing vocational training. The former includes formal programmes at secondary and tertiary level for young people at the beginning of their careers and before entering the labour market. Continuing education, on the other hand, includes all other programmes, including in-company training for employees and training specifically aimed at the unemployed. (Based on the document '*Panorama de la educación técnica profesional en América Latina y el Caribe' [Overview of technical and vocational education in Latin America and the Caribbean]* by María Paola Sevilla B for ECLAC[5] and the Norwegian Ministry of Foreign Affairs).

The author, María Paola Sevilla B for ECLAC, highlights that in Latin American and Caribbean countries, despite the growing strategic importance and recognition of the structural problems facing the region, technical vocational education has rarely been studied and presented in a comparative perspective. The conduct of research at the regional level has been limited by the lack of national diagnoses and the scarcity of information on technical vocational education and training in each country.

[5] ECLAC stands for 'Economic Commission for Latin America and the Caribbean'. It is a United Nations agency created in 1948 with the objective of promoting the economic and social development of the countries of the region, as well as cooperation among them. ECLAC conducts research, prepares reports and provides technical assistance to address the economic and social challenges facing Latin American and Caribbean countries.

Hence the relevance of three papers from Argentina, El Salvador and Ecuador that explore the links between vocational training institutions and the electricity employer sector.

Regarding training in 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 quality technical and vocational education. Some 13.47% stressed the importance of fostering collaboration between educational institutions and the industry/employer sector; 12.65% mentioned promoting the use of new and advanced technologies in education; and 11.02% emphasised the need to support research and innovation in the sector.

Furthermore, 8.57% indicated that it is necessary to update curricula and teaching resources in line with labour market requirements, while 7.35% stressed the importance of providing guidance and support to students in their entry into the labour market. On the other hand, 6.94% stressed 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 into all areas of education.

In addition, the relationship between academic provision and the needs of the sector was included in the survey on new areas of activity emerging in the energy labour market.

In all three countries, the largest number of respondents answered 'various updates'. In Argentina, 65.21% answered yes, while in Ecuador 81.81% and in El Salvador 79.31%.

Other important variables that have 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 the system is performed and analysed by artificial intelligence. This situation represents an opportunity to gain knowledge of energy management systems or specialise in other areas, as data analysis will be interpreted by artificial intelligence.

The link to sustainability and management of cross-cutting skills have also been identified as new performance areas in the electricity market.

The ECLAC article predicts that, in contrast to academic education, the provision of which is generally well organised and homogeneous across countries, the organisational and management patterns of technical vocational education are very different. It is not possible to speak of a single model for the provision of these services, and the Latin American and Caribbean region is no exception. Nevertheless, it has been identified that, despite its high regional heterogeneity, technical vocational education has certain logics and characteristics that are cross-cutting between countries, including the fact that it welcomes populations with lower socio-economic levels and who have traditionally been excluded from or unable to reach advanced levels in the formal education system. Notwithstanding, its expansion at the tertiary level is still limited in most countries, so it is seen as a space to be developed to progress in the expansion and democratisation of higher education.

Regarding these issues, reports from selected countries characterised the educational context for technical and vocational education as follows.

The technical and vocational education system in Ecuador includes formal, non-formal and informal education, promoting lifelong learning oriented towards employment, innovation, and entrepreneurship. At the formal level, the system offers secondary education (secondary technical education - bachillerato técnico and production technician - técnico productivo) and higher technical and technological education, including postgraduate programmes in technical areas. Non-formal education includes short courses and certification of professional competences, while non-formal education focuses on skills acquired through work or everyday experience.

The Ecuadorian Vocational Training Service facilitates the updating of knowledge and issues certificates to improve entry into the labour market. In the field of electrical engineering, the Politecnica Salesiana University (Universidad Politécnica Salesiana, UPS) and the

Polytechnic College of Litoral (Escuela Superior Politécnica del Litoral, ESPOL) are leaders in Ecuador, known for their high-quality education. To a lesser extent, the Catholic University of Santiago de Guayaquil (Universidad Católica de Santiago de Guayaquil, UCSG) and the National Polytechnic School (Universidad Politécnica Nacional, EPN) are also recognised, although according to respondents they enjoy less prestige than UPS and ESPOL.

The academics surveyed emphasise that the most advanced institutions in teaching are distinguished by their focus on personalised practices, strong organisation, and effective use of technology. The above aspects are crucial to prepare students to adapt to uncertainty and develop creative and effective skills to contribute to the welfare of humanity through research and practical application of knowledge. In addition, the importance of dual training is emphasised, which includes contracts with companies so that students can gain experience in real-world settings, as well as the integration of complementary knowledge such as languages, soft skills, and up-to-date tools. Interdisciplinarity also plays a key role, enabling technicians to collaborate effectively in multidisciplinary teams and understand the interconnections between different fields of work.

El Salvador has academic programmes in the energy sector offered by fifteen higher education institutions. However, there is a need to better adapt the curricula to market needs and to focus on new technological areas.

The General Education Law (1996) organises the system in formal and informal modes. Formal education takes place in regular cycles and leads to qualifications at initial, primary, secondary, and tertiary levels. Non-formal education, on the other hand, aims to supplement or update knowledge and focuses on short-term needs without a degree structure. Vocational-technical education also exists in both systems, with the Ministry of Education coordinating technical programmes for secondary and higher education.

In the energy sector, the shift towards efficiency and diversification has created jobs, with significant growth driven by renewable energy, which now accounts for 85% of the energy

generated in the country. El Salvador faces challenges in terms of innovation and quality of education (105th and 99th in the world), which limits research and development in renewable energy.

The country needs to strengthen links between academia and the energy industry, improve training programmes and promote specialisation in energy technologies. Building strategic alliances between universities, research centres and the productive sector will be key to improving El Salvador's competitiveness and positioning in the global energy market.

In Argentina, Law No. 26.058 regulates technical vocational education at secondary and higher non-university levels and vocational education. Technical diplomas and vocational education certificates can be homologated at the national level through the standards of the Federal Council for Culture and Education.

Technical secondary schools offer an additional year of training compared to other courses and include work placements in the final year to provide work experience. Currently, there are more than 1,600 secondary technical education institutions in Argentina, with more than twenty specialisations, including electricity and electromechanics.

At the tertiary level, non-university technical vocational training institutions offer short-term pathways and technical specialisations related to employment, in line with CFE Resolution 13/07. In vocational training, courses can be initial or continuous and are organised at certification levels. Vocational training centres provide short-term training and specialisation in areas such as electricity, from helpers to domestic and industrial electricians.

Technical vocational training has emerged in the region in a fragmented manner, both in terms of time and institutions. This fragmentation has not been conducive to the development of a coherent vocational training system or the creation of training routes that

effectively link secondary and tertiary levels, or between them and vocational training provided outside the formal education system.

6. OUTCOMES

Technical and Vocational Education in Latin American and Caribbean countries: Characteristics, Supply and Challenges in the Energy Sector

There is now a consensus on the need to invest in young people's skills to drive economic growth and build a solid foundation for future progress. In particular, globalisation and technological transformation are rapidly changing the skills required, so VET policies increasingly need to anticipate and adapt to new requirements.

There is therefore a growing interest in technical vocational education around the world[6], There is therefore a growing interest in technical vocational education around the world,[4] recognising its potential to respond to the challenges of equality, productivity, and sustainable development of nations. Various international agencies are committing efforts and resources to advise countries in strengthening their vocational training systems to make them more relevant to the needs of the productive sector and society in general.

Reading the studies carried out in Ecuador, El Salvador and Argentina makes it clear that vocational training in the electricity sector in Latin America is characterised by diversity and the need to adapt to an ever-changing context. Addressing existing challenges and exploiting opportunities for improvement will be key to providing quality education that responds to labour market needs and contributes to the sustainable development of the region.

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

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

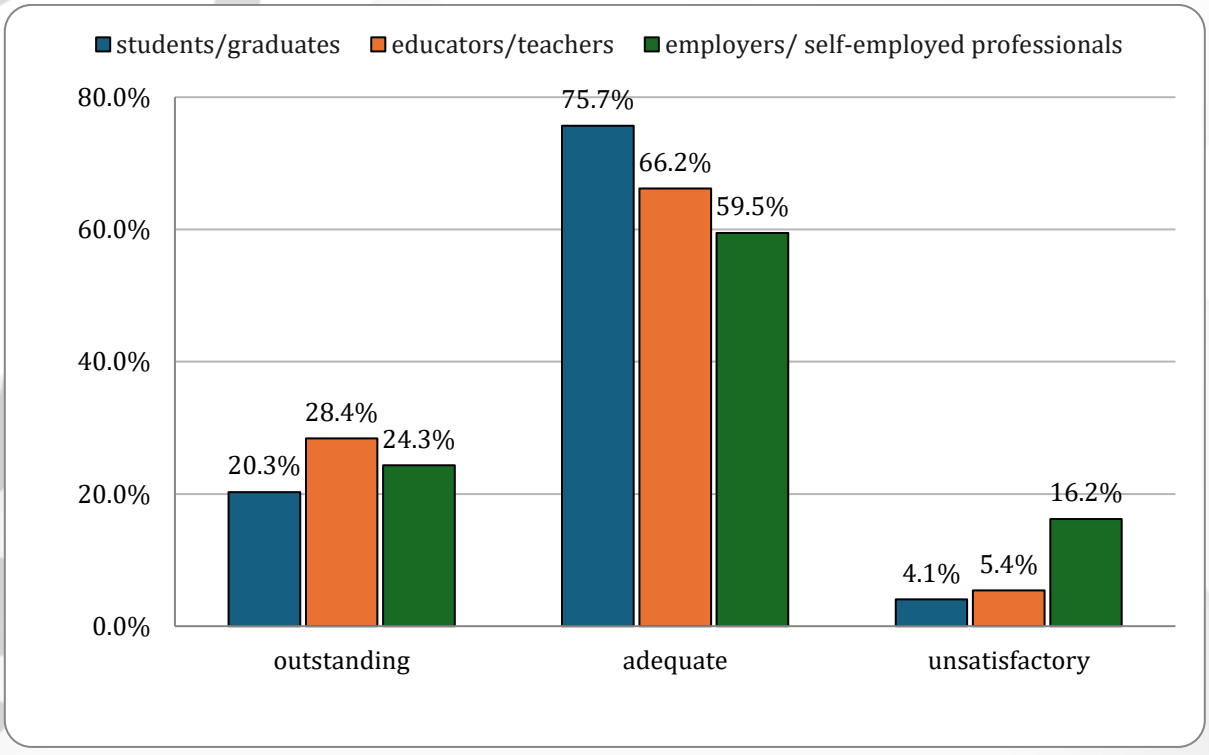
However, if this question is broken down into key subjects, we get results showing that for 74.3% of graduates, professional training is adequate, for 18.9% excellent, for 4.1% unsatisfactory and 2.7% of respondents do not know what the system means.

On the other hand, 63.5% of teachers perceive electrical engineering training as adequate and 28.4% consider it excellent. Only 5.4% found it unsatisfactory and 2.7% of respondents do not know what the system means.

Finally, 58.1% of employers/self-employed responded that they consider on-the-job training as adequate, 24.3% as excellent and 14.9% as unsatisfactory.

It is clear that the most unfavourable perception of training is among employers.

Chart 2. Perspective on vocational training by different actors in the sector



Source: compiled by the authors from the results of a survey of seventy-four key stakeholders

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

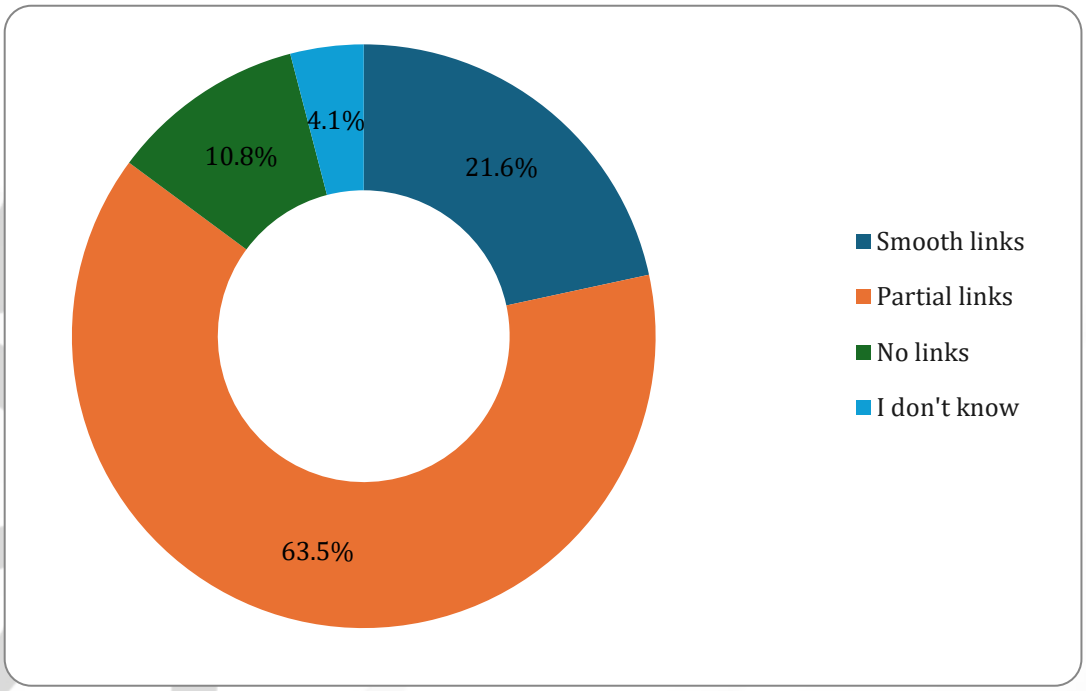
A bottleneck that affects all levels of training is the lack of coordination between the production sector and the training and education sector. Coordination is essential to promote education that is consistent with the needs of the labour market.

Accordingly, 63.5% of the total number of respondents at the diagnostic stage answered that they perceived a 'partial link' between academic and vocational training institutions and the employer sector.

Only 21.6% of respondents said that there was a 'smooth link' between education and employment.

Below is a chart.

Chart 3. Links between academic institutions, training centres and the employer sector



Source: own compilation based on surveys of seventy-four key actors

7. Gaps between Vocational Education and the Labour Market. Challenges and Perspectives

One of the most pressing challenges facing education systems in the 21st century is 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 need to acquire.

The transition from education to employment is fraught with many challenges, mainly related to the lack of practical experience, the need to deepen the links between academic training and market requirements and the need to strengthen transversal skills training. In addition, factors such as insufficient preparation for selection processes, lack of professional networks and low demand in some sectors further complicate this transition. Educational institutions and policymakers should consider these areas to improve the employability of new professionals, through more robust apprenticeship programmes, mentoring and better alignment of training with market needs.

The current situation in Latin America shows that there are significant gaps in the knowledge and skills acquired in various vocational training institutions and the labour market.

Three studies confirm that the main demand in the electrical sector is related to automation, home automation and PLC control (programmable logic controller). This trend reflects the move towards more automated processes and the growing importance of control technology in industry. It also highlights the need to strengthen competence in the interpretation of electrical drawings, maintenance of electrical systems and compliance with safety regulations.

Overall, the following trends in the electrical market can be identified:

- digitalisation and automation. The integration of technologies such as artificial intelligence (AI), the Internet of Things (IoT), Big Data and robotics are transforming the electrical engineering sector, requiring professionals with expertise in these areas;
- environmental sustainability. Growing concern for the environment is driving demand for specialists specialising in renewables, energy efficiency and clean technologies;
- Electricity 4.0. Data management, information analysis and decision-making based on artificial intelligence are key aspects of today's energy management.

On the other hand, considering the stakeholders' perspective is precisely one of the most valuable aspects of this project, as it allows for a more precise definition of their needs and requirements for entering the labour market.

Actors identified the following requirements as common points.

- Updating the curriculum. There is a need to renew the content and methodology of vocational training. In Ecuador, the curriculum focuses mainly on household electricity, so it is proposed to include areas such as industrial automation and motor maintenance. In Argentina, for example, the focus is on incorporating digitalisation, IoT and renewable energy sources.
- Strengthening practical training. Graduates often find it difficult to apply knowledge due to a lack of experience with advanced equipment and technologies. A lack of access to modern tools has been reported in Ecuador, limiting practical learning and its alignment with theory.
- Competence in renewable energy. The energy transition towards renewables requires specialists to be trained in sustainability, safety regulations and the automation of smart systems.
- Cross-cutting Skills. Social-emotional skills, such as leadership, communication, and teamwork, necessary for working in collaborative projects, were found to be lacking.
- Project-based learning (PBL). This approach allows students to apply theoretical knowledge to real-world problems, developing practical skills and fostering teamwork, problem-solving and creativity necessary in technical areas such as electrical engineering.

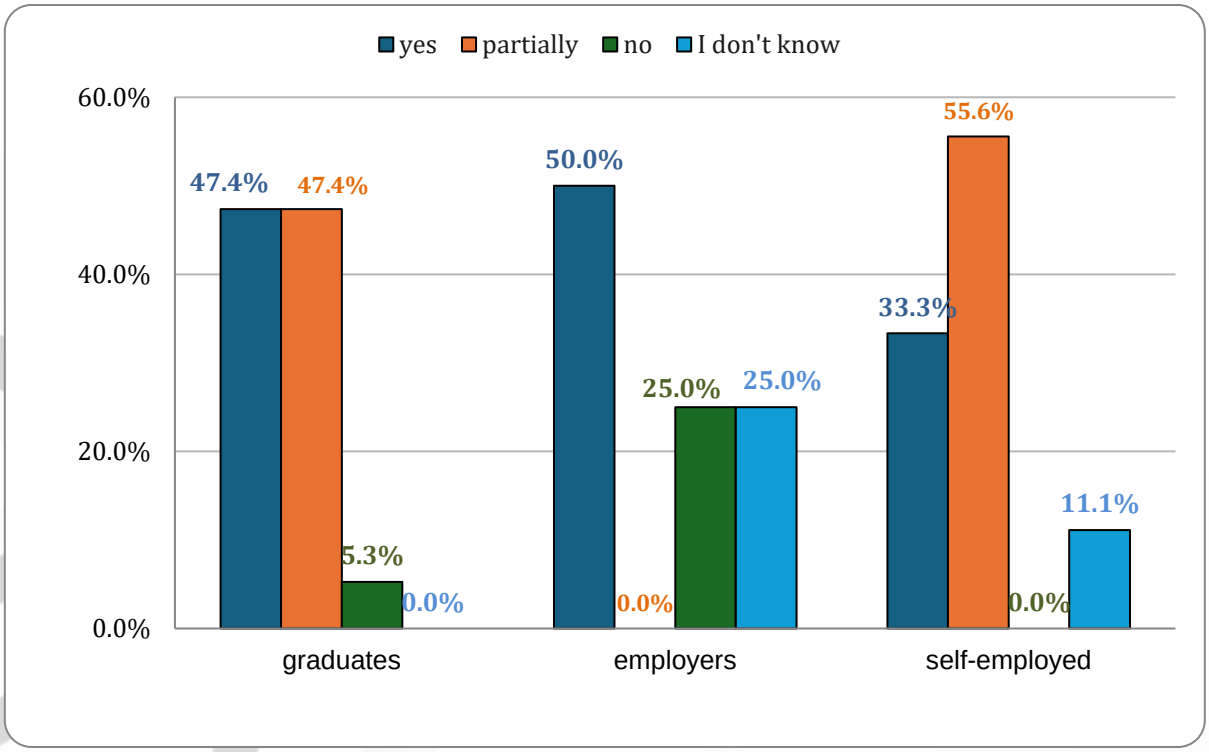
Interactive methods, on the other hand, focus on creating a more dynamic learning environment in which students and teachers are constantly interacting. This can include the use of digital technologies such as simulators, online collaboration platforms and computer-aided design tools. Interactive methods may also include debates, workshops, case studies and other activities that require the active participation of students, encouraging discussion and critical reflection.

- Use of specialised software. Simulation and design tools. Participants report that it is crucial for electrical engineering education to integrate modern technologies, such as artificial intelligence and data analytics, to prepare future engineers for the rapid changes in industry. The inclusion of specific tools such as Python and Power BI is becoming essential to equip students with practical programming and data analysis skills, which are increasingly in demand in the sector.
- Preparation for the world of work. Insufficient preparation for interviews and recruitment processes. Many students and graduates lack the necessary tools and skills to deal effectively with interviews.
- Teaching the skills, knowledge, and capacity for self-employment. In economies with high-levels of informality, it is essential that vocational training institutions include self-employment-oriented competences in their programmes. It is crucial to identify how such institutions address the development of practical skills and tools that enable individuals to generate self-employment, especially in the domestic sector. The capacity to foster entrepreneurship and self-management can be crucial to addressing economic challenges and providing sustainable opportunities in this context. If it is not present enough, it would be advisable to include it as a strategy to be strengthened in future education policies.

As mentioned in the previous paragraphs, graduates, employers and the self-employed 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 indicated that such a gap does indeed exist, while 50% of employers and 33.3% of the self-employed agreed with this assessment.

Chart 4. Perspective on gaps between skills acquired during training and labour market needs



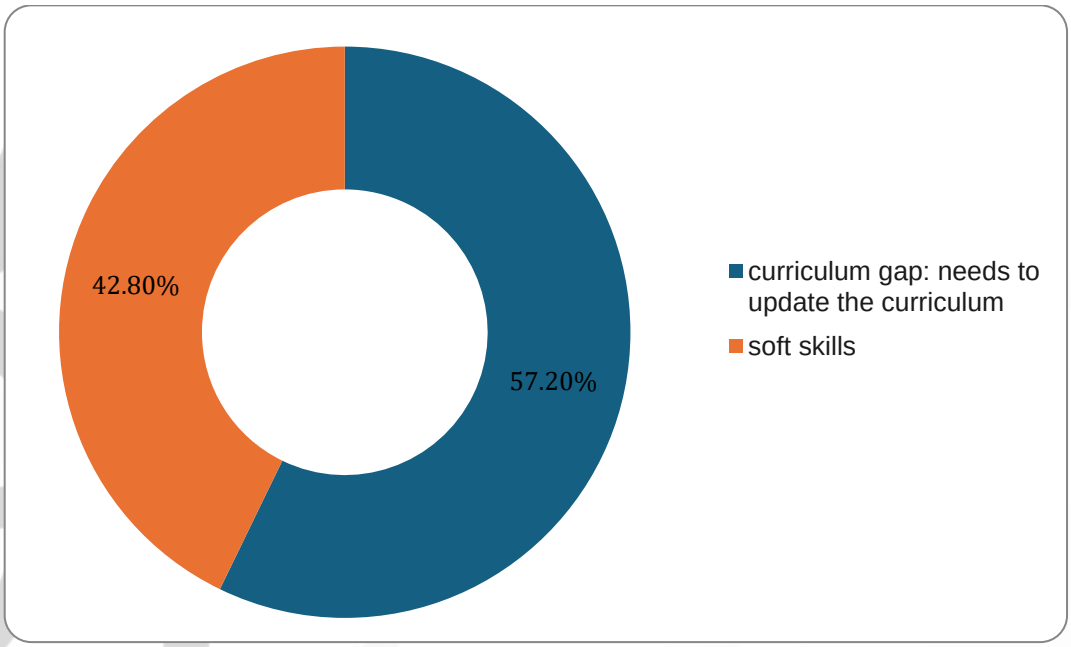
Source: own elaboration based on survey of seventy-four key actors

The survey deepened the responses of the graduates by asking them to elaborate on their comments for those who indicated that there were gaps between the skills developed during the training and the needs emerging in the labour market.

For 57.2%[7] of graduates who perceive a gap between training and job requirements. This gap is related to curricular aspects, highlighting the need to update academic content. On the other hand, 42.8% indicated that the gap is related to the development of transversal skills, such as the ability to communicate effectively, project management, budgeting, interpersonal skills, leadership and empathy.

[7] Result obtained from the coding of open-ended questions from the questionnaire applied to seventy-four participants in the diagnosis.

Chart 4. Types of gaps between skills developed during training and labour market needs (according to graduates)



Source: own compilation based on surveys conducted with seventy-four key stakeholders

Various stakeholders were also asked about the type of additional or specialised training that students should receive before entering the labour market.

Students (15.38%), graduates (18.09%), practising professionals (15.79%) and academics (14.96%) agreed that students should have work experience or an internship in companies in the sector.

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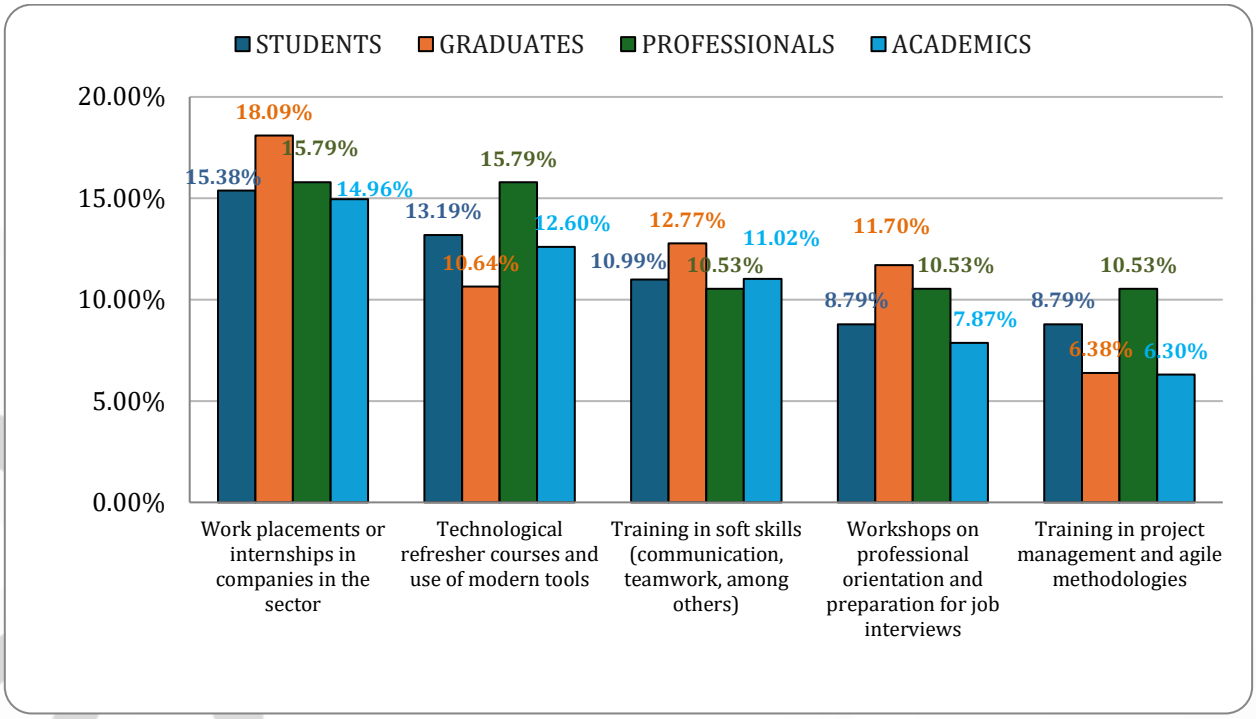

Source: own compilation based on a survey of seventy-four key stakeholders

Although it is a major achievement that there are many initiatives in the region to improve the relevance of vocational education and training, there are still many challenges to overcome to fully achieve this goal. These challenges relate to a lack of data to guide the supply and demand of VET; a lack of understanding of the level of socio-emotional skills (transversal skills) that young people currently possess; and a lack of links between business and academia.

Another important aspect to mention is the participation of women in the energy sector, which, although improved, still faces barriers to achieving gender equality. Although there are treaties promoting equality, their implementation needs further progress. Currently, most of the available data is qualitative, while there is a lack of quantitative information reflecting the number of women in the sector and their level of participation in technical and managerial roles. It is important to measure not only the number of women in projects

and professional fields, but also to assess their experience, voice, and treatment in these environments.

The United Nations Educational, Scientific and Cultural Organisation (UNESCO) has found that the participation of girls and women in science, technology, engineering, and mathematics (STEM) is low (2019). Some of the factors identified include, but are not limited to, socio-cultural issues that encourage girls less to study these areas of knowledge, as well as a lack of female role models and an education that is still steeped in stereotypes.

Latin America is currently the most unequal region in the world. Women and girls are at a disadvantage compared to men in such basic and important aspects as education, health, identity, work, political participation, and physical and mental integrity. These inequalities are exacerbated when factors such as territory, ethnicity, disability, age, migration status, LGTBIQ membership and prisoner status are added.

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

This is partly because areas of social knowledge, such as psychology, anthropology, pedagogy, and sociology, are commonly socially linked to activities that are more suitable for women because they are related to their reproductive role (ECLAC, 2016b). According to data from UNESCO, between 2015 and 2017, the number of women graduating in STEM in Latin American countries in no case reached 50%.

During the transition from education to the labour market, it can be observed that occupations related to science studies are often associated with jobs with higher productivity and thus higher incomes, again putting women at a wage disadvantage. UNESCO

also points out that even when women study STEM studies and are employed in the same jobs as men, they are often taken on in subordinate positions to men or with restrictions on the activities for which they have been trained, such as doing administrative or maintenance work. Women are also paid less compared to men for work of equal value.

Women study specialisations that are less well paid in the labour market, while the labour market rewards women who specialise in better paid fields less well (ECLAC, 2016b).

In summary, many initiatives are underway in the countries of the region to increase the relevance of technical education and vocational training and to ensure that they meet the country's economic needs. However, several bottlenecks are limiting their impact: low scale of action, little evaluation, poor communication between sectors, poor integration of women and gaps in information that can help develop effective programmes. Progress in these areas will be critical to improving human capital formation in the region.

Therefore, the opportunity is to obtain more and better information on training offers and needs, including data on the impact of different forms of training, the type of skills and job profiles that will be needed in the short to medium term.

The main objective of this report, at its various stages, is to improve vocational training in electrical engineering and to promote sustainable practices in education. In a context where the labour market is constantly changing and the demand for technical and specialised skills is increasing, it is essential that educational programmes evolve to offer students experiences beyond the theory taught in schools.

The emphasis on internships addresses the need to prepare students for the real-world challenges they will encounter in their future careers. Internships not only allow students to apply the knowledge they have acquired in a controlled environment, but also give them exposure to the dynamics of the manufacturing sector. This allows them to better understand employer expectations, adapt to industry standards and develop key

interpersonal skills such as teamwork, effective communication and real-time problem solving.

In addition, incorporating practical elements into academic training strengthens students' ability to innovate and make informed decisions. Internships give them a fuller insight into the specific challenges of the sector they want to enter, whether it is engineering, technology, management, or other fields. These experiences allow them to develop the necessary technical skills, improve adaptability and gain an in-depth understanding of current trends and changes in the labour market.

A key aspect also highlighted in this report is that internships not only benefit students but are also a benefit for employers and educational institutions. For employers, internships provide a pool of young talent who, when properly trained, can make a significant contribution to the business. Employers can train students on specific systems and assess their performance before considering long-term employment. For their part, educational institutions can strengthen their links with industry by ensuring that their educational programmes are aligned with current labour market needs.

Students' transition into the labour market is also facilitated by internships, which provide a springboard to formal employment. Students who complete internships in companies or institutions in the sector are more likely to obtain employment at the end of their studies, as they have already gained relevant experience and developed a network of professional contacts. In this sense, internships act as a bridge between academia and the world of work, reducing existing gaps and promoting a smoother integration of young people into the labour market.

Finally, this report highlights that the inclusion of practical elements in academic training also has a positive impact on students' personal development. It helps them gain confidence in their skills, face challenges with greater resilience and develop problem-solving skills. It also fosters active and participatory learning, in which students become agents of their own

education, which ultimately contributes to improving their employability and long-term career prospects.

In conclusion, the importance of bridging the gaps that exist between the training provided in educational institutions in the electricity sector and the requirements of the labour market has been highlighted, to ensure that the competences acquired by students are better aligned with the actual needs of the industry. The integration of practical experiences in educational programmes is essential to meet the current and future challenges of the labour market, thus strengthening the competitiveness and adaptability of graduates in an ever-changing environment.

8. RECOMMENDATIONS

As mentioned earlier in this document, the ADVENTURE project (Advancing VET Institutions' Capacities for Building Electrical Engineering Skills and Sustainable Future) is a strategic response to the growing need to improve vocational training in electrical engineering and promote sustainable practices in education. The project focuses on strengthening the capacity of vocational education and training institutions to offer relevant education adapted to the requirements of today's labour market.

With this objective in mind, this document gathers the views of various stakeholders from both the education and labour sectors in the energy sector. The report focuses on three key aspects that provide a broader understanding of the current situation and challenges of technical vocational education in Latin America and the Caribbean, particularly in relation to the energy sector.

1. Technical vocational education in Latin America and the Caribbean: characteristics, supply, and challenges in the energy sector. In relation to this axis, technical vocational education in the region was characterised, analysing its institutional structure, its responsiveness to sectoral needs and its evolution in recent years. Educational provision in the energy sector in the three participating countries is addressed and the challenges of adapting content and methodology in the face of an increasingly demanding and specialised labour market are identified.

2. Analysis of the relationship between vocational education and the labour market: perceptions, challenges, and graduate profiles at regional level. The second axis investigated the relationship between the training received by students in vocational education and the actual 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. We highlighted

the difficulties faced by graduates entering the energy sector, the profiles most sought after 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 requirements: challenges and expectations of the energy sector. In this segment, the aim was to identify existing gaps between the competences acquired during training and the skills required by the labour market, and in the energy sector some significant gaps were observed in key areas such as automation, PLC control and domotics.

The analyses have allowed us to outline critical areas of intervention and propose evidence-based recommendations to try to reduce training gaps and improve the alignment of vocational and technical education in the region with the energy sector labour market.

The following are some of the recommendations that could benefit.

a. Improving the Quality of Education

Updated curricula. According to ECLAC, the rapid technological transformation in the electricity sector requires a continuous review of educational programmes. The integration of modern technologies, such as artificial intelligence and smart grid management, into curricula is recommended. This should be supported by international certifications that enable graduates to access opportunities in wider markets. The recommendations take place in a regional context of deep social and economic inequalities, which set ongoing needs and challenges for education policy. However, prioritising innovation and quality training will bring greater benefits in the medium to long term, both in terms of productivity, development, and the ability to generate skilled employment in the region.

Improved educational resources. UNESCO stresses the importance of up-to-date materials to improve 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 modern technologies, providing a flexible and modern approach to electrical engineering education. This study has been developed within the framework of an exchange project between the Latin American region and Europe, which is a pilot experience with potential in the process of sharing experiences in training models involving these technologies. Its application in the region, and even in the institutions that are part of this project, requires support from different spheres in each country and institution.

b. Effectiveness of Teaching and Learning Processes

Professional development of teachers. 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[8] should focus on improving teachers' pedagogical and technical competences and promote the use of active teaching methods such as project-based learning, simulations, case studies, etc.

Professional exchanges. Encouraging the exchange of knowledge with other regions and international institutions is key to improving teaching competence. This meeting space or arena of good practice, intended for teachers and professionals in the field, is conceived as a forum for exchanging, discussing, and reflecting on those practices which, because of their relevance, characteristics, and results, deserve to be shared with colleagues. Its aim is to encourage the analysis, inspiration, and improvement of these practices, while rethinking innovations in electrical engineering teaching.

According to Axel Rivas, 'the best way to define good practice is what is worth telling other colleagues about' (Rivas, André and Delgado, 2017). It is valuable because it works, creates

[8] **UNESCO (2018)**: *Rethinking Education: Towards a Global Common Good?'*

better learning processes, is meaningful and can be sustained over time. As such, it should not remain 'buried' in the institution but should be disseminated and replicated.

When we think of good practice, we think of it from the point of view of sharing knowledge that can be useful to others, with a view to creating networks, leading those who teach to rethink their practice (Pérez and Solá, 2006). As Sennet (2003) argues, it is a matter of 'narrators of experience' who tell their potential audience about small steps, about concrete and limited victories. These suggestions are particularly valuable because they are not based on the imposition of specific knowledge, but rather on action, seeking to evoke and inspire. In this way, they start with the simple, the small and the mundane, offering an example that can be valuable to others (Alliaud, 2017).

c. Improving Employability

Adaptation to the labour market. Both ECLAC and the International Labour Organisation (ILO9) emphasise the need to systematically address the links between training and market needs. It is crucial that VET institutions carry out regular labour demand surveys and adapt their programmes to the profiles that are most in demand. This includes specialisations in areas such as renewable energy and industrial automation, which increase the employability of graduates.

Links between industry and education. To bridge the gap between education and employment, it is necessary to strengthen partnerships between educational institutions and companies in the electricity sector. Alliances enable the creation of apprenticeships, internships and joint projects that provide students with first-hand experience, ensuring that their training is relevant and applicable to the working environment.

[9] **ILO (2021)**: *'World Employment and Social Outlook"*

d. Economic Development

Impact on the electricity and energy sector. This diagnosis shows that there is a need to deepen and update vocational training. It also defines their link to increased innovation and productivity in the electricity sector, which in turn contributes to the country's economic growth. ECLAC recommends promoting applied research and development of energy technologies, not only to modernise the sector, but also to generate quality employment in areas related to renewable energy.

Promotion and sustainability. Professionals must be trained to implement sustainable energy technologies, in line 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.

Inclusion of the Most Vulnerable in the Sector

Increased scholarships and funding. It is important at the public policy level to promote programmes that are linked to the public and private sectors to fund low-income students in science, electrical engineering, and related fields. These programmes should include not only scholarships, but also other forms of financial assistance to cover additional expenses such as educational materials and transport. In addition, they should include an inclusive approach that prioritises underrepresented groups, such as Indigenous peoples, to ensure equitable distribution of opportunities.

Encouraging participation from an early age. It is essential to develop educational policies to encourage interest in energy-related technical careers from an early age, especially in disadvantaged communities. Given the expected growth of employment in the electricity sector, this represents a significant opportunity for social and professional integration. STEM awareness and skills training programmes for secondary and technical school students could better prepare young people for these opportunities in the future.

Given the projected growth in employment in the energy and electricity sectors, these initiatives represent a key opportunity to promote social and economic inclusion, particularly in rural and marginalised areas in Latin America where inequalities in education and employment are most pronounced.

It is also important that these policies are accompanied by continuous monitoring and evaluation to ensure a positive impact on overcoming socio-economic barriers. It will also enable students to complete their studies and access good employment opportunities.

e. Increase Women's Participation in the Sector

Gender equality and opportunities for women.

Measures in the academic field. To promote gender equality, ECLAC and UNESCO recommend increasing the number of scholarships for women in electrical engineering professions, 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 developed by the countries that are part of this study, to a greater or lesser extent, suggest the importance of deepening the approach, at the level of educational policy from an early age, of initiatives to promote women's participation in science-related careers.

Measures in the labour sphere. In the labour sector, ECLAC recommends the implementation of affirmative action to eliminate gender inequalities and the promotion of internal policies in companies that favour gender equality, such as the prevention of harassment and the promotion of an inclusive work environment. This is in addition to other general labour and social policies, such as a fairer regulatory framework for caring work.

9. CONCLUSIONS

The diagnosis developed in El Salvador, Ecuador and Argentina shows that the challenges of improving the relevance of vocational and technical vocational training in Latin America are many and vary from country to country. However, the reality is that countries in the region are aware of the importance 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 decision-makers, but in the difficulty of implementing transformative programmes and policies on a large scale and with high quality. A review of current experience suggests that despite regional diversity, there are some common elements that create opportunities with high transformational potential.

The changing 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 the sector, it is necessary to implement a dynamic educational offer that responds to both current needs and emerging competences. Regrouping and optimising training programmes and facilitating access to lifelong learning for SMEs is key to ensuring that both current and future professionals are equipped to lead these changes.

Attracting young people, workers 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 demonstrate the strategic value of the electricity sector in the energy transition, not only to ensure its relevance but also to stimulate its long-term growth.

Finally, working with other regions and anticipating employment and skills needs will strengthen the sector's ability to effectively manage career pathways, driving high-demand job creation. Supporting SMEs in their development and adaptation to this new context will

be a key pillar to ensure a sustainable and resilient ecosystem that drives both innovation and sustainability in the Latin American electricity sector.

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adventure

Educational journey to sustainable innovation

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