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

National Report – El Salvador

Research Group

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Executive Summary

The results present a detailed analysis of the challenges and opportunities of the electricity and energy sector in El Salvador, in the context of the global energy transition. It focuses on the matching vocational education and training (VET) with labour market needs, framed within the Advancing VET Institutions' Capacities for Building Electrical Engineering Skills and Sustainable Future "ADVENTURE" project, which aims to strengthen the capacities of VET institutions in electrical engineering and promote sustainable practices.

The research was conducted using a mixed methodology, combining surveys, interviews and focus groups. These tools allowed the collection of quantitative and qualitative data that reveal the gaps between the educational offer and the demands of the energy sector. The fieldwork focused on strategic areas with significant development in the electricity sector, covering educational institutions, graduates, employers, managers, researchers, administrators.

Main Findings

1. **Structure and productive capacity of the energy sector:** In 2023, El Salvador's installed capacity reached approximately 2,600 megawatts (MW), highlighting the growth in the incorporation of renewable energies. The country has diversified its energy matrix, strengthening its competitiveness in the Regional Electricity Market (Mercado Eléctrico Regional, MER).
2. **Occupational demand and skills**: Key occupations and necessary competencies were identified, such as knowledge of the regional electricity market, energy efficiency management, and technical skills in maintenance and machinery operation. Continuous training and technological upgrading are relevant to close the current gaps between education and market needs.
3. **Educational offer:** The country counts with various academic programmes in the energy sector offered by 15 Higher Education Institutions (HEIs). However, the need to better align curricula with market demands was identified, promoting training in emerging and technological areas.
4. **Sector competitiveness**: El Salvador ranks 81st in the *Energy Transition Index (ETI)* 2023, indicating progress in its energy transition, although challenges remain in innovation and educational quality. Improved collaboration between industry and academia is essential to raise the overall competitiveness of the sector.
5. **Energy transition challenges and strategies**: The ILO report underlines the need for policies that promote decent and sustainable jobs, adapting the workforce to new technological demands. The transition to clean energy must generate quality job opportunities and minimise negative impacts on existing employment.

Conclusions and recommendations: The conclusion is that, although El Salvador's electricity sector has advanced in terms of productive capacity and adoption of renewable energies, there are significant gaps in professional training that need to be addressed to ensure the competitiveness and sustainability of the sector. It is recommended to update educational curricula, foster collaboration between academia and industry, and strengthen continuous training programmes for teachers and professionals in the electricity sector.

1. Introduction

The main objective of the present report is to document the development and findings of the ADVENTURE project, which aims to improve the quality and relevance of technical and professional education in the field of electrical engineering in Latin America. The project seeks to address the existing gaps between the skills demanded by the labour market and the training provided by Vocational Education and Training (VET) institutions, through curriculum updating and teacher training in innovative pedagogical and technological practices.

1.1 Methodology and Information Gathering Techniques

Both qualitative and quantitative techniques were used for data collection. The methodology included 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. In addition, an exhaustive documentary analysis of existing curricula was carried out to identify areas for improvement according to the current demands of the labour market.

1.2 Territorial Scope of the Fieldwork

The ADVENTURE project has a transnational approach, involving several countries, including Argentina, Ecuador and El Salvador in Latin America, and Belgium, France, Italy and Poland in Europe. The fieldwork in El Salvador took place mainly in the regions where the VET institutions involved are located, thus ensuring an adequate representation of the diverse educational and labour realities of the country.

1.3 Technical Teams and Roles in the Research Stages

The technical team was composed by experts in technical and vocational education, mainly electrical engineers, and administrative and research professionals in the educational field. Roles included planning and executing surveys, moderating focus groups, conducting interviews, and analysing the data collected. Each stage of the research was coordinated by a central team, with the collaboration of local institutions in each country.

1.4 Fieldwork Implementation Schedule

The fieldwork was carried out over a 12-week period, which included phases of planning, data collection, analysis and synthesis of results, and finally validation with stakeholders.

1.5 Report Purpose

The specific purpose of the national report is to present the results of the primary and secondary data collection carried out in the framework of the ADVENTURE project, identifying the main gaps in training competences and proposing concrete solutions to overcome them. The report also aims to provide recommendations to serve as a basis for updating curricula and implementing the innovative pedagogical methodologies designed by the project.

2. National Framework. Regulatory Frameworks. Educational and Labour Market Context

2.1 Regulatory Framework of the Educational Sector in El Salvador

In the regulatory and educational context of El Salvador, the General Education Law (Decree 917) organises the education system into formal and non-formal modalities. Formal education includes levels from initial to higher education, while non-formal education seeks to supplement or complement knowledge with a more flexible approach and adapted to the immediate needs of the labour market, although it faces important challenges, such as the lack of formal recognition and certification, and its insertion in informal sectors.

The technological transition and the growing demand for advanced technical skills, especially in Industry 4.0, have brought technical and vocational education to play a key role. At the policy level, there is increasing need to strengthen the alignment between non-formal training and the demands of the formal labour market, as highlighted by the International Labour Organisation (ILO).

The Ministry of Education, Science and Technology (MINEDUCYT) of El Salvador regulates the curriculum, the teaching career and coordinates technical-professional training, which includes secondary technical education and the training of technologists at the higher level. The Teaching Career Law (Decree 665) regulates teacher training and job stability, guaranteeing quality education.

In terms of vocational technical education, the Salvadoran system offers training in both formal and non-formal settings. In 2023, MINEDUCYT statistics showed that technical careers accounted for 20% of the total number of graduates in the country, with 2% corresponding to technologists. Graduates in technical careers are focused on key sectors such as manufacturing, technology and services, while technologists have more advanced training, oriented towards engineering and other technological areas.

An important actor in labour training is the National Institute for Training and Education (INCAF), which is in the process of reform following the transformation of the former Salvadoran Institute for Vocational Training (INSAFORP). This reform aims to modernise labour training in response to market challenges, while largely maintaining INSAFORP's previous provisions, which focused on human resources skills.

El Salvador faces the challenge of improving the coordination between the educational offer and the demands of the labour market, especially with regard to the certification and recognition of

competencies, which underlines the need for continuous updating and reform of training and regulatory institutions.

2.2 Characteristics of Vocational Training in El Salvador

Vocational training in El Salvador, which encompasses both formal and non-formal education, has as its main objective to prepare students with technical competencies and practical skills, adapted to the needs of the labour market. The main characteristics are highlighted below.

1. Types of Training

2.3 Formal education: Includes technical-vocational levels in secondary and higher education, with technical and technological bachelor's degrees, which allows for educational continuity to higher levels. This modality offers structured training, with official recognition and possibilities for professional development.

2.4 Non-formal education: Focuses on short-term job training, aimed at supplying or updating specific knowledge according to market demand. Its flexibility allows it to adapt to rapid changes in technology and industrial processes, but it faces challenges in terms of lack of formal recognition.

2. Focus on Technical Competences

2.5 Training is oriented towards specific technical skills, particularly in key sectors such as manufacturing, construction and technology. Graduates are often well prepared for operational and technical roles.

2.6 Training programmes, both formal and non-formal, prioritise practical skills and the mastery of technical tools and processes.

3. Adaptability to the Labour Market

2.7 Vocational training has a high adaptability to changing market needs, especially in areas of rapid technological evolution, such as Industry 4.0 and digitalisation. This allows graduates to adapt to new working and technological environments with greater flexibility.

2.8 However, graduates from non-formal programmes face difficulties in accessing jobs in the formal sector due to the limited recognition of their certifications.

4. Challenges in Certification and Recognition

2.9 Non-formal education programmes, while providing highly specialised training, often lack formal nationally or internationally recognised certification. This reduces the competitiveness of graduates compared to those with formal academic degrees, limiting their access to better job opportunities.

5. Technological Transition and Sustainability

- Vocational education is gradually adapting to the challenges of green transition and digitalisation, training students in sustainable technologies and automated processes. However, the pace of this transition varies and depends on the infrastructure and resources available in each institution.

2.3 Sector Characteristics, Labour Supply and Demand: Projections and Challenges

(i) Structure and Production Capacity of the Electricity Sector in El Salvador

In 2023, the productive capacity of the electricity sector in El Salvador reached approximately 2,600 MW, with a significant diversification of the energy matrix, highlighting the incorporation of renewable sources such as hydroelectric, solar, biomass and geothermal. In addition, the recent inclusion of natural gas has complemented this matrix. The country actively participates in the Regional Electricity Market (MER), which allows it to optimise its production through energy exports and imports in the Central American region.

(ii) Labour Market and Occupational Profiles

The electricity sector remains an employer of a small part of the population, mostly men in technical and operational positions. As the sector grows, a highly skilled workforce is required to handle emerging technologies and new energy market demands. The demand for key skills, such as knowledge of the electricity market, new energy technologies, energy efficiency (EE) and environmental management, is increasing, especially in renewable generation projects.

(iii) Educational offer related to the energy sector

El Salvador has an educational offer related to the energy sector that includes programmes in various higher education institutions (HEIs), such as the Universidad Don Bosco (UDB), Universidad de El Salvador (UES), and others. Programmes range from technical levels to bachelor's and engineering degrees in areas related to energy generation, transmission, and distribution, as well as energy efficiency management. However, there is a need to better align curricular content with the demands of the labour market, adapting to technological innovations in the sector.

Projections and Challenges

The electricity sector has improved its competitiveness thanks to the diversification of the energy matrix and the optimisation of resources through the Regional Electricity Market (MER). However, it faces challenges in training personnel with advanced technical skills and practical experience. Graduates, although well trained in theory, often lack experience in real projects, which hampers their employability. In addition, the sector demands international certifications such as ISO 50001 and LEED, which are not always available to new professionals.

The growth of the electricity sector will continue to be driven by renewable projects, creating more job opportunities. However, graduates must overcome barriers such as lack of experience and key certifications. It is expected that the educational offer will continue to adapt to prepare professionals with technical and soft skills essential for an increasingly competitive labour market.

The energy sector in El Salvador continues to expand, but future success depends on improving educational offerings, practical training for graduates and access to international certifications. Projections point out an increase in labour demand, but also to higher demands for technical skills and experience.

3. Field Results in relation to the Survey of Demands and Needs in the Electricity Sector

3.1 Overall results

The analysis presented offers a comprehensive view of the situation of education and labour market insertion in the electrical engineering sector in El Salvador, highlighting several key aspects:

3.2 diversity of roles in the sector: The survey reveals a balanced representation of practising professionals, academics and regulators, ensuring a comprehensive view of the sector. This diversity is important for the development of policies and strategies aligned with the needs of the labour market;

3.3 technical and vocational education: 96% of respondents stress the importance of educational institutions providing high quality technical education. In addition, fostering collaboration with industry (62%) and supporting research (60%) are seen as relevant roles. This reflects a clear demand for training that is more practical and connected to the needs of the sector;

3.4 academy-industry linkage: The majority (66.7%) perceive the linkage between academic institutions and the employer sector to be 'partial', suggesting that existing connections are not strong enough. Lack of practical opportunities and weak integration between theory and labour market reality are mentioned as areas for improvement;

3.5 strengthening the linkage: Five main strategies are identified to improve this connection:

- internships (30%);
- applied research (20%);
- curricular updating (20%);
- collaboration and networking (15%);
- adaptation to real industry (15%);

3.6 Perception of vocational training:

- students and graduates: 74% consider the training 'adequate', but only 22% rate it as 'outstanding', suggesting that there is room for improvement;
- teachers: 67% see the training as 'adequate', and 33% rate it as 'outstanding';

- employers and self-employed professionals: The majority (67%) consider the training as 'adequate', although 29% rate it as 'outstanding';

3.7 difficulties in entering the labour market: The main difficulties identified were:

- lack of work experience (70%);
- disadjustment between technical skills and the market's demands (48%);
- lack of soft skills (48%);
- insufficient preparation for interviews and selection processes (44%);
- shortage of professional networks (37%);

3.8 outstanding training centres: The universities most mentioned for their leadership in teaching in the electricity sector are the Don Bosco University, the José Simeón Cañas Central American University and the University of El Salvador, reflecting their strong reputation and confidence in training highly qualified professionals;

3.9 regional comparison: 70% of respondents consider education in El Salvador to be 'in line with the region', although 28% perceive it to be 'below', suggesting that there are still structural challenges that need to be addressed;

3.10 evaluation of training in relation to professional practice: 79.3% consider training to be 'adequate' for its application in professional practice, but 17.2% find it 'not very adequate', which points to areas for improvement to ensure more practical and up-to-date training.

The findings highlight the importance of strengthening the connection between academia and industry, improving technical and vocational training, and addressing labour market insertion difficulties, mainly through a greater offer of internships, applied research and curricular updating.

3.2 Perspectives / visions of the different stakeholders: Students, Graduates, Academics, and Employers

The analysis of the groups of students, graduates, academics, and employers in relation to the additional training needed for a better insertion in the labour market in the electrical engineering sector in El Salvador reveals some key findings.

1. Students Group

- Internships or apprenticeships: 100% of the students consider that practical experience in companies is fundamental for their labour preparation.
- Technological refresher courses: 85% highlight the importance of keeping up to date with modern tools and technologies.
- Preparation for interviews and selection processes: 85% also value career guidance workshops as essential.

- Project management and agile methodologies: 71% point out the relevance of these skills for the working environment.
- Soft skills: 57% recognise the importance of communication and teamwork.
- 57% are interested in learning about industry trends and how to develop their own business.

Students prioritise practical and technical training, but also value the development of soft skills and preparation for job selection processes.

2. Graduates Group

- Work placements or internships: Like students, 100% of graduates consider practical experience to be crucial.
- Technological updating: 75% mention the importance of being up to date with technological tools.
- Soft skills and sector regulations: Both areas are valued by 62.5% of graduates.
- Project management: Also 62.5% see project management as an essential skill.
- Foreign languages: 50% emphasise the need for language training for the globalised environment.

Graduates reaffirm the need for practical training, technological updates and soft skills, being aware of the challenges of the labour market.

3. Academics Group

- Work placements or internships: Academics highlight these experiences as essential for students.
- International exchange programmes: This is one of the most valued areas, reflecting the importance of global exposure.
- Soft skills and project management: These are also considered crucial for the holistic education of students.
- Sector rules and regulations: Academics stress the importance of students understanding the laws and regulations governing the sector.

Academics emphasise the need for practical experience and international training, along with a focus on interpersonal skills and regulatory knowledge.

4. Employers Group

- Traineeships or internships: 80% of employers value practical experience as the most important training.
- Soft skills: 70% highlight the importance of effective communication and teamwork.

- Technological updating: 60% point to the need for graduates to be familiar with modern tools.
- International exchange programmes: 50% value global exposure as an advantage for students.
- Sector regulations: 40% consider it important for students to be aware of sector-specific regulations.

Employers are looking for graduates with practical experience, up-to-date technological competences and strong soft skills, as well as knowledge of industry regulations.

General Overview

- Internships are a priority for all groups (100% of students and graduates, 80% of employers, high priority for academics), underlining the need for real work experience.
- Technological updating and mastery of modern tools are also fundamental aspects, valued by students, graduates and employers alike.
- Soft skills such as communication, teamwork and project management are seen as essential, especially by employers and graduates.
- There is a growing interest in international exposure, either through exchanges or global collaboration programmes.
- Training in industry standards and regulations is relevant to ensure that students can operate within the legal and regulatory framework of the industry.

Taken together, these findings suggest that educational institutions should prioritise a balanced training that combines theory, practice, soft skills, and constant updating with industry technologies and regulations.

Gaps between skills trained and labour market needs

1. Technical skills mismatch: There is a gap between technical competences developed in the curricula and the labour market's actual demands. Graduates and employers point out that current training is not fully aligned with the needs of the sector, suggesting that updates in the technologies and tools taught are required to improve employability.
2. Lack of practical experience: Both students and employers highlight the importance of internships and placements. The lack of practical experience during academic training is a key gap that prevents graduates from being better prepared to face immediate employment challenges.
3. Insufficient soft skills: Employers highlight the lack of soft skills, such as communication, teamwork and project management, which are crucial for a dynamic working environment. Curricula do not seem to prioritise these competences sufficiently.
4. Partial connection between academia and industry: The link between educational institutions and the employer sector is seen as insufficient. Limited collaboration restricts students' ability to acquire directly applicable skills and adapt to work requirements.

5. Teacher training and curriculum updating: Although teachers perceive training to be adequate, there is a need for continuous training and updating in technological trends so that they can teach more relevant and current skills. This underlines the importance of programmes that keep teachers up to date with developments in the sector.

6. Internationalisation and mobility: There is a gap in access to advanced educational resources and technologies compared to other regions, such as Europe. Global exposure through exchange programmes is valued as a key tool for aligning training with international standards.

The main gaps are in the lack of technological upgrading, practical experience, and soft skills in curricula. Greater emphasis on academia-industry collaboration, curriculum updating and strengthening teacher training is needed to close the gap between academic training and labour market expectations.

4. General conclusions

- Priority skills: There is a need to align the technical skills trained with the labour market demands, highlighting the importance of technological upgrading.
- Teacher Training: There is a recognised need for continuous teacher training programmes, aligned with sector trends.
- Graduates' profile: There is a perception of adequacy, although the need for more training in modern technology is pointed out.
- International comparisons: International collaboration and exchanges are seen as vital to improve the quality of education and better prepare students for the global market.
- Trends: There is a trend towards the integration of research and innovation in training, as well as an effort to improve the link between educational institutions and the employer sector.
- Challenges: The main gaps identified relate to the matching of the skills trained with the labour market needs, and the expectation is that education will adjust more dynamically to these demands.

5. Recommendations

- Always value curricular updating with representatives of the productive sector, teachers, and graduates, to systematically review the curriculum according to institutional and national time regulations, ensuring that contents reflect current market demands.
- Integrate specific modules on emerging technologies, such as artificial intelligence, automation, and renewable energies, which are increasingly in demand in the labour market.
- Include compulsory courses on soft skills, such as leadership, effective communication, and time management, which are essential in the modern workplace.
- Establish mandatory internship programmes that are aligned with the academic curriculum, allowing students to apply their knowledge in a real work environment.
- Organise regular forums where employers and academics can exchange information on the needs of the sector, which will allow the curriculum to be adjusted according to market trends.
- Encourage students to participate in research projects that solve real problems in the sector, enabling them to apply their knowledge and develop innovative solutions.
- Create partnerships with innovation centres to provide students with access to advanced technologies and opportunities to participate in pioneering projects.
- Create alliances with innovation centres so that students have access to advanced technologies and opportunities to participate in pioneering projects.

- Promote and facilitate the participation of students in exchange programmes with institutions in other countries to enrich their training with a global perspective.
- Adopt international standards in the teaching of the profession, aligning the contents with the best educational programmes at a global level.
- Implement continuous training programmes that allow teachers to update their knowledge of new technologies and teaching methodologies.
- Provide incentives for teachers to develop and implement new teaching methodologies that make learning more dynamic and effective.
- Create a feedback system in which the opinions of students, graduates and employers on the relevance of the curriculum and the competences acquired are collected on a regular basis.
- Establish a graduate tracking system to assess the performance of graduates in the labour market and adjust the curriculum according to the results obtained.
- Develop innovation and creativity laboratories within educational institutions where students can experiment and develop innovative projects.
- Establish prizes and awards for students and teachers who propose innovative ideas that improve the teaching-learning process or contribute to the development of the sector.

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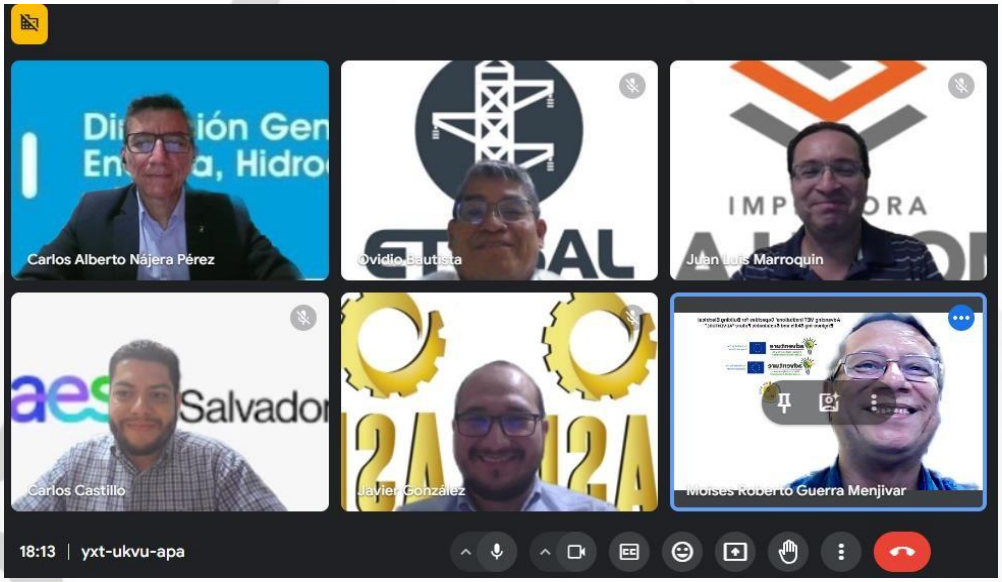
Sample Interviews

Face-to-face interview with Ing. Edwin Núñez, executive president of Empresa Transmisora de El Salvador (ETESAL) and Employees of that company.

Sample of employers' focus groups



a. Carlos Nájera – Representative of the General Directorate of Energy, Hydrocarbons and Mines
b. Carlos Castillo – Representative of the company AES El Salvador
c. Ing. Juan Bautista – Representative of the company Transmisora de El Salvador (ETESAL)
d. Ing. Juan Luis Marroquín – Representative of the company Impresora la Unión (Electrical and Maintenance)
e. Javier González – Representative of the Asociación Salvadoreña de Industriales