

*Electricity Transmission Planning in Latin America:
Regulatory Challenges and Recommendations to Speed Up
Network Expansion*

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**ELECTRICITY TRANSMISSION PLANNING IN LATIN AMERICA:
REGULATORY CHALLENGES AND RECOMMENDATIONS TO SPEED UP
NETWORK EXPANSION**

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Abstract

The Latin American and Caribbean (LAC) region has advanced regulations governing transmission expansion planning in the power sector and has been and continues to be the birthplace of numerous innovative experiences in this field. Even so, there are certain gaps in transmission planning practices that prevent these networks from expanding at the necessary pace. Criticalities arise in the form of bottlenecks in the queue of interconnection requests, rising congestions and a significant increase in renewable energy curtailment. This article presents a detailed analysis of transmission planning in Brazil, Chile, Colombia, Ecuador, and Guatemala, with a particular focus on regulatory aspects such as the organisation of the planning process and the socio-environmental licensing of transmission projects. This review was complemented and enriched through direct contact with public institutions and stakeholders in the five countries. This exercise allows us to identify gaps with respect to international best practices and put forward recommendations to improve planning efficiency and enable countries in the LAC region to fulfil its energy policy ambitions.

Keywords

Transmission regulation; Expansion planning; Public acceptance; Social Licensing; Environmental Assessment.

1 INTRODUCTION

The transmission network is the backbone of any power system [1]. It allows electricity to be transported from areas with the greatest generation potential to centres of demand. It improves the reliability and the resilience of the system, facilitating a constant balance between injections and withdrawals. It allows neighbouring electrical systems to be connected and regional markets to be created. Globally, transmission activity costs typically account for between 5% and 10% of total electricity supply costs[2][3]. In the United States, transmission is estimated to account for about 13% of the national average cost of electricity [4]. However, given its strategic nature, the transmission network also significantly impacts generation costs, which account for the largest proportion of supply costs.

For this reason, transmission expansion planning (TEP) is undoubtedly one of the key strategic decisions for the proper functioning and efficient development of the electricity system as a whole [5]. In the vertically integrated monopolies that characterised the industry from its origins until the last decades of the last century, transmission network planning was part of an integrated process of electricity system expansion, which minimised overall transmission and generation costs. However, the liberalisation of the electricity sector, first implemented in the LAC region (with Chile as a pioneer in 1982 [6]) and then in the rest of the world, has led to a paradigm shift in transmission planning, which must now be coordinated with the decentralised development of other resources in the system and the autonomous investment decisions by market agents.

This liberalised paradigm has faced further challenges over the past few decades due to the energy transition and the imperative to decarbonise the economy. Intermittent renewable generation, on which this transition in the electricity sector is based, tends to be installed in areas where the availability of its primary energy source is greatest [7]. These areas may be remote or far from the grid. In a liberalised environment, the balance between reducing the generation costs and transmission costs must be achieved through complex coordination models and sophisticated regulatory tools that send efficient signals to the actors involved [8]. Beyond problems that may arise from the complexity of coordinating transmission planning and generation developments, others challenges are caused by implementation problems. For instance, strong public opposition can delay, sometimes significantly, and can even block the granting of licences for new transmission facilities, forcing regulators and

developers of these facilities to implement more participatory decision-making processes [9][10].

These new (or renewed) challenges have become increasingly acute over the past decade, with transmission capacity shortages emerging as a major obstacle to the energy transition [11]. Bottlenecks in grid interconnection queues, escalating congestion costs, reduced system reliability, and rising levels of renewable energy curtailment highlight the severity of the issue. [12]. Only in the power systems of the European Union, renewable curtailments due to grid congestion have resulted in the loss of 12 TWh of clean electricity in 2023 [13].

In order to solve the problem of shortages in transmission capacity, governments and regulators around the world have introduced reforms that significantly affect the process of planning the expansion of transmission networks. Among the most notable regulatory initiatives, are several recent orders from the United States Federal Energy Regulatory Commission (FERC), especially Order 1920, which defines new rules for regional transmission planning and the allocation of resulting costs [14], and the Department of Energy's Building a Better Grid Initiative [15]. In the United Kingdom, the Government is creating different regulatory packages within the framework of the so-called Transmission Acceleration Action Plan [16]. Meanwhile, the European Commission has launched the EU Action Plan for Grids [17] and the European Grids Package [18] that also covers transmission planning. In Australia, the system planning process has been reformed in 2018, with the introduction of the so-called Integrated System Plan [19].

1.1 The Latin American context

The Latin America and the Caribbean (LAC) region has one of the lowest levels of greenhouse gas emissions from the electricity sector worldwide. This milestone has been achieved over the last century by harnessing the region's enormous hydroelectric potential. Hydroelectric generation accounts for more than 50% of the energy produced in recent years [20]. Non-conventional renewable resources (wind, biomass and solar photovoltaic) already

cover 16% of the total energy produced, while fossil fuels account for less than 30% (Figure 1)¹.

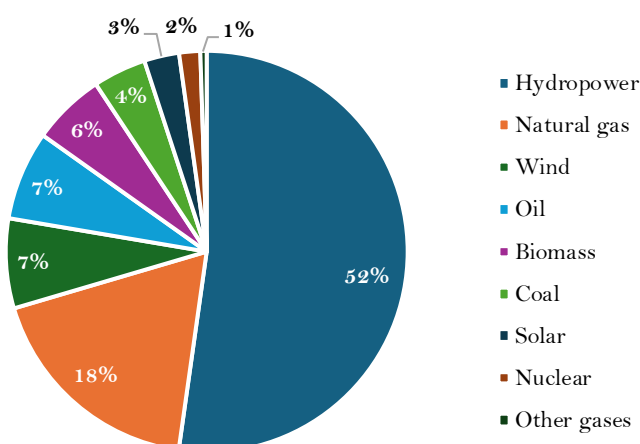


Figure 1. Electricity generation by technology in the LAC region, values represent the average for the years 2018-2023; data from [20]

This mix of resources, which is already very clean on average, faces major challenges. The most important is probably the need to diversify the energy matrix [21]. On one hand, some countries still need to reduce their use of fossil fuels. On the other hand, climate change is altering hydrological conditions in the region, with an obvious impact on hydroelectric generation. Production using this technology, historically subject to the variability imposed by the Southern Oscillation climate phenomenon (El Niño/La Niña), could undergo changes due to the increased frequency and magnitude of extreme weather events. These changes could affect different areas of the region in different ways, as illustrated in Figure 2.

¹ That said, it should be noted that the region is also highly heterogeneous. It ranges from countries with a 100% renewable electricity supply to countries that are almost entirely dependent on fossil fuels for their electricity.

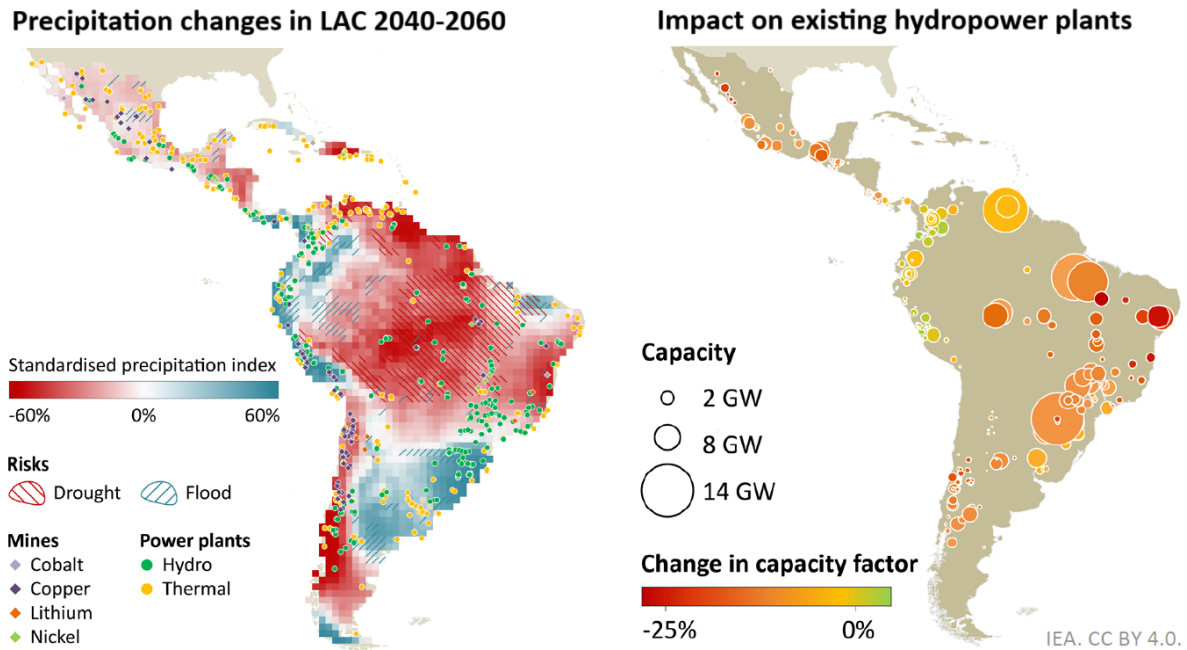


Figure 2. Expected changes in rainfall in LAC and possible impact on the output of existing hydroelectric power stations; chart from [22]

LAC power systems must continue to take advantage of this clean and flexible resource, but reduce their dependence on hydroelectricity through energy sources capable of complementing it. In this sense, the energy transition in Latin America and the Caribbean represents not only a strategy for mitigating climate change, but also for adapting to it. To diversify the resource mix, the region has almost unrivalled potential for intermittent renewable generation. As illustrated in Figure 3, there are areas in the region where solar photovoltaic capacity factors can reach 36%. In addition, there is enormous wind potential, both onshore and offshore, across much of the region. The LAC region has already begun to exploit this potential, with average year-on-year growth in wind and solar production over the last five years reaching 22% [20]. The region needs to maintain or increase this growth rate in order to meet its objectives of diversifying the resource mix in the electricity sector and supplying a demand that could grow at a very rapid pace in the coming decades, in terms of both annual volume and peak demand [22].

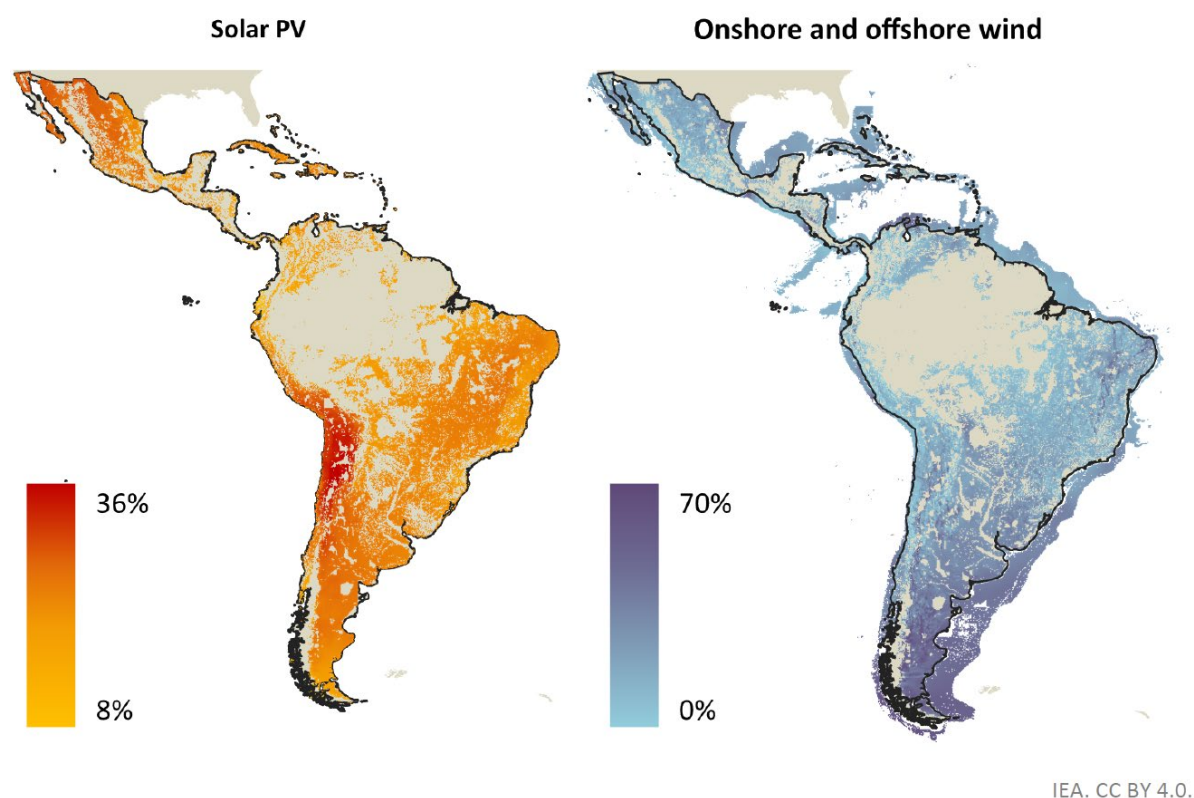


Figure 3. Simulated average of solar and wind capacity factors in LAC; chart from [22]

In order to cope with these challenges, significant new investments will be necessary, both in renewable generation and in storage facilities. The integration of these new resources, as well as new electricity demands, will also require massive investments in new transmission and distribution networks. However, current trends in transmission investment are not aligned with these needs [22]. Over the last decade, a significant gap has emerged and widened between the transmission infrastructure developments that have been carried out and those that would be necessary to meet the region's energy transition objectives. Electricity systems in the LAC region are already experiencing significant bottlenecks in interconnection request queues, as well as increased congestion management costs and renewable energy curtailment, particularly in Brazil [23] and Chile [24].

1.2 Research questions and structure of the article

Several scientific papers have addressed various aspects of transmission planning in the LAC region. Mastropietro et al. [25] present a broad review of transmission regulation in a selection of Latin American countries, although they do not place a strong emphasis on transmission planning. Other articles focus on transmission planning but restrict their analysis to a specific jurisdiction or region: Argentina [26][27][28][29], Brazil [30][31], Chile [32][33], Mexico [34][35], Paraguay [36], or the SIEPAC interconnection in

Central America [37]. However, to the best of the authors' knowledge, no article has reviewed and compared transmission planning practices in a broad set of countries within the LAC region with those implemented in other power systems.

This article aims to provide a thorough review of transmission planning in Latin America and the Caribbean (section 2), with the intention of identifying common regulatory practices and some gaps with respect to international best practices. Section 3 then draws regional recommendations based on recent trends and lessons learned from the same LAC region and other jurisdictions. Section 4 summarises the main conclusions and identifies possible future work. The article argues in favour of centralised, proactive transmission expansion planning that anticipates the investment decisions of players in the electricity sector and, to a certain extent, guides them towards a solution that is efficient for the system as a whole. This centralised planning should not be affected by functional or geographical regulatory segmentation of the grid and encourage private sector involvement in both the planning and execution phases. Licensing authorities should be involved in the planning process from the outset to provide socio-environmental information. Standardised citizen participation, the designation of a coordinating entity for permits and the identification of national corridors could further accelerate project approval and implementation.

This article focuses on the regulatory aspects of electricity transmission planning. An evaluation of the technical specifics or the optimisation tools and models employed in the planning process is beyond the scope of this article, but can be found in Lumbreras and Ramos [38] or Hemmati et al. [39]. Other aspects related to transmission planning, such as the locational signals from electricity prices with spatial granularity or transmission tariffs, the remuneration of transmission service providers or system operators, or the interconnection process and queue management are also beyond the scope of this article, which focuses on the general framework and organisation of transmission expansion planning, as well as the social and environmental licensing involved.

2 TRANSMISSION PLANNING IN LATIN AMERICA AND THE CARIBBEAN

This section presents a review focusing on five LAC jurisdictions: Brazil, Chile, Colombia, Ecuador and Guatemala. These countries were selected to represent the heterogeneity of LAC power systems in terms of network size, orography, and the prevalent approach to transmission (predominantly market-oriented vs. relatively more regulated). This review was conducted through a detailed desk research, which was complemented and enriched through direct contact with public institutions and stakeholders in the five countries.

Information was exchanged with these entities via questionnaires and video conference interviews. A list of the entities that collaborated on this review can be found in Annex I.

2.1 Brazil

Brazil has the largest electricity system in Latin America and the Caribbean and the most extensive transmission network (189 600 km of transmission lines in 2024 [40]). The Brazilian electricity sector was vertically separated, liberalising generation activity between 1995 and 1998 with a series of regulations, notably Law 8.987 of 1995. An electricity market was created, now operated by the *Câmara de Comercialização de Energia Elétrica* (CCEE), a private non-profit company. The system came to be operated by the *Operador Nacional do Sistema* (ONS) and an independent regulator, the *Agência Nacional de Energia Elétrica* (ANEEL), was also created. The supply crisis of 2001, however, forced a new reform of the sector, embodied in Law 10.848 of 2004, which introduced stricter rules on long-term contracting and energy planning and created the *Empresa de Pesquisa Energética* (EPE). The main division within the transmission system established by regulation is between the *Rede Básica* (Basic Network), with voltages greater than or equal to 230 kV, and the *Demais Instalações de Transmissão* (Other Transmission Facilities, or DIT), with voltages below 230 kV, which also include lines for the exclusive use of a small group of users [41].

2.1.1 Transmission planning framework

Planning the expansion of Brazil's transmission network is a complex process involving different entities. Figure 4 shows a diagram of this process, which consists of two separate but coordinated plans, one from EPE and the other from ONS, which are ultimately consolidated by the relevant Ministry (*Ministério Minas e Energia*, MME). The two plans may overlap and are usually carried out with a high degree of coordination and information exchange between ONS and EPE.

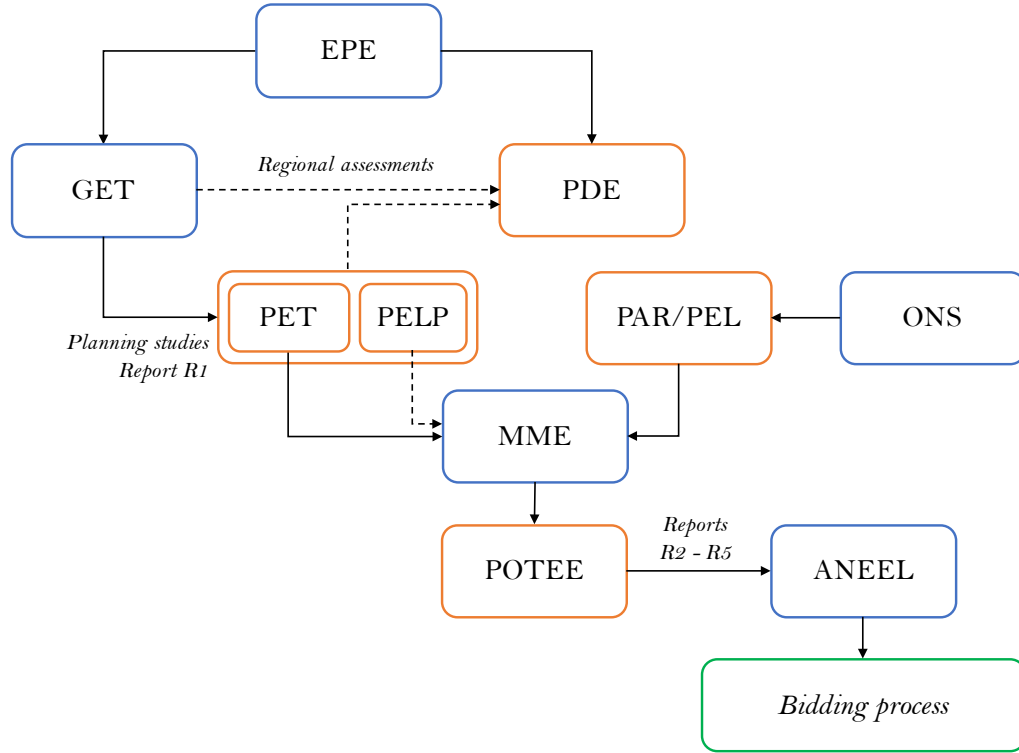


Figure 4. Outline of the transmission planning procedure in Brazil, authors' own elaboration

With regard to EPE planning, the process is regulated in [42] and begins with the so-called Transmission Study Groups (*Grupos de Estudo de Transmissão*, GET), which are regional working groups chaired by EPE and involving companies from the electricity sector in each region. The GETs ensure effective interaction with market agents, so that they can provide information about their plans and priorities that can be internalised in the transmission planning. There are currently six GETs, according to the zoning shown in Figure 5, although there is also a group that deals with the connection between different regions.



Figure 5. Transmission Study Groups in Brazil; EPE chart (web)

The main inputs for planning within each GET are the regional assessments carried out by EPE within each group, some of which are also reflected in the Ten-Year Energy Expansion Plan (*Plano Decenal de Expansão de Energia*, PDE), published annually by EPE. Based on the needs defined through these diagnoses, the GETs identify projects that can meet those needs and develop so-called planning studies (*estudos de planejamento*) for each of these projects. The studies are prepared following a methodology defined in [43] and are compiled in the R1 Report, which aims to demonstrate the technical, economic, and socio-environmental feasibility of each new project.

The projects identified by the GETs are compiled in biannual reports called the Transmission Expansion Programme (*Programa de Expansão da Transmissão*, PET) and the Long-Term Expansion Plan (*Plano de Expansão de Longo Prazo*, PELP). The PET covers the first six years from the publication of the report and includes projects that EPE considers necessary, while the PELP covers the period from the seventh year onwards from the publication of the report and is indicative in nature, identifying projects that could be processed if included in subsequent PETs.

On the system operator side, the ONS publishes every year the Medium-Term Electrical Operation Plan (*Plano da Operação Elétrica de Médio Prazo*, PAR/PEL), which assesses the expected operation of the system over a five-year horizon. For the first two years of the analysed horizon, the PAR/PEL adopts a short-term, or operational, approach, based only

on operational recommendations to be applied while the problem cannot be addressed by developing new projects. For the last three years of the analysed horizon, the PAR/PEL adopts a structural approach, considering the deployment of additional transmission assets, taking into account connection requests from agents, among other factors.

The Ministry receives the PET/PELP prepared by EPE and the PAR/PEL prepared by ONS and periodically consolidates them in the Electricity Transmission Delivery Plan (*Plano de Outorgas de Transmissão de Energia Elétrica*, POTE). This planning aims to reconcile the plans of EPE and ONS through dialogue between the different entities. The works identified in the POTE may be put out to tender for the creation of new concessions or, in the case of minor extensions, be authorised as expansions of existing concessions. For those works that follow the bidding process, the MME requests other studies, known as Reports R2, R3, R4 and R5, the scope of which is described below.

- Report R2 provides technical details of the new network facilities identified in R1.
- The R3 Report identifies the preliminary layout or location of the new facilities and includes a socio-environmental characterisation of the affected areas.
- The R4 Report analyses the impact of the new facilities on the surrounding system.
- The R5 Report presents an estimate of the costs of the land and easements required for the new facilities.

The regulator, ANEEL, is the entity responsible for authorising or tendering new transmission projects, which are normally organised into lots whose construction is auctioned jointly. In transmission tenders, agents bid percentage discounts based on the maximum Annual Permitted Revenue (*Receita Anual Permitida*, RAP) defined by the regulator.

2.1.2 Social and environmental licensing

In Brazil, transmission planning incorporates certain socio-environmental analyses. The R1 Report, the initial element of any new expansion project, includes the definition of a corridor, 10-20 km wide, through which the line will have to pass, or the approximate location of the substations. The corridor is identified using a geographic information system that allows different socio-environmental layers (areas of native vegetation, indigenous or *quilombola*²

² A *quilombola* is a member of a community in Brazil whose ancestors escaped slavery and formed autonomous settlements known as quilombos [44].

lands, etc.) to be superimposed and the most favourable areas for project development to be identified.

If the project is included in the POTEE, the Ministry may request other studies, and the R3 Report delves deeper into the socio-environmental analysis, defining guidelines for determining the route of the line. In defining the route, this study must include a high-level socio-environmental characterisation of the affected areas and identify those elements that could involve some complexity in the environmental and social licensing of the project. It should be noted that planning studies (Reports R1-R5) do not consider the participation of local communities at any stage, which, like the socio-environmental licensing of the project itself, is the responsibility of the successful bidder.

In Brazil, developers of transmission project selected through auctions must request environmental licences from the competent environmental authorities. In the case of projects that impact more than one state, jurisdiction lies with the Brazilian Institute of the Environment and Renewable Natural Resources (*Instituto Brasileiro de Meio Ambiente e Recursos Naturais Renováveis*, IBAMA), an entity linked to the Ministry of the Environment. In the first phase, the project is submitted to IBAMA, which conducts an initial assessment to define, through terms of reference, the minimum content of the environmental studies that must be submitted. The environmental licensing stage also includes various opportunities for public participation, through public hearings to present the environmental impact study and public consultations to gather proposals from the public. Depending on the location of the project and its expected impact, IBAMA may also involve other entities in the licensing process, such as the National Indigenous Peoples Foundation (*Fundação Nacional dos Povos Indígenas*, Funai) or the bodies responsible for managing nature protection areas potentially affected by the project. The application for permits is not centralised, and the concessionaire must request all relevant authorisations for its project from the entities involved, at both the federal and the state level.

Since 2018, EPE and IBAMA have been cooperating to improve integration between the planning and socio-environmental licensing processes for new transmission lines. In 2025, the two entities signed a technical cooperation agreement [45], which institutionalises coordination through technical meetings and workshops during the preparation of the R1 Reports. In recent years, the possibility of internalising part of the environmental licensing process into the planning process has also been studied, bringing forward some of IBAMA's actions, such as the initial framing of the project and the definition of the terms of reference,

within the studies prior to the tenders (R2-R5 Reports). In this way, potential developers would submit bids knowing in advance what type of environmental impact studies would be required of them.

2.2 Chile

The Chilean electricity sector was the first in the world to be liberalised in 1982 through Decree No. 1 of 1982 of the Ministry of Mining. The original design of the electricity market, and the regulation of the sector in general, has remained fairly faithful to the 1982 reform, which also served as an example for the liberalisation of other electricity systems in the LAC region. The reform provided for the creation of an electricity market, assigned the operation of the system and the short-term market to what is known today as the National Electricity Coordinator (*Coordinador Eléctrico Nacional*, CEN), and its supervision to the National Energy Commission (*Comisión Nacional de Energía*, CNE), while the definition of national energy policy is the responsibility of the competent ministry, now the Ministry of Energy (*Ministerio de Energía*, ME).

The most recent regulatory change for the transmission activity came in 2016, through Law 20.936. Beyond introducing the figure of the National Electricity Coordinator, Law 20.936 reformed the regulatory segmentation of the transmission network, renaming the segments as follows.

- National Transmission System: all facilities for common use in the electrical system.
- Zonal Transmission System: facilities that carry energy from the national system to the distribution networks.
- Dedicated Transmission Systems: facilities for private use or whose use is limited to a small number of agents.
- Transmission Systems for Development Hubs: facilities necessary for the evacuation of electrical energy from areas with high renewable potential.

All these segments form Chile's National Electricity System, which had 39 500 km of lines in 2025.

2.2.1 Transmission planning framework

In Chile, the regulator, CNE, is responsible for drawing up and publishing the transmission expansion plan. However, this plan incorporates previous studies carried out by other institutions and is followed by other stages relating to the tendering process and environmental and social licensing of the new works. The first step consists of the Ministry

of Energy drawing up the Long-Term Energy Plan (*Planificación Energética de Largo Plazo*, PELP [46]). This plan is published every five years and has a planning horizon of 30 years. The main objective of the PELP is to serve as the primary input guiding the transmission expansion plan carried out by the CNE, establishing scenarios for the development of electricity generation and storage. Another fundamental objective of the PELP is to identify the aforementioned development hubs. These hubs are defined as territorial areas where there are resources for the production of renewable electricity, the use of which, using a single transmission system, is in the public interest because it is economically efficient for electricity supply.

Another stage prior to the CNE's annual planning is the transmission expansion proposal by the Coordinator [47]. This proposal, which like the CNE's planning is published annually and has a 20-year planning horizon, covers the national and zonal transmission systems. The Coordinator's expansion proposal may include proposals from other players in the sector, such as generation developers and transporters.

Based on the latest edition of the PELP and the Coordinator's proposal, the CNE draws up the annual transmission expansion plan, following the methodology defined in the regulation [48]. The plan has a 20-year planning horizon and covers all segments of the Chilean transmission system (national, zonal, dedicated and development hubs). The Coordinator's proposal is not the only input to the CNE's planning, as the regulation provides for a stage for the submission of proposals by project developers active in transmission and generation. This duplicates, in a way, the interaction with industry players, who can submit their proposals to both the Coordinator and the CNE. According to Chilean institutions, most proposals go directly to the Commission's planning process. Those developers who disagree with the annual plan presented by the CNE (e.g., whose proposal for new transmission assets has not been selected in the final planning) may appeal to an independent panel of experts, which is responsible for resolving these discrepancies. The panel is made up of seven professionals, five engineers or graduates in economics and two lawyers, all with extensive professional experience in the power sector.

2.2.2 Social and environmental licensing

Law 20.936 introduced a highly innovative tool for the environmental and social licensing of transmission works, through the so-called corridor study (*estudio de franjas*). The Law grants the Ministry of Energy the power to define the corridor of territory in which the

successful bidder will subsequently have to locate the new transmission line route and apply for the relevant environmental permits. The objective of the corridor study is to seek alternative locations for transmission works that reconcile the project with the environmental, social and technical-economic considerations required by the territory [48].

The corridor study includes a strategic environmental assessment that conducts certain environmental and social analyses at an earlier stage of the expansion process, prior to the tender for the work. The corridor study also considers various instances of citizen and indigenous participation, with the aim of incorporating their views and interests, thereby giving social legitimacy to transmission projects and reducing the risks involved in their execution. This reduction of the risk perceived by bidders prior to the tendering process may result in lower price bids. It should be noted that the corridor study does not exempt the successful bidder for the transmission project from the obligation to submit an environmental impact study to Chile's Environmental Assessment Service (*Servicio de Evaluación Ambiental*, SEA) in order to obtain a favourable environmental qualification resolution. However, it is expected that the strategic environmental assessment of the corridor study will make it easier to obtain a positive resolution.

Corridor studies, which are carried out by consultants identified by the Ministry [49], are lengthy and costly processes that can add around two years to the already lengthy transmission project cycle [48]. For this reason, Law 20.936 establishes that the Ministry of Energy shall determine which of the new works included in the annual transmission plan will have to undergo corridor studies and which will go directly to tender, leaving the decision on the location of the project to the successful bidder. The law defines reference criteria for making this decision, such as the voltage level of the new transmission assets or the likelihood that they may have a high environmental or social impact.

The most emblematic case of the application of the corridor study has been the Kimal-Lo Aguirre HVDC line, a project of great importance for the Chilean electricity system. Although the Ministry of Energy had originally included the Kimal-Lo Aguirre line among the projects subject to corridor studies, fears of delays in the execution of the project (together with its fundamental role in Chile's energy transition process) led the Ministry to revoke its initial decision and exempt the project from the corridor study [50].

2.3 Colombia

The Colombian electricity system was vertically separated and liberalised by Laws 142 and 143 of 1994 and has since been an important laboratory for electricity system regulation,

particularly in terms of market design. Together with Brazil, it is among the countries in the region with the highest hydroelectric generation capacity. The Ministry of Mines and Energy (MME) is the ministry responsible for the electricity sector. The country also has a specialised planning agency, the Mining and Energy Planning Unit (*Unidad de Planeación Minero-Energética*, UPME), attached to the MME, which draws up all national plans relating to the energy sector. The operation of the system and the administration of the market is carried out by XM. The electricity sector is regulated by the Energy and Gas Regulatory Commission (*Comisión de Regulación de Energía y Gas*, CREG). Both the generation and transmission sectors are open to private investment.

Colombia's National Transmission System (STN) consists of 220 and 500 kV lines. The total length of the STN in 2020 was 15 640 km. There is also a Regional Transmission System (STR), including assets with voltage levels between 57.5 and 220 kV.

2.3.1 Transmission planning framework

The specialised planning agency, UPME, periodically draws up various plans, the most relevant for the electricity sector being the National Energy Plan, the Indicative Generation Expansion Plan and the Transmission Expansion Plan. The generation and transmission expansion plans are developed jointly, considering a 15-year planning horizon, and are published annually. The generation expansion plan is merely indicative and identifies the new resources needed to meet demand.

The transmission expansion plan is binding and is developed by the UPME in collaboration with the Transmission Planning Advisory Committee (*Comité Asesor de Planeamiento de la Transmisión*, CAPT). The CAPT is made up of representatives from the following companies:

- generation companies (one representative);
- distribution companies (one representative);
- large consumers (three representatives);
- retailing companies (three representatives);
- transmission companies (three representatives).

The CAPT allows transmission planning to be informed by advice from key industry players. These players, together with the system and market operator, are required to send the UPME the information necessary for planning. STR network operators must also

submit expansion plans for the network they manage to the UPME [51]. The transmission expansion plan identifies those network assets in the STN that are required to meet demand, complying with current quality, reliability and safety requirements and seeking to minimise investment costs, operating costs and system losses [52]. The UPME may also identify new network projects in the STR that go beyond the operators' planning. The plan thus developed is submitted to the Ministry of Mines and Energy for adoption.

Once the plan has been approved by the Ministry, the UPME is also responsible for preparing and executing public tenders to select the contractors for the projects identified in the STN. In these public tenders, the investor who has offered the lowest Expected Annual Incomes (*Ingresos Anuales Esperados*, IAE) is selected (provided that these incomes do not exceed the maximum value defined for each tender). The successful bidder is entitled to receive the IAE during the first 25 years of operation of the network assets³. Once the successful bidders have been selected, the UPME must submit the results of the calls for tenders to the CREG, so that the regulator can approve the IAE for each project. A peculiarity of the competitive processes used in Colombia for assigning transmission works is that the company ISA (*Interconexión Eléctrica S.A. E.S.P.*, a regional electricity transmission company that has always had strong participation from the Colombian state) is obliged to submit a bid in all public calls for tenders in order to ensure that no project is left unexecuted [53]. With regard to the STR, the projects identified in the planning submitted by the operators must be carried out by the operators themselves. If they do not express interest, these works will also be awarded through a public tender.

The transmission expansion plans, published annually by the UPME, had to be supplemented in 2024 to address urgent investment needs. In recent years, the system operator has declared a state of alert, or emergency, at various nodes in the transmission network. To address this situation, the UPME has launched the so-called Transmission Mission, which includes two packages of urgent works [54][55] and a Master Modernisation Plan [51].

³ After 25 years, annual revenues are calculated using a methodology based on the replacement value of electrical assets.

2.3.2 Social and environmental licensing

In terms of environmental and social licensing, UPME's planning does not identify the location of new assets or the detailed routes of new lines. However, in 2022 the UPME has adopted a territorial approach in its planning exercises, which also has an impact on transmission expansion plans, for example, by requiring the involvement of the country's environmental authorities in the planning phase [54]. However, it is still unclear how the territorial approach will be applied in the planning methodology.

Currently, the successful bidder in the public tender is responsible for processing the environmental licence and other relevant permits (including permits for forest reserve withdrawals and road crossing permits). Environmental studies are conducted according to specific terms of reference, which define the information that the studies must contain. Applications for environmental licences for STN assets are handled by the National Environmental Licensing Authority (*Autoridad Nacional de Licencias Ambientales*, ANLA), an entity under the Ministry of Environment and Sustainable Development. Applications for environmental licences for STR assets, on the other hand, are handled by the Regional Environmental Corporations (*Corporaciones Autónomas Regionales Medio Ambientales y de Desarrollo Sostenible*, CAR).

Transmission projects that require the removal of forest reserves for their deployment must apply for a specific permit, in which they must also define a compensation proposal. According to the UPME [51], this mechanism can create a bottleneck in the expansion of the electricity system due to the limited availability of areas in the country in which to carry out compensation projects (e.g., replanting of similar species).

With regard to social licensing, a specific public entity (*Dirección de la Autoridad Nacional de Consulta Previa*, DANCP) determines the appropriateness and timeliness of prior consultation for projects subject to environmental licensing. Colombia's ethnic communities may apply to the DANCP for inclusion in the prior consultation process. In this regard, the UPME noted that, in some cases, the DANCP does not identify ethnic communities that may be subject to prior consultation, but these communities subsequently appear before a judge to have this right guaranteed. In this case, the ANLA is obliged to suspend the environmental licensing process until the case is resolved, slowing down the proceedings [51].

2.4 Ecuador

Over the last 20 years, Ecuador's electricity sector has been characterised by high regulatory instability, which has affected all segments of the supply chain. The 1996 Electricity Sector Regime Law (*Ley de Régimen del Sector Eléctrico*, LRSE) initiated the liberalisation of the sector through the creation of the National Electricity Council (*Consejo Nacional de Electricidad*, CONELEC), a regulatory, normative and supervisory body through which the State could delegate the generation, transmission, distribution and commercialisation of electricity to concessionary companies [56]. Out of the vertically integrated company, six generation companies and one transmission company (Transelectric) were created to allow private capital to enter them. The National Energy Control Centre (*Centro Nacional de Control de Energía*, CENACE) was also created to coordinate and operate the system.

However, the new Constitution of 2008 and, subsequently, the Organic Law on Public Electricity Services (*Ley Orgánica del Servicio Público de Energía Eléctrica*, LOSPEE) of 2015 reinstated public control over the electricity sector. Generation and transmission companies were merged into a new public company called *Corporación Eléctrica de Ecuador* (or CELEC EP) and a specific regulatory agency was created (*Agencia de Regulación y Control de Electricidad*, ARCONEL). Ecuador's National Transmission System has 500, 230 and 138 kV lines.

The current length of the transmission network is 6 845 km [57]. There are also subtransmission networks (5 729 km of lines with voltages ranging from 46 to 138 kV), whose operation and planning depend on the distributors.

2.4.1 Transmission planning framework

The Ecuadorian electricity sector is characterised by public control of most companies in the supply chain. Although there is the possibility of launching public selection processes, which allow private and international capital to invest in the sector in specific projects, supply is guaranteed by companies that can be deemed vertically integrated with each other. This significantly impacts the transmission planning process, particularly in terms of coordination with generation planning and interaction with market agents. While in the other electricity systems analysed in this regional review, generation planning can be considered indicative, in the case of Ecuador, generation and transmission companies are integrated into a single entity (CELEC EP) and the Master Electrification Plan (*Plan*

Maestro de Electrificación, PME [57]), published by the Ministry of Energy and Mines, carries out centralised planning for both segments of the supply chain.

Although the final publication of the PME, and the transmission expansion planning (*Plan de Expansión de la Transmisión*, PET) it contains, is the responsibility of the Ministry of Energy and Mines, the entity in charge of developing the plan is CELEC EP, in collaboration with the Ministry, the regulator ARCONEL, and the system operator CENACE. This planning has a ten-year horizon. Two assessments are carried out to identify new transmission investment needs. The short-term assessment covers the first two years and is based mainly on CENACE's biannual operating study, although it also considers transmission assets expected to come into operation during this period. The medium-term assessment covers the following two years and is based on forecasts to define the need for new transmission projects to ensure the safety, quality and operational reliability of the system. Based on these assessments, CELEC EP defines a transmission expansion plan divided into three work plans:

- Short-term works plan, which includes projects that already have financing and are under way, with commissioning scheduled for the first two years.
- Medium-term works plan, which includes projects that are not yet underway and do not have guaranteed funding, but for which studies are progressing and which are expected to come into operation in the following two years.
- Long-term works plan, which includes projects that are not yet underway; the long-term works plan is developed for reference purposes only and the projects it identifies are not subject to mandatory implementation [58].

Figure 6 shows a diagram of the overall planning process used in Ecuador.

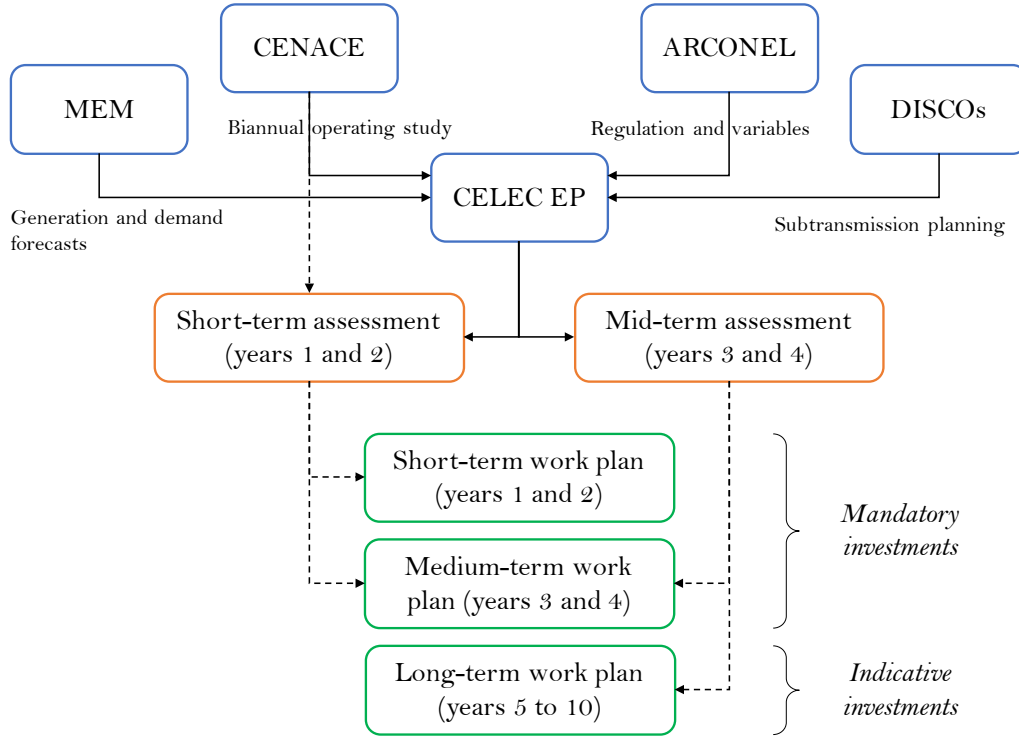


Figure 6. Outline of the transmission planning procedure in Ecuador, authors' own elaboration

2.4.2 Social and environmental licensing

The projects identified in the short- and medium-term work plans are executed by CELEC EP through its Transelectric business unit. Like all infrastructure projects, new investments in network assets must obtain an environmental licence, granted by the Ministry of the Environment, Water and Ecological Transition, in accordance with the guidelines defined in the Organic Code of the Environment and the corresponding Regulations [59]. The environmental impact study required to obtain the licence must include a Community Relations Plan (*Plan de Relaciones Comunitarias*, PRC), which aims to maintain an optimal relationship between the investment promoter and the local communities located in the project's area of influence. The transmission planning exercise, therefore, does not provide for any preliminary definition of the routes, and interaction with local communities is the responsibility of the project developer, Transelectric in the case of investments in electricity transmission.

2.5 Guatemala

Guatemala's electricity system has the highest demand among the systems in Central America, with which it is interconnected in the Regional Electricity Market (*Mercado Eléctrico Regional*, MER). Guatemala also has an interconnection with Mexico, which

represents the interface between the MER and the North American country. The Guatemalan electricity sector was liberalised in 1996 through the General Electricity Law and related regulations [60]. The Ministry of Energy and Mines (MEM) is responsible for defining the country's energy policy, while the National Electric Energy Commission (*Comisión Nacional de Energía Eléctrica*, CNEE) regulates the operation of the electricity market and transmission and distribution activities. The Wholesale Market Administrator (*Administrador del Mercado Mayorista*, AMM) also acts as the system operator. The Guatemalan transmission system comprises approximately 5 135 km of lines, with voltages ranging from 69 to 400 kV. Electricity transmission in Guatemala is open to private investment. There are currently 10 active transmission operators.

2.5.1 Transmission planning framework

According to the regulation [60], there are three modalities for expanding the electricity transmission network: i) agreement between parties, ii) own initiative, and iii) public tender. While the agreement between parties and own initiative modalities consider an active role for transmission companies and electricity market agents, expansions through public tender are defined within centralised expansion plans. The Ministry of Energy and Mines draws up an indicative expansion plan for generation (*Plan de Expansión Indicativo del Sistema de Generación*, PEG), which serves as input for the transmission expansion plan (*Plan de Expansión del Sistema de Transporte*, PET). Both plans must be published every two years and cover a minimum planning horizon of ten years.

The MEM draws up plans based on information on the status of the transmission system provided by the AMM. Electricity market agents may submit expansion projects for consideration in the PET. Considering this information, the Ministry identifies the transmission network expansions that would be necessary to meet the expected evolution of generation resources and demand in the Guatemalan electricity system. The planning objectives include increasing rural electrification (Guatemala's electricity access rate in 2023 was 90.5%, with more than 400 000 households still to be electrified [61]) and promoting regional trade.

However, not all projects identified in the PET proceed to the public tender phase. The CNEE, with the advice of the AMM, analyses the projects identified by the MEM and

defines, by resolution, which of these projects form part of the so-called main system⁴ and are necessary for the following two years. These projects are considered mandatory to deploy and must be assigned through tenders. The CNEE, within a period of three months, must draw up the terms and conditions of the public tender and submit them to the MEM, which approves them (within one month) and carries out the tender (within six months). Figure 7 shows a diagram of the planning process.

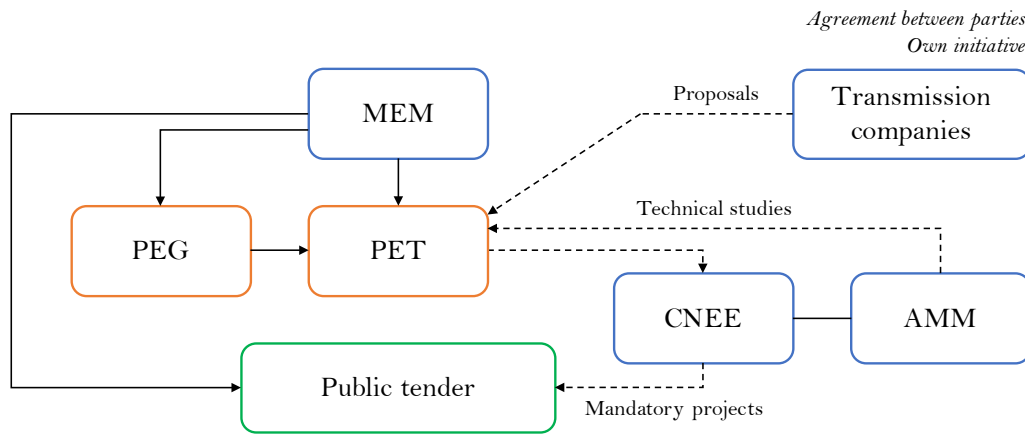


Figure 7. Outline of the transmission planning procedure in Guatemala, authors' own elaboration

2.5.2 Social and environmental licensing

Once network expansion projects are awarded through tender, the successful bidder is responsible for defining the location and route of the new network assets and for managing the relevant permits and relations with local communities. The cornerstone of this process is the project's environmental impact assessment. The successful bidder must carry out the assessment in accordance with specific terms of reference for the project drawn up by the Ministry of Environment and Natural Resources [62]. The terms of reference determine the minimum content of the assessment and may also define the public participation process to be carried out. The environmental impact assessment must be reviewed and approved by MARN. The successful bidder is also responsible for applying for and obtaining municipal permits, signing easement agreements with landowners, and applying for other permits, such as the forestry licence granted by the National Forestry Institute, if the work involves this type of land.

⁴ The main system is defined as the transmission system shared by generators, while the secondary system is one that is not part of the main system and is therefore private.

3 RECOMMENDATIONS FOR LATIN AMERICA AND THE CARIBBEAN

Some power systems within the LAC region have developed and implemented advanced regulations for planning and expanding the transmission network. The region has been, and continues to be, the birthplace of many innovative experiences in this field. Nevertheless, there are certain gaps between the transmission planning practices of the countries analysed in section 2 and international best practices, including those resulting from the reforms mentioned in section 1 and those already applied in some systems in the region. These gaps should be addressed to facilitate network expansion in line with the needs of the region's economies. This section identifies these gaps and provides regional recommendations tailored to the LAC regulatory context, as well as embedded descriptions of best practices from international experiences.

3.1 Transmission planning framework

In none of the LAC countries analysed in this study is the system operator responsible for the main transmission planning. In most cases, the operator plays an important role in planning, particularly in the diagnostic phase of the network status and in providing data on the connection procedure, but it is not the entity that carries out the planning itself. This peculiarity distinguishes the planning practices in the region from the more widespread international approach, in which the system operator indeed plans network expansions. The system operator is normally considered to be the entity with access to the best information on the state of the transmission network and, for this reason, is often responsible for expansion planning. Other entities can perform this task just as efficiently, provided they have access to all the information available to the system operator and the entity that manages connection requests, and have sufficient skills and resources, both in terms of personnel and IT tools, to tackle this complex task. In Brazil, for example, the independent planning agency EPE is responsible for transmission planning. Regardless of which entity is responsible for planning, oversight mechanisms are necessary to consider the possible spurious interests of the planner, who could put the interests (or even the mandate) of their institution above the general objective of maximising the net social benefit of the plan. This is especially important when the planning entity is allowed to own transmission assets.

Another peculiarity of transmission regulation in the analysed countries is the presence of regulatory segmentation of the transmission network. In some cases, this segmentation is purely technical (e.g., by voltage level). However, in many jurisdictions, functional segmentation (e.g., according to the number or type of users served by a network asset) or

geographical segmentation (e.g., according to the country's provinces) is applied. These functional or geographical segmentations can be used for other purposes (such as to define who carries out the works in the implementation phase of the plan), but they should be transparent for the planning process, whose ultimate goal is to find a planning solution that maximises the benefits for the system as a whole. In this regard, it should be noted that, rather than simply compiling expansion projects identified in other studies, expansion planning should take a centralised approach⁵ to identify those projects that would be more beneficial to the entire system.

The LAC region has been a pioneer in promoting private initiative in the transmission sector, both in terms of planning and project implementation. Private actors, both transmission companies and agents from other segments, should always be allowed to propose new investments in the transmission network, but these should be analysed and evaluated within a centralised planning framework. There is also the possibility for private actors to propose expansions of the transmission network outside of centralised planning, but these transmission projects should be subject to clear rules with respect to their approval and the allocation of the corresponding costs. On the other hand, the experience in the region with private participation in the execution of new projects (identified by centralised planning) through competitive selection processes has been very satisfactory, resulting in significant economic savings⁶. Where possible, this private participation should be extended to contexts where it has not yet been introduced, provided that competitive conditions are guaranteed to allow for a high level of economic efficiency.

⁵ Another type of segmentation in the planning process can occur when transmission concessionaires can propose expansions and, after approval, carry them out on their own initiative, without these expansions being evaluated within the overall network planning framework and compared with possible alternative projects. Planning processes should always provide for phases of interaction with stakeholders and the possibility for transmission operators to identify new needs in their network and propose reinforcements to it, but there must be clear rules on the classification of reinforcements into those promoted through the centralised planning process and those others that the concessionaire can carry out without going through a centralized process. And there should also be clear rules on how to assess the second type of reinforcements for their approval and which remuneration conditions should apply to them.

⁶ According to [63], implementing Independent Power Transmission models has resulted in economic savings of 36% in Peru, for example.

Another element that distinguishes the analysed countries from other international experiences is the frequency with which transmission expansion plans are developed⁷. In many electricity systems in the region, an expansion plan is published every year. In Brazil, the plan prepared by EPE is published as often as every six months. In some cases, this frequency is because these plans do not result from an integrated, cyclical planning process. Instead, they are developed by compiling the reinforcements identified as necessary in other studies. In other cases, the expansion plans are the result of thorough planning; however, the frequency with which they are drawn up can sometimes cause overlaps in planning tasks for different years. These overlaps can complicate planning tasks and create uncertainty for the agents involved. Centralised planning must be carried out according to a clearly defined methodology and frequency and must always include an implementation phase for the projects identified as necessary.

Some expansion plans in the region consider a very broad planning horizon, but then identify as necessary only those transmission projects needed in the short term. This approach is also found in international best practices. However, the division between these two different time horizons must take into account the reality of the implementation of new transmission projects in each system, a process that, considering tendering, licences and permits, and construction, can take many years. In this sense, a short- or medium-term horizon of two to four years (as in Guatemala or Ecuador) could be too short, and it would be better to move projects that have been identified as necessary in a longer horizon to the executive phase. In Brazil, for example, the executive expansion plan considers those projects expected to be necessary within the first six years, which seems a very appropriate timeframe.

It is important to consider realistic schedules in both the planning and execution phases. Expansion plans that set binding deadlines for the development of transmission projects must define these deadlines based on historical experience in the execution of previous works of a similar nature. Furthermore, the project developer should not see the time available for licensing and construction reduced due to delays beyond their control (such as delays during the public tender phase). In this regard, it may be more efficient to set a construction deadline for new projects from the official award date (as in Chile) than to set

⁷ For instance, the new British Centralised Strategic Network Plan (CSNP) will be published every three years [64], and the Australian Integrated System Plan is developed every two years [19].

a fixed commissioning date (like in Colombia). Setting unrealistic deadlines can create uncertainty among potential project developers and may result in auctions being declared void. Moreover, unrealistic timeframes for project execution directly affect the quality of the entire expansion plan, as delays to one project affect the optimality of other investments in the system.

In those systems where a high number of tenders have been declared void, beyond investigating the causes of low investor interest, the definition of a transmission company of last resort (such as ISA in Colombia) could be considered. This company would have the obligation to bid in certain tenders or develop projects whose tenders have been declared void. However, the economic conditions for developing these projects should be negotiated with the company taking on this role and should not pose an unmanageable risk.

In countries with rural areas that still have no access to electricity, it is advisable to combine the centralised planning process for network expansion with rural electrification studies carried out using geospatial information tools. This makes it possible to identify which demands can be served through network expansion and which should be supplied through mini-/micro-networks or stand-alone systems.

3.2 Social and environmental licensing

Most electrical systems in the LAC region do not have a Strategic Environmental Assessment (SEA) as part of the transmission planning process, leaving all these studies, and the administrative burden they entail, to the environmental and social licensing process carried out by the developers of the projects proposed in the plan. The main exceptions are Chile, with its so-called corridor study, and partially Brazil, through Reports R1-R5. The entity responsible for transmission planning should involve the entities responsible for the subsequent socio-environmental licensing of the projects, so that they can contribute territorial information to the planning process. This information, on environmental restrictions or territorial conflicts, should be internalised in the early stages of the planning process, and it is advisable that the expansion plans themselves include a preliminary definition of the route of the new transmission lines based on this information. It is even possible to move some of the socio-environmental licensing procedures to the planning phase, especially for projects that are going to be put out to tender, so that the developer can submit a bid knowing in advance the socio-environmental studies that will have to be carried out.

It is advisable to consider introducing an SEA phase into the planning process that entails mechanisms for public participation at a very early stage. Ideally, the introduction of an SEA should lead to improved acceptance of new projects by affected communities, as well as reducing the time required for the execution phase of the corresponding works, particularly the socio-environmental licensing phase. To this end, it is essential, once again, that the entities responsible for socio-environmental licensing play an active role in the SEA phase. If the regulation provides for the application of SEA only to certain transmission projects, there must be clear criteria for deciding which projects are subject to SEA and which are not, leaving little room for discretion that could increase the risk perceived by stakeholders.

Regardless of when public participation takes place in the planning process, it is advisable for regulations to define a standardised procedure for interacting with affected local communities. This should specify the tools for public participation to be used and establish clear deadlines for each sub-phase. In countries where responsibility for granting socio-environmental licences is distributed among different entities (e.g., regional or provincial authorities), it is important that the criteria to be considered and the modalities of citizen participation are harmonised. When regulations provide specific rules for the participation of indigenous communities affected by a transmission project, a clear and effective procedure must be in place to identify these communities. This prevents them from being overlooked in the initial phase, which could lead to subsequent legal proceedings.

Socio-environmental licences are just one of the procedures required during the execution phase of a network expansion project. It is recommended to consider identifying an entity responsible for coordinating the granting of the various permits and licences required to carry out a transmission project, thereby reducing the administrative burden on developers⁸. While this practice may have high start-up costs due to the need for agreements and memoranda to be signed by all the granting entities, it can significantly reduce project execution times. In this area, it is also important that the entities responsible for granting licences and permits have an adequate budget for hiring and training sufficient staff to

⁸ In the United States, under the Coordinated Interagency Authorisations and Permits (CITAP) Programme, the Department of Energy acts as the lead agency, coordinating the acquisition of all federal permits for transmission projects with a federal geographic scope [65]. A similar scheme can be found in the European regulation on projects of common interest for Trans-European Networks for Energy (TEN-E) [66] and is now proposed to be applied also for national transmission projects [18].

manage the expected volume of applications, as well as for implementing the digitalisation of these processes.

It is also advisable to study the possibility of establishing corridors of national interest for transmission projects, with a simplified licensing process for projects installed within these corridors⁹. This solution should be explored especially in countries with large forest areas or other potentially protected habitats and where bottlenecks are occurring in relation to the removal of forest reserves. The identification of a corridor of national interest in these areas would still have to comply with the relevant socio-environmental requirements, but it would centralise the process, including any compensation required for removing forest reserves.

In jurisdictions where there is strong public opposition to projects that are essential for the proper functioning of the electricity system, either now or in the future, it is advisable to consider the possibility of introducing financial compensation mechanisms (beyond the remuneration received for the expropriation of land) for communities or citizens affected by new transmission projects¹⁰. Regardless of the source of the funds that would cover this compensation, this measure would lead to an increase in the cost of electricity supply. However, this increase could be justified when compared to the loss of efficiency caused by congestion in some parts of the transmission network associated with the failure to undertake these projects. If this financial compensation were to apply only to certain expansion projects considered critical to the system, clear rules would need to be established to decide which projects are eligible for compensation and which are not, so as not to give perverse incentives to citizens that could even exacerbate public opposition to transmission projects.

⁹ A notable example in this area is the National Interest Electric Transmission Corridors (NIETCs), which the Department of Energy can identify within the country. NIETC status may be granted when the DOE determines that transmission assets built in that corridor would enable the achievement of strategic national objectives. The NIETC designation process includes initial interactions with affected local communities and also takes environmental criteria into account [65].

¹⁰ This kind of economic benefits are common in the European Union [67], Australia [68], and are being studied in Great Britain [69].

4 CONCLUSIONS AND POLICY IMPLICATIONS

The transmission network forms the backbone of any electricity system. Efficient planning for the expansion of this grid is essential to integrate the most beneficial resources into the system. In the coming decades, the transmission network will need to expand rapidly to facilitate decarbonisation, diversification of the energy mix, and the electrification of many sectors of the economy. However, many experts and regulators have recently highlighted that the transmission network is becoming a bottleneck for the energy transition, and that the planning methodologies used since the liberalisation of the electricity sector are ineffective in this new context. The extension of the terms for obtaining permits and the lack of response to the strong public opposition to the construction of new transmission lines are exacerbating this situation.

The LAC region has one of the cleanest resource mixes in the electricity sector worldwide. The main challenges for the region's electricity systems are the need to diversify their energy matrix, especially to adapt to climate change that could affect hydroelectric production capacity, and to meet the sustained growth in both annual and peak electricity demand. To meet these challenges, massive investments in new grids will be required. However, in many countries in the region, transmission networks are not expanding at the necessary pace. The objective of this article is to provide a comprehensive review of transmission planning in Latin America and the Caribbean and to draw regional recommendations based on international best practices, focusing on two main aspects: i) the general framework and organisation of transmission planning and ii) the social and environmental licensing.

Regarding the organisation of the planning process, the expansion of the transmission network should mainly be based on centralised and proactive planning. This approach maximises the net social benefit and anticipates investments by market players, guiding them towards the most efficient system solution. This centralised planning should be carried out at regular intervals with realistic deadlines to ensure the effective involvement of all stakeholders. Furthermore, centralised planning should not be affected by any regulatory segmentation of the transmission network, whether functional or geographical. Otherwise, its outcome will differ from the optimal one, with the consequent efficiency losses. The existence of centralised planning does not preclude significant private participation, either in the planning phase, through considering expansion proposals from private agents, or, most importantly, in executing the works. The LAC region has pioneered the involvement

of the private sector in transmission project execution, and it is recommended to extend this practice, provided competitive conditions allow it.

Regarding socio-environmental licensing for transmission projects, the licensing authorities should be involved in the planning process, so that they can provide information on the socio-environmental conditions of the territories in question. This information can then be taken into account as far as possible when preparing the expansion plan. It is also suggested that the introduction of a Strategic Environmental Assessment (SEA) be considered during or immediately after the planning phase. The aim of this would be to increase acceptance of the transmission project within the affected communities, while reducing the perceived risk to developers. The SEA should simplify subsequent socio-environmental licensing and reduce the total time from plan approval to commissioning of the transmission asset. The modalities of citizen participation and interaction with the affected communities should be defined in the regulation and standardised throughout the national territory. Appointing an entity to coordinate the granting of licences and permits for transmission projects could streamline this phase. Defining corridors of national interest could also speed up the licensing of projects developed within them.

Future research in this area should focus on the aspects of power sector regulation related to transmission planning and that may affect its outcome, such as the implementation of locational signals or the organisation of the interconnection process. The exercise presented in this article for the LAC region could also be repeated for other regions to produce specific regional recommendations.

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ANNEX I

Below is a list of the entities consulted for the review presented in section 2.

- Brazil
 - Empresa de Pesquisa Energética (EPE)
 - ISA Energia Brasil
 - Ministério de Minas e Energia (MME)
 - Operador Nacional do Sistema (ONS)
- Chile
 - Asociación Transmisoras de Chile
 - Ministerio de Energía (ME)
- Colombia
 - Interconexión Eléctrica S.A. E.S.P - ISA
 - Ministerio de Minas y Energía (MME)
 - XM Compañía de Expertos en Mercados S.A. E.S.P.
- Ecuador
 - Agencia de Regulación y Control de Electricidad (ARCONEL)
 - Centro Nacional de Control de Energía (CENACE)
 - Empresa Pública Corporación Eléctrica del Ecuador (CELEC EP)
 - Ministerio de Energía y Minas (MEM)
- Guatemala
 - Ministerio de Energía y Minas (MEM)