Technical Report

March 2025

ELECTRICITY PRICING AND SECTOR REFORM:

Key Decisions to Consider for Electricity Sector Liberalisation

PRESIDENTIAL
CLIMATE COMMISSION
TOWARDS A JUST TRANSITION

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About this report

This report was prepared by the Regulatory Assistance Project to support the work of the Presidential Climate Commission (PCC) on its stakeholder engagements on electricity pricing and sector reform.

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Document Overview

This report summarizes findings from the Regulatory Assistance Project (RAP) power sector study for South Africa's Presidential Climate Commission (PCC) on key institutional arrangements and decisions for South Africa to consider when transitioning to a more liberalized electricity market. The report is not intended to be a primer on electricity markets, but rather a document that can be used to highlight and inform key decisions related to structural reform of the electricity sector.

The report surveys the background and includes examples from other countries that have gone through similar processes in reforming their power sectors. The findings summarize both secondary and first-hand research conducted for this project.

Executive summary

While there have been discussions and draft plans for changes to South Africa's power system market since the 1998 White Paper on Energy Policy, comprehensive reforms have yet to be fully implemented. More competition in the electricity supply industry in South Africa has already begun to emerge with the growth in wheeling and the participation of independent power producers (IPPs) and traders in the market; but issues with grid capacity constraints, a shortage of investment, high electricity tariffs and connection queues suggest the country would still benefit from a more formalized structure to prevent common roadblocks.

This report summarizes key institutional arrangements and decisions for planners and regulators in South Africa to consider as the country introduces more reforms that will significantly change its power system. It also builds on findings and lessons learned in other emerging economies (i.e., India, Brazil, Mexico, Chile, Guatemala) that have gone through a similar process of electricity sector reforms.

Over the past few decades, many large power systems around the world have started to move away from the vertically integrated utility monopoly model for various reasons (to improve efficiency, reduce costs, incentivize investment, reduce risks etc.). Regional power systems follow different paths when making reforms, and – since challenges and local factors vary by region – there is no one-size-fits-all design for a liberalized electricity sector. Key questions and decisions, however, can help guide the process and avoid challenges faced in other regions. For example, decisions need to be made on how to phase in competition in a way that creates a downward pressure on private sector costs but also allows regulators to continue to play a vital role both during and after the reform process: this can ensure that savings are passed on to consumers and that the power system operates efficiently.

Responsibilities regarding planning and investment must also evolve when a system transitions from a vertically integrated utility to a liberalized electricity sector. The chief reason is to prevent conflicts of interest by letting neutral parties - such as the regulator, independent system operators or the nodal Ministry/Department - make decisions in the public interest. Table 1 provides more details on how these responsibilities differ in a competitive market.

Table 1: Planning and investment activities for a vertically integrated utility vs. a competitive electricity sector

Activity	Vertically integrated utility (Either State-owned or regulated monopoly)	Competitive electricity sector
Power sector policy (reliability standard, emissions, renewable energy share, industrial policy etc.)	Government	Government, e.g., a ministry
Integrated planning	Vertically integrated utility makes proposals with approval from government or regulator	Neutral entity – e.g., a ministry, system operator or regulator – to coordinate
Planning for generation	Vertically integrated utility and/or government	Neutral entity (generation planning is indicative)
Planning for transmission	Vertically integrated utility	Independent system operator/ transmission system operator (transmission and distribution planning is binding)
Planning for distribution	Vertically integrated utility	Distribution company
Authorization of/Decision on investments	Regulator/ministry	Regulator for transmission and distribution
		Market participants for generation

Electricity markets are unique in a number of ways, and this influences the design and complexity of the products and services traded at the wholesale level. For example, real-time balancing of electricity supply and demand is required to avoid major grid faults.

Wholesale markets offer a solution for trading high volumes of energy and related services from multiple generation facilities (supply-side participants) and multiple customers, such as large consumers or distribution companies (demand-side participants) who then sell to their own customers. Key decisions dictating the rules for a wholesale market need to be taken, and these can evolve over time. For example, rules on the types of stakeholders that are eligible to participate in a wholesale market need to be established for both the supply side and the demand side. Some power systems set a minimum size for generation facilities that want to sell on the wholesale market. Likewise, demand-side stakeholders eligible to purchase directly at a wholesale level to then sell on to small consumers are also usually restricted based on size or license criteria. Limiting the number of eligible buyers at the wholesale level mainly helps to control the administrative costs of handling a large volume of transactions from numerous participants; and the criteria can also be adjusted over time.

The International Energy Agency (IEA) report from 2022 provides in-depth analysis on some key issues for liberalized power systems and highlights the main decisions that need to be made during the process. These are listed below and are discussed in more detail in this report.

- How to ensure the **wholesale and retail markets interact** efficiently in both the short term and the long term?

- Which regulations can **protect consumers** in a more liberalized power system?
- How can **tariffs and pricing** enable efficient system operation and still incentivize longer-term infrastructure investments?
- How to adapt **power sector planning** to an evolving power system with higher levels of uncertainty and new participants?
- What is required to level the playing field for **variable renewable energy** and new technologies to meet decarbonization goals?
- How can **market-based mechanisms** be leveraged to shift risks to the private sector?
- Which **adequacy mechanisms** could be used to ensure system reliability?

Wholesale markets also need to provide incentives to promote an adequate level of investment in generation. Government's role here is to help create an enabling environment for investment, initially through the way in which it designs the power system, and then in some cases by offering further support. For example, while opening its electric supply industry, Mexico used auctions where the state-owned enterprise was the off-taker of the generation projects, providing an implicit government guarantee and reducing the risks for development. Brazil still uses auctions for generation and transmission projects to create credibility in its power system and to make some projects bankable. The big difference is that in the Brazilian case there is no implicit government guarantee, and investments come thanks to the certainty provided by long-term contracts where the off-takers are the private distribution companies who have strong incentives to collect the revenue in their footprint. Brazil has learned through experience of the need to plan for reforms that will enable finance and proactively coordinate between wholesale, generation, transmission and distribution sectors.

Table 2 lists some of the main components for wholesale markets, and other key questions for planners to consider. The short-term market is listed first, as a robust spot market with adequate liquidity, good competition and balancing area authorities is critical in a wholesale market.

Table 2: Common wholesale market aspects to consider

Component	Common objective	Sample tools	Key questions
Short-term market (spot market design)	Provide economic signals for the value of energy for a specific time and location	• Length of time between when power is purchased and produced (e.g., day ahead, intra-day, real-time market) • Locational pricing and signals (e.g., single node, zonal markets, nodal markets)	Are contracts physical (not transferable to other parties) or financial (the obligations can be transferred, e.g., a generator can fulfil its contract buying energy from a third party)? How will congestion be handled and who takes the risk?

Component	Common objective	Sample tools	Key questions
Long-term market (investment models)	Achieve the desired level of reliability of the electricity network	• Energy-only markets • Capacity markets and payments • Centrally planned investment • Capacity auctions	How will long-term contracts be made compatible with cost minimization goals from short-term markets?
	Risk mitigation	• Bilateral contracts	How are contracts settled?
	Decarbonization	• Auctions • Feed-in premiums/Feed-in tariffs • Clean energy or renewable energy certificates • Tax exemptions	How can markets be made to work efficiently by including environmental costs?
Transmission	Physical infrastructure expansion	• Auctions • Investment in grid upgrades by third parties	Who decides the expansion? Who proposes it, and how is it paid? What is the role of the regulator?
Distribution	Expansion, operations and maintenance	• Regulation and/or privatization • Yardstick competition or competition by benchmarking • 'Ideal network' cost recovery	How is the investment made? Is it subject to competition? How will pressure to reduce costs be introduced?

Retail arrangements, whether regulated or open to competition through retailers, are another key component to consider in order to develop a power system that is compatible with what consumers want and to protect them from certain risks. For example, regulators have to find a balance between protecting consumers from short-term price spikes in a wholesale market while also providing incentives in tariffs and pricing for efficient behavior to help maintain system reliability.

From the consumer perspective, a key question is where consumers can purchase their electricity. In general, some very large and sophisticated consumers may have access to the wholesale market, but most consumers – including large companies – usually still buy from a retailer. Many electricity power systems allow small consumers to choose their own retailer, but in some they do not have a choice and must buy from their local distribution company or from a regulated retailer. The threshold that defines what is a "small" or a "large" consumer also depends on each country, and can be changed over time to manage risks associated with providing choice to less informed or interested consumers. Likewise, at a wholesale level, defining who qualifies as a demand-side participant (e.g., retailers, municipalities, large customers) to purchase in bulk from the wholesale market and resell to final consumers also needs to be decided, and can be changed over time to increase competition among off-takers.

In addition, market-based mechanisms help shift risk and support technology choices that provide the highest economic value to society, as summarized in Table 3.

Table 3: Mapping policy objectives to specific instruments

Policy objective	Instruments to achieve the objective	Instrument description
Long-term and short-term cost minimization 	Wholesale markets (unbundling, market monitoring)	Wholesale markets ensure efficient electricity trading by separating production from distribution, and monitoring competition.
Market power prevention 	Market monitoring, unbundling, legacy contracts	These measures prevent monopolistic behavior by monitoring competition, ensuring fairness, and phasing out old anti-competitive contracts.
Renewable energy deployment 	Renewable portfolio standards, renewable energy auctions	Standards require a percentage of energy to come from renewables; auctions incentivize cost-competitive clean energy projects.
Resource adequacy 	Scarcity pricing, capacity remuneration mechanisms	Scarcity pricing increases market prices during shortages; capacity mechanisms ensure there is enough supply to meet demand.
Final consumer price stability 	Hedging contracts, long-term and mid-term auctions	Hedging and auctions protect consumers from price volatility by fixing prices over specified periods.
Affordable rates for vulnerable populations 	Budget transfers, cross subsidies	Budget transfers provide direct financial support; cross subsidies balance costs between consumer groups.

Case studies from other countries further highlight that there is no one-size-fits-all design or transition process, and that the approach in South Africa can be customized to align with the existing local and planned power sector dynamics. Table 4 lists key power system components for five countries researched in this paper, to highlight their commonalities and to show the varying degrees of liberalization that can exist in a functional power system.

Table 4: Key power system components by country

Power system component	India	Brazil	Mexico	Chile	Guatemala
Generation	Mix of IPPs and state	Mix of IPPs and state	Mix of IPPs and state	Fully privatized and competitive	Fully privatized and competitive
Transmission	Mix of state and private concessions	Mix of state and private concessions	Mostly state-owned, although private operation is possible	Many private companies with regulated monopoly	One private company with regulated monopoly

Power system component	India	Brazil	Mexico	Chile	Guatemala
Distribution	Mostly state-owned, some private operators	Mostly privatized, some regulated	State-owned	Privatized with regulatory oversight	Privatized
Market operation	Dispatch at regional level	Centralized dispatch	Centralized dispatch	Centralized dispatch	Centralized dispatch, coordination on day-ahead with Central America regional market (SIEPAC)

The challenge of municipal debt and non-payment for electricity in South Africa has also been experienced in other markets that have undergone liberalization reforms; India, for example, has demonstrated that privatized distributors can generate higher rates of revenue collection than their regulated counterparts. Various measures in India have been trialed to reform distribution companies, including subsidy reforms with the direct benefit transfer approach reflected on consumer bills, and linking privatization efforts to improved electricity reliability – this also brings local socioeconomic benefits (e.g., small and medium enterprises, agriculture, education, health) (EY, 2023). Similarly, the privatization of the distribution sector in Brazil has led to positive outcomes in terms of the profitability of distribution companies and improved service quality (Muller & Rego, 2021). Table 5 provides more details on the key features and facts from each power sector researched.

Table 5: Country power sector features and facts

Country	Key electricity sector features and facts
India	• There is a national wholesale market. Private sector IPPs operate about 50% of the generation and a well-integrated transmission grid. • Large consumers in India (>1MW in demand) can choose which generator to buy from through a trader or direct power purchase agreement (PPA), as the 2003 Act enabled open access. • Small consumers (>100kW and <1MW in demand) can choose to buy green power from the local power distribution company in exchange for green certificates. • India currently operates a voluntary net pool wholesale market primarily structured around the day-ahead market as well as the real-time market with zonal price signals. • India has various programs (tax incentives, subsidies, grants, credit guarantees and preferential loans) for promoting distributed energy resources, and a goal of

Country	Key electricity sector features and facts
	40GW of rooftop solar by 2022 which was extended to 2026[1] with some states setting their own policies on solar and electric vehicles. • About 86% of the trading still takes place via long-term PPAs, highlighting the need to integrate long-term PPAs into the wholesale market reform process over time to avoid inefficiencies. • While most of India's distribution companies (DISCOMs) are still state-owned, many have also been privatized with positive outcomes for revenue collection and reliability.

Brazil	• The initial liberalization design failed to ensure sufficient investment in Brazil's energy sector due to a lack of coordination with the planning and finance sectors. This led to an energy crisis in 2001 and a second wave of reforms in 2004 to correct distortions and fully unbundle generation, transmission and distribution.
	• Since 2004, investment has come through long-term contracts where the off-takers are mainly private distribution companies with a regulated monopoly over regulated customers in their concession footprint.
	• The Brazilian Development Bank (BNDES) played an instrumental role by offering enabling finance and risk mitigation to make renewable energy and transmission project more attractive, including the development of local supply chains (e.g., wind turbine manufacturing).
	• The electricity transmission network is planned centrally for the country. The regulator uses auctions to award 30-year contracts for construction and operation and maintenance (O&M) of transmission infrastructure, which is remunerated based on the annual permitted revenue (APR) bid in the auction.
	• Distribution companies in Brazil are privatized and considered creditworthy.
	• Brazil still uses auctions to ensure resource expropriation (e.g., rights for large hydro plants) and help with credibility for some projects, but government guarantees are not required for projects since distribution companies are the long-term off-takers for projects, reducing the need for government support.
	• As of 2023, 40% of Brazil consumption was sold through the free market to two types of consumers:
	  • Free consumers – Started with large customers (demand >2 MW), but by 2024 any consumer served at any high voltage (2.3kV).
	  • Special consumers – Individual customers or sets of customers connected at the high/medium voltage with the choice to purchase renewable energy from generators or traders. Initially demand from these customers needed to be ≥500 kW, but now high-voltage customers with lower demand are eligible.

Mexico	• The Mexican wholesale market is operated by an independent system operator. Participants buy and sell electric energy, power, clean energy certificates, financial transmission rights, and related services (operating reserves and rolling reserves,

[1] India installed 16.28 GW of grid connected rooftop solar as of January 2025, so still has a ways to goal to meet its goal of 40GW by 2026. https://mnre.gov.in/en/physical-progress/

Country	Key electricity sector features and facts

	frequency, voltage and reactive energy regulation, emergency start-up, island operation and dead bus connection).
	• Private generation companies compete directly with state-owned companies based on least-cost criteria using nodal prices in the day-ahead market and real-time market.
	• The Ministry of Energy has the option to hold auctions for contracts to expand the transmission grid which are awarded to the private party who offers the lowest cost over a number of years. Assets must be transferred back to the state at the end of the contract.
	• There are three types of consumer groups:
	  • Basic service users: must buy energy from a regulated retailer, in this case from an affiliate company of the State-owned company (CFE).
	  • Qualified users: have a demand ≥1 MW and can sign contracts with qualified service retailers to supply their energy.
	  • Qualified market participant users: have a demand ≥5 MW and can participate in the wholesale market.
	• Long-term auctions (15-year contracts) reduce dependency on fossil fuels and enable reliable electricity services by procuring capacity, energy and clean energy certificates.

Chile	• A competitive wholesale market has existed for energy generation and marketing of electricity since 1982; prices are determined by supply and demand in a spot market and through long-term contracts. • Private investment in generation capacity is encouraged through a stable and predictable regulatory framework, which has led to a significant expansion and diversification of the energy matrix. • Transmission expansion uses a public bidding process designed to be transparent and competitive for both national and international firms. • Free consumers with demand >500 kW can participate directly in the wholesale market, purchasing energy through bilateral contracts with producers or in the spot market. • Foreign direct investment is treated on equal terms as national investment, increasing the capital available for development and innovation. • Distribution companies purchase energy through competitive bidding in the wholesale market on behalf of regulated customers. • The regulatory framework allows for a level playing field for clean and renewable energy technologies to compete in the market. • Laws also exist requiring distribution companies to purchase a minimum percentage of renewable energy which increases over time. • Net billing allows residential consumers and small generators (<300 kW) to sell surplus energy to the grid at regulated prices.

Country	Key electricity sector features and facts
Guatemala	• In 1998, the vertically integrated utility was unbundled into different companies for generation, transmission, and two distribution companies. • The wholesale market trades two products (power and energy) which are remunerated in six markets: spot market, contract/bilateral market, power deviation market, complementary services (rolling reserve, fast reserve, black start, voltage control), and two export/import markets. • The spot energy market is a day-ahead market with a surplus/shortage market. The spot price is determined hourly by the short-term marginal cost, which represents the maximum variable cost incurred each hour to supply an additional kWh. • The construction of new transmission lines and substations is primarily conducted through public bidding and paid for through regulated tariffs. The Ministry of Energy uses a 30-year planning horizon for the transmission network and publishes an updated plan annually, taking into account government policies and the indicative generation investment plan. • Distributors are also privatized and responsible for organizing long-term and short-term auctions to contract the power and energy they require, which is then sold to their customers. • Large consumers (demand >100 KW) can buy energy directly from a generator or traders and freely negotiate the electricity price. Smaller consumers buy electricity from distributors at regulated tariffs.

Acronyms

ACL	Brazil's free electricity market
ACR	Brazil's regulated electricity market
AMM	Wholesale Market Administrator (Guatemala)
ANEEL	The Brazilian Electricity Regulatory Agency
CCEE	Electric Energy Commercialization Chamber (Brazil)
CEA	Central Electricity Authority (India)
CEN	National Electric Coordinator (Chile)
CENACE	National Energy Control Center (Mexico)
CERC	Central Electricity Regulatory Commission (India)
CFE	Federal Electricity Commission (Mexico)
CNEE	Electricity National Commission (Guatemala)
CNE	National Energy Commission (Chile)
CRE	Electricity Regulatory Commission (Mexico)
DBT	Direct benefit transfer
DER	Distributed energy resource
DISCOMs	Electricity distribution companies
DPE	Department of Public Enterprises (South Africa)
ERA	Energy Regulatory Act (South Africa)
GTAM	Green Term Ahead Market
IEA	International Energy Agency
INDE	Vertically integrated national utility (Guatemala)
IPPs	Independent power producers
kW	kilowatts
MAD	Day-ahead market (Mexico)
MEM	Wholesale electricity market (Mexico)
MW	Megawatt
NERSA	National Energy Regulator of South Africa
ONS	National Electric System Operator (Brazil)
PLD	Difference settlement price (Brazil)
PML	Locational marginal prices (Mexico)
POSOCO	Power System Operation Corporation (India)
PPA	Power purchase agreement
REC	Renewable energy certificate
SAPP	Southern African Power Pool
SENER	Ministry of Energy (Mexico)
SERC	State Electricity Regulatory Commission (India)
SNT	National transmission grid (Mexico)
SSB	Basic service supplier (Mexico)
VAD	Distribution value added charge (Chile and Guatemala)
VRE	Variable renewable energy
VIU	Vertically integrated utility

1 Introduction

A number of research papers and primers have already been published on electricity liberalization and power sector reforms. This document, however, aims to focus on key topics and important decisions related to electricity sector reforms in emerging economies that South Africa can consider when transitioning to a more liberalized electricity sector. Asking the right questions can help lead to more informed decisions for South Africa, in a way that allows both its future electricity sector and its future economy to thrive.

1.1 Why are Power Systems Liberalized?

There are a number of reasons why regional power systems and utilities may move away from a traditional utility monopoly. For example, some may be looking to reduce costs, while others are trying to deal with electricity supply shortfalls. Other regional power systems have been structured in order to share resources in different jurisdictions, either within the same country (like PJM in the United States) or internationally (like in Europe or the Southern African Power Pool). Different problems exist in each electricity sector, as well as different solutions to those problems, so there is no one-size-fits-all design for a more liberalized power market. Likewise, there is no single path to follow during the transition process.

An initial question decision-makers should ask is: What problem are we trying to solve? The answer to this question then informs the objective of the power sector reforms, which will vary according to local challenges. Examples of common objectives that address key challenges include:

- Reduce costs
  - Optimize short-term costs
  - Share resources and pay a fair economic value for those resources
- Shift investment risks for new power plants from consumers to independent power producers
  - Incentivize efficient investments in new electricity infrastructure
- Increase development of new power projects
  - Enable investment and development in new projects to ensure an efficient balance of supply and demand
- Address revenue shortfalls
  - Distribution/retail sector reform if unable to fully recover energy costs from consumers

1.2 How are Liberalized Power Sectors Organized?

As discussed, there is no one-size-fits-all design for a more liberalized power system, as challenges and local factors vary. Additional delegation of responsibility is often required for critical activities in a more liberalized power system, which would previously have been the primary responsibility of the vertically integrated utility. These include (Table 6):

- Planning – The activity of making long-term forecasts, typically from 10 to 15 years, and defining the set of investments in generation, transmission and distribution that are needed to satisfy the demand at least cost.
- Oversight and regulation – Ensuring fair cost recovery for infrastructure investments and power sector operations.
- Generation – The development, investment, construction and operation of generation infrastructure.
- Transmission, system operation, and distribution – The physical operation of grid infrastructure.
- Retail sales to various customers – Tariff methodology and potential tariff amount changes for various customer types (e.g., small, large).

Table 6: Planning and investment activities for a vertically integrated utility vs. a competitive power sector

Activity	Vertically integrated utility (either state-owned or regulated monopoly)	Competitive power sector
Power sector policy (reliability standard, emissions, renewable energy share, industrial policy etc.)	Government	Government (such as ministry)
Planning	Vertically integrated utility proposes with approval from government or regulator	Coordinated by neutral entity such as ministry, system operator, or regulator
Planning for generation	Vertically integrated utility and/or government	Neutral entity (generation planning is indicative)
Planning for transmission	Vertically integrated utility	Independent system operator /transmission system operator (T&D planning is binding)
Planning for distribution	Vertically integrated utility	Distribution company
Authorization of/Decision on investments	Regulator/ministry	Regulator for T&D
		Market participants for generation

Many vertically integrated utilities manage most of their electricity sector value chain activities. In a more liberalized power sector, however, responsibilities for key activities typically shift to independent entities, helping to enable competition and incentivize efficient decision-making. **The level of competition introduced varies for each regional power sector and may be phased in over time.** On the more liberalized end of the spectrum, competition exists for generation, retail and transmission development activities, while other activities – including system operation, transmission operations, and in many cases distribution – remain regulated or use benchmark competition to provide incentives.

1.3 What are the Competitive Activities in a Wholesale Market?

A wholesale market refers to the platform typically used for selling and buying bulk energy products and services. The wholesale market enables the trading of electricity. Likewise, many

more liberalized power sectors use wholesale markets to buy other services that are required for effective operation of the power sector, such as frequency and voltage control.

1.3.1 Why are Electricity Markets Special?

Electricity markets are unique from other markets in a number of ways; this influences the complexity of the electricity products and services traded on the wholesale market. Some examples of these characteristics include:

Real-time balancing – The power sector requires balancing of supply and demand in real time to avoid major service delivery faults.

Power flows – Electricity flows following the path of least resistance through the transmission and distribution grids. These flows have to be managed to avoid surplus or deficit in certain sections of the grid. The consequence is that although different sections of the grid can have different owners, it still requires coordinated operation.

Electricity demand is often inelastic and not representative of consumers' willingness to pay – In most markets, consumers are able to moderate or increase their consumption of a good or service in response to a change in price, avoiding situations where they pay more than the goods are worth to them. Since there is no practical way to link willingness to pay to the real-time cost of electricity, most system prices for consumers are an average or a simplified estimate of the real costs that the system incurs during those periods. For the same reason, most markets set price caps—even at high levels—to reflect the economic impact of unserved electricity, also known as the value of lost load.

Expensive storage options – Relative to back-up generation options, storing electricity has historically been expensive and often not economic on a large scale. This can contribute to a large volatility in prices, even on an intra-day basis.

1.3.2 Who Participates in a Wholesale Market?

Various stakeholders can participate in a wholesale market: the power sector structure and regulatory rules establish which of them are allowed to buy or sell products/services. Two general categories of participants include:

- **Supply-side participants** – Typically generation facilities that sell electricity and other products, such as IPPs that sell electricity from their power plants.
- **Demand-side participants** – Entities that purchase in bulk and resell the energy to final consumers such as retailers, regulated entities selling to "regulated consumers" such as municipalities, distribution companies, or retailers selling to "free consumers" and sometimes very large customers themselves.

Increasing the number of stakeholders eligible to participate on both the supply side and demand side increases the level of competition; this can be carried out incrementally to allow for the power sector to liberalize over time. For example, this could entail initially only allowing IPPs above a certain size to sell to the wholesale market while limiting demand-side participation to certain retailers, before changing the eligibility criteria over time.

1.3.2.1 Short-term and long-term markets

Wholesale markets often allow for the sale of energy products and services over both the long and short term. Long-term Power Purchase Agreement (PPA) contracts, for example, exist in many wholesale markets for projects that require longer contracts to be bankable or to account for critical legacy projects built before power sector liberalization. In addition, short-term markets help the system operator balance real-time fluctuations in supply and demand for electricity, and provide economic signals for the value of energy in time and by location.

Given the large volatility that electricity prices can exhibit, energy is typically contracted in advance through long-term bilateral contracts. Spot markets, however, are still critical in maintaining system balance, and their design is essential to reflect the economic value of electricity at different moments in time. **The importance of a robust spot market with adequate liquidity, good competition, and balancing area authorities is further highlighted in the case studies below**.

Wholesale markets also need to provide incentives to promote an adequate level of investment in generation and to signal the kind of assets that are required, their location and amount. Table 7 lists some of the main components for wholesale markets along with the objective of each, tools for customization, and key questions for planners to consider.

Table 7: Common wholesale market aspects to consider

Component	Common objective	Sample tools	Key questions
Short-term market (spot market design)	Provide economic signals for the value of energy for a specific time and location	• Length of time between when power is purchased and produced (e.g., day ahead, intra-day, real-time market) • Locational pricing and signals (e.g., single node, zonal markets, nodal markets)	Are contracts physical (not transferable to other parties) or financial (the obligations can be transferred, e.g. a generator can fulfil its contract buying energy from a third party)? How will congestion be handled and who takes the risk?
Long-term market (investment models)	Achieve the desired level of reliability of the electricity network	• Energy-only markets • Capacity markets and payments • Centrally planned investment • Capacity auctions	How will long-term contracts be made compatible with cost minimization goals from short-term markets?
	Risk mitigation	• Bilateral contracts	How are contracts settled?

Component	Common objective	Sample tools	Key questions
	Decarbonization	• Auctions • Feed-in premiums/Feed-in tariffs • Clean energy or renewable energy certificates • Tax exemptions	How can markets be made to work efficiently by including environmental costs?
Transmission	Physical infrastructure expansion	• Auctions • Investment in grid upgrades by third parties	Who decides the expansion? Who proposes it, and how is it paid? What is the role of the regulator?
Distribution	Expansion, operations and maintenance	• Regulation and/or privatization • Yardstick competition or competition by benchmarking • 'Ideal network' cost recovery	How is the investment made? Is it subject to competition? How will pressure to reduce costs be introduced?

Retail arrangements, whether regulated or open to competition among retailers, are another key component to consider in order to develop a power system that is compatible with what consumers want and to protect them from some risks. The retail options also depend on how transmission and distribution are regulated.

2 Common International Trends with Power Sector Liberalization Reforms

Over the past few decades most large electricity systems across the world have transitioned away from the vertically integrated utility monopoly. They have done this for various reasons – to increase efficiency, reduce costs, incentivize investment etc. Figure 1 shows which regions have already unbundled their utility monopoly and implemented more competition. Once China finishes its transition process, then close to 75% of the world's electricity will be produced in regions that have transitioned towards some degree of liberalization. Vertically integrated utilities are still primarily prevalent in smaller systems and island nations, while many large power systems are now organized around wholesale markets.

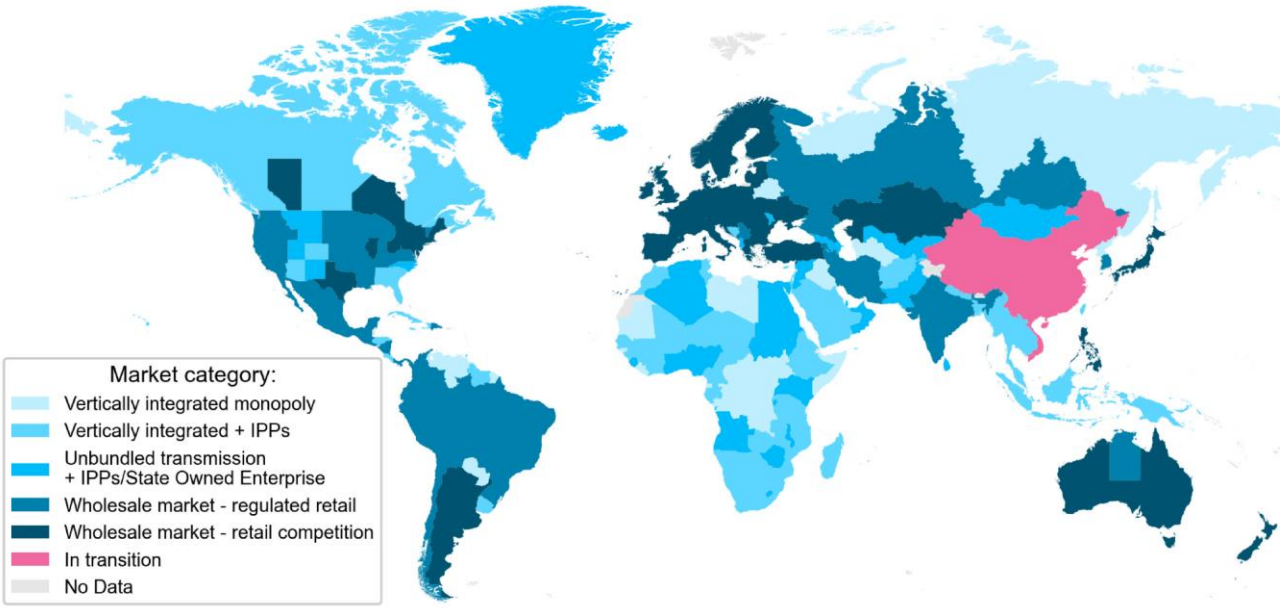

Figure 1: International electricity sector reform status as of 2022 (IEA, 2022)

Different trends have emerged depending on the local needs and objectives of power systems in each country. For example, European power systems primarily rely on net pools, as many electricity trading markets begin as net pools where vertically integrated utilities also own the wires and then trade power over transmission lines. Gross pools (e.g. as used by the Australian National Electricity Market) involve a system operator which sets location-specific prices for each settlement period and can provide a number of benefits such as more transparency in prices that send investment signals, efficient dispatch and simplified settlements.

What is the purpose of wholesale electricity markets?
Wholesale electricity markets are platforms for the sale and purchase of electricity and related services which aim to foster competition and efficiently allocate resources in the power sector. Wholesale markets are an instrument to achieve policy goals such as increasing private sector investment, promoting transparency, and removing operational inefficiencies to ultimately minimize electricity costs (see Table 8 for more examples of market-based instruments). While electricity markets incentivize low system costs, additional instruments or tools may still be required to ensure that cost savings from efficiency gains are passed through to customer bills and that low-income customers can still afford electricity (e.g., through targeted subsidies) within a liberalized framework.

The Southern African Power Pool (SAPP) is another example of a net pool. It has faced various challenges beyond power system design, highlighting the need to also address other local parameters such as concentration of market power, guarantee arrangements to secure the creditworthiness of electricity sector participants, proper commercial incentives, corporate governance, and competition.

2.1 Key Decisions to Consider when Introducing a Wholesale Market

There are a number of considerations for decision-makers when moving away from a vertically integrated utility power sector, including whether the local power sector is large enough to be compatible with a wholesale market, how the wholesale market will be designed (e.g., day ahead, real time), and the degree of retail choice for some customers. The IEA's 2022 report discusses a number of these key questions, which are summarized in the following sections.

2.1.1 Wholesale and Retail Market Interaction

Well-designed wholesale markets enable efficient price signals by leveraging competition in both electricity generation and consumption. Key decisions related to the design of an effective wholesale market include:

- *How to establish efficient price signals that incentivize power system participants to make decisions aligned with overall system needs?* Price signals that reward services that add the most value to the system, such as generation during peak demand and periods of distress and flexible generation/consumption that can respond to changes in system supply/demand.
- *How and when to adapt the design of the wholesale market in response to system changes and evolving technology?* System needs change as technology evolves, so changes may be required over time to ensure price signals continue to reward the services that add the most value to the system.
- *How to ensure price signals account for both the temporal and geographic needs of the system?* For example, refining time resolution and moving gate closure times closer to the hour of delivery can result in price signals that reflect the time and flexibility value of electricity. In addition, designing the market model to match the physical reality of the system enables price signals for services that meet system needs in specific locations.

- *How to ensure long-term contracts do not impede optimal dispatch?* Separating long-term signals and price hedging from the physical dispatch of assets can help to enable least-cost dispatch of electricity in the short-term market and still allow for long-term contracts like PPAs.

In addition, retail markets also need to be designed to ensure that savings from competitive generation and services in the wholesale market are passed on to consumers. Regulators play a critical role here both during and after the transition process; for example, by setting tariffs that encourage demand-side flexibility and behaviors that provide value to the system. Likewise, policymakers need to decide who will be responsible for educating consumers on managing consumption and integrating smart technologies (e.g., grid-friendly EV charging, smart appliances) which can benefit both the customer and the system.

2.1.2 Protecting Consumers

The interaction between wholesale and retail markets significantly impacts consumers, since retailers pass on their costs and market risk to consumers through the prices or tariffs they charge for electricity. This means that in a liberalized electricity sector, much of the risk for consumers depends on the retailers' decisions. Regulators design regulations to protect consumers and oversee the risks that can be passed on by retailers, promote system-friendly behaviors, and ensure a competitive retail market without overburdening taxpayers. Sample approaches used in liberalized power systems to protect consumers include:

- **Encourage system-friendly behaviour and digital innovation** – Promote programs that incentivize consumers to behave in ways that improve system efficiency and increase cost savings (e.g., demand-response programs, smart meters, EV charging programs, smart home devices, energy management tools)
- **Proactive policies and regulations** – Introduce measures such as requiring retailers to hedge and contract electricity in advance, and service regulations to safeguard consumers from excessive market risks and price volatility. These can also help encourage fair practices, avoid poor service, and provide stable and predictable pricing from retailers. Continuously assess and adjust regulations to ensure both protection and the encouragement of technological advancements.
- **Tailor options and support for different consumer groups –** For example, large consumers may benefit from time-of-use and seasonal rates that align with their usage patterns and demand-response capabilities. Small consumers may benefit from mechanisms that let them get the cheapest energy through auctions if they do not choose their retail provider. Some consumers may also choose to opt out of complex and dynamic tariffs for a simple fixed tariff from financially stable suppliers.

Even in more liberalized power systems, many customers can still only buy from a default retailer, so the tariff they pay for electricity remains regulated to protect them. Regulators for these captive customers often need to answer the following questions:

- To what degree should basic service retailers be exposed to spot prices?
- What contract duration is needed to protect the basic service retailer from spot prices?
- Should the basic service retailer hedge on fuels linked to electricity spot prices?

- What happens if large gaps arise (either in quantity or value) between demand and the hedging contracts? (IEA, 2022)

Tools such as customer segmentation and competitive auctions for retailers can help regulators to manage these issues, along with iterative improvements to policy and regulations as the electricity sector evolves.

Tools also exist for regulators to protect customers from potential market manipulation that could impact the price they pay for electricity. Since electricity demand is highly inelastic, wholesale electricity markets with a small number of participants are prone to market manipulation. Fortunately, decades of experience with electricity market liberalization demonstrates that competitive outcomes can be fostered with the right tools even with a small number of market participants. Examples of these tools include:

- Careful and constant market monitoring by the regulator, who oversees the performance of the market and can detect wrongdoing.
- In the short term, cost-based markets and bid screening which requires some generators deemed large enough to manipulate the market to construct their bids based on their marginal costs and uses preventive automatic checks to avoid bids above a certain margin.
- In the mid to long-term, contracts to hedge electricity prices and more competition help disincentivize manipulation. For example, contracted generators that reduce generation supply to increase prices will not directly benefit as the competitors would sell to the market instead, while the generators would be obliged to obliged to buy electricity on the spot market at higher prices in order to fulfil their contracts.

Structural separation of generators in different companies may also be needed to foster competition in the market (RAP, 2016).

2.1.3 Tariffs and Pricing

Tariffs and prices both refer to charges associated with the sale of electricity or services, but a distinction is often made between the two in the electricity sector as tariffs refer to charges from regulated entities (e.g., a customer that buys from a regulated retailer pays a tariff), while prices refer to the amount charged by the private sector under a competitive market with a willing seller and willing buyer agreement (e.g., a private IPP charges a price for electricity it sells directly to a large customer).

Tariffs and pricing can also be designed to provide incentives (or disincentives) that guide the behavior of electricity sector participants. For example, pricing signals that vary geographically and time-of-use rates can reward participants that align their decisions with the needs of the system (e.g., reducing demand during peak periods).

Will electricity tariffs and prices increase or decrease with liberalization?
Wholesale markets are very effective at reducing overall system costs and improving efficiency, which puts a downward pressure on the tariffs and prices consumers pay relative to monopolistic power systems. However, other variables also influence the final bill for customers, such as existing cross-subsidies and fuel prices which fluctuate, so there is not an easy yes/no answer to this question for all customers. More detailed analysis and price forecasting is often required, taking into account local market factors and the generation mix to understand how tariffs and pricing will likely change over time.

Another key question regulators face is how to ensure the power system fully values system services such as ancillary services that support T&D and reserve capacity, to enable adequate investment in these services. Strategies exist to manage this, such as increasing the resolution of the power system to provide participants with detailed price signals for shorter intervals and improve the scheduling of system assets. Increasing power system resolution also further enables higher shares of variable renewable energy and flexible assets like storage in the system.

When a power system does not fully value system services, including the full economic value of unserved energy or the value of lost load, this can lead to what is known as the "missing money" problem. Unless scarcity is allowed to be reflected in prices, the marginal cost of energy alone is insufficient to justify larger capital investments, resulting in underinvestment in infrastructure that reduces reliability. Mechanisms for policymakers and regulators exist to address the missing money problem, such as:

- **Scarcity energy pricing and price adders** that increase prices when the system operator faces a generation supply shortage for both energy and reserves.
- **Capacity remuneration mechanisms** that pay for the availability of generation or demand-side resources to be available when needed.
- **Regulated procurement** where the regulatory body determines the amount and the price of capacity. (IEA, 2022)

2.1.4 Power Sector Planning

Power sector planning has continued to evolve to meet the changing needs of a more liberalized electricity sector and to incorporate advancements in technology. Government and vertically integrated utilities were historically responsible for planning, but system operators are more likely to play this role in a more liberalized electricity sector. Many vertically integrated utilities used to plan with the aim of building centralized dispatchable generation to meet variable demand, but the increase in variable renewable energy and the prevalence of demand-side resources have changed this dynamic to make generation more variable and demand more dispatchable. Moreover, liberalized power sectors have more participants, which requires more stakeholder engagement in the process.

In many international power sectors, generation planning is indicative and subject to change, while T&D planning is often indicative for long-term scenarios and binding for shorter time frames (often less than five years). Binding transmission plans provide more certainty for generation projects that depend on this infrastructure. Effective planning also includes

designing market frameworks that encourage investment, and adapting to technological and policy changes over time.

The IEA report outlines a few strategies to manage planning in a more liberalized power sector, including:

- **Holistic planning** that considers how the whole power system and its assets (e.g., generation, T&D, demand) can best work together and interact with other sectors.
- **A detailed cost-benefit analysis** that accounts for the cost and value of all technologies and options to accurately compare the most cost-effective solutions.
- **Planning for uncertainties** by identifying and addressing them with scenario forecasting (including for external events like extreme weather), sensitivity analysis to key assumptions, and stochastic approaches.
- **Frequent and proactive stakeholder consultation** throughout a planning process that is transparent and inclusive of diverse expertise.
- **Adaptive governance structures** that align with decarbonization goals and formalize feedback mechanisms for planning, policymaking and market design.

2.1.5 Variable Renewable Energy Support Schemes

Markets in general do not provide an efficient outcome to society unless all the participants bear the costs of their actions. The production of electricity creates significant externalities, costs that impact society as a whole and not just generators or consumers. For that reason, electricity markets without any public intervention do not provide a level playing field between sources producing less pollution, such as renewable energy, and fossil fuels. The fact that fossil fuels do not pay the full costs they impose on society creates a bias that favors them in more liberalized markets or in vertically integrated utility systems that do not consider these externalities in their planning and operations. Many electricity markets across the world have established different mechanisms to address this issue and level the playing field.

For this reason, designing a wholesale market that accounts for the full value that variable renewable energy (VRE) technologies provide to the system is key to achieving decarbonization goals and efficient market operation. In addition, accounting for the negative externalities of pollution from fossil-fuel-based technologies with carbon pricing (e.g., carbon tax) further levels the playing field for VRE. In some instances, more support may be required to unlock investment in VRE through measures such as:

- **Balancing long-term revenue certainty with market integration** to ensure that decarbonization instruments support the efficient deployment of low-carbon technologies and account for their full value to the system and society.
- **Incentivizing value based on location and time** by designing decarbonization instruments that account for location and time-of-generation on the system, to enable investments in new clean technology.

- **Refining competitive price signals and market-based decarbonization mechanisms** to minimize potential policy support subsidies (often passed on to consumers) that may be required for initial investment in low-carbon dispatchable generation. These can be refined over time as the power sector and technology develop to avoid market distortions (IEA, 2022).

2.1.6 Market-Based Mechanisms

Market-based mechanisms help shift risk and promote technology choices that provide the highest economic value to the private sector. Examples include spot markets, ancillary service markets and net pools, which in general help to improve market efficiency and lower costs compared to a centrally planned approach or an auction model, since the private sector is often better informed on least-cost options.

Auctions still play a role in many liberalized power sectors to procure various products such as clean energy, energy demand, transmission infrastructure, and firm capacity. Auctions aim to incentivize developers to offer the most competitive technology to meet system needs specified by the system operator. Likewise, some liberalized electricity sectors (e.g., Mexico) have used auctions and government guarantees for utility-scale generation, as this increases off-taker credibility and enables more investment with longer-term price certainty.

Regardless of the instrument used (e.g., auctions, market-based mechanisms), policymakers need to:

- Ensure smooth integration of new projects with the power system.
- Balance the cost burden between power sector participants fairly rather than passing it all to the consumer.
- Enable prioritization of electricity generation (merit order) that rewards low-emitting and dispatchable technologies rather than more expensive and inflexible fossil-fueled generation.

Policy targets such as a renewable portfolio standard set high-level policy goals, but still allow the market to decide the most efficient and scalable approach to meeting them. Policy goals also help provide the longer-term visibility required by investors to make long-term infrastructure investment decisions.

2.1.7 Adequacy Mechanisms

Adequacy mechanisms refer to various strategies designed to ensure that the electricity system has enough capacity and resources to reliably meet current and future demand. These mechanisms help balance supply and demand, support system stability, and encourage long-term investment in infrastructure and technology. Common examples of adequacy mechanisms include:

- Capacity markets that help incentivize investment in generation capacity.
- Flexibility measures like demand response and energy storage to manage system variability.
- Scarcity pricing and capacity remuneration mechanisms also help maintain the balance in supply and demand.

Reliability standards are policy decisions that provide regulators with guidelines for the acceptable amount of unserved energy in a given time period. Reliability standards can be measured (e.g., outage hours per year) and may require additional firm capacity to maintain reserve margins that enable compliance.

Scarcity pricing provisions allow system operators to manage operating reserves during supply shortages by increasing prices to reflect the economic value of scarcity, and therefore improve investment prospects in dispatchable resources such as battery storage. Defining capacity products to better reflect actual scarcity periods is the first step to determining the right scarcity prices. In Mexico, for example, the capacity market defines the product based on the hours in which the system reserves are lowest rather than designing it around peak demand, since stress periods can also occur at times of day other than during peak demand.

Many markets also use capacity remuneration mechanisms (CRMs) to improve reliability by directly compensating for the capacity of technologies and not just the energy sold. For example, CRM payments can be designed to be technology-neutral for generation or demand-side resources when they are needed.

Many of these adequacy mechanisms can be used in parallel to complement each other (e.g., CRMs and market price signals) to achieve reliability goals.

Table 8: Mapping policy objectives to specific instruments

Policy objective	Instruments to achieve the objective	Instrument description
Long-term and short-term cost minimization 	Wholesale markets (unbundling, market monitoring)	Wholesale markets ensure efficient electricity trading by separating production from distribution, and monitoring competition.
Market power prevention 	Market monitoring, unbundling, legacy contracts	These measures prevent monopolistic behavior by monitoring competition, ensuring fairness, and phasing out old anti-competitive contracts.
Renewable energy deployment 	Renewable portfolio standards, renewable energy auctions	Standards require a percentage of energy to come from renewables; auctions incentivize cost-competitive clean energy projects.
Resource adequacy 	Scarcity pricing, capacity remuneration mechanisms	Scarcity pricing increases market prices during shortages; capacity mechanisms ensure there is enough supply to meet demand.
Final consumer price stability 	Hedging contracts, long-term and mid-term auctions	Hedging and auctions protect consumers from price volatility by fixing prices over specified periods.
Affordable rates for vulnerable populations 	Budget transfers, cross subsidies	Budget transfers provide direct financial support; cross subsidies balance costs between consumer groups.

3 South African Context

Historically, Eskom has operated as a monopoly with vertically integrated control over South Africa's generation, transmission and distribution assets. Eskom has also facilitated the import and export of electricity with several neighboring countries with the assistance of the Southern African Power Pool (SAPP). While there have been discussions and draft plans for changes to South Africa's electricity sector since the 1998 White Paper on Energy Policy, comprehensive reforms have yet to be fully implemented.

In 2019, South Africa's Department of Public Enterprises (DPE) published a roadmap for reforming Eskom and unbundling its monopoly. The roadmap established a high-level timeline, but unbundling is currently behind schedule as the dates were not binding. Figure 2 is based on information in this DPE plan and shows some of the stakeholders in the local electricity sector. Embedded generation for own-use by customers is currently allowed, as is wheeling for some eligible customers (typically over transmission networks as distribution wheeling rules for municipalities have yet to be widely adopted), and the purchase of electricity from IPPs by municipalities – so some customers have the choice to buy from an IPP, from their local municipality, or from Eskom.

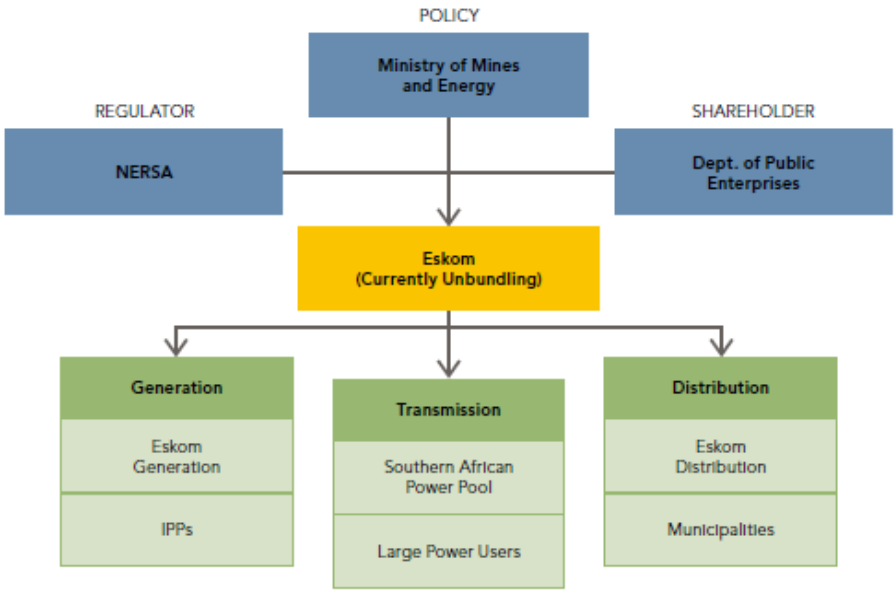

Figure 2: South Africa's electricity sector stakeholders (DPE, 2019)

The Energy Regulatory Act (ERA) amendments were passed by the National Assembly in March 2024 and signed into law in August 2024, paving the way for the implementation of a new market structure.[2] In particular, the amendments aim to:

- Establish a national regulatory framework for the electricity supply industry and give NERSA authority of enforcement.

[2] Green Building Africa. (2024, March 16). *South Africa's electricity regulation amendment bill passes paving the way for a more decentralized energy sector.* https://www.greenbuildingafrica.co.za/south-africas-electricity-regulation-amendment-bill-passes-paving-the-way-for-a-more-decentralised-energy-sector/

- Provide guidance on regulation of licenses and registration for generation, transmission, distribution, system operation, reticulation,[3] trading, and the import and export of electricity.
- Facilitate the opening of the national power grid to private generators and establish a transmission system operator that is legally separate from Eskom.
- Establish the transmission system operator and transitional measures including an open market platform to allow for competitive electricity trading.

Various stakeholders oversee and participate in South Africa's evolving electricity sector, including government agencies, the national energy regulator (NERSA), regulated utilities (Eskom and many municipalities), industry associations, independent power producers, and customers. The roles of these stakeholders will continue to evolve as the sector becomes more competitive with the unbundling of the national utility Eskom and more private sector participation.

3.1 Summary of Eskom's Proposed Multi-Market Model

A more competitive electricity sector in South Africa is already beginning to take shape with the growth in wheeling and participation of IPPs and traders in the power sector. Eskom has done its own research on options for power sector reform to adapt to these changes, and has proposed a multi-market model for NERSA to consider as a solution to be implemented over the course of a five-year transition period. With the approval of the ERA amendments, the transmission system operator would remain under Eskom during the five-year transition period before becoming an independent entity. Eskom has also drafted a market code, and has recommended that NECOM should set up a workstream with various detailed workshops to help finalize and implement the code. Figure 3 provides an overview of the multi-market model; this would have a market operator, transmission system operator and network operator, a central purchasing agency, and would account for day-ahead and balancing transactions among the various stakeholders.

[3] Reticulation is defined by NERSA to include the trading or distribution of electricity and includes the services associated therewith. Eskom and municipalities are primarily responsible for this in South Africa, but wheeling rules have recently given primarily large customers the option to purchase directly from IPPs.

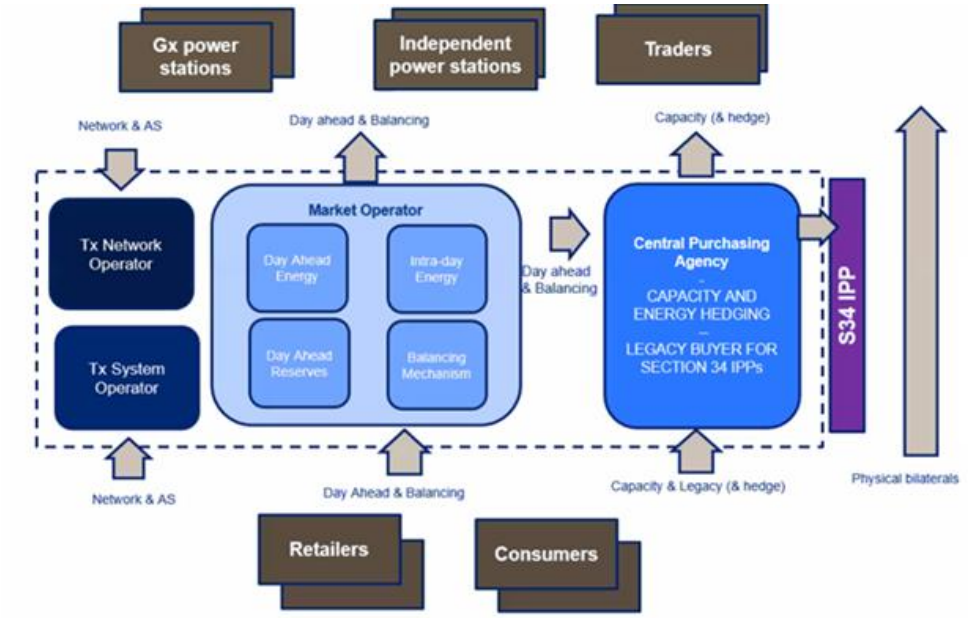

Figure 3: Eskom's proposed multi-market model (Eskom, 2023)

Major electricity market structure reforms can take time to develop and multiple years to fully implement. These reforms also have widespread implications for all electricity sector stakeholders, including the customers that ultimately finance the reforms through their electricity bills and taxes. While approaches to addressing these issues vary by country and are not always considered "best practice," elements of the institutional landscape and particular approaches for reforms from other countries are summarized in this document, to help inform South Africa as it implements a new electricity market structure.

4 Key Models and Features from More Liberalized Power Sectors in Other Countries

This section provides summaries of the electricity sectors of several other countries, namely India, Chile, Mexico, Brazil and Guatemala. More detail on each of these country case studies can be found in the Annex, including key implementation details and the main features of each country's wholesale market design.

4.1 India Summary

India has successfully implemented a national wholesale market (with private sector IPPs that account for about 50% of the generation) and a well-integrated transmission grid. However, about 86% of the dispatch still takes place via long-term PPAs, highlighting the need to integrate long-term PPAs into the wholesale market reform process over time to avoid these inefficiencies. Table 9 provides a summary of the key power sector characteristics and market components for context.

Table 9: Power sector summary for India

Power sector characteristics	Summary and key features
Liberalization context	Liberalization began back in 1991 with policies to open up the electricity sector and amend regulations to allow for private sector involvement. The Electricity Act of 2003 aimed to further reform the power sector in India and made 'open access' to the sector a priority along with bilateral trade, which led to the opening two power exchange markets in 2008. There is successful implementation of a national wholesale market with a well-integrated transmission grid, but ~86% of the dispatch still takes place via long-term PPAs, including many expensive coal plants as of 2023.
Demand side	Open access is allowed, and distributors sell electricity to consumers along with distribution and retail services. Large consumers in India (>1MW in demand) can choose which generator to buy from through a direct purchase arrangement or through a trader/power-exchange/OTC platform. The Green Open Access Rules of 2022 gave small consumers (>100kW in demand) the choice to buy green power from their local power distribution company in exchange for green certificates.
Supply side	Private sector IPPs now operate about 50% of the generation, and there has been significant growth in renewable generation. Long-term PPA prices have been significantly higher than market prices, with almost half of the coal projects costing 40% more on average compared to the spot price.

Power sector characteristics	Summary and key features
Wholesale and spot market characteristics	India currently operates a voluntary net pool structured primarily around the day-ahead market, as well as the real-time market, which allows participants to schedule their generation or pre-purchased power and buy/sell residual power from the market/imbalance. The independent system operator runs a separate pay-as-bid ancillary services market. Other features include an intraday market for same-day delivery of services (there is a new auction every 30 minutes), term-ahead contracts for both daily and weekly contracts, renewable energy certificates, and energy saving certificates. Zonal price signals are provided (prices paid for energy or related services that vary based on zones of the generator to provide incentives to address grid congestion).
Transmission business model	The government prioritized an all-India synchronous grid, adding large amounts of transmission infrastructure, and kept the transmission planning institution separate from the transmission owner to avoid potential conflicts of interest.
Investment framework and viability	Many electricity distributors are operating at a loss due to insufficient revenue collection, expensive long-term PPAs with coal plants, and inadequate infrastructure/operations. A direct benefit transfer (DBT) initiative was introduced to directly subsidize customer accounts to improve transparency and reduce leakage of subsidies.
Customer choices and protection	The DBT also protects customers from subsidy leakage. A green term ahead market (GTAM) uses power exchanges to enable spot trading of renewable energy, allowing corporate consumers access to a trading window for purchasing renewable energy rather than a PPA.
Enablers for renewable energy and distributed resources	India has various programs (tax incentives, subsidies, grants, credit guarantees, and waiver of transmission charges and preferential loans) for promoting distributed resources with goals for solar irrigation pumps and rooftop solar, but adoption has been slow to date. India also has a goal to reach 40GW of rooftop solar by 2026, and some states have their own policies on solar and electric vehicles.
Distribution business model and trends	While most of India's distribution companies (DISCOMs) are still state-owned, some have been privatized, leading to positive outcomes for revenue collection and reliability. India has various programs for promoting distributed energy resources at the national and state level with goals for solar irrigation pumps, electric vehicles and rooftop solar.

4.2 Brazil Summary

Brazil has gone through several stages of reforms to effectively liberalize its electricity sector. The initial reforms failed to ensure sufficient investment, leading to a severe energy crisis in 2001. Additional reforms enabled a new regulatory framework, along with a more efficient electricity sector that has successfully attracted billions of dollars in investments and now has private distribution companies, private generation, and partially privatized transmission. Table 10 provides a summary of the key power sector characteristics and components for context.

Table 10: Power sector summary for Brazil

Power sector characteristics	Summary and key features
Liberalization context	• The debt crisis of the late 1980s made the vertically integrated federal companies model unsustainable, leading to comprehensive reforms in the mid-1990s. • These reforms liberalized electricity generation and commercialization, opening the sector to private and foreign investment. • The liberalized market model failed to ensure sufficient investment in Brazil's energy sector, due to a lack of coordination of planning and finance, leading to a crisis in 2001-2002. • A second wave of reforms were implemented: Law 10848/2004 created free (ACL) and regulated (ACR) power contracting markets, and Law10847/2004 created a planning agency (EPE).
Demand side	• In the free market large consumers buy electricity directly from the plants or traders/retailers, in a private negotiation. • In the regulated market the distributors of electricity sell it to small consumers, charging regulated tariffs. Distributors are obliged to buy 100% of forecast load in central auctions.
Supply side	• The main source of generation is hydroelectricity (48%), followed by wind (14%), biomass (7%), solar (7%), and gas-fired thermal generation including LNG (6.2%). Microgrids and distributed generation account for about 15% of the total. • The electricity distribution industry consists of 53 concessionaires, the majority of which are privatized.
Wholesale and spot market characteristics	• The spot market in Brazil is limited to settling differences between contracted energy and actual generation or consumption levels. • The difference settlement price for light, medium and heavy load levels in each of the four subsystems of the national transmission system (SIN) is a consequence of the marginal operating cost based on energy generation and the costs of meeting the system's electricity demand.

Power sector characteristics	Summary and key features
Transmission business model	• The transmission and distribution of electricity are carried out by public and private sector companies through concessions (30-year contracts awarded in public auctions). • The electricity transmission network is planned centrally for the country by EPE.
Investment framework and viability	• Auctions offer generators and investors long-term PPAs to reduce price volatility and provide revenue stability. • The regulator uses auctions to award 30-year contracts for the construction and O&M of transmission infrastructure, which is remunerated based on the APR bid in the auction. • Since 2004, investment has come through long-term contracts where the off-takers are mainly private distribution companies with a regulated monopoly over regulated customers in their concession footprint. • BNDES played a key role by offering enabling financing and risk mitigation to make renewable energy and transmission projects more attractive, including the development of local supply chains (e.g., wind turbine manufacturing).
Customer choices and protection	• The main types of auctions for the ACR market are: • Existing energy auctions: these award PPAs of up to 15 years. Only existing power plants can take part in this type of auction, which aims to renew distributors' current contracts and reduce the risk of price increases. • New energy auctions: these allocate PPAs of up to 30 years, for delivery to begin in 3 to 6 years or more. New energy auctions take place at least twice a year, to ensure that electricity supply capacity grows in line with the expected increase in demand. • Adjustment auctions: these are for short-term PPAs, with supply starting in the same year. They are held four times a year to allow distributors to make short-term adjustments to meet demand.
Enablers for renewable energy and distributed resources	• The PROINFA program fostered renewable energy, after market liberalization in 2002. • Dedicated auctions for alternative energy sources, restricted to renewable energy plants, were carried out to increase their contribution to the national electricity matrix. These auctions were facilitated with funding schemes from BNDES. • Brazil has implemented a net-metering scheme created in 2012 which was reformed a few times and become a law in 2022: this has created a huge incentive for distributed solar PV.
Distribution business model and trends	• Distribution is mostly privatized, with regulation for some distribution companies and concession agreements used to define service areas.

4.3 Mexico Summary

The Mexican wholesale market is operated by an independent system operator. Participants sell or buy electric energy, power, clean energy certificates, financial transmission rights, and related services. Mexico's legal framework allows the use of auctions with government guarantees for contracts to expand the transmission grid and bring generation: these are awarded to public and private parties who offer the lowest cost over a number of years. Table 11 summarizes key power sector characteristics and components for context.

Table 11: Power Sector Summary for Mexico

Power sector characteristics	Summary and key features
Liberalization context	• In 1992 the regulatory framework allowed the entry of private investment for some activities. • In 2013, Mexico deregulated the electricity market to attract private investment. • Private companies are allowed to compete with state-owned companies in the wholesale market. Prices at a wholesale level are defined at every node in the system, based on supply and demand.
Demand side	Consumers are grouped into three types: • Basic service users: must buy their energy from a regulated retailer, a role fulfilled by an affiliate company of the state-owned company (CFE). • Qualified users: have a minimum demand of 1 MW and can sign contracts with a qualified service supplier to supply their electricity demand. • Qualified market participant users: have a minimum demand of 5 MW and annual consumption of at least 20 GWh and can participate directly in the wholesale market.
Supply side	• An estimated 54% of the energy generated in Mexico in 2023 came from natural gas, followed by 13.5% from other types of fossil fuels. Renewable energy – such as hydropower and wind power – accounted for 23% of the total produced.
Wholesale and spot market characteristics	• The Mexican wholesale market started operations in 2016, operated by an independent system operator. Participants can sell and buy electric energy, power, clean energy certificates (CELs), related services (operating reserves and rolling reserve, frequency, voltage and reactive energy regulation, emergency start-up, island operation and dead bus connection) and financial transmission rights (DFT). • The wholesale prices of electricity are determined by means of nodal prices in the day-ahead market and real-time market, based on variable costs. Generation technology plays an important role, since the lowest-cost generation is the first to be dispatched.
Transmission business model	• SENER, the ministry, is allowed by law to hold auctions to assign contracts for grid expansion. These contracts are awarded to the public or private parties who offer the lowest cost over a number of years. At the end of the contract, the assets must be transferred to the state. Each investor in transmission assets will be paid back through the general tariffs for use of the network.

Power sector characteristics	Summary and key features
Investment framework and viability	• The wholesale market (MEM) offers a range of products to help cover the fixed costs of a power plant, including capacity and CELs. Depending on the plant's technology, the generator can sell capacity, CELs or both on the market.
Customer choices and protection	• Customer choice is primarily only available for larger users (>1MW). • Small users must be catered for by state-owned companies.
Enablers for renewable energy and distributed resources	• Long-term auctions help make electricity less dependent on fossil fuels and ensure a reliable, efficient electricity service by procuring capacity, energy and clean energy certificates.
Distribution business model and trends	• Distribution is mostly managed by the state-owned monopoly (CFE), with some private distributed generation projects (e.g., private microgrids).

4.4 Chile Summary

Liberalization in Chile started in the 1980s and has benefited from several reforms in the years since then to develop a stable and predictable regulatory framework which offers a level playing field for private investors and new technologies (e.g., clean energy, storage) to compete in the power sector. Customer choice is also prioritized, giving users the right to choose and change suppliers to improve competitiveness and efficiency. Table 12 summarizes key power sector characteristics and components for context.

Table 12: Power sector summary for Chile

Power sector characteristics	Summary and key features
Liberalization context	• The process of deregulation and privatization of the industry started in 1980. • The General Law of Electrical Services (enacted in 1982) established the framework for the first competitive electricity market in the world. • During the 1990s and early 2000s the Chilean electricity market continued to evolve with the implementation of new regulatory frameworks that promoted competition and efficiency in the sector.
Demand side	• Free consumers (contracted demand ≥500 kW) can participate directly in the wholesale market, purchasing energy through bilateral contracts with producers or on the spot market. This allows them to manage their energy costs more effectively and take advantage of market price fluctuations. • Prices for regulated customers are established by regulation, based on methodologies that seek to reflect production and distribution costs.
Supply side	• Private investment in generation capacity has been encouraged through a stable and predictable regulatory framework; this has led to a significant expansion and diversification of the energy mix.

Power sector characteristics	Summary and key features
Wholesale and spot market characteristics	• A competitive market has been established for the generation and marketing of electricity since 1982; prices are determined by supply and demand in a spot market and through long-term contracts. • A pricing model based on marginal costs was adopted, where electricity node prices or spot prices reflect the cost of the last unit of energy demanded. Generators submit cost-based production bids for how much electricity they are willing to supply and at what cost.
Transmission business model	• The expansion of the transmission network is determined in a planned and regulated manner. • Expansion projects undergo a public bidding process. This process is designed to be transparent and competitive, allowing various companies, both national and international, to participate.
Investment framework and viability	• Private investment in generation capacity has been encouraged through a stable and predictable regulatory framework; this has led to a significant expansion and diversification of the energy matrix. • Foreign direct investment is treated on equal terms with national investment, increasing the capital available for development and innovation.
Customer choices and protection	• Distribution companies purchase energy on behalf of regulated customers through competitive bidding. Prices and conditions are regulated by the National Energy Commission (CNE) and are based on projected generation and transmission costs. Distribution companies are required to carry out competitive tenders to contract energy for their regulated customers. • Users have the right to choose and change their supplier, and other recent legislative projects seek to improve market competitiveness and efficiency.
Enablers for renewable energy and distributed resources	• The integration of non-conventional renewable energy (NCRE) has been supported by several important laws, including Law 20,257 (known as the "NCRE Law" of 2008), which establishes specific obligations for electricity companies regarding the percentage of their energy that must come from renewable sources. • Since 2018, Chile has had the Net Billing Law, which allows all self-generators to install projects of up to 300 kW of renewable energy for self-consumption connected to the distribution grid.
Distribution business model and trends	• Distribution is privatized, with private companies operating in concession areas under regulatory oversight. • Distribution rates are set by the regulatory agency every four years, based on an efficient company model factoring in O&M, infrastructure investment, and a reasonable rate of return on capital.

4.5 Guatemala Summary

Guatemala's vertically integrated utility was unbundled in 1998 into separate generation, transmission, and multiple distribution companies. Private distributors are responsible for organizing long-term and short-term auctions to contract their power and energy requirements, which they then sell on to customers. The construction of new transmission lines and

substations is primarily conducted through public bidding and paid for through regulated tariffs. Table 13 shows the main features of the power sector in Guatemala.

Table 13: Power sector summary for Guatemala

Power sector characteristics	Summary and key features
Liberalization context	• In 1996 the Guatemalan Congress passed the General Electricity Law, which liberalized the electricity market. Under this law, the state of Guatemala relinquished its role as the sole provider of electricity services to allow private participation, and assumed the role of regulator of the new players. • In 1998, INDE (the state-owned, vertically integrated company) was unbundled into different companies: generation, transmission, and two distribution companies. • The government launched a privatization process that included all the distribution companies. Performance parameters such as reduced electricity losses and higher collection improved significantly.
Demand side	• Large consumers are those with a demand of more than 100 kW. These consumers can directly buy energy from a generator or from traders (locally known as comercializadores) and freely negotiate the price. • The remaining consumers receive the service at a regulated tariff. Their electricity supply is guaranteed by the distributor.
Supply side	• Guatemala's installed generation capacity is 3,435.1 MW, including DER capacity. Non-renewable capacity represents 32% of the total effective power, with coal, petroleum coke, bunker and diesel being the most important resources.
Wholesale and spot market characteristics	• The spot energy market is a day-ahead market. This market is a surplus and shortage market, where the price fluctuates hour to hour. • The spot price is determined by the short-term marginal cost, which represents the maximum variable cost incurred each hour to supply an additional kWh. The marginal cost of each resource is bid by the generators. The spot price applies to all market participants, as there are no locational or zonal prices.
Transmission business model	• The construction of new lines or substations for the Electric Energy Transportation Service is primarily conducted through public bidding. • Remuneration is provided through regulated tariffs.
Investment framework and viability	• Distributors organize long-term and short-term auctions to contract their power and energy requirements, which they then sell to customers. Existing power plants and new projects are allowed to participate according to the terms of reference of each bidding process.
Customer choices and protection	• Large consumers can select their service provider and negotiate the rights and obligations. It's their responsibility to find demand coverage.

Power sector characteristics	Summary and key features
Enablers for renewable energy and distributed resources	• In 2007, the General Electricity Law introduced a new type of agent: the distributed energy resource or distributed renewable energy producer. These generators can participate in transactions on the Mexican energy market and bid for electricity supply contracts with distribution companies. Since 2014, self-generators have also been able to supply surplus energy to the grid, reducing their electricity bills through net metering.
Distribution business model and trends	• Distribution is privatized, with private companies operating under regulatory oversight. • The distribution service is paid for through an added value for distribution (VAD) charge, which includes costs related to the user (regardless of demand), average distribution losses, and the capital, operation, and maintenance costs per unit of power supplied.

5 Additional Insights from Country Case Studies

A few examples from the case studies profiled are summarized in this section, to provide more context on some additional attributes of liberalized power sectors that are relevant for South Africa.

5.1 Translating Wholesale Prices to Retail

Wholesale markets often use a similar approach to vertically integrated utilities to calculate electricity tariffs, where the tariff reflects the sum of various electricity value chain components such as generation, transmission, distribution, and utility overhead. Wholesale markets often provide more transparency for the tariff component costs, making it easier to identify and address potential inefficiencies along the electricity value chain.

Digital infrastructure is also expected to help electricity tariffs more accurately account for the locational and temporal value of electricity, to ensure fair cost recovery and better integration of distributed energy resources on the grid. Two examples are discussed below.

5.1.1 Mexico

Mexico's electricity regulator established a methodology for determining end-user tariffs. Tariffs are determined monthly for each of the electricity distribution areas and 12 categories of users according to their type of demand and voltage level.[4]

Regulated tariffs are composed of several charges, including the generation charge (which has both an energy and a capacity component), the transmission charge for the category, the distribution charge for the user's zone and category, the National Energy Control Centre's operation charge, the operation charge for basic service suppliers, and charges for related services in the wholesale electricity market.

Mexico's federal government also provides subsidies to residential and agricultural users through the public budget. These budget resources are transferred to the public regulated utility, which is still responsible for network infrastructure including distribution.

5.1.2 Guatemala

Guatemala's electricity laws and supporting regulations inform the tariff calculation, which includes the sum of the electricity production costs, transmission and distribution charges, and a reasonable component for energy losses.

The General Electricity Law established that tariffs for the final consumers of the distribution service, in its energy and power components, are calculated using the sum of the weighted price of all the purchases of the distributors and an added value for distribution charge. Electricity purchases by distributors must be made through open tenders.

[4] Low voltage residential <150kWh-month, low voltage residential > 150 kWh-month, small demand in low voltage (<25 kWh-month), high demand in low voltage (>25kWh-month), agricultural irrigation in low voltage, street lighting in low voltage, street lighting in medium voltage, high demand (>=100 kWh-month) in hourly medium voltage, high demand (<100 kWh-month) in medium voltage, agricultural irrigation in medium voltage, industrial demand in sub-transmission, industrial demand in transmission. For more details: https://www.dof.gob.mx/nota_detalle.php?codigo=5715449&fecha=29/01/2024#gsc.tab=0

In 2000, the Guatemalan Congress introduced a social tariff to address the rising costs of energy production and subsequent increases in energy prices. This special tariff was designed to provide a more affordable energy supply for users with energy demand up to 300 kWh. However, the Congress did not specify how the tariff reduction would be financed, so the national utility was responsible for transferring the necessary resources to the distributors. The current social tariff applies to users with consumption between 89 and 100 kWh.

5.2 Dealing with Non-Payment and Debt from Off-Takers

Many power systems have found strategies to encourage timely payments from participants. These include penalty fees, interest payments, credit lines, pre-paid deposits, and – in some cases – revoking licenses for those who consistently fail to meet payment obligations. A few examples from the case studies profiled are summarized below.

5.2.1 India

To address the challenges associated with inefficient disbursement of subsidies to DISCOMs, India's government introduced a **direct benefit transfer (DBT)** initiative to improve transparency and reduce leakages of subsidy funds. DBTs were tested in pilot projects with direct transfers of subsidies to a citizen's account as a deduction on their monthly bill, which improves transparency and avoids market distortion associated with reducing consumer prices. The transition to DBT is expected to increase revenue recovery and enable DISCOMs to implement more cost-reflective tariffs (e.g., time of day) along with other improvements[5] (EY, 2023).

5.2.2 Mexico

Since 2016, the Mexican power sector has had a Compliance Guarantee Manual in place to enable the market administrator to effectively manage the risk of wholesale market participants failing to comply with their payment obligations to the National Energy Control Center (CENACE).[6] This provides certainty of creditworthiness and prevents unpaid bills from being transferred to the rest of the participants. This Manual establishes, among other things:

- CENACE will implement the policy to address non-compliance from market participants.
- A methodology to be used to estimate the total amount of money that each market participant will pay to CENACE.
- The types of instruments that market participants may use to guarantee compliance with obligations. The following instruments may be accepted as collateral:
    - Letter of credit

[5] Ernest & Young (EY), Federation of Indian Chambers of Commerce and Industry (FICCI), & International Copper Association India. (2023, December 21). *Study on moving to a self-sustainable power distribution sector*. https://copperindia.org/wp-content/uploads/2024/01/Report-on-Moving-to-a-Self-Sustainable-Power-Distribution-Sector_FICCI-x-ICA-India_2024.pdf

[6] Ley Orgánica de la Administración Pública Federal [LOAPF], Diario Oficial de la Federación [DOF] 16-03-2016, (Mex.). https://www.dof.gob.mx/nota_detalle.php?codigo=5430146&fecha=16/03/2016#gsc.tab=0

- Financial instruments with low credit and market risk in accordance with the resolutions of the Risk, Guarantee and Investment Committee
- Deposit of funds
- Federal government guarantee

5.2.3 Guatemala

In order to protect the wholesale market from the risk of non-payment, the wholesale system operator established a requirement for participants in the wholesale market to have a credit line with the clearing bank, equivalent to at least two months of the agent's obligations to the wholesale market, excluding the bilateral market. The amount of this credit line must be adjusted annually in accordance with a set of guidelines, and always remains in force.[7]

5.3 Mechanisms to Protect Customers

Wholesale markets have been operating for decades in some countries, and have demonstrated they are an efficient way to reduce total power system costs. A number of common market mechanisms also exist to protect customers from potential price shocks, supply shortages, and other issues. Common market mechanism options include:

- Market monitoring
- Long-term contracting
- Cost-based electricity markets
- Hedging through different types of auctions

Guatemala provides another example of a wholesale market that has learned to manage risks for customers through the following mechanisms:

- Cost-based market
- Central dispatch
- Obligation to have contracted capacity one year in advance
- Compulsory auctions for regulated consumers to provide hedging

In addition, wholesale markets help create a platform for demand response and innovative tariffs (e.g., capacity subscriptions) which can also help avoid price shocks and supply shortages. Customers may also prefer to avoid exposure to market fluctuations and could choose fixed tariffs from suppliers with long-term contracts.

Tools also exist for regulators to protect customers from potential market manipulation that could impact the price they pay for electricity. Since electricity demand is highly inelastic, wholesale electricity markets with a small number of participants are prone to market manipulation. Market manipulation happens when generators deliberately do not offer their capacity and energy to the market, even when prices are larger than their marginal cost, which increases the prices paid by retailers purchasing energy in the spot market – and ultimately by customers. California's energy shortage in 2001 is a prime example of how things can go wrong

[7] Resolución 157-09 AMM. For more details: https://www.amm.org.gt/portal/?wpfb_dl=21NCC-12%20actualizado%2008-2021.pdf

if the necessary measures are not taken to ensure a competitive market. Fortunately, decades of experience with electricity market liberalization demonstrate that competitive outcomes can be fostered with the right tools even with a small number of market participants. Examples of these tools include:

- Careful and constant market monitoring by the regulator who oversees the performance of the market and can detect wrongdoing.
- In the short term, cost-based markets and bid screening which requires some generators deemed large enough to manipulate the market to construct their bids based on their marginal costs and uses preventive automatic checks to avoid bids above a certain margin.
- In the mid to long term, contracts to hedge electricity prices and more competition help disincentivize manipulation. For example, contracted generators that reduce generation supply to increase prices will not directly benefit, as their competitors would sell to the market instead while the generators would be obliged to obliged to buy electricity in the spot market at higher prices in order to fulfil their contracts.

Structural separation of generators in different companies may also be needed to foster competition in the market (RAP, 2016).

6 Conclusion and Next Steps

The research and case studies discussed in this report highlight some of the key decisions about market structure and participation that need to be made, and various approaches that can be taken, when transitioning to a more liberalized electricity sector in a country like South Africa.

While most large power systems have become or are planning to become more liberalized, there is no one-size-fits-all design as each varies based on local characteristics and objectives.

The findings from this study are intended to provide content for discussion and context for a web-based dialogue organized by the Presidential Climate Commission in the coming months once this report is finalized.

Annex I: Key Terms and Definitions for Electricity Markets

Table 14: Key terms and definitions for electricity markets

Term	Definition
Adequacy mechanisms	Adequacy mechanisms encompass various strategies designed to ensure that the electricity system has enough capacity and resources to reliably meet current and future demand.
Ancillary services	A generating plant can sell additional services to help with the operation of the transmission system, including operating reserves, reactive power and energy imbalance services, among others. These products help maintain system reliability, stability and efficiency.
Balancing market	Managed in real time by the system operator to maintain balance between supply and demand with pre-purchased reserves to correct any imbalances between scheduled and actual generation.
Bilateral contracts	Contracts between two parties (e.g., a power purchase agreement between an IPP and large customer or system operator for electricity).
Capacity market	Mechanism designed to ensure the reliability of the power supply with payments to electricity generators not only for the actual electricity generated but also for their capacity to generate electricity when needed.
Closed auctions	Auctions are used to contract energy and/or related services for delivery over a certain period of time. Closed auctions allow suppliers to keep these prices confidential.
Credit profile of participants	Instant energy payments reduce credit risks, and providers are required to meet credit requirements like ratings, letters of credit, cash deposits and collateral. Organized exchanges lower credit risk and cost through centralized procedures, revoking trading rights if creditworthiness is not verified.
Day-ahead market	Electricity trading market for buying and selling of electricity one day before the actual production and delivery of electricity.
Demand-side participants	Typically refers to entities that purchase from the wholesale market in bulk and resell the energy to final consumers, such as retailers, regulated entities selling to “regulated consumers” such as municipalities, distribution companies, or retailers selling to “free consumers” and sometimes very large customers themselves.
Energy market	A commodity market where electricity suppliers bid to sell electricity generated by their power plants to load-serving entities that bid to meet their customers’ energy demands.
Gate closure	Specified point in time when market participants must submit plans for operation or consumption to the system operator – for example, one hour prior to the start of a settlement period.
Gross pools	Refers to all the electricity traded through the system operator, which sets location-specific prices for each settlement period.
Locational price signals	Prices paid for energy or related services that vary based on the location of the generator’s grid connection (e.g., single node, zonal markets, nodal markets). These prices provide incentives to help address grid challenges such as grid congestion.
Market operator	A market operator is a centralized institution which operates an organized market for the (commercial) exchange of electricity or other energy products on behalf of market participants.
Merit order	Priority ranking system for available sources of electricity generation typically based on least-cost principles or sometimes emissions.
Net pools	Platforms where generators and load-serving entities schedule their own generation purchased in advance, and buy or sell residual power from the system operator. The system operator also runs a separate pay-as-bid balancing market and sets the price paid by generators and load-serving entities at the marginal cost of power in the balancing market. The system operator does not set a price for the majority of trades in a net pool, which are self-scheduled. Almost all European markets use net pools.

Term	Definition
Network operator	Manages the electricity grid that delivers power to consumers (e.g., distribution grid).
Nodal pricing	A method for determining the price of electricity based on location. It involves dividing a national network into hundreds or thousands of nodes, each with a specified wholesale electricity price.
Real-time electricity market	A spot market where electricity is bought and sold for immediate delivery, usually within an hour of delivery.
Resolution	Refers to both the granularity of the dispatch period for electricity traded on the market (the market time unit) and the minimum period of time during which the system operator will consider imbalances between scheduled and actual generation and consumption (the imbalance settlement period).
Reticulation	The trading or distribution of electricity including all associated services. Eskom and municipalities are primarily responsible for this in South Africa, but wheeling rules have recently given primarily large customers the option to purchase directly from IPPs.
Settlement	Some markets use a two-step structure for spot markets with a mandatory day-ahead market and real-time market, and use real-time prices to determine penalty payments.
Settlement period	On a wholesale market, electricity is often traded in specific time windows. For example, if it is traded in half-hour chunks, then each 30-minute window is a new settlement period, totaling 48 settlement periods every day.
Spot bid-based single-priced markets	The spot price equals the marginal cost of bids for a given settlement period, typically set hourly or half-hourly, with some markets using 5-minute intervals. Each period has a single price for electricity, but prices can vary by grid location because of constraints.
Spot market	Market for immediate delivery of a product.
System operator	Coordinates the generating plants with the load (the sum of all customers' usage at a given time) to maintain a stable transmission system. One system operator is required per system, and cannot be competitive. The grid operator must maintain independence because of industry complexity and regulatory importance. In the United States, independent system operators (ISOs) are regulated by state or federal authorities; while in Europe, unbundling rules separate system operations from competing market participants.
Traders	An electricity trader is an individual or entity licensed to buy and sell electricity. The process involves power generators selling electricity to power suppliers, who then distribute it to consumers.
Vertically integrated utilities	Without deregulation, the electricity industry relies on single companies to manage generation, systems operations, transmission and distribution of electricity, acting as both retailers and producers. These companies hold regional monopolies, leading to state-level regulation of prices in the United States and central government regulation in other countries.
Voluntary pool	A term used in trading arrangements to describe the legal agreements between traders and the system operator and/or transmission owners. Traders must sign agreements to obey the rules for using a transmission network, and compliance is not voluntary.
Zonal pricing	Also referred to as regional pricing, this is a method of determining electricity prices by dividing the transmission system into zones and setting a wholesale price for each zone during settlement periods.

Annex II: Full Country Case Studies

A India

A.1 Historical Context

Power sector and market reforms in India began in 1991 with policy measures to open up the electricity sector and amend regulations to allow for more private sector involvement in generation. These changes helped to unbundle the utility business model and led to significant growth in generation, transmission and distribution infrastructure. In 1998, the Central Electricity Authority (CEA) on behalf of the government of India helped to form the Central Electricity Regulatory Commission (CERC). In addition to the national government, the states in India also have a large role in the electricity sector with their own State Electricity Regulatory Commissions (SERCs), along with state-owned generation/transmission/distribution assets, as well as coordinated scheduling and deviation settlement at the interstate level. The Electricity Act of 2003 further aimed to reform the power sector in India, making open access to the sector a priority along with bilateral trade. This led to the opening of two power exchange markets in 2008.[8] Figure 3 summarizes the key policy, regulations and technical standards that have been developed to guide India's electricity sector as it implements its market reforms over time.

[8] Chattopadhyay, D., Chatterjee, SK., Soonee, SK. (2023, January). Spotlight on the spot market: A Review of the Indian Wholesale Electricity Market. *The Electricity Journal, 36*(1), 107239. https://doi.org/10.1016/j.tej.2023.107239

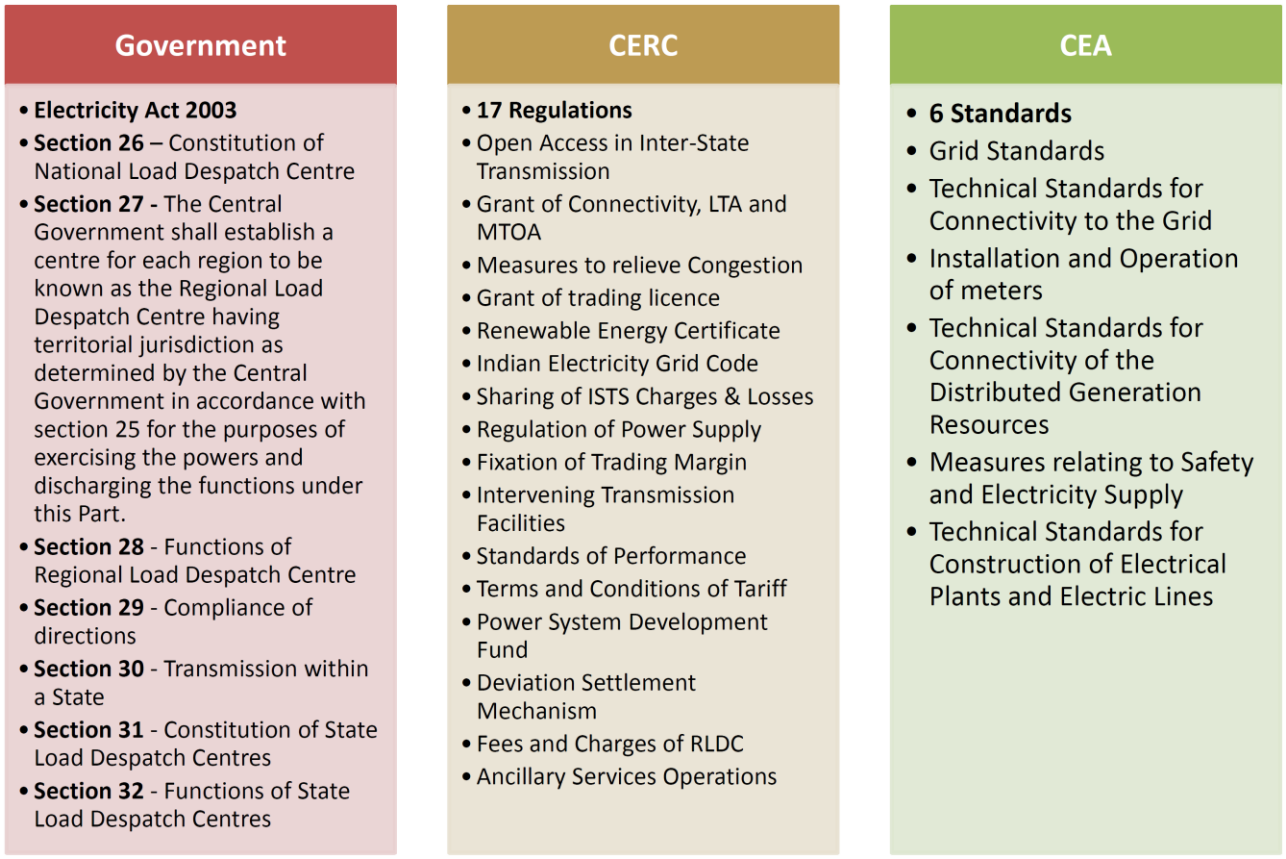

Figure 3: Institutional framework of India's electricity sector[9]

Over the past couple of decades, the government of India has prioritized an all-India synchronous grid with substantial amounts of transmission added to the network along with transmission pricing and organized grid access. Despite some challenges along the way, India has also seen more private sector investment, further unbundling of its utility responsibilities, improvement in distribution company viability, and significant growth in the renewable energy sector.

A.2 Demand Side

India's electricity demand increased by 7% in 2023, and its demand per capita has continued to rise steadily over the past decade: this makes it a high-growth market relative to many other countries where electricity demand has stagnated or decreased. Energy supply and expansion of the grid have also grown over this time, suggesting the investment framework in the country has proven effective.[10] A mix of stakeholders make up the demand side in India, including open access companies and distribution companies, who then sell the electricity to consumers by providing both distribution and retail services. India also makes a distinction under the open access transaction regime between large and small consumers. These market rules allow large

[9] Soonee, SK. (2016, April). *Role of transmission, system operators and integration of regional grid in the development of Indian power market: Key challenges and lessons learnt.* [Presentation]. USAID Power Market Development in India: Key Lessons Learnt. Workshop. https://www.researchgate.net/publication/346963332_Power_Market_Development_in_India_Key_Lessons_Learnt

[10] IEA. (2024). *Electricity 2024: Analysis and forecast to 2026.* https://www.iea.org/reports/electricity-2024/executive-summary

consumers in India (>1MW in demand) to choose which generator to purchase electricity from via a direct arrangement or through a local trading company/power exchange, while small consumers remain captive. Recent government reforms introduced the Green Open Access Rules of 2022[11] to give smaller consumers (>100kW in demand) the choice to buy green power from their local power distribution company in exchange for green certificates, but additional reforms are required to give low-voltage customers full retail choice in India (Ministry of Power India, 2022).

A.3 Supply Side

India's installed generation capacity was about 415 GW and it produced about 1,624 TWh as of early 2023. Coal accounted for about 51% of this installed capacity and 74% of the energy, while solar and wind energy accounted for ~10% of the national electricity generated from 2022-2023 (Government of India, 2023).

India's electricity market has made significant progress over the last three decades, with the private sector now operating nearly 50% of the generation, and growth in renewable energy generation.

Despite India's progress and successful implementation of a national wholesale market with a well-integrated transmission grid, about 86% of the dispatch still takes place via long-term PPAs (as of 2023). The bilateral PPAs have resulted in many expensive coal plants being kept operational using fixed cost payments, and have limited the impact of market forces towards least-cost solutions. For example, PPA prices have been significantly higher than market prices, with almost half of the coal projects costing 40% more on average compared to the spot price.[12] This highlights the importance of making a plan to integrate long-term PPAs and generation facilities into the wholesale market reform process to avoid these inefficiencies in the future.

A.4 Basic Characteristics of the Spot Market

India's electricity market reforms have been implemented over time, and a lot of preparatory work was required before the opening of the wholesale spot market in 2008. Key market phases evolved over time, with reforms to the national transmission utility (PGCIL) and electricity market being implemented over a number of years since 1994. These have included:

- Functional separation and ring-fencing of system operation, as per Act 2003.
- Financial separation and development of a wholly owned subsidiary for the system operator (POSOCO) in 2010.
- POSOCO officially becoming an independent system operator in 2015.[13]

Figure 4 shows some of the key components of India's power market as of 2022. It is considered a voluntary net pool, structured primarily around the day-ahead market and real-time market. Net pools allow participants to schedule their generation or pre-purchased power and buy or sell residual power from the system. The system operator runs a separate pay-as-bid ancillary market. The term 'voluntary' refers to the legal agreement between stakeholders and system

[11] Ministry of Power, (notified on June 6, 2022). *Green Energy Open Access Rules*. Press Information Bureau Delhi. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1842737
[12] Chattopadhyay, 2023.
[13] Soonee, 2016.

operators requiring them to follow the rules for using the transmission network – which are *not* voluntary.

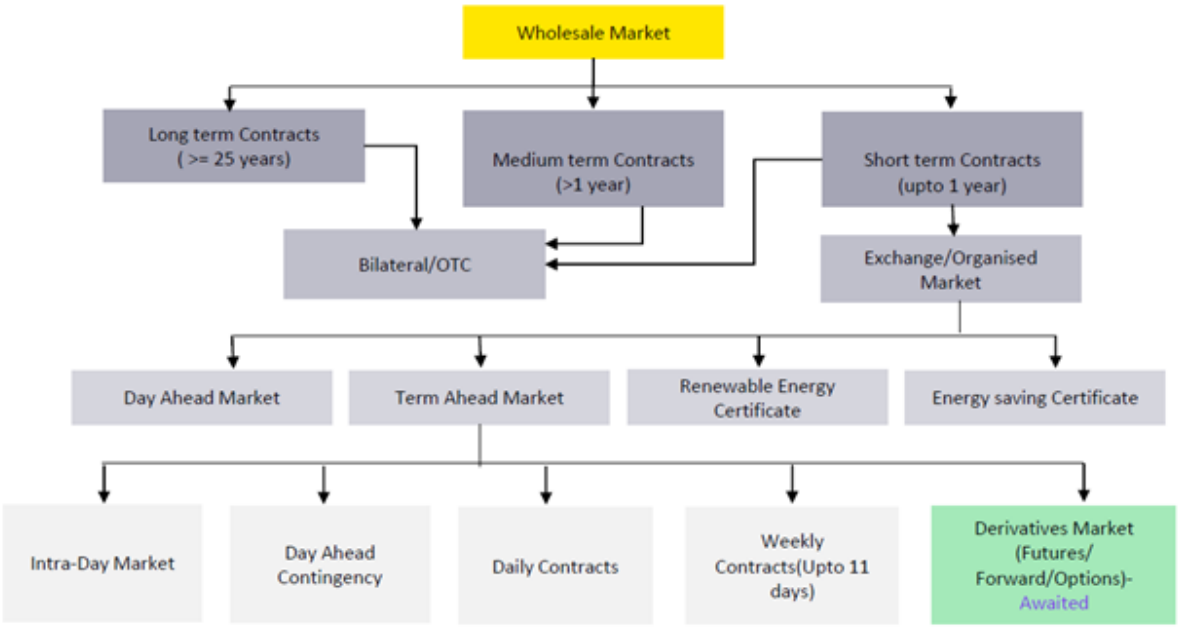

Figure 4: Overview of India's wholesale electricity market (EY, 2023)

Key components of India's wholesale market include:

- **Day-ahead market –** Refers to next-day delivery using a double-sided auction with closed price discovery, to allow suppliers to keep prices confidential.
- **Real-time market** – Refers to same-day next-hour delivery using a double-sided closed uniform clearing price.
- **Over-the-counter market** – For non-standard bilateral direct transactions between buyer and seller or through traders.
- **Intraday market and day-ahead contingency (these run 24 x 7)**– Intraday refers to same day delivery of services, while day-ahead contingency is another window for the next day. It uses a three-hour gate closer approach which requires market participants to finalize their trades/schedules three hours before the actual dispatch period to give the system operator time for any grid stability interventions.
- **Term-ahead contracts** – For delivery up to 11 days, and includes both daily and weekly contracts.
- **Renewable energy certificates** – Refer to green attributes of power projects in the form of certificates for renewable energy generators that do not benefit from a feed-in-tariff. The buyers purchase renewable energy credits (RECs), which are equivalent to 1 MWh per REC.
- **Energy saving certificates** – An energy saving certificate equals 1 Metric Tonne Oil Equivalent.[14]

[14] EY et al., 2023.

Recent initiatives introduced since 2020 include the **Green Term Ahead Market (GTAM)**, which uses power exchanges to enable spot trading of renewable energy. This allows corporate consumers to use a trading window for purchasing renewable energy rather than a PPA. Likewise, an intraday electricity market was introduced in 2020 to allow distribution utilities to more efficiently manage demand by moving the trading window closer to the time of delivery (i.e., delivery of power with one hour advanced notice). The intraday market enables a new auction every 30 minutes, resulting in 48 auctions per day.

One other objective of the wholesale market is to provide zonal price signals (prices paid for energy or related services that vary based on the zone of the generator's grid connection, to provide incentives to address grid congestion). While the Indian market has 13 zones, the large scale of its grid and generation capacity suggests that more zones could help send more cost-reflective price signals.[15]

A.5 Transmission Business Model

Over the past decade, India's government and electricity regulator have made bold decisions to prioritize large investments in transmission infrastructure. This has made it easier to plan for the development of future power projects in regions with high renewable resource potential, and effectively to recover use-of-system costs associated with significant and intermittent infrastructure investments in transmission upgrades. They have also kept the transmission planning institution separate from the transmission owner to avoid potential conflicts of interest.

A.6 Trading Arrangements, Investment Frameworks and Financial Viability

India's power market uses a voluntary net pool approach primarily based on the day-ahead market. Net pools allow generators and load-serving entities to schedule their own generation purchased in advance, and buy or sell residual power from the system operator. The system operator also runs a balancing market with a price set at marginal power costs.

A.6.1 Investment Frameworks

Long-term PPAs with coal power plants still dominate the Indian market and have limited the expansion of the wholesale spot market to date. If reforms to these PPAs are not implemented, then India runs the risk of continuing to subsidize high-emitting coal plants and missing its 450 GW renewable energy target in 2030. Fortunately, reform options exist that do not compromise the financial viability of the DISCOMs or other market participants.

A.6.2 Financial Viability

Many DISCOMs in India are operating at a loss (estimated at Rs 90,000 crore for 2021 or ~US$11 billion) due to challenges such as:

- Insufficient revenue collection from consumers who don't pay, or make late payments
- Expensive long-term PPAs
- Inadequate infrastructure and operational inefficiencies

[15] Chattopadhyay, 2023.

DISCOMs typically try to make up for this shortfall in revenue recovery from consumers by borrowing from lenders, leveraging government subsidies, and sometimes reducing capital expenditure for ongoing or planned projects. Dependence on state subsidies remains high, especially among agricultural consumers, who benefit from a subsidized tariff. Government subsidies to DISCOMs are sometimes paid late or are only paid partially, resulting in further challenges for the DISCOMs as they are unable to make the investments required to maintain and improve the distribution network and associated customer services.[16] In addition, defaulting DISCOMs are subject to late payment surcharges and access restrictions.

To address these challenges associated with inefficient disbursement of subsidies to DISCOMs, India's government introduced a **direct benefit transfer (DBT)** initiative to improve transparency and reduce leakages of subsidy funds. DBTs were tested in pilot projects with direct transfers of subsidies to a citizen's account as a deduction on their monthly bill, improving transparency and avoiding market distortion associated with reducing consumer prices. The transition to DBT is expected to increase revenue recovery and enable DISCOMs to implement more cost-reflective tariffs (e.g., time of day) along with other improvements (EY, 2023).[17] Despite reforms to the electricity market, electricity tariffs and tariff structures in India still remain complex. Numerous tariff structures, inconsistent tariff categorization between states, and cross-subsidies discourage wide-scale investment and industrial growth. Cross-subsidies, for example, require commercial and industrial customers to pay higher tariffs than residential consumers, which impacts the viability of their operations in the country, especially for energy-intensive industries.[18]

A.7 Distribution-Level Resources and Trends

India has various programs for promoting distributed energy resources, with goals for solar irrigation pumps and rooftop solar installations. For example, India had a goal to reach 40 GW of rooftop solar by 2022 which they pushed out to 2026, since its solar deployment has been slow despite various incentives including tax incentives, subsidies, grants, credit guarantees and preferential loans. As of January 2025, India installed 16.28 GW of grid connected rooftop solar. This slow uptake is a result of a number of factors, including:

- Existing cross-subsidies that reduce electricity tariffs for many residential customers.
- High up-front equipment costs and challenges with access to finance.
- Lack of commercial incentive for DISCOMs to expand rooftop solar (IEA, 2021).

Some states have their own policies and goals for rooftop solar and electric vehicles (EVs). For example, EV incentives such as net metering tariffs have been introduced in some regions to increase EV sales, and companies are building more EV charging stations across India. These distributed energy resources and applications associated with these assets are expected to continue to grow in the coming years.

India has also linked privatization efforts at the distribution level with improved electricity reliability that can also bring socioeconomic benefits (e.g., for small and medium enterprises,

[16] EY et al., 2023.
[17] EY et al., 2023.
[18] EY et al., 2023.

agriculture, education, health), making it easier for customers to afford electricity and thus boosting local economic activity (EY, 2023).

B Brazil

B.1 Historical Context

Historically, Brazil's energy sector was dominated by large, vertically integrated public companies under the federal Eletrobras group, and by state governments. This model enabled significant investments, such as in the Itaipu (14 GW) and Tucuruí (8.4 GW) hydroelectric plants, and a vast transmission and distribution network. However, the debt crisis of the late 1980s made this model unsustainable, leading to comprehensive reforms in the mid-1990s. These reforms liberalized electricity generation and commercialization, opening the sector to private and foreign investment (Instituto E+ Transicao Energética , 2020).

The liberalized market model failed to ensure sufficient investment in Brazil's energy sector, leading to a severe crisis in 2001-2002. In the new environment, distributors had no incentive to expand because existing energy supply contracts covered 100% of forecast consumption, without there being adequate physical backing. For their part, the generators, although exposed to financial losses, did not invest either. Furthermore, the regulatory framework lacked a coherent set of rules that would provide a reliable and transparent environment for consumers while also encouraging market participation. Additionally, public and private agents lacked awareness that the contracts would be honored. These issues occurred in an environment of low institutional coordination, where the problems and risks of the sector were poorly communicated (Kelman, 2001).

This prompted a second wave of reforms, culminating in a new regulatory framework in 2004, which aimed to correct market distortions and led to the unbundling of generation, transmission and distribution. Despite the 1990s efforts at privatization having previously been halted, the new framework incentivized private investment, significantly enabling IPPs.

Law 10848/2004 created free (ACL) and regulated (ACR) power contracting markets. This law also imposed an additional level of unbundling by preventing the distribution concessionaires from developing power generation and transmission activities, selling power to free customers, holding equity interests in other companies, and performing activities unrelated to power distribution services.[19] This phase of reforms introduced the following changes to the market:

- **Sector unbundling**: the new regulatory framework mandated the unbundling of the energy sector, separating generation, transmission and distribution activities. This separation aimed to increase transparency and competition in the market.
- **Creation of independent operators**: the framework led to the establishment of the national electric system operator (ONS), responsible for coordinating and controlling the operation of generation and transmission facilities. Additionally, the Electricity Commercialization Chamber (CCEE, Cámara de Comercialização de Energia Elétrica) was created to manage the wholesale electricity market.

[19] Yanasse, D., Salzano, B., Tortolano Barreto, L. & Braga, J. (2024, July). *Power Generation, Transmission & Distribution 2024*. Chambers & Partners. https://practiceguides.chambers.com/practice-guides/power-generation-transmission-distribution-2024/brazil

- **Regulatory agency strengthening**: The Brazilian electricity regulatory agency (ANEEL, Agência Nacional de Energia Elétrica) saw its role strengthened, gaining more authority to oversee the market, regulate tariffs, and ensure fair competition.
- **Creation of a planning agency**: the Energy Research Company (EPE) is responsible for a series of planning activities including ten-year and long-term plans, and consolidating demand for auctions, among others.
- **Long-term energy auctions**: The introduction of long-term energy auctions aimed to ensure the procurement of sufficient electricity to meet future demand. These auctions allowed for the contracting of energy through competitive bidding processes, promoting efficiency and reducing costs.
- **Universal access programs**: The framework included measures to promote universal access to electricity, aiming to expand the electricity grid to underserved areas and ensure that all regions of Brazil had reliable access to energy.
- **Focus on renewable energy**: The reforms emphasized the importance of renewable energy sources, encouraging investments in hydroelectric, wind, solar and biomass projects to diversify the energy mix and promote sustainability.

The resulting institutional framework is depicted in Figure 5.

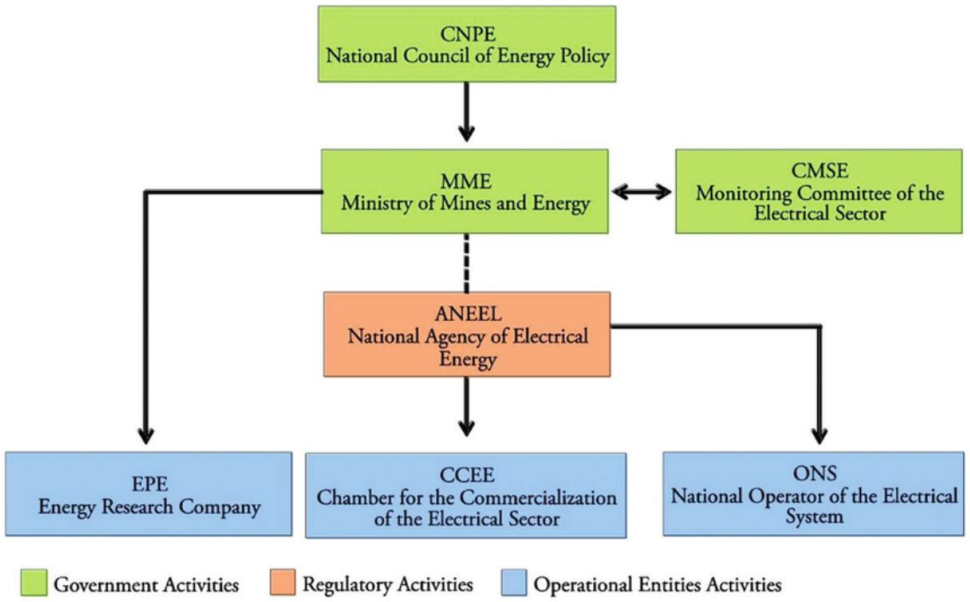

Figure 5: Main institutions of the Brazilian electricity sector (Leite, 2020)

B.2 Demand Side

In 2022, Brazil consumed 570 TWh of electricity. Industry was the primary consumer, accounting for 40% of total final consumption, followed by residential consumers, who represent 28% of the total.

Electricity consumers can be classified in two broad categories based on how they can acquire electricity: the free users (**ACL**, Ambiente de Contratação Livre) who buy electricity directly from generators, and the regulated users (**ACR**, Ambiente de Contratação Regulada) who buy electricity from monopoly distributors.

As of the third quarter of 2023, the regulated users represented 61% of total electricity consumption.[20] The free users category includes two types of consumers:

- Free consumers: originally, these were large customers with demand greater than 2 MW, served at any voltage and contracted with the distributor. By 2024, the definition had been broadened to include every consumer served at high voltage (+2.3kV).
- Special consumers: individual customers or sets of customers located in a common area or with the same taxpayer contribution number, whose load is greater than or equal to 500 kW (total of the contracted demand), and connected at high/medium voltage. Special consumers may contract only renewable energy (e.g., solar, wind, biomass, qualified co-generation sources or small hydro-electric plants). These contracts can be entered into between special consumers and generators or traders.[21]

Towards the end of 2022, Brazil approved the opening of the free energy market for consumers with a load of less than 500 kW, to take effect in 2024.[22] All high-voltage consumers (Group A) have become eligible to migrate to the free energy market, where they can choose their electricity suppliers.[23] The new rule has led to an intense acceleration in the pace of migrations to the free energy market. The Chamber for Electricity Commercialization reported that in the first quarter of 2024, 5,360 new consumers joined the segment, a volume higher than the total number of entrants in the whole of 2022. As a result, at the end of March there were a total of 43,540 units, 10,000 more than in the same period in 2023.[24]

B.3 Supply Side

In June 2024, Brazil had 222,986 MW of installed generation capacity. The main source of generation is hydroelectricity (48.5%), followed by wind (14.1%), biomass (7.2%), solar (6.7%), and gas-fired thermal generation including LNG (6.2%). Microgrids and distributed generation account for 14.8%.[25]

Brazil has an extensive transmission system – the Sistema Interligado Nacional (SIN), or National Interconnected System – which consists of four subsystems (or markets): South (S), Southeast/Central-West (SE/CO), Northeast (NE) and North (N). The diversity and complementarity of hydrological conditions in the four subsystems allow for synergies in the

[20] Greener. (2023, October 26). *Participação do Mercado Livre no consumo de energia cresce em média 1,7% a cada trimestre no Brasil* (Share of the Free Market in energy consumption grows on average 1.7% each quarter in Brazil). https://www.greener.com.br/participacao-do-mercado-livre-no-consumo-de-energia-cresce-em-media-17-a-cada-trimestre-no-brasil/

[21] Metron. (n.d.). *Overview of the Brazilian energy market.* https://www.metron.energy/blog/overview-brazilian-market/

[22] Cushman & Wakefield. (2024, March). *Free energy market advantages and news for 2024.* https://www.cushmanwakefield.com/en/brazil/insights/energy-trends

[23] Mercado Livre de Energia. (n.d.) https://www.mercadolivredeenergia.com.br/

[24] Câmara de Comercialização de Energia Elétrica. (2024, April 19). *Volume de migrações para o mercado livre bate novo recorde no primeiro trimestre* (Volume of migrations to the free market hits new record in the first quarter). https://www.ccee.org.br/pt/web/guest/-/volume-de-migracoes-para-o-mercado-livre-de-energia-bate-novo-recorde-no-primeiro-trimestre-de-2024

[25] Operador Nacional de Sistema Eléctrico. (n.d.) *O sistema em números* (The system in numbers). https://www.ons.org.br/paginas/sobre-o-sin/o-sistema-em-numeros

SIN. The transmission network comprises 200,015 km of transmission lines with voltage levels between 800 kV and 230 kV.

The electricity distribution industry consists of 53 concessionaires, the majority of which are large private sector companies. The 10 largest distribution companies account for 57% of the market share. Additionally, there are 56 distributors and authorized companies (mainly rural electricity cooperatives) that provide distribution services in remote areas.

Brazil's electricity market structure as of 2020 is shown in Figure 6 and consists of various market participants including generation companies, distributors, traders and free consumers. Eletrobras was privatized in 2022.

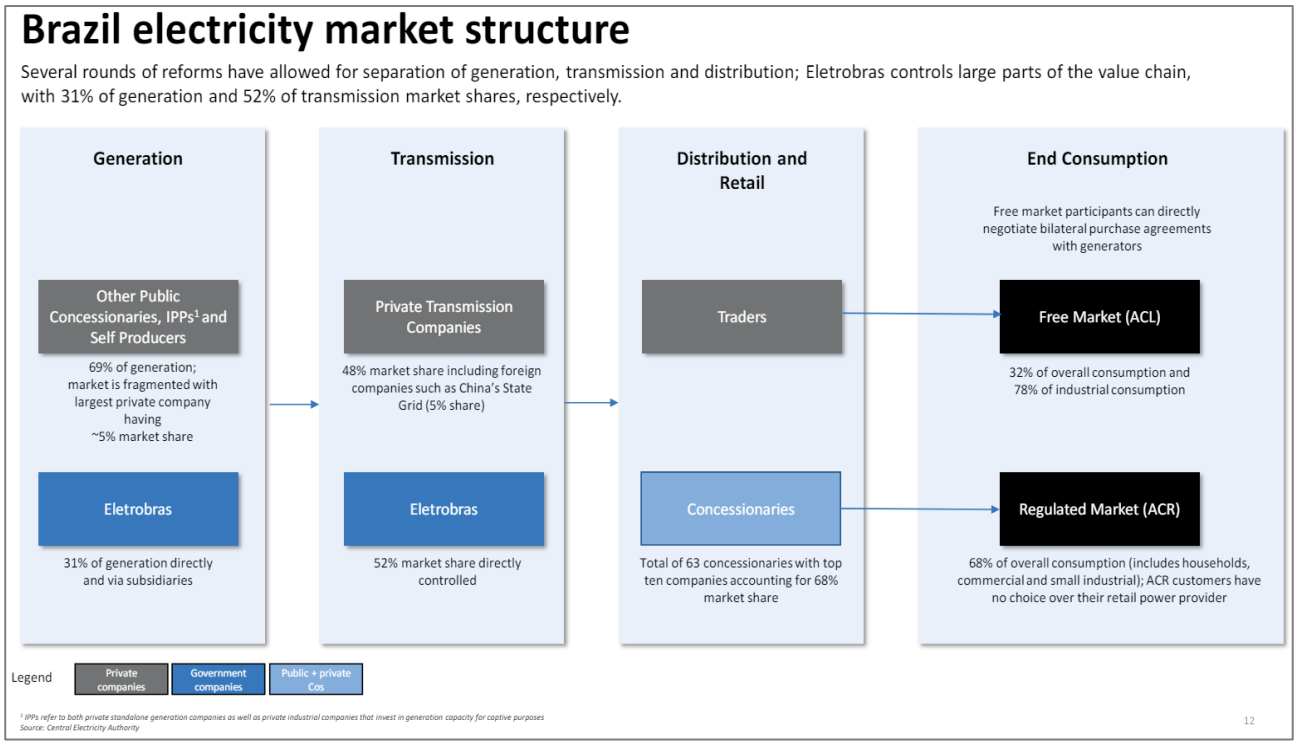

Figure 6: Brazil electricity market structure (as of 2020) (World Economic Forum, 2020)

B.4 Basic Characteristics of the Spot Market

Due to the obligation for all demand to be covered by PPAs to ensure energy security (Section 4.2.6), the role of the spot market (MCP, Mercado de Curto Prazo) in Brazil is limited to settling differences between contracted energy and actual generation or consumption levels. Therefore, the price that comes closest to a spot market price in the Brazilian electricity sector is the difference settlement price (PLD, preço de liquidação das diferenças), which is updated weekly by the Chamber for Electricity Commercialization (CCEE) for light, medium and heavy load levels in each of the four SIN subsystems. The difference settlement price is published by CCEE based on an hourly analysis, and depends on the marginal operating cost (COM, custo de operação marginal). The marginal operating cost is determined and published by CCEE based on energy generation and the costs of meeting the system's electricity demand (Instituto E+ Transicao Energética , 2020).

The spot market determines the negotiation of spot prices, which are regularly updated in line with the characteristics of energy production and demand.

The weekly difference settlement price has been in place for over 20 years, but investments in wind and solar power plants with variable operation have contributed to increasing marginal operating cost volatility. Furthermore, the hydrological crisis in Brazil over the last few years has led to significantly lower water inflows into major watersheds, and changes to the typical load profile due to the COVID-19 pandemic have also worsened the decoupling with the system's marginal operating cost. Significant discrepancies between the difference settlement price and the actual costs of operating the system have prompted criticism of CCEE's methodology for calculating the difference settlement price. In January 2021, the Brazilian energy ministry (MME, Ministry of Mines and Energy), in collaboration with CCEE and the national system operator, adopted an hourly granularity for the daily spot price calculation with a day-ahead horizon (Ciniro Aparecido Leite Nametala, 2023).

B.5 Transmission Business Model

The transmission and distribution of electricity is carried out by public and private sector companies through concessions. Currently, there are 75 transmission companies in the interconnected system. An estimated 49% of the transmission lines are owned by Eletrobras and its subsidiaries.

The construction, operation and maintenance of the transmission lines are awarded by the regulator (ANEEL) through auctions, in 30-year contracts. Transmission companies are remunerated based on the annual permitted revenue (APR), determined in transmission auctions. The maximum value of this revenue is published in the auction notice, and the company asking for the lowest remuneration wins the auction. The transmission companies' APR values are reviewed every four or five years, according to the concession contracts.

Transmission and distribution costs are passed on to the end consumer. Generators, distribution companies, and large free market consumers connected directly to the transmission network (i.e., those with facilities operating at voltages above 230 kV) are charged for the transportation of electricity through the transmission system use tariff (TUST). The regulator has developed a methodology for calculating the transmission tariff, based on the long-term marginal cost with annual adjustments.

The electricity transmission network is planned centrally. The Ministry of Energy consolidates the concession programs based on technical studies by the Energy Research Company (EPE) and the national system operator. Once the Ministry has defined the expansion programs, the regulator (ANEEL) grants new concessions.

B.6 Trading Arrangements, Investment Frameworks and Financial Viability

The wholesale market players make transactions through the following instruments (Instituto E+ Transicao Energética , 2020):

- Spot market (MCP, Mercado de Curto Prazo, described above)

- Power purchase agreements (PPAs): To guarantee energy security, all electricity consumption must be backed by PPAs linked to a "physical guarantee"[26] This guarantee limits the amount of electricity that power plants can sell through PPAs, depending on their installed capacity and technology. The physical guarantee, therefore, represents the amount of energy that a plant can deliver under predefined reliability criteria. CCEE is responsible for the accounting and financial settlement of contracts, and registers all the PPAs on the market.

B.6.1 Investment Frameworks

Prices on the wholesale market for regulated (ACR) consumers are established through regulated energy auctions. The distribution companies submit the projected energy demand for their concession area, and the auction is launched to receive the generators' bids, which correspond to the aggregate demand of the distribution companies. After the collective auction, each distribution company signs its individual contracts with the electricity generators.

The Ministry of Energy and the regulator conduct these auctions for the regulated demand, specifying guidelines, contract types, indexing, and delivery deadlines. Auctions, called "A-x," contract energy for delivery a specified number of years ahead, with new and existing plants competing separately. The Ministry establishes the volumes for each generation technology to ensure competitive and cost-effective electricity procurement. The main types of auctions for the regulated market are:

- Existing energy auctions (LEE, Leilões de energia existente): award PPAs of up to 15 years. Only existing power plants can take part in this type of auction, which aims to renew distributors' current contracts and reduce the risk of price increases.
- New energy auctions (LEN, Leilões de energia nova): allocate PPAs of up to 30 years, for delivery to begin in three to six years or more. New energy auctions take place at least twice a year, to ensure that electricity supply capacity grows in line with the expected increase in demand.
- Adjustment auctions (LA, Leilões de ajuste): for short-term PPAs, with supply starting in the same year. LAs are held four times a year to allow distributors to make short-term adjustments to meet demand.
- Auctions for alternative energy sources (LFA, Leilões de fontes alternativas de energia): restricted to renewable energy plants, to increase their contribution to the national electricity matrix.

The auction model used in Brazil since 2005 is a hybrid system that combines a descending price auction (Dutch auction) (phase 1) with a pay-as-bid model (phase 2). In 2017, the mechanism was modified to a sequential and iterative pay-as-bid auction, with a closed envelope in the initial stage and a time lag in the second stage (continuous stage).

In addition to these auctions, the government occasionally holds reserve energy auctions (LER, leilões de energia de reserva) to guarantee security of supply or promote specific energy

[26] The physical guarantee is the maximum monthly amount of electricity in MWh that a generator can sell through contracts and is therefore a critical parameter for assessing the viability of a power plant.

sources. The PPAs for LERs are not required to be linked to physical guarantees. The costs of reserve energy are passed on to consumers in both the regulated market and the free market (ACR and ACL, respectively), through a sector charge.

New energy auctions

The government coordinates the expansion of generation capacity for the regulated market (ACR) through new energy auctions (LENs). LENs, which are programed based on official demand forecasts, are updated every two years. This approach allows for the identification of hydrological risks in the Brazilian hydrothermal system, which are reflected in high generation costs.

These auctions guarantee predictable revenue for plant owners and distributors alike, as well as a guaranteed supply of energy for the duration of the contract, which can be for 15, 20 or 30 years. It is through the guarantee of long-term contracts between generators and distributors that the former make their projects financially viable, obtaining long-term financing for the construction of the projects.

Electricity contracts in the ACR and ACL

There are two types of electricity contracts in the regulated market (ACR):

- Energy quantity contracts: in this type of contract, generators agree to deliver a fixed quantity of energy over a set period at a set price per MWh. This type of contract is generally used for hydroelectric generation, but also applies to other sources.
- Availability contracts: in this type of contract, generators make their plants' generation capacity available in exchange for a fixed revenue. In the case of plant dispatch, the distribution companies assume the variable generation costs (fuel costs) and possible costs or revenues from the settlement of differences in the spot market (MCP). Power plants contracted through availability contracts (the majority of which are thermal and wind power plants) are dispatched by the national system operator (ONS) based on merit order, considering the maximization of security of supply.

In the free market (ACL) prices are negotiated bilaterally and are not made public. Although ACL contracts are attractive to consumers and generators, they are generally limited to durations of three to five years, which makes capital-intensive investments difficult. To make these investments viable and attractive to investors, robust long-term contracts are needed. As a result, short-term ACL contracts are often complementary to long-term ACR revenues.

B.6.2 Financial Viability

The Brazilian Development Bank (BNDES) has played an instrumental role by offering enabling financing and risk mitigation strategies to make renewable energy projects more financially attractive, including through the development of local industry supply chains (e.g., wind turbine manufacturers). For example, from 2000-2023 BNDES invested about US$100 billion in renewable energy projects and transmission lines with a focus on decarbonization through its green finance instruments (e.g., green bonds, Brazilian Climate Fund, long-term financing in local currency). BNDES support has also encouraged more private investment in higher-risk projects for generation and transmission expansion (IRENA, 2024).

Brazil's distribution service is funded through the distribution system use tariff (TUSD), which is divided into two components: TUSD Fio, which covers the operating costs of the distribution system, and TUSD Encargos, which includes sector charges and fees. The cost of distribution is detailed in consumers' electricity bills.

B.7 Distribution-Level Resources and Trends

Brazil defined distributed generation in the regulatory framework in 2004 as: "the production of electrical energy coming from concessionaires, permit holders or authorized agents, connected directly to the buyer's electrical distribution system, except that coming from:

- hydroelectric plant with an installed capacity exceeding 30 MW;
- thermoelectric, including cogeneration, with efficiency of less than 75%."

Later, in 2012, this definition and the regulatory conditions were developed for the inclusion of distributed generation in the Brazilian energy matrix, using the following terminology:

- Distributed microgeneration: renewable energy generation or qualified cogeneration systems connected to the grid with power less than or equal to 75 kW.
- Distributed mini generation: renewable energy generation systems or qualified cogeneration connected to the grid with power greater than 75 kW and less than 5 MW.

The same year, the regulator established an electricity compensation system, or net metering, for projects involving distributed mini and micro-generation of renewable energy and cogeneration projects. In its first version, net metering was limited to generation units of up to 1 MW.

In 2015, the limit was raised to 3 MW for hydroelectric sources and 5 MW for all other eligible sources. New forms of compensation, such as shared generation, remote generation and compensation for multiple consumer units (e.g., condominiums), were also incorporated.
The basic rules, defined in 2012, were improved in 2015 to include:

- The right to use credits for excess energy injected into the grid within 60 months.
- Deadlines for processes, standardization of forms for connection requests and definition of responsibilities assigned to customers, the company responsible for implementing the system and the distributor.
- A form of remote self-consumption, in which there is generation in one unit and consumption in another unit owned by the same owner.
- Shared generation, in which a group of consumer units is responsible for a single generation unit.

In October 2019, the regulatory agency presented a proposal to change the compensation system. The text provided for the end of tariff parity, with compensation of only a percentage of the energy credit in favor of the consumer, which varied depending on the proposed scenarios. This proposal was seen as extremely unfavorable by the solar energy sector.

The solar sector's reaction to this proposal led to the drafting of a bill to establish a legal framework for distributed generation. After two years of discussions, the final proposal was approved in January 2022. According to this new legal framework, systems that already exist or

that file a request for access within 12 months after the publication of the law will remain under the tariff parity rule until December 31, 2045. This situation is defined as an “acquired right”. (Portal Solar, s.f.).

C Mexico

C.1 Historical Context

The 1975 Electricity Public Service Law established that the generation, transmission, transformation, distribution and supply of electricity for the provision of public services was the exclusive responsibility of the state. However, in 1992 the regulatory framework allowed the entry of private investment for some sector activities.[27]

In 2013, Mexico deregulated its electricity market to attract private investment and introduce competition into the power system. The state kept its role in transmission, distribution, planning and operation of the national electricity grid.

The state-owned electricity utility (CFE, Federal Electricity Commission) previously had a monopoly on electricity generation, transmission, distribution and supply. Liberalization preserved the state's exclusivity on network infrastructure, transmission and distribution, but enabled the state to enter into contracts with private companies to carry out grid operations.

Mexico's electricity reforms of 2013 included (Medrano, 2016):

- Liberalization of generation and sale of energy to consumers with peak demand exceeding 5MW, with a 1 MW reduction of this threshold down each year until a **1 MW** threshold was reached. Private companies were allowed to compete with state-owned companies in generation, with prices in the wholesale market defined at nodes based on supply and demand.
- The legal separation between transmission and generation.
- The National Energy Control Center (CENACE) became the public independent system operator.
- The state-owned electricity utility (CFE) gained greater operational and organizational flexibility to increase competition and reduce energy costs.
- Investment and adoption of clean and low-cost energy sources such as solar, wind and geothermal were favored, and mechanisms to reach the previously existing clean energy generation targets were set out.
- The responsibilities and functions of key public institutions were defined:

[27] Self-generation, cogeneration, small power generation, independent power producers selling power to the Federal Electricity Commission, generation for export, power imports for self-supply, power generation for use in emergencies resulting from interruptions in public service.

SENER (The Ministry of Energy)	CRE (Electricity Regulatory Commission)	CENACE (National Energy Control Center)
• SENER designs energy policies (hydrocarbons and electricity). • It oversees the operation of the wholesale market. • It coordinates the planning process, which includes a demand forecast, indicative generation plans and binding transmission and binding expansion plans. Promotes energy efficiency.	• CRE regulates the gas, oil and gas transport, and electricity industries. • In electricity, it issues permits for generation and regulates transmission and distribution tariffs. • It issues and applies tariff regulations. • It regulates and supervises standardization and normalization processes. • It issues permits for the generation, sale, and distribution of electricity.	• CENACE controls the operations of the national electricity system and operates the wholesale electricity market. • It guarantees free access to transmission and distribution networks. • It proposes the expansion and modernization of the transmission network and the elements of the distribution networks that correspond to the wholesale energy market.

C.2 Demand Side

In 2023, electricity demand in the national interconnected system (SIN) was 319 TWh, an increase of 3.7 percent from 2022 (Ordaz, 2024). After the electricity market was opened, it grouped consumers into three types:

- Basic users – must buy their energy from basic service suppliers, in this case an affiliate company of CFE.
- Qualified users – can sign contracts with qualified service retailers to supply their energy demand. The Ministry of Energy (SENER) defines the threshold to be a qualified user.
- Qualified market participant users – have a minimum demand of 5 MW and annual consumption of at least 20 GWh, and can participate in the wholesale market (MEM). Qualified users with a minimum demand of 1 MW can do so through a qualified service supplier and sign contracts with generators (EY Mexico, 2018).

C.3 Supply Side

In 2023, installed capacity for electricity generation connected to the national grid in Mexico was 89,008 MW (SENER, 2024). An estimated 54% of the energy generated in Mexico in 2023 came from natural gas, followed by 13.5% from other types of fossil fuels such as oil derivatives and coal. Renewable energies such as hydropower and wind power accounted for 22.9% of the total produced (Statista, 2024).

Combined cycle technology has been the most common form of installed capacity in the last decade, with an increase of almost 11,000 MW in new capacity. However, when viewed collectively, the largest increase in installed capacity over the past decade has occurred in clean renewable energy plants, which grew by 12,360 MW. In contrast, conventional thermal plants collectively added approximately 9,200 MW to the country's installed generation capacity (CONAHCYT, s.f.).

The Mexican wholesale market – run by the National Energy Control Center (CENACE) – started operations in 2016. Participants can sell and buy electric energy, power, CELs, related services (operating reserves and rolling reserve, frequency, voltage and reactive energy regulation, emergency start-up, island operation and dead bus connection) and financial transmission rights.

Generators and suppliers participate in the wholesale market (MEM). Wholesale market generators are holders of a generation permit with a capacity greater than or equal to 0.5 MW. They do not need to be represented by a trader. Generators with a capacity of less than 0.5 MW do not require a generation permit. They sell their electricity and associated products to the basic service suppliers, based on tariffs determined by the Electricity Regulatory Commission (CRE). To participate in the wholesale market, they require a qualified supplier designation.

Suppliers sell electricity to users. They are classified as basic service suppliers (SSB) or qualified suppliers (SSC), depending on the type of consumers they can serve. There are also suppliers of last resort that provide temporary supply when a qualified supplier stops operations.

Some market participants do not serve final consumers, they only trade electricity. To do so, they must register with the electricity regulator.

The wholesale products are traded through the following markets (EY Mexico, 2018):

- The short-term market, where energy and related services are traded
- The power balancing market
- The financial transmission rights market
- The clean energy certificates (CEL) market
- The mid-term energy and power auctions
- The long-term energy, power and CEL auctions

The **spot market** is described in the next section.

The capacity **balancing market** is a capacity market where suppliers can buy firm additional peak capacity in order to satisfy their regulatory firm peak capacity requirements, or sell surplus capacity they have contracted. Generators' firm peak capacity offered to the market is based on their generation or availability during the 100 critical hours of the year. The price at which power is remunerated is calculated by CENACE for each interconnected system and in each power zone.

The financial transmission rights (DFT) market provides a hedging instrument for participants to manage the locational risks inherent to the delivery of energy between nodes. DFT auctions are annual and can be for three months, one year, or three years. These auctions allow stakeholders to manage the risks derived from system congestion and thereby mitigate the costs of congestion in the transmission and distribution networks.

A DFT is equivalent to 1 MWh and its cost is based on the expected difference between local marginal prices in two nodes.

The **clean energy certificates (CEL) market** operates at least once a year. It is a spot market operated by CENACE. The market closing price is determined once supply and demand are balanced. Only technologies classified as clean technologies in the Electricity Industry Law are entitled to CELs.

CEL are bankable instruments introduced by Mexican government to promote clean energy, and certify one megawatt-hour (MWh) from a low-emission source. Clean energy projects are eligible to receive one CEL for each MWh produced for a period of 20 years.

Clean energy generators are assigned CELs depending on their generation capacity. The certificates must be bought by market agents like suppliers and qualified users. These agents must show they have enough CELs to cover their clean energy use. The percentage of CELs required is stipulated to gradually increase until 50% of energy comes from clean sources by 2050.

The **medium and long-term auctions** are run by CENACE and organized by the regulatory agency. In these auctions, energy and power can be traded. In the long-term auctions, CELs can also be traded.

The purpose of the **medium-term auctions** is to enter electricity coverage contracts on a competitive basis to eliminate price exposure. They are remunerated at the price resulting from the balance between the amount of energy or power bought and sold.

Long-term auctions help make electricity less dependent on fossil fuels and ensure reliable, efficient electricity service. They allow electricity generators to enter into long-term contracts with the state-owned electric utility (CFE), which is the basic services supplier.

Mexico's power sector structure is illustrated in Figure 7.[28]

[28] During his tenure, outgoing President López Obrador championed a reform that prioritizes the CFE over private renewable energy and natural gas generation facilities. The 2022 reform was subsequently blocked in the courts

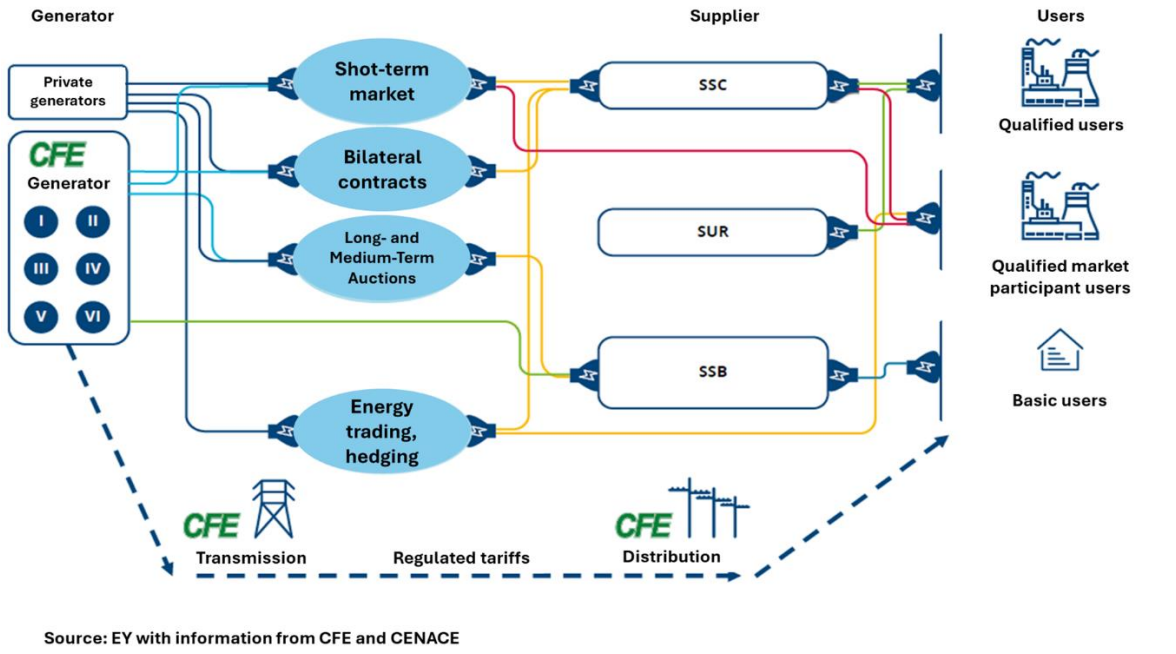

Figure 7: Electricity sector structure in Mexico (EY Mexico, 2018)

Figure 8 shows the characteristics of medium (SMP) and long-term auctions (SLP).

	Long-term Auction (SLP)			Medium-term Auction (SMP)	
Products and Validity	Power 15 Years	Energy 15 Years	CEL 20 Years	Power 3 Years	Energy 3 Years
Periodicity	At least one per year			One per year	
Clearing House	Does not exist for SLP 2015 and 2016	Exist for SLP 2017		In process	
Potential Buyers	**SLP 2015 and 2016** • Basic Service Providers	**SLP 2017** • Suppliers of: o Basic Service Providers o Qualified Services Providers o Last Resort Providers • Qualified Market Participants		• Suppliers of: o Basic service providers	
Potential Sellers	Any market participant; on the condition that if they win, they will have to legally incorporate as a generator.			• Any market participant*	

Figure 8: Characteristics of medium and long-term auctions (EY Mexico, 2018)

C.4 Basic Characteristics of the Spot Market

In the spot market, buyers are qualified service suppliers (SSC), traders, and qualified market participant users, while sellers are generation companies and traders.

Spot prices are determined by the marginal cost of the system, where generators' bids need to be consistent with their marginal costs.

The National Energy Control Center (CENACE) is in charge of dispatch to balance supply and demand based on the local price of energy.

The short-term market is divided into three markets:

- Day-ahead market: where energy is bought and sold for use the **following day**.
- Real-time market: where energy is bought and sold for **same-day** dispatch.
- Hour-ahead market: where energy is bought and sold for use the **following hour** (not yet implemented).

These markets will be operated in two stages. In the first stage, the day-ahead market and the real-time market are meant to operate. In the second stage, the hour-ahead market is expected to be added to the day-ahead and real-time markets.

The cost of electricity is determined by means of nodal prices on the day-ahead and real-time markets, based on variable opportunity costs of the marginal plant. Generation technology plays an important role, since the lowest-cost generation is the first to be dispatched.

Locational marginal prices represent (PML, precios marginales locales) represent the increase in the system costs to supply an additional MWh of energy demand to a given node in the power grid. They are used for transactions in the short-term market and are calculated based on three components: energy (which is the same for all national interconnected system nodes), transmission losses, and congestion (marginal cost caused by transmission restrictions when supplying an additional 1 MW of demand).

C.5 Transmission Business Model

The national transmission grid (SNT, sistema nacional de transmisión) is divided into 53 regions, 45 of which are connected.

The Ministry of Energy (SENER) is allowed to hold auctions to assign contracts to expand the transmission grid. The contracts are awarded to the private party which offers the lowest cost over a number of years. At the end of the contract, the assets must be transferred to the state. Each investor in transmission assets is paid back through the general tariffs for use of the network.

The Electricity Regulatory Commission (CRE) sets transmission and distribution tariffs. By law, tariffs must be fair, stable, and easy to understand. They should also be efficient and predictable. In addition, tariffs must cover the costs of providing the service.

C.6 Trading Arrangements, Investment Frameworks and Financial Viability

The wholesale market (MEM) offers a range of products to help cover the fixed costs of a power plant, including power and clean energy certificates (CELs). Depending on the plant's technology, the generator can sell power or CELs in the market.

C.6.1 Financial Viability

The national regulator requires electricity consumers and/or their representatives to buy power and CELs in proportion to their peak demand and their energy consumption. These products can also be traded through bilateral contracts and balancing and spot markets.

Variable Costs Recovery	Fixed Costs Recovery
Spot market: • Day-ahead market • Real-time market • Hour-ahead market	Medium and long-term auctions Bilateral contracts CELs Balancing market

Source: (EY Mexico, 2018)

C.7 Distribution-Level Resources and Trends

The state, through the state-owned electric utility (CFE), provides energy distribution services through 16 business units.

The general distribution networks are remunerated through a maximum price, which must be applied to end-users under a non-discriminatory basis.

The regulator must define the quality, reliability, continuity, and safety parameters for the distribution and transmission services.

Regulated distribution tariffs should cover the costs of providing service, including operating, maintenance, financing, depreciation and taxes. They should also allow for reasonable profitability.

The transition to a liberalized sector meant that a new tariff period was created for distribution. This allows for: (i) price stability and predictability, (ii) transparency, (iii) cost recovery, (iv) feasibility, and (v) efficiency in tariff regulation.

To estimate the cost of capital, CRE uses a real rate of return of 10.07% before taxes and a weighted average cost of capital methodology. It considers a regulatory useful life of 30 years for the assets.

The distributor is responsible for covering the difference between actual (observed) losses and regulated (recognized) losses, which varies by region with no fixed threshold for high-voltage network. Additionally, an efficiency plan is established for each distributor, outlining targets for reducing both technical and non-technical losses over time.

Regulated distribution revenue is allocated based on the consumer category and the voltage level at which they are connected. This generates base tariffs that are adjusted by incorporating an inflation factor, an operating cost efficiency factor, and an economies of scale factor, specific to each year of the initial tariff period.

Regarding distributed energy resources, the current regulatory framework in Mexico defines distributed generation as the use of small-scale electricity generation technologies (less than

500 kW) connected at the distributed level, including in the residential, business, building, small and medium-sized industry and agricultural sectors. In 2023, Mexico had 3,361.7 MW of distributed generation assets installed.

Before the energy reforms, distributed generation was only allowed for self-consumption. The regulation currently allows the commercialization of electric energy through the distributed generation scheme.

In accordance with the regulations set out by the Electricity Regulatory Commission (CRE), two contracts are required for the sale of energy in this scheme. These are the interconnection contract and the compensation contract. The compensation contract is the model contract entered into between the basic service supplier (SSB) and the distributed generator, using one of the three types of payment specified by the regulation for the interconnection of a power plant with a capacity of less than 0.5 MW: a) net energy metering, b) net billing, and c) total energy sale (EY Mexico, 2018).

D Chile

D.1 Historical Context

The Chilean electricity sector has undergone various phases of development and significant regulatory changes since the 1980s, when the process of deregulation and privatization of the industry began. This marked a transition from a state-run to a market-based model, with the goal of increasing efficiency and attracting private investment. In 1982, the General Law of Electrical Services was enacted, establishing the framework for a competitive electricity market, the first in the world. This legislation paved the way for private actors to enter the electricity generation and distribution sectors, fostering competition and efficiency.

During the 1990s and early 2000s, the Chilean electricity market continued to evolve with the implementation of new regulatory frameworks that promoted competition and efficiency in the sector. The expansion of generation capacity was significant, with an increase in the diversity of energy sources, including the growth of hydroelectric, thermoelectric and, more recently, non-conventional renewable energy generation.

Regulation has played a fundamental role in designing markets and promoting competition, with continuous adjustments to adapt to new realities in the sector, such as the growing importance of sustainability and energy security, mainly as a consequence of the Argentinean gas supply crisis in 2004. This includes the development of policies to promote the generation of renewable energy and the integration of cleaner and more efficient technologies in the energy matrix.

The recent implementation of the user's right to choose and change their supplier, along with other legislative projects that seek to improve market competitiveness and efficiency, stand out – as do the adaptiveness of the regulatory framework to current challenges, including the transition towards a more sustainable energy system with less dependence on fossil fuels.

The integration of non-conventional renewable energy (NCRE) has been supported by several important laws, including Law 20,257 (known as the "NCRE Law" of 2008), which establishes specific obligations for electricity companies regarding the percentage of their energy that must come from renewable sources.

Chile has sought to mitigate the uncertainty associated with the introduction of new technologies in an open and competitive market, fine-tuning the regulation of the electricity market to accommodate the particularities of NCRE generation methods. This includes economic and tariff incentives that facilitate the incorporation of these technologies into the energy matrix.

Specific measures have been taken to eliminate barriers that limit the development of renewable generation, both general and specific to certain technologies. This allows NCRE projects to compete more effectively with traditional forms of generation.

As well as establishing obligations and providing incentives, the regulatory framework has been adjusted to create favorable conditions for NCRE technologies to be developed in Chile as

planned in the National Energy Strategy 2050,[29] where the country aims to achieve 70% of its installed electricity generation capacity through these technologies by 2050. This includes support for research and development, as well as improving knowledge about available renewable resources.

The main changes introduced by the regulatory reforms are listed below:

- Generation and distribution were privatized.
- Vertical de-integration was promoted, especially separating generation and transmission from distribution.
- A competitive market was established for the generation and marketing of electricity, where prices are determined by supply and demand in a spot market and through long-term contracts.
- Specific regulatory bodies, such as the National Energy Commission (CNE) and the National Electric Coordinator (CEN), were created to supervise and regulate the market, ensuring compliance with standards and efficient operation of the system.
- A pricing model based on marginal costs was adopted, where electricity prices in the spot market reflect the cost of the last unit of energy demanded.
- Private investment in generation capacity was encouraged through a stable and predictable regulatory framework, which has led to a significant expansion and diversification of the energy matrix.
- Foreign direct investment was allowed and encouraged in the electricity sector, expanding the capital available for development and innovation.

D.2 Demand Side

Chile, from the point of view of consumers or buyers of electricity in the wholesale market, has different mechanisms for accessing electricity. This allows consumers to actively participate and benefit from market conditions.

Consumers are divided into regulated clients, who are mainly residential and small businesses with lower energy demands, and unregulated or free clients, who are large consumers with demands above a specific threshold. In Chile, the limit to be considered an unregulated user or free user has varied over time, changing according to the policies and needs of the electricity market. The limit is set in terms of power demand. To qualify as an unregulated or free user, a consumer must have a contracted demand equal to or greater than 500 kW. This allows large energy consumers to directly negotiate their rates and supply conditions with generators or energy suppliers, thus taking advantage of competition to obtain potentially lower prices.

Free consumers can participate directly in the wholesale market, purchasing energy through bilateral contracts with producers or on the spot market. This allows them to manage their energy costs more effectively and to take advantage of market price fluctuations.

[29] Ministerio de Energía. (2015). *Energia 2050*. https://www.minenergia.cl/archivos_bajar/LIBRO-ENERGIA-2050-WEB.pdf

Prices for regulated customers are established by regulation, based on methodologies that seek to reflect production and distribution costs; while unregulated consumers negotiate their rates directly with suppliers, which may be competitive with the market or may include higher prices that are adapted to specific customer needs.

The distribution of electricity consumption by type of user is shown in Table 15: most of the energy is sold through the unregulated market, with some fluctuations each year.

Table 15: Energy demand by customer type in Chile from 2022-2023

Sales (GWh)	Nov – 22 [GWh]	Nov – 23 [GWh]	2023 vs 2022
Regulated	2,396.6	2,469.1	**+3.0%**
Free	3,958.0	3,883.7	**-1.9%**
Total	6,354.5	6,352.8	0.0%

Source: CEN Report (December 2023)

D.3 Supply Side

The mix of installed capacity in the Chilean electrical system reflects a diverse combination of generation sources, with thermal power and hydropower accounting for more than half of the capacity. Notably, the combined capacity of solar and wind together represents a higher proportion than all thermal – coal, natural gas, diesel – combined, as is shown in Table 16:

Table 16: Mix of installed capacity generation in Chile

Technology	MW	%
Hydropower	7,512.8	21.7%
Reservoir	3,483.8	10.0%
Run-of-river	4,029.0	11.6%
Thermal Power	13,207.4	38.1%
Natural Gas	4,506.1	13.0%
Coal	3,994.5	11.5%
Diesel	2,967.7	8.6%
Solar Thermal	114.4	0.3%
Other Thermals*	1,624.6	4.7%
Wind	4,627.8	13.3%
Solar	9,228.9	26.6%
Geothermal	94.8	0.3%

* Other Thermals: Biogas, Biomass, Fuel Oil, Petcoke, and Cogeneration

Source: CEN Report (December 2023)

In terms of energy generation, the mix is led by hydropower, then thermal, solar and wind, as follows (Figure 9):

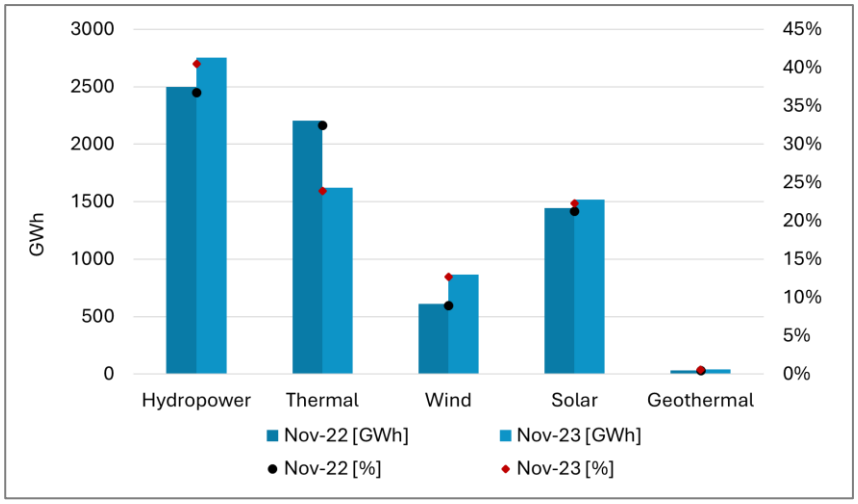

Figure 9: Power generated by technology[30]

Participants in the wholesale market include:

- Generators: These include both hydroelectric and thermoelectric plants, along with renewable energy sources such as solar and wind. These generators sell their electricity on the wholesale market, either through bilateral contracts with unregulated consumers or on the spot market.
- Traders (marketers): These actors buy energy in the wholesale market to sell it to consumers, both regulated and unregulated. Marketers play a crucial role in market competition, as they seek to offer the best conditions and rates to their customers to maintain or increase their market share.
- Non-regulated customers: These are large energy consumers that can directly negotiate their supply contracts with generators or marketers. They have the freedom to choose their provider based on the best rates and services available.

The CEN is responsible for ensuring the correct functioning of the electricity market, the technical operation of the system and the economic coordination of energy dispatch. Its objective is to guarantee efficiency, transparency, and non-discriminatory access to the network.

In addition to the spot market, the wholesale energy market includes long-term contracts and PPAs. These are agreements between generators and consumers (both regulated and unregulated) or marketers that establish predefined terms for the supply of electricity over an extended period. These contracts are essential for the financial stability of generation operations, especially for new renewable capacities and technologies.

The market structure of the electricity sector, including transactions between agents, is shown in Figure 10.

[30] Source: CEN Report (December 2023)

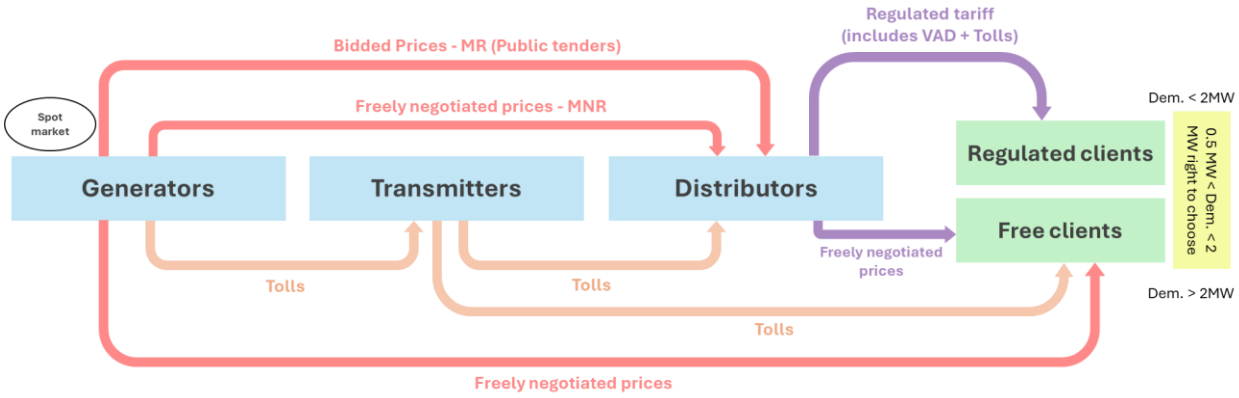

Figure 10: Market structure and transactions

Chile has implemented policies to increase the proportion of renewable energy in the energy matrix. These policies include tax incentives, guaranteed tariffs for certain technologies, and specific installed capacity targets for renewable energy, as follows:

- The NCRE Law establishes mandatory quotas for a part of the electricity supply to come from NCRE. Originally set at 5% for 2014, the quota has been gradually increasing, with the goal of reaching at least 20% by 2025.
- Tax incentives such as tax exemptions or tax credits for NCRE projects.
- Stabilized price system: For small and medium-sized NCRE projects (up to 9 MW), a fixed price is guaranteed for the energy delivered to the grid during a certain period.
- Net billing (netting off): Allows residential users and small generators to sell surplus energy to the grid at regulated prices.
- Existence of government funds and direct subsidies to support research, development and implementation of NCRE technologies.
- Government agencies and development banks offer loans at preferential rates, credit guarantees and other financial instruments to facilitate access to the capital necessary to develop NCRE projects.
- Initiatives to improve the technical skills and capacity of professionals in the NCRE sector.
- Support for research and technological development in universities and research centers to promote innovations in NCRE.
- Network infrastructure improvement: Investments in the electrical network to improve the integration of NCRE, including the improvement of transmission and distribution capacity to manage the variability and geographic distribution of renewable sources.
- Preferential access policies: Regulations that prioritize or facilitate NCRE access to the electricity market, ensuring that they can compete on equal terms with conventional energy sources.
- International projects and financing: Participation in international NCRE projects and access to global funds for climate and renewable energy.

D.4 Basic Characteristics of the Spot Market

In Chile, the spot price of electricity, also known as the node price, is formed from the interaction of supply and demand in the wholesale electricity market. This price reflects the marginal cost of operating the electrical system at each moment in time – that is, the cost of supplying 1 additional MW to the system, meeting the required safety and quality parameters. The marginal cost is calculated for each hour of the day and for each bus (node) of the system, which will depend on its operating conditions: demand, generation availability, transmission restrictions etc. The process takes the following steps:

- Electricity demand is projected by the CEN, taking into account historical consumption patterns, weather conditions and other economic and social factors that may affect energy consumption.
- Generators submit cost-based production bids for how much electricity they are willing to supply and at what cost. These bids depend on the plants' operating costs, which include fuel costs, maintenance, and other variable costs. The generation offers that producers present to the CEN are incurred costs that are audited and justified.
- The CEN selects the cheapest generation offers first and moves towards the most expensive ones until total demand is met. This dispatch is carried out in order of increasing costs, considering the variable generation costs (audited) subject to security and quality of service restrictions.

The node price or spot price for each time interval is established at the marginal cost of the last unit of energy delivered necessary to satisfy the demand. Essentially, this is the price offered for the most expensive generator that needs to be used to meet the power requirements at that specific time.

Spot prices can vary every hour of the day and are updated in real time, reflecting changes in demand and availability of generation resources. The introduction of renewable energy sources such as solar and wind has increased the volatility of spot prices due to their intermittence and dependence on weather conditions.

Price can also be influenced by interconnections with other electrical systems, allowing the import or export of electricity, which can affect local supply and demand – and, consequently, prices.

A nodal marginal cost is formed for each of the main bars of the transmission system (nodes) (Figure 11). In the north, generation capacity is based mainly on thermal units, and capacity in the south is based on hydropower units.

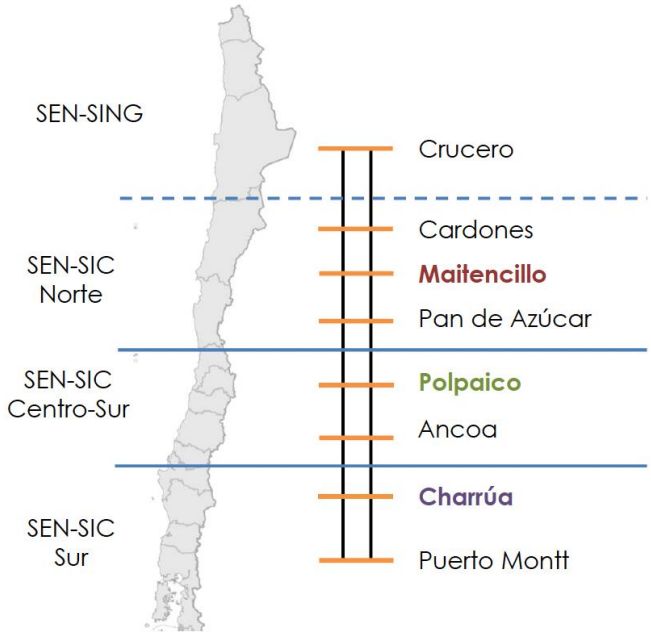

Figure 11: Main bars of the interconnected transmission system in Chile (Rudnick, 2018)

D.5 Transmission Business Model

Transmission services are regulated due to their monopolistic nature. The government, through the National Energy Commission (CNE) and the National Electric Coordinator (CEN), establishes rates, operating regulations and service standards. These regulations ensure that the transmission of electricity is efficient, safe and accessible to all users of the electrical system.

Transmission rates are designed to cover the costs of construction, maintenance and operation of the transmission network. These rates are reviewed periodically to reflect changes in electricity costs and demand. Transmission rates are paid by users of the electricity system, including generators, distributors and unregulated consumers. The business model also guarantees equitable and non-discriminatory access to the transmission network for all electricity generators and users.

The CEN manages the operation of the transmission network to optimize the flow of electricity through the system, coordinate maintenance, and manage operational contingencies. This includes real-time power dispatch management and long-term planning of transmission needs.

The expansion of the transmission network is determined in a planned and regulated manner. This helps to ensure that the transmission infrastructure is capable of supporting current and future demand, integrating new generation sources, and maintaining the reliability and security of the national electrical system.

The transmission expansion process is centralized and coordinated by the National Electric Coordinator. This body is responsible for carrying out technical and economic studies to determine the needs for network expansion in the short, medium and long term. These studies consider factors such as the expected growth in demand, the incorporation of new generation

plants, the retirement of obsolete facilities, and the need to improve the reliability and efficiency of the network.

Based on planning studies, the CEN proposes specific transmission expansion projects. These projects are evaluated and must be approved by the National Energy Commission (CNE) and, in some cases, by the Ministry of Energy.

Once approved, expansion projects undergo a public bidding process. This process is designed to be transparent and competitive, allowing various companies, both national and international, to submit offers to carry out construction for the new transmission infrastructure. Chile, like other countries in the region, operates a merchant transmission model.

The contract for the construction and sometimes the operation and maintenance of the new infrastructure is awarded to the bidder that meets all the technical requirements and offers the best quality-price ratio. The winning company is in charge of building the infrastructure, under the supervision of the CEN and other regulatory bodies to ensure that quality and safety standards are met.

Financing for transmission projects can come from various sources, including public funds, private financing, or a combination of both. In some cases, the costs of transmission projects can be recovered through grid usage fees paid by electricity system users.

Once completed, new transmission facilities are integrated into the existing network. The CEN is responsible for the operation of the expanded network, ensuring that electricity transmission is efficient and safe.

Payment for transmission activity is regulated and is based on a methodology designed to cover the costs of transmission companies. Remuneration is structured through access tolls to the transmission network, which are paid by network users (generators, distributors and large consumers).

D.6 Trading Arrangements, Investment Frameworks and Financial Viability

Trading of electricity in Chile is negotiated through bilateral contracts and the spot market. Figure 12 illustrates how energy purchase and sale contracts work in the wholesale market.

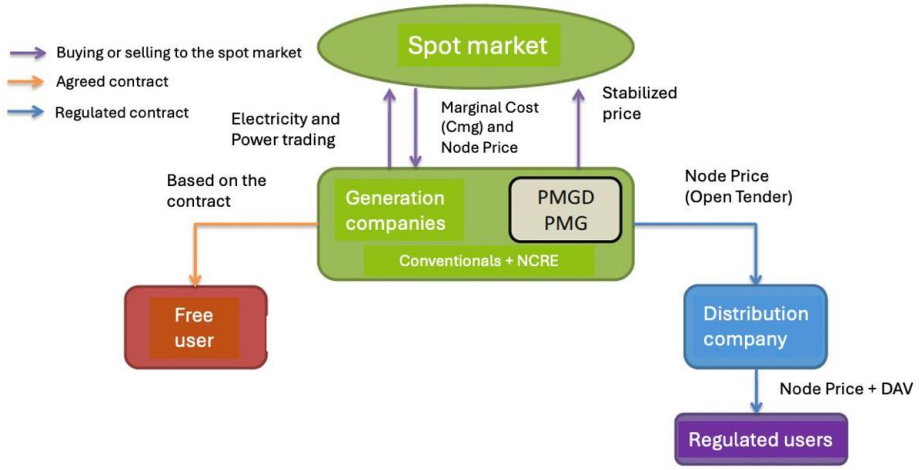

Figure 12: Payments in the Chilean electricity market

In the spot market energy is traded at prices that vary hourly, based on real supply and demand. It is mainly used for the adjustment between what is contracted and actual consumption, and as a mechanism to manage imbalances.

Aside from energy, there are markets for ancillary services such as frequency control and power reserve. These services are essential to maintain the stability and reliability of the electrical system.

D.6.1 Investment Frameworks

Bilateral contracts are the mechanism used to manage price risk and ensure stable long-term supply. They are private agreements between generators and large consumers (free customers) or marketers. Contract conditions such as price, energy quantity, contract duration and delivery terms are freely negotiated.

D.6.2 Financial Viability

Distribution companies purchase energy on behalf of regulated customers through competitive bidding. Prices and conditions are regulated by the National Energy Commission (CNE) and are based on projected generation and transmission costs. Distribution companies are required to carry out competitive tenders to contract energy for their regulated customers. This promotes the entry of new players into the market and the construction of new generating plants to comply with the contracts awarded.

Tariffs are typically binomial, with a capacity and an energy charge. Regulated customers have rates that include both components, where the capacity rate may be less significant than the energy rate, depending on the type of user and their consumption profile.[31]

[31] The energy charge is based on the amount of electricity (kWh) consumed during a billing period. This is the variable component of the bill, which fluctuates based on the consumer's actual usage. The energy rate can vary depending on the time of day, day of the week and season, in rates with hourly discrimination, reflecting the variable costs of generation and system demand at different times.
Power charging (kW): Power charging is related to the maximum capacity that the system must be prepared to supply to a customer at any time, regardless of how much energy it actually consumes. This charge offsets the fixed costs of maintaining the generation and transmission capacity necessary to meet peak customer demand, ensuring that the necessary infrastructure is available when needed. It is measured in kilowatts (kW) or

Large consumers or free customers often negotiate contracts that specify both energy and power rates, tailored to their specific needs and usage patterns. In these cases, power demand management can be a key strategy to optimize costs.

Having separate components for energy and power incentivizes users to improve efficiency and manage their peak demand, which can result in significant savings and more efficient operation of the electrical system.

D.7 Distribution-Level Resources and Trends

In Chile, the electricity distribution business is regulated and operates under a framework that defines rates, obligations and the relationship with generators and renewable energies.

Distribution rates are set by the regulatory agency (CNE) every four years, based on an efficient company model, and are based on operation and maintenance costs, investment in infrastructure, a reasonable rate of return on the capital invested, and efficiency factors through a comparison of costs and performances between different distributors.

Distributors are required to purchase electricity for their regulated customers through public tenders, which guarantees competition and fair prices. These tenders are open to all generators, including renewable energy generators.

In line with Chile's energy policy, distributors must ensure that a specific percentage of the energy they sell comes from NCRE (Law 20,257 of NCRE).

Additionally, Chilean legislation encourages distributed generation (such as solar panels on homes and businesses) by allowing small systems to connect to the grid and sell surplus energy to distribution companies at regulated prices.

Since 2018, Chile has had the Net Billing Law, which allows all self-generators to install projects of up to 300 kW of renewable energy for self-consumption connected to the distribution grid. This law stipulates that energy injections from distributed generation are discounted from the billing for the month in which they are made.

megawatts (MW) and is generally based on the peak demand recorded during the billing period or a contracted value of maximum power that the customer expects to use.

E Guatemala

E.1 Historical Context

In 1990 the electricity sector in Guatemala was controlled by the state by means of the Instituto Nacional de Electrificación (INDE), which was the vertically integrated national utility, and the Empresa Eléctrica de Guatemala S.A. (EEGSA), a subsidiary of INDE in the distribution business.

At the time, Guatemala was experiencing electricity shortages due to insufficient generation capacity and transmission networks to meet growing demand. In addition, preventive and corrective maintenance of the infrastructure was inadequate, and technical and non-technical losses were high (CNE, 2007).[32] Electricity service coverage reached only 52% of households, with significant deficiencies in billing and control.

During the supply crisis, the government included private generation (e.g., power ships and cogeneration from sugar cane biomass) through long-term contracts between mainly public generation and distribution companies, under discretionary conditions in the absence of a regulatory framework (CNE, 2007).

In this context, the Guatemalan Congress passed the General Electricity Law in 1996, which liberalized the electricity market.[33] With this law, the Guatemalan state relinquished its role as the sole provider of electricity services to allow private participation, and assumed the role of regulator of the new players.[34]

The Electricity Law created a new institutional framework:

- The Electricity National Commission (CNEE) was created as the regulator, which gave it control and surveillance functions, sanction capacity, and the responsibility to resolve conflicts between energy firms or between energy firms and consumers. The law also defined which prices or tariffs could be determined by the regulator.[35]
- The law also created the wholesale electricity market and the wholesale market administrator (AMM), which is an independent, private, non-profit agent.
- The Ministry of Energy and Mines retained its role as director of the energy sector to coordinate policies and plans.

The main changes introduced by the General Electricity Law were as follows. It:[36]

[32] Non-technical losses exceeded 30% in some regions of Guatemala.
[33] For more details about the General Electricity Law: https://www.amm.org.gt/portal/?wpfb_dl=6AMM-ley-general-electricidad.pdf
[34] Since 1985, the Constitution in Guatemala contains an article that declares as a national emergency the electrification of the country, based on plans formulated by the State of Guatemala and the municipalities, where the private sector could participate.
[35] The Law identified the prices subject to regulation: the power and energy transfers among generators, distributors, traders except those bilaterally negotiated, the charges for the use of transmission and distribution infrastructure, the tariffs to distribution service users.
[36] Espinasa, R.,Balza, L., Hinestrosa, C. & Sucre, C. (2013, March). *Dossier energético: Guatemala*. Banco Interamericano de Desarrollo. https://publications.iadb.org/es/publications/spanish/viewer/Dossier-energ%C3%A9tico-Guatemala.pdf

- Prohibited vertical integration between generation, transmission and distribution companies, even for public companies.
- Made access to the networks mandatory.
- Divided the country into three large areas for distribution services.
- Liberalized the tariffs for energy and power transactions among generators, distributors, suppliers, importers and exporters.
- Liberalized energy prices for large consumers (consumers with power demand higher than 100 KW).
- Allowed the free installation of generation (except nuclear technologies), requiring Ministry approval only for hydro and geothermal units higher than 5 MW.
- Established that the state may grant resources in the form of subsidies to finance all or part of rural electrification, social or public utility projects. These funds cannot be included in the user's tariff.
- Prohibited cross-subsidies between categories of users.[37]

Two years after the law was introduced, in 1998, the national utility INDE was unbundled into separate companies: the Electric Power Transmission and Control Company (ETCEE) for transmission activity, the Electric Power Generation Company (EGEE) for generation activity, and two distribution companies (Distribuidora de Electricidad de Oriente, S. A. (Deorsa) and the Distribuidora de Electricidad de Occidente, S.A. (Docsa)). In 2000, the Empresa de Comercialización de Energía Eléctrica (ECOE) was created to promote the sale of power, energy and services on the wholesale market. Nowadays ETCEE, EGEE and ECOE are subsidiaries of INDE.

Later, the government launched a privatization process that included all the distribution companies. The previously existing (INDE-subsidiary) distribution company EEGSA was sold to a consortium led by Iberdrola Spain. Deorsa and Docsa were sold to Union Fenosa. In 2001, INDE, Deorsa and Docsa supplied 99% of the interconnected customers, with INDE distributing electricity directly to customers.

E.2 Demand Side

The total electricity demand of the national interconnected system of Guatemala in 2023 was 12,574.94 GWh, a growth of 6.32% since 2022 (11,827.13 GWh). Distributors represented 60.3% of the 2023 consumption, followed by retailers (28%). Large users participating in the market accounted for only 0.2%.[38]

Regulation defines large consumers as those with a demand of more than 100 KW. These consumers can buy energy directly from a generator or from traders (locally known as comercializadores) and freely negotiate the price (AMM, 2020). Their rights and obligations are also bilaterally negotiated, and their demand coverage is their responsibility.

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[37] See Article 61 of Ley General de Electricidad, Decreto No. 93-96 (Guatemala). https://www.cnee.gob.gt/pdf/marco-legal/LEY%20GENERAL%20DE%20ELECTRICIDAD.pdf

[38] Administrador del Mercado Mayorista. (2023, January). *Informe Estadístico Preliminar 20243*. https://www.amm.org.gt/pdfs2/informes/2023/PRELIMINAR/INFEST20230101_04(Trimestre_4).pdf

The remaining consumers receive the service at a regulated tariff. The quality of service is also regulated for these users. Their rights and obligations are defined by law. Their electricity supply is guaranteed by the distributor.

Distributors are required to have contracts with generation companies that guarantee their total power and energy requirements for at least the current year and the following calendar year. In that sense, distributors must purchase electricity for regulated customers through an open tender. The price resulting from the tenders must be treated as a pass-through to the regulated tariff (CNEE).[39]

To add new generation the distributor must offer open tenders to contract the supply that guarantees its power and energy requirements for a maximum period of 15 years. These tenders must take place at least five years before the start of the supply to be contracted, and the bases must be approved by the regulator.[40]

E.3 Supply Side

Guatemala's wholesale market structure is depicted in Figure 13, below.

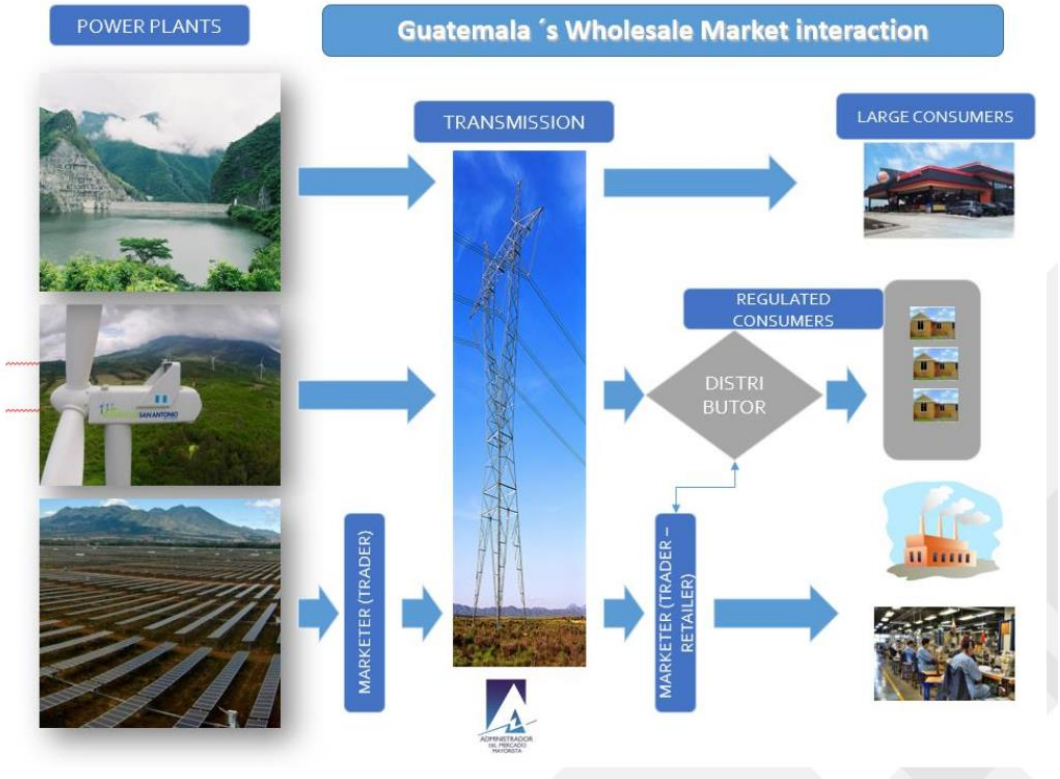

Figure 13: Market model in Guatemala (AMM, 2020)

[39] Ley General de Electricidad, Decreto No. 93-96 (Guatemala, Art. 53, 62 and 71

[40] Art. 65 Bis. Reglamento de la Ley General de Electricidad. https://www.cnee.gob.gt/pdf/marco-legal/Reglamento%20de%20la%20LGE.pdf

The actors in the wholesale market are generators, distributors, transporters, traders and large consumers, who must comply with the following minimum conditions (Ministry of Mines and Energy, 2013):

- Generators have a maximum power of at least 5 MW.
- Distributors have at least 15,000 users.
- Transporters have a minimum transportation capacity of at least 10 MW.
- Retailers, importers and exporters buy or sell blocks of energy associated with an efficient firm offer or firm demand of at least 5 MW.

In 2007, the General Electricity Law introduced a new type of agent, the distributed energy resource or distributed renewable energy producer (Generador Distribuido Renovable, GDR). Later, in 2014, the regulator defined the technical and commercial requirements for GDRs.[41] GDRs were defined as generators with a capacity of up to 5 MW, connected to the distribution network, and capable of trading on the wholesale energy market.

In 2023, Guatemala's installed generation capacity was 3,435.1 MW, including distributed generation. Non-renewable capacity represented 32% of the total effective power, with coal, petroleum coke, bunker and diesel being the most important resources. In contrast, renewable energy capacity (which includes hydroelectricity) made up the largest share, reaching 51% (Ministry of Energy and Mines, 2024).

E.4 Basic Characteristics of the Spot Market

The spot energy market is a day-ahead market. This market is a surplus and shortage market, where the price fluctuates hour by hour. The spot market is optimized using economic dispatch, which consists of employing the available offer (energy and power) to supply the forecasted demand. The dispatch is optimized on an hourly basis.

The spot price (POE, Precio de Oportunidad de la Energía) is determined by the short-term marginal cost, which represents the maximum variable cost incurred each hour to supply an additional kWh. The marginal cost of each resource is bid by the generators. This spot price applies to all market participants, as there are no locational or zonal prices.[42]

E.5 Transmission Business Model

The construction of new lines or substations for the Electric Energy Transportation Service is primarily conducted through public bidding. However, the law recognizes that transmission infrastructure may also be developed through an agreement between parties or on a company's own initiative.[43]

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[41] Comisión Nacional De Energía Eléctrica (CNEE). Resolución CNEE-227-2014. https://www.cnee.gob.gt/pdf/resoluciones/2014/CNEE%20227%202014.pdf

[42] Administrador del Mercado Mayorista. (2020, July). *Guatemala's Electricity Market*. https://www.amm.org.gt/portal/?wpfb_dl=611Gui%CC%81a%20para%20inversiones%20mercado%20ele%CC%81ctrico%20de%20Guatemala%20Versio%CC%81n%20ingles%20VF.pdf

[43] Ministerio de Energía y Minas (Guatemala). (2012). Reglamento de la Ley General de Electricidad. https://www.mem.gob.gt/wp-content/uploads/2012/05/Reglamento-de-LGE.pdf. Art. 50

Due to difficulties in obtaining the necessary permissions from Indigenous communities to construct infrastructure in their territories, the extension of the network is developed through a public auction process, and paid for through regulated tariffs.

The regulation provides two ways of paying for transportation services:[44]

- It corresponds to a fee paid when the Ministry puts out an invitation to tender. The price is agreed in the contract as annual income. For these projects, the remuneration is made in phases. After the end of this phase, or amortization period, the transport assets are paid for by tolls.
- The price for the use of transport networks (tolls) is determined by the regulator, except when the infrastructure is developed by agreement between parties or on a company's own initiative. If no agreement is reached between the transporter and the user of the transport service, the maximum toll is set by the regulator.

The expansion of the electricity transmission system is planned with a 30-year horizon by the Ministry of Energy, which publishes an annually updated plan taking into account government policies and the indicative electricity generation investment plan. Once this plan is published, the regulator must identify the expansions to be allocated by public bidding.

E.6 Trading Arrangements, Investment Frameworks and Financial Viability

The wholesale market trades two products, power and energy, on six markets:[45]

- Spot market: already described.
- Contract market: bilateral contracts between agents of power and/or energy.
- Power deviation market: transactions in the wholesale market that result in surplus or shortage of power capacity agreed in contracts among its participants.
- Complementary services: operative rolling reserve, fast reserve (start-up in less than 20 minutes), interruptible demand, black start, regulating rolling reserve and voltage control. These services are supplied by generators, except for interruptible demand.
- Regional electricity market: Guatemala is connected to the Central America's electric market which works as a seventh market where the regional member-countries have the possibility to trade energy.
- The Mexican electricity market: this market started operations in January 2016, founded on a new regulation affecting transactions between Guatemala and Mexico.

Nearly all the energy traded in 2023 was conducted through bilateral contracts, with the spot market representing only 10% of the market.[46]

E.6.1 Investment Frameworks

Due to regulatory obligations where consumers must have their power and energy contracted, distributors are responsible for selling electricity to end-users, so they must organize long-term

[44] Ministerio de Energía y Minas (Guatemala). (2012).
[45] Administrador del Mercado Mayorista, 2020.
[46] Administrador del Mercado Mayorista, 2023.

and short-term auctions to contract their power and energy needs. Existing power plants and new projects are allowed to participate, according to the terms of reference of each bidding process. The distributors define these terms with approval and supervision from the national regulator. Distributors have organized short-term and long-term auctions for expansion plans, technology changes, and the expiration of existing contracts, among others.[47]

E.7 Distribution-Level Resources and Trends

The distribution service is paid for through an added value for distribution (VAD) charge. This charge reflects the average capital and operation costs for an efficient distribution network in a specific area. It includes costs related to the user (regardless of demand), average distribution losses, and the capital, operation and maintenance costs per unit of power supplied. The regulated value of VAD applies for five years.

In 2008, Guatemala permitted the introduction of distributed generation based on renewable energy sources. The General Electricity Law of Guatemala stipulates that distribution companies are obliged to allow connections to their facilities and the necessary modifications and extensions to enable the operation of distributed renewable generators. This has resulted in a high and controlled development of distributed generation.

It is expected that by 2027 Guatemala will be able to generate 80% of its total electricity supply from renewable sources.

The Technical Norm for Renewable DG and Users – Self Producers with Surplus Energy (enacted in 2008 and updated in 2014) defines renewable generators as distribution renewable generators with a generation capacity equal to or less than 5 MW from renewable energy resources connected to the distribution grid. These generators have the option of participating in transactions on the Mexican energy market and bidding for electricity supply contracts to distribution companies (NARUC, 2023). Since 2014, self-generators have also been able to supply their surpluses to the grid, and in return reduce their electricity bill through the net metering mechanism.

[47]Administrador del Mercado Mayorista, 2020.

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