

Formación de competencias administrativas para la transición energética. Propuesta didáctica

Training in administrative skills for the energy transition. A teaching proposal

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RESUMEN: La crisis climática y los acuerdos alcanzados en la COP30 han reforzado la urgencia de acelerar la transición energética en coherencia con la Agenda 2030. Este artículo propone una estrategia didáctica para posgrados en administración, centrada en el diseño de planes de negocio para empresas dedicadas a la instalación de sistemas fotovoltaicos. A lo largo de un proyecto semestral, se prevé que el estudiantado analice el contexto energético, formule modelos de negocio y evalúe su viabilidad financiera y socioambiental. La propuesta se orienta a favorecer el desarrollo de competencias administrativas vinculadas a los Objetivos de Desarrollo Sostenible 4, 7, 9 y 13.

Palabras clave: Educación superior; Competencias administrativas; Energía solar fotovoltaica; Transición energética; Educación para el desarrollo sostenible; Plan de negocios

ABSTRACT: The climate crisis and the agreements reached at COP30 have underscored the urgency of accelerating the energy transition in alignment with the 2030 Agenda. This article proposes a pedagogical strategy for graduate-level management programs, centered on designing business plans for companies specializing in the installation of photovoltaic systems. Through a semester-long project, students are expected to analyze the energy landscape, formulate business models, and evaluate their financial and socio-environmental viability. The proposal aims to foster the development of management competencies linked to Sustainable Development Goals 4, 7, 9, and 13.

Keywords: Higher education; Management competencies; Solar photovoltaics; Energy transition; Education for sustainable development; Business plan

Introduction

The acceleration of climate change has placed the energy transition at the heart of international debates. The most recent synthesis report from the IPCC (Intergovernmental Panel on Climate Change) warns that the window of opportunity to limit global warming to 1.5°C is rapidly narrowing and that profound transformations in energy, production, and consumption systems are required (IPCC, 2023). In this context, renewable energies are consolidating their position as one

of the pillars of the global response and are recognized as a substantive component of Sustainable Development Goal (SDG) 7: Affordable and Clean Energy, closely linked to Sustainable Development Goal (SDG) 13: Climate Action.

Within the range of renewable technologies, solar photovoltaics occupies a privileged position. Recent reports from the International Renewable Energy Agency (IRENA) indicate that expanding photovoltaic capacity is essential to maintaining a trajectory compatible with the 1.5°C limit, in which the electrification of end uses and energy efficiency, supported by renewable sources, are the central drivers of the transition (IRENA, 2023). This is further supported by the sustained decrease in the levelized costs of photovoltaic electricity, which now places it among the most competitive options for new generation capacity (IRENA, 2024). This dynamism is also reflected in the job market: the report *Renewable Energy and Jobs: Annual The 2023 review* documents the growth of employment in the renewable sector and the emergence of new business models and green ventures (International Renewable Energy Agency (IRENA) & International Labour Organization (ILO), 2023), in line with SDG 9: Industry, innovation and infrastructure.

The international political framework was strengthened by COP30, held in Belém, Brazil, from November 10 to 21, 2025. The Belém Political Convention was adopted at that conference. Package, which brings together decisions on mitigation, adaptation, financing and just transition, and renews calls to intensify climate action at multiple levels (United Nations Framework Convention on Climate Change (UNFCCC), 2025a, 2025b). These decisions imply the need for advanced capabilities to design, evaluate and manage clean energy projects, as well as to mobilize investments and partnerships that contribute to SDGs 7, 9 and 13.

The 2030 Agenda explicitly recognizes higher education as a strategic actor for driving transformations toward sustainability. SDG 4: Quality Education, and in particular target 4.7, underscores the importance of education systems promoting knowledge, skills, values, and attitudes geared toward sustainable development. In line with this, UNESCO has highlighted the need to integrate Education for Sustainable Development (ESD) into university programs so that students can understand global challenges, such as climate change and the energy transition, and act in an informed manner (UNESCO, 2020, 2022, 2024).

Postgraduate programs in administration are in a privileged position to articulate organizational management, innovation, and sustainability, and simultaneously contribute to SDGs 4, 7, 9, and

13. The development of administrative skills linked to the energy transition, for example, through the design of business plans in photovoltaic solar energy, allows the curriculum to be linked to real problems and concrete goals of the 2030 Agenda.

Within this framework, this article aims to design, describe, and justify a teaching strategy based on the development of business plans for photovoltaic solar energy, which is proposed for implementation in postgraduate management programs. This teaching proposal seeks to contribute to the development of administrative competencies related to the energy transition and explicitly aligns with SDGs 4 (Quality Education), 7 (Affordable and Clean Energy), 9 (Industry, Innovation and Infrastructure), and 13 (Climate Action).

Development

Energy transition and linked SDGs

The energy transition can be understood as a structural change in energy systems, based on the accelerated expansion of renewable sources, the electrification of end uses, and improved efficiency. The *World Energy Transitions Outlook 2023* indicates that, to stay on the 1.5°C pathway, it is essential to significantly increase installed renewable energy capacity and transform not only infrastructure, but also institutions, policies, and human capabilities (IRENA, 2023). This process presents technological, organizational, and financial challenges closely related to SDG 7, which aims to ensure access to affordable, reliable, sustainable, and modern energy, and to SDG 13, which calls for urgent action to address climate change and its impacts.

The deployment of renewable energy also opens up opportunities to advance SDG 9, which promotes the development of resilient infrastructure, sustainable industrialization, and innovation. The value chains associated with photovoltaics, ranging from equipment manufacturing to design, installation, maintenance, and consulting services, require skills in project management, finance, marketing, and business organization. These are precisely the areas that inform the curricula of public administration programs, and where students can position themselves as future managers of the energy transition.

Higher education, skills and SDGs

Education for Sustainable Development is grounded in a competency-based approach that integrates knowledge, skills, values, and attitudes geared toward transformative action for

sustainability (UNESCO, 2020). In the university context, various policy documents and academic studies concur on the need for educational programs to contribute to the implementation of the 2030 Agenda through experiences that strengthen students' sustainability competencies (UNESCO, 2022, 2024). Thus, SDG 4 is realized not only through access to education but also through the quality of learning and its relevance to challenges such as climate change and the energy transition. The specialized literature identifies sets of key competencies for sustainability, among which stand out systems thinking, anticipation, critical reflection, collaboration and strategic competence (Redman *et al.* , 2021; Sa *et al.* , 2022). These competencies become meaningful when linked to the management of organizations and projects that contribute to SDGs 7, 9, and 13. Furthermore, studies on higher education and sustainability underline the importance of interdisciplinary experiences that articulate knowledge from different areas around complex problems (Mokski *et al.* , 2023), as occurs in the planning and evaluation of photovoltaic solar energy projects.

Project-Based Learning (PBL), solar energy, and administrative training

Project-Based Learning (PBL) has become established as a particularly suitable methodology for developing sustainability competencies, as it places students in front of real-world problems that require research, analysis, and decision-making. Recent research shows that working on renewable energy projects in Latin American universities fosters both an understanding of environmental challenges and the acquisition of technical and sustainability skills (Soplin) . *et al.* , 2025; Syamra & Suryadi , 2025). When these projects are designed in dialogue with the local context, the social relevance of the training is further increased and its link with the SDGs is strengthened.

In the field of administration, PBL allows for the integration of content from finance, marketing, operations, and the legal framework around projects that, like photovoltaic solar energy business plans, are directly connected to the achievement of SDGs 7, 9, and 13. At the same time, the learning experience is framed within SDG 4, by offering opportunities for active, meaningful, and action-oriented training, consistent with the goals of education for sustainable development.

Educational proposal: business plans in photovoltaic solar energy

Based on these principles, a teaching strategy is designed for a postgraduate program in administration at a public university in northwestern Mexico. The institution is located in a region characterized by high temperatures for much of the year, high electricity demand in the residential and commercial sectors, and a growing interest in grid-tied photovoltaic systems. The proposal is

designed to be developed over one academic semester and is organized into three phases: diagnosis of the energy and market environment, formulation of the business plan, and financial and socio-environmental evaluation.

Phase 1: Diagnosis of the energy and market environment

In the first phase, students will conduct an environmental assessment based on a review of official and scientific sources on climate change, energy transition, solar energy costs and electricity consumption patterns in the region, such as IPCC reports, IRENA documents, green jobs reports and government materials related to electricity rates and distributed generation schemes, among others.

This process will allow us to identify potential market segments, including high consumption households, small businesses, and offices, and to understand the technical, economic, and regulatory factors that influence the adoption of photovoltaic systems. From the perspective of the SDGs, this stage is expected to foster an understanding of the links between the local context and the challenges of SDG 13, by analyzing the impacts of climate change; SDG 7, by exploring clean energy alternatives; and SDG 4, by developing the capacity to interpret complex information and compare diverse sources.

Phase 2: Formulation of the business plan

In the second phase, each student team will design a business plan for a photovoltaic system installation company. The plan will include defining the value proposition, market segmentation and positioning, marketing strategies, and the company's organizational and operational design. The value proposition will integrate services ranging from energy audits to managing interconnection permits and system maintenance.

The marketing strategy will explicitly incorporate customer education initiatives, using informative content about the benefits, costs, and myths associated with solar energy. This will reinforce the educational nature of the proposal and its alignment with SDG 4 by extending the educational dimension beyond the classroom. Simultaneously, the formulation of the business model and the identification of market opportunities in the photovoltaic sector connect with SDG 7 by promoting clean energy solutions, and with SDG 9 by fostering innovation and the provision of services related to renewable energy infrastructure.

This stage aims to strengthen strategic planning and marketing skills by requiring coherence between context analysis and positioning and communication decisions, as well as skills to innovate in business models that respond to the challenges of the energy transition.

Phase 3: Financial and socio-environmental assessment

The third phase will focus on the financial and socio-environmental assessment of the projects. The teams will estimate the necessary initial investment, operating costs, project cash flows, and calculate indicators such as the break-even point, payback period, and internal rate of return. They will also identify associated risks, including fluctuations in electricity rates, changes in equipment costs, and regulatory modifications, and propose strategies to mitigate them. Finally, they will estimate the positive environmental impacts of the projects, primarily in terms of CO₂ emission reductions and cumulative savings on customers' electricity bills.

This phase aims to develop financial and project evaluation skills, essential for designing economically viable initiatives in the renewable energy sector. Within the framework of the Sustainable Development Goals (SDGs), the comprehensive evaluation of projects contributes to SDG 7 by valuing affordable and clean energy solutions, and to SDG 13 by considering the climate mitigation potential of the proposals. Reflection on corporate responsibility towards its customers and the environment will, in turn, seek to reinforce ethical dimensions associated with a just transition.

Expected contributions to the energy transition and the Sustainable Development Goals

The proposal described allows for a clearer understanding of the contributions of the teaching strategy to both the energy transition and the achievement of the SDGs. On the one hand, working with business plans in photovoltaic solar energy will place students in a field of action directly aligned with SDG 7, by fostering the design of clean energy solutions for homes and businesses. On the other hand, the incorporation of financial analysis tools, strategic planning, and service innovation is linked to SDG 9 by strengthening capacities to develop businesses and services related to sustainable energy infrastructure.

It is expected that understanding climate change, along with estimating the impacts of emissions reductions, will connect the experience to SDG 13 and reinforce the idea that business decisions have climate implications. Finally, the project-based and competency-based pedagogical approach, consistent with Education for Sustainable Development (ESD), contributes to SDG 4 by offering

quality, action-oriented education that is relevant to contemporary challenges and focused on training professionals capable of actively participating in the energy transition.

Conclusions

Analysis of the proposed teaching approach suggests that designing business plans for photovoltaic solar energy can be a suitable strategy for developing administrative skills in postgraduate programs. Organizing the work into three phases environmental assessment, plan formulation, and financial and socio-environmental evaluation emerge as a way to facilitate the integration of theoretical knowledge and practical tools in a coherent project, situated within a specific regional context and linked to real-world challenges of the energy transition.

In terms of training, the program anticipates strengthening competencies in environmental analysis, strategic planning, financial evaluation, and socio-environmental responsibility, as well as a more solid understanding of the concepts of energy transition and sustainability. The project-based methodology is designed to empower students to take an active role in constructing their own learning, in line with the principles of Education for Sustainable Development (ESD), and to foster the integration of knowledge from administration, finance, law, engineering, and environmental sciences.

From an educational policy perspective, proposals such as the one presented here help management programs respond more directly to the challenges posed by the climate crisis and international agreements, such as those adopted at COP30. Incorporating projects related to solar energy and other green economy solutions into the postgraduate curriculum not only increases the social relevance of the training, but also prepares future professionals to participate in the management of just transition and sustainable innovation initiatives.

In summary, the examined teaching strategy aims to contribute to the development of administrative skills for the energy transition in accordance with the 2030 Agenda. By linking SDG 4 through project based and skills based education, SDG 7 through the design of solar energy solutions, SDG 9 through innovation in business models, and SDG 13 through the explicit consideration of climate impacts, this proposal creates a training environment in which business management is geared towards sustainability and responding to the global challenges of our time.

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