

Advancing VET Institutions' Capacities for Building Electrical Engineering Skills

and Sustainable Future “ADVENTURE”

COMPARATIVE GENERAL REPORT-SUMMARY

ARGENTINA

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1. Executive summary

This research identified the main gaps in skills, infrastructure, and pedagogical practices in chosen VET institutions. It also deepened the understanding of the specific needs of the labour market in relation to electrical engineering.

The research results were obtained through surveys, interviews and focus groups, and point to several problems in the training of professionals in this field, among which we can mention:

- lack of curricular updating;
- lack of soft skills;
- lack of practical experience;
- lack of up-to-date technical knowledge;
- lack of motivation and interest in the career.

The paper recommends a number of actions to improve the quality of electrical engineering education, including:

- updating curricula;
- encouraging practical training;
- encouraging student motivation and engagement;
- promoting lifelong learning;
- improving the quality of secondary education;
- evaluate vocational education.

The set of recommendations developed based on the work aims to ensure that their implementation will help train new generations of professionals prepared to face the challenges of the electricity sector and contribute to the sustainable development of the country.

This effort, led by La Salle Foundation Argentina, reinforces the institution's commitment to improving education and vocational training in the country, aligning with the global objectives of the ADVENTURE project.

2. Introduction

The present work set out to:

- identify current gaps in skills, infrastructure and pedagogical practices in the selected vocational education and training (VET) institutions;
- understand specific labour market needs in relation to electrical engineering.

To achieve these objectives, three different information gathering techniques were employed:

- i. surveys. These were answered by 22 respondents representing six different interest groups. The distribution by sector of the survey respondents can be seen below;
- ii. interviews. The interviews were conducted virtually through the Zoom platform, with the permission of the interviewees, and were recorded for later analysis. Eight people from different interest groups participated in the interviews, with the average duration of each interview being 30 minutes;
- iii. focus groups. Two focus groups were conducted, one from the business sector and the other from the academic sector. In each focus group, 4 members of the corresponding sector took part. The focus groups were also implemented virtually through the Zoom platform and were recorded with the consent of the participants for subsequent analysis.

The work team included a research coordinator and three research assistants.

The work schedule included four stages.

First stage: recruitment of stakeholders and application of surveys, weeks 1 to 4.

Second stage: application of interviews and focus groups, weeks 5 and 6.

Third stage: data collection, i.e. application of forms, development of interviews and execution of focus groups, week 7.

Fourth stage: development of research document.

3. National Framework. Regulatory Frameworks.

Educational and Labour Market Context

Characterisation of the educational environment

The Argentine national education system (National Education Law No. 26.206) comprises 4 levels: early childhood, primary, secondary, and tertiary education, and eight modalities.

a. Technical Vocational Education

Technical vocational education is one of the modalities of the Argentinean education system; it integrates diverse types of institutions and programmes of education for and by work. There are three main groups of institutions that form part of technical vocational education: middle-level technical schools, higher-level technical schools, and vocational training centres.

Law N° 26.058 is the law that aims to regulate and organise technical and vocational education at the intermediate and higher non-university level of the national education system and vocational training.

Non-university intermediate and higher technical qualifications and vocational training certificates may be recognised at national level based on the recognition criteria and standards agreed and defined by the Federal Council for Culture and Education.

Within compulsory education, technical secondary institutions, unlike 'oriented' ones¹, have curricula that are one year longer than those providing vocational training. In the last year of the course, and as part of the training of future technicians, students must carry out professional internships that allow them to obtain professional experience and links with the occupational field towards which their training is oriented -Ley de ETP N° 26.058/05 (articles 11, 15 and 16).

¹ Oriented secondary institutions are those offering a generalist education with the possibility of choosing a specialisation in the final years. They allow students to study specific areas of knowledge in depth, but without the technical or vocational component that characterises technical schools. The possible orientations may vary according to the jurisdiction, but usually include areas such as: natural sciences, communication, humanities, economics and administration, and art, among others.

Currently in Argentina there are more than 1,600 technical vocational education institutions at the secondary level in the 24 jurisdictions of the country. Students can choose from a varied range of more than twenty specialisations, including electricity and electromechanics. Both profiles enable them to install low- and medium-voltage electricity consumption and distribution lines.

Higher level technical institutions, also known as tertiary, fall within the scope of technical education under the terms of CFE Resolution N°13/07 and provide post-secondary education linked to the labour market. They offer short duration trajectories compared to university degree courses, and a specific technical specialisation.

They differ from the university level, where engineering degrees have a formal duration of between 5 and 6 years. These degrees are based on a deeper scientific, mathematical, and theoretical background, with a focus on understanding the principles of electrical engineering and their application. The aim is to prepare the student for positions with greater technical responsibility, such as system designer, project manager, etc.

b. University Education

In the field of engineering, there are a variety of options such as universities throughout the country that offer energy-related engineering degrees. The university with the greatest national presence in the field of engineering is the National Technological University, with more than 85,000 students, representing more than 40% of the total number of engineering students in the country. At the same time, it is the one that offers the widest range of Electrical Engineering courses, as it offers this degree in twelve of its thirty regional faculties. It is also taught in several state-run universities, such as the University of Buenos Aires, which, like the National Technical University, has many students (approximately 8,500), but none of them are privately run.

This is an indicator of the low level of interest in and/or lack of knowledge about training in this specific area of engineering. In particular, the Buenos Aires Institute of Technology (ITBA) used to teach this speciality until a few years ago but stopped doing so due to the lack of students interested in it.

According to the database provided by the University of Buenos Aires (UBA), enrolment in the Common Basic Cycle for Engineering degrees evolved as follows.

Overall enrolment for engineering careers grew between 2016 and 2022 by 36%, from 2,930 to 3,979 students, while the electrical orientation practically remained constant, without a defined trend, at around 100 students. In 2022, the total enrolment for electrical engineering (94 students) represented only 2.4% of the total.

According to the survey presented at the 72nd Plenary and Assembly of the Federal Council of Deans of Engineering (Confedi), in 2020 a total of 205,835 students studied engineering degrees in Argentina, while there were only 6,367 graduates, corresponding to 3.09%. As for electrical engineering in particular, there were 5,937 students and 128 graduated, corresponding to 2.15%.

c. Labour Market

Regarding the electricity market, Argentina is a global energy power and ranks among the 29 main energy producing countries. In terms of the labour sector, in 2022, according to data from the Ministry of Labour, Employment and Social Security, the energy supply employed on average a total of 103,020 workers in the private sector, distributed in various positions in generation, transmission and distribution, and in related industries and services.

At present, the most sought-after careers and the best paid jobs in the current labour market are those related to science, technology, engineering, and mathematics, but also those related to knowledge economics, energy, and health.

In the first place are all systems-related careers including systems engineering, computer engineering, electronic engineering, bachelor's degrees in systems, bachelor's degrees in computer science. Secondly, there are more specific engineering careers such as electrical engineering, mechanical engineering, and chemical engineering. Thirdly, energy and petroleum-related careers are in high demand.

The demand for these careers currently exceeds the number of graduates from our universities. On the other hand, the expected growth in Argentina of², such as in renewable energies, the need

² Vaca Muerta is a sedimentary formation deposited in a Jurassic-age Sea in the Neuquén Basin in the province of Neuquén. It was given this curious name in 1931 by the American Charles Edwin Weaver (1880-1958), a doctor of geology and palaeontology, who found it outcropping throughout the Vaca Muerta Mountain range. It is the most prolific liquid and gaseous hydrocarbon producing rock in the Neuquina Basin and is key to the country's energy development. According to data from the National Energy Secretariat (CAP IV), the average daily production for the month of April 2022 was:

for gas pipelines and high voltage lines, electro mobility and mining for the energy transition, chemical engineering for hydrogen and synthetic fuels and data science for smart meters will generate an explosion in the demand for engineers in the different specialities in the near future,' says the Vice-Dean of the Faculty of Engineering of the UBA.

4. Results

4.1. Surveys

This analysis is based on the information provided in the survey on professional training in electrical engineering. It was answered by 22 respondents, representing six different stakeholder groups, including students, teachers, practising professionals and employers, giving a comprehensive picture of the current situation.

Characteristics of vocational training in the sector.

According to the respondents, the main objectives of educational institutions, are:

- 72.7% considered the main objective to be Providing high quality technical and vocational education;
- 36.4% stated that the objective is to update curricula and teaching resources according to the demands of the labour market;
- 31.8% considered that the objective is to foster collaboration between educational institutions and the industry/employer sector.

Regarding the connection between academic institutions and the employer sector, 82% stated that they have 'partial connection' or 'fluid', which indicates an area for improvement, while the remaining 18% reported no connection.

The strategies mentioned by the interviewees to improve the connection between educational institutions and companies are the development of professional internships, mixed workshops, agreements, and discussion forums.

As to how training in the profession is viewed from the perspective of the different stakeholders in the industry, each stakeholder group was asked about their point of view regarding students, teachers, and employers.

80% of the students surveyed identified the training of students as adequate.

64% of teachers perceive it as adequate, with the remaining 36% equally divided between those who see it as outstanding and those who see it as inadequate.

Finally, we note that in the perspective of employers/self-employed professionals 54% think it is adequate, 36% think it is insufficient and the remaining 10% think it is outstanding.

By sector, the perception on the need for additional training is similar. 75% of the students consider that they need training in soft skills and work experience. 80% of professionals favour technological updating and soft skills training. 65% of teachers prioritise internships and soft skills training. 90% of employers consider practical training and technological updating to be indispensable.

In general, respondents consider that electrical engineering education needs to adapt to the new realities of the market. It is essential that educational institutions update themselves, integrate modern technologies, develop continuous training programmes, and strengthen collaboration with companies to ensure that graduates are prepared to face the challenges of the sector.

4.2. Interviews

As described in the introduction, eight interviews were conducted with different actors related to electricity. The central point emerging from these interactions are as follows.

Consensus Points

1. need for curriculum updating;
2. soft skills training;
3. interaction between education and the private sector;
4. changing market demand;
5. importance of practical training;

6. differentiation in specific needs.

Dissent Differences of Opinion

1. Perspective on technical training: 75% of the interviewees emphasise the updating of regulations and integration with educational institutions to ensure the quality of training, 25% focus more on the comprehensive development of skills that allow engineers to adapt to various situations, beyond the technical.
2. Focus on industry: 25% highlight the need to train people in the field of electrical safety and to create new job opportunities, such as solar energy. On the other hand, the remaining 75% focus more on specific training in technologies and the connection with energy regulations.
3. Educational experience: 12.5% emphasise the student experience at University of Buenos Aires, reflecting concerns about teaching and updating of content, while 87.5% are more positive about the quality of university education, although they recognise areas for improvement.
4. National vs. local view: 25% speak from a more local or regional perspective, while 75% approach the situation from a more global perspective, including comparisons with other countries.

4.3. Focus groups

4.3.1. Employers' Focus Groups

Consensus

- Need for better training: all participants agree that technical and university education needs significant improvement, especially in the connection with the labour sector.
- Shortage of technicians and professionals: there is a consensus on the lack of skilled technicians and professionals in the electricity labour market, which creates significant job opportunities.

- Lack of motivation and commitment: it is recognised that the new generations show a lack of motivation which impacts on their educational performance and in the labour market.

Differences

- Perspectives on practical training: while the prescribing engineer of Schneider Electric Argentina criticises the lack of practical contact of students with electrical products, the Founding Partner of TRIKOM, responsible for the technical area and new business development mentions that he has had good results with trainees but stresses the need to encourage them to feel the value of being technicians.
- views on secondary education: the Managing Partner at Ritec Ingeniería Eléctrica SAS and the TA Operations Supervisor at SACME share concerns about the state of secondary education and how it may be failing to motivate students, while Mora focuses more on the employment situation faced by graduates.

4.3.2. Academic Focus Group

Consensus

- The need for more up-to-date and practical training.
- The importance of the theoretical base.
- The need for a better link between academia and business.

Differences

- Perspectives on training: 50% of participants agree that technical training needs to be more practical, 25% stress the importance of working in collaboration with companies, while another 25% consider that training in mathematics and physics needs to be strengthened to give students a solid foundation.
- Experiences with vocational training: 50% highlight the need to prepare students for the world of work from secondary education, while the other 50% talk about the importance of internships so that students can develop skills and gain experience.

5. Gaps between Skills Taught and Labour Market Needs

- Lack of previous work experience. Recent graduates lack the practical experience needed to function in the workplace.
- Misalignment between technical skills and market demands. Educational institutions do not always manage to align their curricula with the current needs of the market, which generates a discrepancy between the technical skills acquired and those demanded in practice.
- Lack of soft skills. Interpersonal communication, teamwork, project management and adaptability are key skills that, according to respondents, are not always developed during training.
- Outdated technical skills. The rapid evolution of technologies and tools used in the sector requires constant updating, which is not always provided in educational programmes.
- Insufficient preparation for interviews and selection processes. Many students and graduates lack the necessary tools and skills to successfully face job interviews.

Main Trends and Demands of the Sector According to the Different Actors

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

6. Conclusion

By way of conclusion, we can say that this research, carried out by the La Salle Foundation within the framework of the ADVENTURE Project (Advancing Vocational Training Institutions' Capacities for Building Electrical Engineering Skills and Sustainable Future), shows that vocational training in electrical engineering in Argentina reveals significant gaps between the skills of graduates and the current demands of the labour market, as well as with regard to the challenges related to environmental sustainability. These gaps represent a challenge to be addressed, as they affect both the employability of future professionals and the country's ability to integrate sustainable practices in the electricity sector.

Among the most significant gaps are outdated curricula, lack of integration of emerging technologies, lack of soft skills, and limited practical experience. These shortcomings limit the development of skilled professionals to respond to current challenges, such as automation, digitalisation, and the efficient use of renewable energy, which are key trends in the global electricity sector.

Key recommendations include updating curricula to cover emerging technologies such as automation and artificial intelligence; promoting practical training and digitalisation; and strengthening the knowledge base in key areas such as mathematics and physics. It also underlines the importance of establishing closer links between educational institutions and businesses, so that students can apply knowledge in real-world environments.

Another focus of the recommendations is the new technological shift towards a sustainable future, the incorporation of sustainability principles in education. By integrating technologies related to energy efficiency and renewable energy, curricula will be able to prepare professionals capable of leading the shift towards a more sustainable electricity sector. This not only responds to the demands of the labour market, but also to international commitments in terms of climate change and sustainable development.

Understanding that the implementation of these actions will be fundamental for Argentina to train a new generation of professionals prepared to face the technological and sustainable challenges of the electricity sector. Strengthening professional training will not only improve the employability of graduates but will also contribute significantly to the sustainable development

of the country, positioning Argentina as a key player in the transition towards clean energy and more responsible practices in the energy sector.

7. Recommendations

From the analysis carried out in the report, several gaps are identified between the skills of graduates and the needs of the labour market. These gaps may hinder the employability of future professionals in the sector. To address these needs, the following actions are recommended.

7.1. Curricular Updating

Emerging technologies. It is essential to update curricula to incorporate technologies that are transforming the sector, such as automation, robotics, artificial intelligence, energy efficiency and renewable energies.

Encourage digitisation. Integrate data management, information analysis and artificial intelligence-based decision-making into training.

Prioritise practical training. Implement internships in companies so that students gain work experience and become familiar with current technologies.

Integrate soft skills. Incorporate the teaching of soft skills such as communication, teamwork, project management, problem solving, critical thinking and adaptability into the curriculum.

7.2. Strengthening the Academy-Business Connection

Encourage collaboration between educational institutions and companies. Design internship programmes, guided visits to companies, joint research and development projects, and continuous training programmes for teachers in collaboration with the private sector.

Implement professional internship programmes. Encourage professional internships in companies in the electricity sector so that students can apply the knowledge acquired during their training.

7.3. Encourage Student motivation and Engagement

Implement strategies to motivate students. Organise talks with professionals in the sector, visits to companies, workshops and competitions that allow them to learn about modern technologies and job opportunities in the sector.

Disseminate job opportunities in the sector: Promote technical careers in secondary schools so that students are aware of the possibilities for professional development in the area.

7.4. Promote Vocational Training

Support continuous training. Facilitate access to continuous training programmes for professionals in the electricity sector to enable them to update their knowledge and skills.

Encourage teacher training. Provide professional development opportunities for teachers to update their knowledge and develop new skills in the use of emerging technologies.

7.5. Improving the Quality of Secondary Education

Strengthen the knowledge base in mathematics and physics. Implement strategies to improve students' performance in these areas, which are fundamental to the understanding of technical concepts.

Motivate students to pursue technical careers. Awaken interest in engineering and technology from an early age to foster vocations and increase enrolment in electromechanical careers.

7.6. Consider Regional Needs

Adapt curricula to the needs of each region. Identify the needs of the labour market in each region and adapt curricula so that graduates are prepared to meet local demand.

7.7. Evaluate Vocational Education and Training

Implement evaluation systems to measure the quality of training. Design mechanisms to evaluate the impact of training actions on the employability of graduates.

The implementation of these recommendations will help to create a new generation of professionals prepared to face the challenges of the electricity sector and contribute to the sustainable development of the country.