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# International Experience with Open Access to Power Grids

Synthesis Report



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## FOREWORD

Reliable and affordable electricity supply is a key driver of economic growth. In recent decades, many developing and emerging economies have embarked on efforts to enhance the efficiency of their electricity markets. The quest for efficiency often involves structural reforms, such as unbundling and other measures, designed to support greater competition in the power sector. Open access to transmission and distribution grids by market participants is an essential element in this reform process.

Open access is not an end in itself but one building block toward a more efficient electricity market. The introduction of open access should be carefully designed, along with other power sector reform measures suitable for the development context of each country.

The Energy Sector Management Assistance Program (ESMAP), a global energy sector technical assistance facility administered by the World Bank, has undertaken an analytical study of open access to electricity transmission and distribution grids. Drawing on good-practice country examples and lessons learned from global experience, this study advises World Bank staff and country clients on effective options for open access implementation.

This study has proceeded on two tracks: one based on empirical findings from specific country cases, and a generic one synthesizing the emerging global issues in open access. Country studies have been prepared for Brazil, Peru, Turkey, India, and the Philippines.<sup>1</sup> A global review of the experience in a broader group of countries, both developed and developing, was also undertaken.

Country selection for this study produced a balanced group of centralized regulatory systems, including Brazil, Peru, Philippines, Turkey, and decentralized, or two-level (federal vs. state), systems such as the United States and India. For the most part, these countries feature large- or medium-size economies with fairly sophisticated power markets. However, countries with smaller or less advanced power systems may also benefit from applying the recommendations of this study to their specific circumstances.

Two distinct levels of grid open access exist: wholesale and retail. Many issues of open access do not play out identically at these two market levels. The present study covers both levels, but either level might merit a more in-depth study of its own.

In facilitating competition, open access is closely linked to other essential elements of market design, such as congestion price signals, in formulating the pricing principles for effective power system operation and development.

Overall, this study has taken a broad approach to defining open access, going well beyond the minimalist notion of simply guaranteeing legal access to the grid for generators and wholesale buyers. The broader definition involves a number of related issues, such as transparency, market design, transmission pricing, management of grid constraints, and demand response. Opening access to the grid is thus seen as an evolutionary process in developing a competitive marketplace, from the most basic, or minimal, open access regime to a full-scale regime with sophisticated prices leading to larger productivity gains for market participants.

This study does not cover the latest advances in financial product markets that complement the physical power markets. In more advanced power markets, traders offering

products such as Financial Transmission Rights, for example, contribute to greater market efficiency. These products make the market more liquid and thus increase the value of open access.

Consistent terminology is a known challenge in an international context, and notable differences exist in the terms produced by the legal frameworks in different countries. For example, the word “license” may be used instead of “concession” in many countries outside Latin America. Conversely, the same sets of issues may fall under different laws in different countries. In Turkey, an electricity market law governs many of the same issues as does the concession law in Latin America, such as the definition of various activities in the market and licenses to conduct them.

Finally, the important role of technology (including smart grids) in advancing the benefits of open access is duly recognized in this study. As technology evolves, opportunities to operate markets more efficiently are bound to grow.

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## EXECUTIVE SUMMARY

Open access to the power grid is an essential element of introducing competition to electricity markets and increasing their efficiency. Open access refers to the possibility for any party selling or buying electricity, for a cost-reflective fee and subject to transparently defined system security constraints, to connect to and make use of transmission and distribution systems, regardless of who owns and operates the power grid.

The flexibility permitted by open access allows for multiple and diverse power supply contracts that take advantage of the load and time diversity and contribute to better utilization of resources. Increased competition leads to more efficient sector operation, improved quality of power supply, and downward pressure on tariffs.

Experience suggests that opening access to the grid is an evolutionary process, not a discrete event. The basic foundations of open access are laid by establishing an initial, or minimal, open access regime through enforcing the generators' legal right to access the grid to sell their capacity and energy, and wholesale buyers' right to contract with the generators, either directly or through an authorized market operator. The institutional requirements for minimal open access include transparent rules, procedures, and protocols for grid and market operations, and a financially disinterested, competitively neutral system operator.

However, affording all market participants the access right is only the first step toward a full-fledged open access regime. Reaping the full benefit of open access requires building a progressively more sophisticated market in which time- and location-specific price signals provide additional information to enhance market efficiency.

A number of countries around the world have embraced the concept of open access. Considerable evidence supports the existence of a positive impact of open access on power sector performance. In countries that have successfully established the basic foundations of an open access regime, such as Brazil, Peru, and Turkey, competitive wholesale markets have expanded and incorporated new and more complex design features. New generators, including those utilizing renewable energy sources, have been better able to enter the market.

International experience points to the variability of power sector reform paths and open access implementation patterns in different countries. For example, Brazil has successfully established the legal framework and institutional structure for a basic open access regime, including the creation of a strong regulatory agency and an independent system operator. A vibrant wholesale market was established, operating through bilateral contracts and through the country's Electricity Trading Chamber. Numerous independent energy traders contribute to the market's liquidity. Free consumers comprise about one-quarter of the country's electricity consumption.

Overall, the Brazilian market model is one of the more advanced open access systems internationally. However, on its path toward a full open access regime, the Brazilian model has yet to put in place effective and transparent pricing signals for ancillary services, grid congestion, and demand response.

Peru is particularly notable for its proportionally large competitive wholesale market, which amounts to nearly half of the country's electricity consumption. Open access provisions have substantially contributed to the growth of the wholesale market and to

its better integration. Formerly isolated self-generators have actively entered the market and reacted positively to the government's call for building up surplus capacity on their sites. At the same time, the experience of both Brazil and Peru highlights the importance of government leadership in system expansion planning, while maintaining open access and supporting competition through transparent auctions for new generation capacity.

In Turkey, the rapid increase in installed power capacity over the past decade has occurred alongside the massive restructuring and liberalization of the power sector, with the open access policy and a dynamic wholesale market effectively underpinning the capacity expansion and deeper competition. Private investors financed the bulk of the added capacity, of which about one-third is renewable power. On the wholesale market, about three-quarters of Turkey's electricity is traded under bilateral contracts between generators and distributors, with the remainder traded mainly in the day-ahead and balancing markets. On the buy side of open access, the threshold of eligibility for consumers has been consistently reduced over time. The eventual aim is to allow all retail consumers to choose their suppliers.

In India, power flows through open access are estimated to have reached about 15 percent of total power generation in the country. The lion's share of this volume comes from industrial facilities producing electricity mostly for their own consumption, but utilizing the grid to sell surplus power. Open access transactions between independent parties have been limited thus far due mostly to the high cross-subsidy surcharges imposed on large consumers wishing to source their power outside the local grid.

In addition to the surcharges, which seem to be unique to India, the Indian experience highlights other significant implementation challenges of open access. Access to the distribution grid appears to be a particularly thorny issue, as the incumbent distribution utilities do not see an incentive to connect new customers unless they buy power directly from them.

Open access may also pose new challenges to long-term transmission planning, as evidenced by the experiences of Brazil, Peru, and Turkey. The planning process in an open access regime must be more transparent than in a vertically integrated power system. An open access process requires inputs from many more actors, such as independent power producers, multiple buyers, and demand responders.

The experience of countries that have implemented adequately functioning initial open access regimes point to the importance of the following enabling factors:

- **Strong sustained political commitment to liberalization and competition in the electricity sector.** The government should be committed to allowing multiple generation companies, including private generators, to operate in the sector. The benefits of open access-induced competition for the consumer should be well understood by the government and effectively communicated to the public
- **Legislation that mandates open access, supports competition, and allows separate contracting for energy and network services.** The law should grant the generators and wholesale buyers the right to nondiscriminatory access to the power grid. Additional legislation is often needed to prevent grid companies from abusing their natural monopoly position
- **A market structure that (a) supports ownership separation (legal unbundling) or, at a minimum, functional unbundling of transmission and distribution facilities from generation, and (b) includes a competitive wholesale market component**

- A professionally strong, autonomous, and credible regulatory body committed to promoting and protecting competition
- An independent and efficient transmission system operator neutral to all sellers and buyers
- Transmission and distribution pricing that is cost reflective, efficient, transparent, and separate from the cost of energy being transported
- Open access implementation sequenced to proceed from wholesale- to retail-market participants over time
- Provisions, at the retail level, that (a) open access implementation is largely revenue-neutral for the distribution utilities, and (b) dispute resolution is simple and efficient
- A transmission system planning process that is transparent and open, including inputs from independent power producers, multiple buyers, demand responders, and other relevant stakeholders
- Transparency of information on the real-time availability of transmission capacity

The key lessons learned and policy recommendations resulting from the study include:

**Legislation.** Countries that have successfully introduced open access to power grids usually have adopted appropriate legislation specifically mandating nondiscriminatory grid access. The law needs to define the roles of various sector actors with respect to open access, with special emphasis on the key role of the system operator. Successful introduction of open access is virtually impossible without requiring that transmission activity be separate from generation and distribution, with prices and revenues specific to this activity.

Similarly, distribution should be treated and priced as a distinct business, separate from the value of energy it transports. Some countries, such as Brazil and Peru, have used concession law to prohibit the same entity from engaging in generation and transmission or generation and distribution activities at the same time. Antitrust legislation allows regulating vertical and horizontal integration to prevent excessive market power. Legislative provisions are also needed for the sector regulator, establishing its role and autonomy from the government and affirming its powers to assure the competitive neutrality of grid planning, pricing, operations, and access.

**Sector Regulation.** The design and enforcement of an open access regime is usually delegated to the energy sector regulator. Ideally, the latter is operationally and financially autonomous from the government. The regulator's success in enforcing an open access regime depends on adequate legal powers to investigate, remediate, and cure regulatory issues; exercise auditing and monitoring functions; and establish and enforce a credible complaint process under clearly defined rules.

**Pricing.** Separation of “carriage” from “content” is an important principle in pricing electricity products and services. Unlike the price of energy, which is market based, transmission and distribution are natural monopolies with regulated prices.

Transmission should be free standing economically, with its own stream of revenues from the provision of network services. A large portion of the revenues from the transmission of energy accruing to transmission owners and operators should be volumetrically based, or proportional to the energy throughput of kWh transmitted. This adequately aligns the transmission operator's interest with the public purpose of ensuring open access.

For distribution companies, the initial premise is the same, in that they should be neutral to energy sales revenues. However, incentives of the distributor to maximize revenues from network services may need to be controlled to avoid conflicting incentives with demand-side energy efficiency programs. This can be done by decoupling revenues from throughput (revenue capping).

While pricing methodologies differ from country to country, transmission prices, minimally, are determined by the revenues needed to provide adequate cost recovery for existing assets, reinforcements, and extensions. In a full-fledged open access regime, pricing allows for locational signals that monetize the management of congestion and other constraints, rather than leaving this to the system operator's discretion. Nodal transmission price signals allow for market participants on both the supply and demand sides to make informed decisions based on the value of grid access to them at any point in time.

**System Operation.** The presence of an independent and efficient transmission system operator is essential for an open access regime. Avoiding conflicts of interest—typically observable under vertically integrated electric utilities—with respect to grid access, dispatch decisions, and grid expansion planning is of particular importance. The neutrality of a system operator toward all seller and buyer agents should ideally be established legislatively. The governance structure of the system operator should ensure the presence of all key stakeholders, including generators, transmission entities, and consumers.

**System Planning.** The quest for greater competition through open access should be properly balanced with centrally directed system expansion. Recent experience in several countries demonstrates that private-sector investors in both transmission and generation react positively to the transparency and predictability of a well-organized system planning framework. This is particularly important for fast growing economies as it helps attract much needed capital into their power systems.



## DEFINING OPEN ACCESS

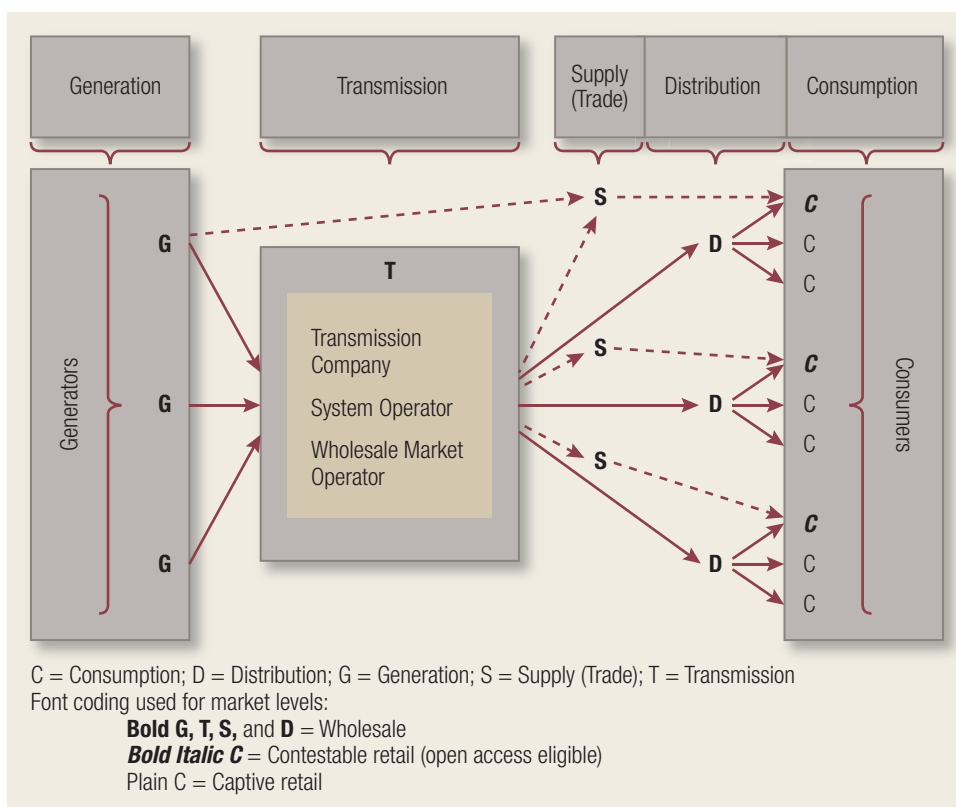
### FUNDAMENTALS OF OPEN ACCESS

Open access to the power grid is an essential element of introducing competition to electricity markets and increasing their efficiency. For most practical purposes, open access can be defined as the possibility for any party selling or buying electricity, subject to transparently formulated system-security constraints, to make use of the transmission and distribution (T&D) systems without discrimination, against payment of adequate fees for accessing and using these systems.

The taxonomy of open access includes two distinct market levels, wholesale and retail, with the wholesale level potentially extending to the interstate or international scale. In addition, open access can be defined in a narrow sense (minimal open access) or in a broader sense (full open access).

Figure 1 is a stylized presentation of market segments typically found in the electricity sector as they relate to open access. Multiple sellers (generators) and buyers (supply or trading companies, distribution companies, and final consumers) interact in the market, relying on the services of the T&D grid. Some elements of an electricity market, such as self-generators and embedded generators connected at the distribution voltage level, are omitted from Figure 1 for simplicity, while independent suppliers or traders shown may not exist in every country. The latter specialize in energy trading, but do not own or

Figure 1 | An Example of Power Sector Structure Allowing Open Access to Power Grids



Source | Authors.

operate T&D networks. Their presence enhances market liquidity and efficiency as they are allowed to compete with distributors on the retail market.

**Nondiscrimination.** In an open access regime, nondiscrimination means that all similarly situated users of the grid are entitled to access under the same terms and conditions. However, not all users are similarly situated. The difference in prices paid by various market participants using the grid is a natural reflection of the physical realities of distance between production and load, the presence or absence of congestion, as well as voltage levels and other grid conditions at particular locations. Thus, differential market positions do not necessarily reflect discrimination as long as the rules driving such results are cost reflective and uniformly applied.

**Wholesale and Retail Market Levels.** The boundary between wholesale versus retail electricity markets is usually set on the basis of the buyer's purpose in the transaction, whether to consume power for the buyer's own needs (retail) or to resell it to other parties (wholesale). At the wholesale level, the relationship is between electricity generators on the one hand, and buyers for resale, including distribution companies and suppliers or traders, on the other. Characteristics such as the size of the buyer and its power purchase transactions, or the voltage level at which electricity is transmitted to the buyer, are often used as alternative yardsticks for setting the boundary between wholesale- and retail-market levels. While these alternatives are convenient in some contexts, the approach preferred in this report is based on the buyer's purpose in the transaction.

**Transmission Grid and Wholesale Markets.** The high-voltage networks are more than just connections enabling the flow of power from the source to destination; they are also a means of commerce in electricity. The experience of advanced economies in North America and Europe demonstrates that a well-integrated high-voltage power grid can support a dynamic marketplace designed to produce transparent and cost-reflective price signals (see Box 1).

In all country cases, however, the introduction of open access has involved legislative measures and strong sector regulation, establishing a level playing field for market participants, especially for generators. Otherwise, established generators may block market entry to other generators. In England and Wales, where the market was initially dominated by two large generators, the regulator intervened to induce them to divest some of their capacity, thus reducing their excessive market power (Newbery 2006).

**Cross-Border Interconnection and Regional Wholesale Markets.** In some regional markets, notably in the European Union, cross-border transmission interconnections have been an essential instrument of integration of the national electricity markets, or “market coupling” (see Box 2). In coupled markets, bids and offers across linked power exchanges are matched by taking into account available cross-border transmission capacity. Demand is met by the cheapest supply, regardless of where the energy is produced. Provided there is enough capacity, the price on all exchanges should be the same. Coupling power markets brings benefits such as increased liquidity, less volatile prices, and more efficient use of interconnector capacity (European Commission 2012).

Germany’s TSO, for example, eventually integrated with the European Network of Transmission System Operators for Electricity in 2009. This created strong interconnections with neighboring countries, expanding the field of competition and helping to balance out wholesale market price volatility on the German electricity exchange. Over the long term, German wholesale power prices have declined and have put downward price pressure on its neighbors, partly because of a sharp increase in solar power generation, which has zero marginal cost and priority grid access (Wynn 2013).

**Retail Market Level.** Access to the local distribution grids is often associated with the retail power market. However, not all retail-level consumers are small in size, and some of them may be contestable. In countries that have set the policy objective of allowing retail electricity consumers the freedom to choose their suppliers, large consumers have usually been the champions of open access.

Thus, in principle, both the wholesale and retail electricity markets can be competitive. India is a good case in point. According to the Electricity Act 2003, open access operates at two levels. At the wholesale level, all generators are accorded open access that varies by contract duration of access. At the retail level, eligible, or contestable, customers are permitted to source energy from suppliers of their choice through open access (Mercados EMI 2012).

**Institutional Infrastructure.** The market designs and traded products continuously evolve in constant pursuit of market efficiency. The institutional arrangements supporting electricity trade are evolving as well. The central roles in establishing a level playing field for market participants to access the power grid usually belong to the regulator, the TSO, the wholesale market operator, and the sector planning agency. It requires all of them to work in concert to ensure that access to the national grid is nondiscriminatory.

## Box 1 | Transmission Access and Wholesale Markets: Developed Country Examples

**The United States.** High-voltage networks in the United States have long been recognized as a means of power trade and electricity market integration. By the 1980s, highly sophisticated forms of transmission pricing were introduced. This supplanted the old system of simply adding transmission to the asset base of retail utilities and imposing the burden for meeting revenue requirements on the utility's captive load customers. The Energy Policy Act of 1992 allowed generators and other market participants selling or buying electricity for resale to apply to the Federal Energy Regulatory Commission (FERC) for an order to access utility transmission assets if the utility refused access. The act also exempted independent power producers (IPPs) from provisions of the Public Utility Holding Company Act that had, up to that point, largely precluded widespread development of an IPP business model.

In 1996, adherence to nondiscriminatory open access rules for the American transmission system was reaffirmed by FERC Order No. 888, promoting wholesale competition through open access. Finally, in 2011, FERC Order No. 1000 increased opportunities for nonincumbent transmission developers to participate in projects, primarily through the elimination of a federal right of first refusal for incumbent public utility transmission providers. These developments were synergistic with increased wholesale market trading utilizing locational marginal pricing (LMP), day-ahead pricing, capacity markets, real-time markets, demand-response bidding, and competition to provide ancillary services.

**The United Kingdom.** Since it is only connected to other countries by direct current links, the United Kingdom has the advantage of a single transmission system operator (TSO) for the entire synchronized system. Therefore, it was reasonably straightforward to design a single system of transmission pricing to handle constraints and the resulting congestion when the industry was restructured in 1990. However, the initial generation market structure in England and Wales was highly concentrated, with two fossil fuel generators setting the price over 90 percent of the time.

The Electricity Act in 1989 established a legal basis for restructuring and appointed a regulatory body. In 1990, the United Kingdom broke up the Central Electricity Generation Board and established the Electricity Pool. The Pool was created as a compulsory bulk spot market that set merit order and wholesale electricity prices (Newbery 2005).

In 1994, the regulator introduced a wholesale (annual average) price cap until the two dominant generators agreed to reduce their market power, eventually divesting some of their capacity. Subsequently, the Pool was replaced by New Electricity Trading Arrangements (NETA). NETA involved self-dispatch, voluntary bilateral, and over-the-counter markets for contracting combined with a pay-as-bid, average-priced balancing mechanism. By abandoning the pool structure, the NETA model moved toward the dominant European model of decentralized trading through power exchanges, such as the Amsterdam Power Exchange and the European Energy Exchange (Newbery 2006).

**Germany.** Germany has Europe's largest power market and its transmission network is connected to nine neighboring countries. Historically, the German electricity sector was dominated by cartel agreements that prohibited competition. Network access and charges were under the purview of the Cartel Office. In 1998, Germany legislated an essential facilities doctrine mandating that network access be nondiscriminatory (Sioshansi and Pfaffenberger 2006). A July 2005 amendment of the European Union Energy Act created the Bundesnetzagentur, or BNA, the German sector-specific regulator with authority over the electricity network. Ordinances in 2006 and 2007 provided general requirements for opening distribution networks and the general terms and conditions for distribution. Power stations were allowed access to the network where technically possible. In 2009, Germany adopted incentive-based regulation to spur efficiency.

At present, Germany's TSO is well integrated with those of other countries of Central Western Europe, with wholesale market operations extending to Austria, Belgium, France, the Netherlands, and Switzerland, through the respective national power exchanges.

*Sources | Newbery 2005, 2006; Sioshansi and Pfaffenberger 2006.*



## Box 2 | Market Coupling and Wholesale Electricity Trade in the European Union

Market coupling refers to the integration of two or more electricity markets from different countries through an implicit cross-border allocation mechanism. Instead of explicitly auctioning the cross-border transmission capacities among the market parties, the capacities are implicitly made available on the power exchanges of cooperating countries. As such, market coupling allows players to trade directly between markets by benefiting from the cross-border capacities without having explicitly acquired the required transmission capacity across markets. The mechanism aims to enable the maximum freedom for moving electricity across integrated markets.

In recent years, the monthly volume of power traded on European electricity trading platforms has been the highest in Northern Europe (the Nord Pool Spot market, including Denmark, Estonia, Finland, Lithuania, Norway, and Sweden) and in Central Western Europe (Austria, Belgium, France, Germany, the Netherlands, and Switzerland).

In the case of Nord Pool Spot, more than two-thirds of quarterly electricity consumption was traded in the market in 2012. In Central Western Europe, this ratio was around 30 percent. The region of Central Eastern Europe showed the most dynamic growth in the monthly traded volume of power between July 2009 and December 2012 among the European power regions, increasing from 1 TWh to 5.3 TWh.

However, the movement of electricity is still limited by the available transmission capacity between markets, creating significant bottlenecks in some parts of the European power market. In Central Eastern Europe, for example, effective market coupling is still largely limited to Hungary and the Czech and Slovak Republics, with only 14 percent of the gross electricity consumption traded on regional platforms in the third quarter of 2012.

*Source | European Commission 2012, 2013.*

**Minimal vs. Full Open Access.** The concept of open access is inseparable from those of market efficiency and the opportunity to compete on a level playing field. Ultimately, success in introducing open access can be measured by the degree to which these broader market efficiency goals are achieved. From this perspective, opening access to the grid is an evolutionary process toward a progressively more efficient market environment.

The first step leading to a minimal open access regime is establishing the legal principle that all generators have the right to access the grid to sell capacity and energy, and the wholesale buyers of electricity have the right to contract with the generators. The institutional requirements for minimal open access include transparent rules, procedures, and protocols for grid and market operations, and a financially disinterested, competitively neutral system operator.

However, while nondiscriminatory access for wholesale market participants is a prerequisite, it is not sufficient for a full open access regime (see Box 3). The distinction between full open access and minimal open access relates to a number of additional issues, such as market design, congestion management, price signals, demand-side response, and the level of transparency of information concerning real-time grid conditions. For example, while market participants may have access to the grid for *using* its services, their ability to *offer* services may be limited or denied. This may be due to the lack of transparency and system operation practices limiting the ability of market participants to

### Box 3 | Brazil's Market Design Features Illustrating Minimal vs. Full Open Access

Brazil has successfully achieved the minimal open access requirements. The open access provisions established in the first round of reform started in the 1990s meant that no generator would be subject to discrimination or denied the right (subject to the security constraints in operating the system) to use the nation's grid to move the energy it produced to the marketplace. The interests of generators accessing the grid were protected by institutional measures, including the creation of a regulatory agency (ANEEL) independent of both the industry and the government, which has the ability to regulate grid practices. Secondly, an independent system operator (ONS) was put in place to manage and operate the grid according to competition-neutral but security-conscious protocols. To preserve its neutrality, the ONS was precluded from having any interest in the outcome of competition in the marketplace. The third measure was to create a market operator that operates the market and clears all transactions. The market operator's neutrality was assured by a governing board whose composition was evenly divided between competing interest groups. Thus, open access, at least with respect to generation at the wholesale market level, was assured.

At the same time, several deficiencies in the Brazilian market design have constrained the achievement of the full benefits of open access. The first one is the lack of transparency in pricing ancillary services such as voltage control, reactive power, load following, energy imbalance, system protection, and loss compensation.

The second deficiency is the lack of appropriate locational (nodal) price signals, meaning that the costs of moving power from one location to another, which vary significantly, are not accurately reflected in the cost of delivered energy. The potential variations in cost are due to a variety of factors, including congestion, distance, and voltage levels. In Brazil, these incremental costs are largely socialized across the system, or subsets thereof, instead of being allocated to those responsible for the cost and beneficiaries. The practice of socializing the incremental costs of transmission discriminates in favor of resources distant from the load, such as large hydropower, and fails to appropriately reward strategic location of new generators closer to the load.

Thirdly, the Brazilian market has largely focused on capacity rather than energy. Not only does it not generate nodal transmission prices, but it also fails to deliver real-time or day-ahead energy prices. As a result, plants are dispatched based on the security-constrained, merit-order protocols of ONS, which do not reflect the actual location-specific costs of moving energy across the grid. The absence of location-specific prices and day-ahead or real-time energy prices deprives some market participants, especially demand-responsive large end users and distributed generators, of the full value of open access.

*Source | Brown 2012.*

fully engage in the commerce of a range of electricity services. Therefore, the grid may be open to some transactions but closed to others.

In addition, the absence of location-specific transmission prices and day-ahead or real-time energy prices may create undesirable cross-subsidies among system participants, possibly depriving them of the full potential value of open access. These market participants may include end users, particularly large ones, who could offer demand bids based on location-specific transmission prices.

The example of Brazil illustrates the key role of establishing the proper institutional foundations of open access, while highlighting the limitations of the minimalist model of open access and the areas to be addressed by policy makers in similar country circumstances.



## RATIONALE AND BENEFITS OF OPEN ACCESS

**Open Access in a Broader Reform Context.** Open access to power grids is not an end in itself but one building block toward a more efficient electricity market. In fact, there are possible merits to starting from relatively limited forms of competition in the market before introducing wider access to the grid. For example, the restructuring of wholesale power trading arrangements may progress from only internal transactions within an integrated power utility to the entry of IPPs, then to opening access to power networks by large users, and eventually to bilateral trading between generators and distributors or to a central power pool under competitive trading (Besant-Jones 2006).

The experience of the countries studied here highlights the variability of power sector reform paths in different countries. The electricity markets in countries with unbundled power sectors, like Turkey and Brazil, simultaneously include IPPs and bilateral trading facilitated through a wholesale company or a competitive trading floor. About 75 percent of electricity in Turkey is traded through bilateral contracts between generators and distributors, with the rest traded mostly in the day-ahead and balancing markets.

In addition, some broader reform measures, such as the efforts to establish a suitable regulatory framework and a competitive market structure can be considered integral parts of constructing an open access regime. The establishment of an effective and impartial regulator, for example, is a critical milestone in enabling open access to transmission,

while also supporting the goals of encouraging private investment in generation and ensuring fair consumer prices.

**Benefits Specific to Open Access.** The main purpose of open access is to create and expand competition. Open access allows for a rich variety of power supply contracts taking advantage of load, time, and location differences. An open access regime facilitates customers switching between grids at different voltage levels, leading to potential efficiency improvements and reliability gains. These conditions spur cost reduction, increase quality of service, introduce new products and services, and stimulate investment in generation and grid infrastructure.

Unleashing competitive forces to bring down costs was the main rationale for the power industry in the United States and regulators to embrace open access. The United States has increasingly relied on open access in its gradual progression from least-cost planning to integrated resource planning, continuing to the IPP model under the Public Utility Regulatory Policy Act (PURPA), and finally toward wider competition with the introduction of a competitive wholesale power market model (see Box 4).

Open access facilitates a greater exchange of electricity flows among different regions of a country, thus enabling more efficient use of resources. In a typical economy of a

#### **Box 4 | The U.S. Experience: Aiming for More Efficient Generation through Open Access**

In the United States, achieving the benefits of competition in generation was a motivating factor for open access to the power grid. Under a number of initiatives, including “least-cost planning,” “integrated resource planning,” and PURPA, it was recognized that independent generators or cogenerators might be able to build and operate plants more efficiently than the incumbent utilities. Therefore, such generators should be provided market access by compelling utilities to bid for new capacity rather than building it themselves. The 1990s saw further moves from planning to promoting competition, including the Energy Policy Act of 1992 to help spur cost reduction and efficiency gains, increase quality of service, introduce new products and services, and stimulate investment in grid infrastructure.

In 1996, adherence to nondiscriminatory open access rules for the U.S. transmission system was reaffirmed by FERC Order No. 888 on promoting wholesale competition through open access. Market efficiency was the primary motive. From an economic point of view, it was recognized that a number of business activities were not well managed. Concerns included the excessive growth of independent generation by PURPA-supported facilities, often in locations suboptimal for the power system. Large loop flows were created that imposed nontransparent burdens and benefits on market players. Thus, open access and wholesale competition became the means to allow more efficient producers to flourish while making market operations more transparent and better managed from an economic point of view.

Another notable development in the United States since 2009 has been the establishment of the demand response market as an integral part of the formal wholesale market design. In the demand response market, energy users can bid demand reduction into the marketplace in direct competition with supply. Two factors enable these activities: (a) nodal prices which reflect location-specific energy costs; and (b) the emergence of smart-grid technology enabling customers to respond to real-time (or day-ahead) price signals. This mechanism produces economically efficient results and removes the need to dispatch older, less-efficient generators. As a result, electricity markets look increasingly like consumer product markets in which buyers can readily react to prices by changing their consumption patterns.

*Source | Brown 2012.*

medium scale or larger, substantial regional differences exist, in terms of energy resource endowment and costs of generation, as well as supply and demand patterns.

In India, for example, hydropower potential is based mainly in the northern and northeastern states and coal is primarily located in the eastern part of the country. While generation surpluses are available in the eastern region, the western region faces a high power deficit. The development of a strong, fully interconnected grid has become one of India's national priorities, with an integrated national power grid expected to carry 60 percent of power generated in the country in the near future (Mukherjee and Pratap 2011).

Open access also creates opportunities for more productive utilization of the capacity of captive power generators (self-generators). Under the Electricity Act 2003 in India, the right of open access is granted to captive generators for the purposes of carrying electricity from the generating plant to the destination of use. Sale of surplus captive capacity by self-generators to third parties can improve the availability and reliability of supply and reduce unmet demand as well as maximize capacity utilization. The increasing participation of self-generators has been an important part of the rationale for open access in other countries, including Turkey and Peru.

Similarly, open access can contribute to greater supply diversification through small distributed generation connecting to the power grid at the distribution-voltage level. Distributed generation steadily gains importance in many countries, including Turkey where, under the Energy Market Law of 2008 and secondary legislation finalized in 2011, such generators can supply excess energy to the distribution grid and distribution companies cannot reject the energy supplied (Dilli 2012).

Furthermore, some evidence exists that reliability of power supply also improves with open access, especially in those cases where the incumbent utility cannot ensure an uninterrupted power supply (see Box 5).

### **Box 5 | India: Evidence of Increased Reliability of Supply with Open Access in Manesar, Haryana**

In India, frequent load shedding and poor quality of the power supply are common. At the same time, the cost of power is one of the highest input costs in certain industries. In automotive production, it is the second largest input cost. For such an industrial consumer, whose entire revenue and profit margin depend on an uninterrupted power supply, getting assured power can make the business more competitive. In this context, open access can play a vital role, as demonstrated by the case study of Manesar in the state of Haryana.

Survey data collected by the study team indicate that, while the average outage time at the city's industrial units was about 15 percent during the month of January 2012, the outage time faced by open access consumers was almost negligible. Almost all the industrial units surveyed used diesel-based captive power during the load-shedding hours, with an average variable cost of power at Rs 12 to 14 per kWh (US\$ 0.23 to 0.27 per kWh).

Furthermore, consumers indicated their willingness to pay additional charges for reliable power, as power outages have a detrimental effect on their industrial production. This is a strong indication of the recognized value of open access for Indian industrial consumers.

*Source | Mercados EMI 2012.*

An open access regime incorporating nodal pricing takes the benefits of reliability to the next level. In systems with nodal pricing used in several North American markets, both suppliers and buyers on the grid can opt for the degree of reliability they require by choosing among various transmission services, where the prices vary with the degree of reliability selected. In a minimal open access market without nodal prices, such choices are either not available or they are priced on a considerably less dynamic and precise basis.

Fair and transparent grid access ultimately serves the objective of mobilizing private sector investment in the power systems, a key consideration for many capital-deficit countries with rapidly growing demand for electricity. Under open access, all market participants using the grid are motivated to invest more and expect a fair return. Open access can also be a credit-enhancement factor since it provides the freedom for a generating entity to choose its own buyer with the requisite credit rating. This, in turn, helps mitigate business and credit risks. Similarly, the freedom for distribution companies and large consumers to source power from alternative suppliers in a competitive manner can improve their financial standing.

There are definite benefits in allowing consumers to leave the incumbent distribution company for alternative suppliers if the former procures energy inefficiently (which may be due to its affiliation with a particular generator). Naturally, there is a difference between having the right to leave and exercising it. It has been observed in several different markets that small retail consumers tend to stick with their distributor even when the reasons for switching to alternative suppliers might appear compelling (see Box 6). However, even an unrealized retail choice may offer value to the consumer and an incentive for the distribution company to perform better.

At an interstate or international level, the benefits of open access to the shared grid include those related to cross-border trade. In European Union countries sharing a common transmission grid, steadily increasing market efficiency manifests itself through wholesale price convergence (see Box 7).

### **Box 6 | Small Retail Customers in the United States Tend to Stay with the Incumbent Distribution Company**

Decisions regarding open retail access to electricity in the United States are made at the state level. Roughly half of all states have retail third-party competition and retail access. Thus, in theory, widespread open access exists at the retail level. However, even in states with open retail competition, many customers do not opt for alternative suppliers.

There are several reasons for this, related to both incentives and market structure. For one, the potential savings are often insufficient to encourage consumers to shop around, especially because small customers do not receive meaningful price signals. In addition, startup costs for new entrants in the mass market of retail competition pose a major barrier, especially when considering the advantages enjoyed by the incumbent utilities. Such advantages include privileged access to customer data, preexisting infrastructure, back-office operations, billing and metering, sales and service crews, and deep knowledge of local circumstances and preexisting relationships with customers.

For larger consumers, particularly industrial, tariffs generally yield far more effective price signals, creating strong incentives for such consumers to consider alternative suppliers.

*Source | Brown 2012*

### **Box 7 | Wholesale Price Convergence in the European Union: The Example of Central Western Europe**

In an interstate power system, the convergence of wholesale prices is a good indicator for the efficiency of allocation of transmission interconnections. To measure the extent of price convergence in the European Union's interconnected power systems, the Market Observatory for Energy analyzed the share of hours when hourly day-ahead power exchange prices within a given zone showed price divergence of not more than 1 percent.

Over the period from 2008 to 2011, the share of hours when price difference between France and Germany was below 1 percent more than doubled; between Germany and the Netherlands, this figure increased by a factor of three. In 2011, the overall convergence of 64 percent in the Germany-Belgium-France-Netherlands region was a remarkable achievement, relative to the situation prior to market coupling. The price convergence observed in 2008 was only in 5 percent of all trading hours.

*Source | European Commission 2012.*

## **CHALLENGES AND BARRIERS TO OPEN ACCESS IMPLEMENTATION**

The presence of multiple sellers and buyers of electricity interacting in the market is an indispensable feature of an open access regime. This requires ownership separation (legal unbundling) or, at a minimum, a clear accounts separation (functional unbundling) of T&D facilities from generation and supply. In particular, transmission must be unbundled from generation and supply to ensure a level playing field for generators. This level of vertical unbundling is required even for a minimal open access regime. Many challenging issues have been often encountered in the process.

**Challenges of Unbundling.** Entrenched monopoly interests may resist unbundling or attempt to block market entry for third parties, for example, by shielding from public view the system's availability to accommodate third-party transactions. Historically, there have been cases in the United States, for instance, when a T&D company with generation interests refused to wheel power from other sources in order to preserve its distribution monopoly. The situation required the application of antitrust legislation (the Sherman Act) to protect open access to distribution franchises, as well as the passage of the 1992 Energy Policy Act, and subsequent regulatory actions taken by the Federal Energy Regulatory Commission (FERC).

India's difficult experience in implementing open access provisions of the Electricity Act 2003 highlighted the challenges of distribution-level unbundling, where the distribution companies hold a joint license for the network service provision and retail sale of electricity. Under this structure, the distribution company tends to place a high value on the ability to engage in energy sales as opposed to limiting its business activities to the transport of energy and associated services (see Box 8).

As long as the distribution company is also a retail sale licensee, there will be a decrease in its revenues if eligible consumers exercise their right to switch to alternative suppliers.

## Box 8 | India: Distribution-Level Challenges to Open Access

Despite the significant emphasis on the subject in the Electricity Act 2003, open access in India still remains poorly implemented, with many problems arising particularly at the distribution level.

**Biased Role of State Load Dispatch Centers.** Most of the Indian states do not have an independent state load dispatch center (SLDC); instead, the SLDCs operate as a department under each state transmission utility. Such arrangements create conditions for a conflict of interest between the state distribution utility and the SLDC, or between the SLDC and an open access consumer. Instances of the SLDC resisting or creating barriers to open access are not uncommon: for instance, the SLDC may “sit” on applications, denying generators the right to sell power to third-parties, citing dubious technical limitations. Further, certain states (Tamil Nadu, Karnataka, and Maharashtra) have invoked Section 11 of the Electricity Act 2003, restricting export of power outside the state. Since SLDCs are operated by the state utility, open access consumers located outside the state are affected.

**Incomplete Unbundling of Distribution from Retailing.** The Electricity Act 2003 does not recognize retail supply of electricity as a separate licensee function and subsumes it within the distribution licensee obligations. While open access in India provides consumers the right to procure electricity from the supplier of their choice, fundamentally, the obligation of retail supply remains with the distribution company. The separation of “wires” from “energy” in the electricity supply business, thus, is not completely achieved, and the distribution licensee continues to perceive its energy sales to contestable customers as an integral part of its business.

**High Open Access Charges.** Open access charges, including the contentious cross-subsidy surcharge, are imposed on consumers who trade the distribution company's retail-sale service for those of an alternative supplier. Such charges differ in size from one state to another, often due to questionable interventions by state governments. Though the Ministry of Power issued a tariff policy dated January 6, 2006, and laid out the mechanisms for each type of charge, some of the states managed to tweak these mechanisms to arrive at a higher level of open access charges. The cross-subsidy surcharge is particularly high in the states of West Bengal, Punjab, and Tamil Nadu. Such charges are serious deterrents to open access, discouraging energy buyers from leaving their distribution companies for other suppliers.

*Source: Mercados EMI 2012.*

There is no compensation mechanism for the resulting revenue decrease. Thus, from the distribution company perspective, market opening exposes it to the risk of losing energy sales to other suppliers, partially or entirely. In most cases, however, the latter prospect is unlikely, since the incumbent company has a number of well-known advantages over its competitors, especially in its role as the last resort supplier.

In particular, as the Indian experience has shown, the key motive for the distribution company to resist open access may be the fear of losing high-paying industrial and large commercial consumers. Not only do these customers represent the major share of revenues in most cases, they also cross-subsidize agriculture and domestic consumers. In the Indian state of Tamil Nadu, for example, 42 percent of all consumers (with 32 percent of the total being industrial consumers and 10 percent commercial ones) contribute 77 percent of the revenues (52 percent from industrial and 25 percent from commercial consumers).

A particular feature of the Indian market design is the cross-subsidy surcharge imposed on consumers who switch from the local distribution company's retail sale service to that



of an alternative supplier. Used by the distribution companies to preserve their status as a single-point supplier of both network service and energy, such charges are a serious deterrent to open access. India's Electricity Act 2003 calls for gradual reduction of the cross-subsidy surcharge, but no such tendency is found in any of the states (Mercados EMI 2012).

Similar incentives are at work when a distribution company is reluctant to connect new consumers who wish to procure energy elsewhere, even if the right is provided by law. In India, both distribution licensees and state load dispatch centers (SLDCs) have resisted connection of open access customers, often citing technical constraints that are difficult to independently confirm.

**Governance Issues.** Many developing countries lack the institutional governance structure necessary to successfully enforce open access, even if the legal framework is in place. Indeed, open access provisions of the law may remain largely on paper if any of the following conditions occur: (a) the state intervenes in electricity market operations and the regulator does not have legal authority or institutional strength to prevent or counteract such intervention; (b) the regulatory bodies at a subnational level act in ways substantially deviating from the national law or from the rules set by the national regulator, such as siding with the local government or local utility in denying open access to eligible consumers; or (c) there is a lack of technically sound, uniform, clearly formulated, and transparently implemented open access guidelines.

The experience of India highlights many of the governance issues mentioned above. For example, under Section 11 of the Electricity Act 2003,<sup>2</sup> the state government has the right to issue directions to a generator in case of extraordinary circumstances. In practice, this provision is often invoked to block a generator's request to sell power outside state boundaries. Similarly, Section 37 of the Act allows the state to issue directions to the SLDC or regional load dispatch center "for maintaining smooth and stable transmission and supply of electricity to any region or state." Clearly, the states have plenty of discretion to intervene in dispatch decisions, and often do so to restrict interstate electricity trade, thereby dramatically reducing open access benefits.

Standardization of regulations across various states has been another challenge in implementing open access in India. The country has 28 states with each state regulator issuing its own set of regulations, making it a challenging task for open access consumers to find the least-cost source to procure power. Gaps and lack of clarity in open access regulations make it difficult to implement the concept on the ground (Mercados EMI 2012).

**Issues with Stand-By Arrangements, Metering, and Billing.** Other regulatory and technical issues specific to open access in distribution include:

- **Stand-by arrangements.** By entering into a power supply contract with a party outside the local distribution company franchise, an open access consumer risks supply interruption due to the fault of that party. In such a contingency, the law may require the distribution company to provide stand-by power for a certain period of time. However, the enforcement of the provision may be problematic if either the distribution company or the system operator fails to cooperate in good faith under clear rules set by the regulator, including a fair and transparent pricing mechanism for stand-by charges. In India, the state regulator's position in some cases (e.g., West Bengal) has been punitive to the open access user, both with respect to the priority of access and the level of charges for stand-by power.

- **Metering and billing**, and related monitoring and accounting protocols, may lack the specificity necessary to support open access. In India, no mechanism is established in the regulations for undertaking and monitoring day-ahead scheduling, real-time dispatch, carrying of weekly meter-reading instruments, or the preparation of unscheduled interchange accounts.

**Coping with Success.** Introducing an open access regime for T&D, like many other measures of market liberalization, has inherent risks, even when successful. One risk is that demand for new connections, especially from generators, can overwhelm the limited resources of the grid and its operators. Since transmission system capacity can only be expanded gradually, it may be difficult for the grid company to accommodate the upsurge in the number of requested connections. This is especially true for developing countries experiencing rapid growth in electricity demand and a correspondingly high level of investor interest in generation (see Box 9).

**Planning Challenges.** Open access may also introduce new challenges to long-term optimum transmission planning. While transmission expansion is the natural response to growing generation, the planning process for expansion becomes more challenging in a competitive open access regime. The planning process requires input from many more players, such as IPPs, multiple buyers, and demand responders. Planning can no longer be confined to the utility level and must instead involve a participatory process with a variety of stakeholders.

Transmission bottlenecks can arise and persist, particularly in congested high-demand areas. Expanded electricity trade enabled by open access brings congestion points to focus, with wholesale electricity prices occasionally spiking due to network constraints. However, this should not be construed as a valid reason to forgo open access

### **Box 9 | Turkey: Challenges of Transmission Planning Under Deregulated Entry**

In recent years, Turkey has implemented a broad range of power sector reform measures to enhance competition and attract investment. Open access was introduced in 2001 with the Electricity Market Law, which initiated the creation of a competitive liberal electricity market. Open access has been an important part of the reform package.

However, with the introduction of open access, the transmission grid operator, Turkish Electricity Transmission Company (TEIAS), has faced thousands of requests from independent generation developers, with a total capacity of twice the existing installed power, asking for connection to the grid in a very short time. In November 2007, based on the Energy Market Regulatory Authority's (EMRA) previous announcement that it would accept license applications on a certain day, 713 license applications were made by project owners. The total capacity of the applications reached 78,000 MW. Under these conditions, TEIAS was not able to prepare and implement a realistic investment program.

For their part, many project owners in generation investments were also frustrated, raising objections to TEIAS's alternative connection points that might require new substation and transmission line investments. Generally, the implementation schedule for new investments proved longer than the applicant's expectation.

*Source | Dilli 2012.*

implementation. On the contrary, price signals due to congestion provide market participants and energy system planners with essential information to act upon.

Still, genuine challenges to planning do arise when consumers connected to distribution systems leave the franchise area too frequently or unexpectedly. In Brazil, for example, large consumers connected to the distribution grid have used the opportunity of open access to seek direct connection to the transmission grid, especially as their energy load grew. The incentive for such connection is usually the marked difference in tariffs for the use of the distribution network and the transmission grid, rather than a genuine technical need to increase the voltage level (Ellery 2012).

Legitimate concerns may arise about large retail customers arbitraging between the regulated and free markets (i.e., switching back and forth between the energy supply from the distribution company and from alternative suppliers in the open market). In the case of Spain, the returning consumers in question were numerous small businesses and millions of households.<sup>3</sup>

Similarly, the return of large customers to a regulated status proved to be a concern in some countries, including Turkey. Even one such “round trip” between the distribution company and other suppliers may put an unacceptable burden on the distribution company, unless ample notice of returning to the regulated market is given by customers or a special compensation mechanism allows the distribution company to recover the incremental costs.

Once a customer opts for an alternative supplier on the open market, the distributor is free to revise its energy procurement plans accordingly. Should the customer then return to regulated tariff service without notice, the distributor would have to buy energy at the marginal price to resume service. The result would be for the distributor to either absorb the risk of not being able to recover the extra cost or pass it on to all customers, creating an undesirable cross-subsidy.

A related issue is whether contestable market participants should even have the option of buying retail energy from the local distribution company at regulated prices or be obligated to buy power from the open market. The question appears to still be open in India, while Turkey seems to have allowed the option of paying regulated prices to contestable consumers.<sup>4</sup>

In the Philippines, the Department of Energy has been advised that leaving open the option for retail buyers to stay regulated would reduce the size of the free market and limit the potential benefits of open access (Tan 2012).<sup>5</sup> This position, if enforced, may compel large consumers to contribute to a more dynamic marketplace. However, this measure may not be suitable in market structures where market power on the supply side severely limits the buyers’ bargaining power.

**Small Distributed Generators.** In some countries, small distributed generators accessing the distribution grid have become part of the open access policy package. Such policies pose challenges related to planning as well as technology. The conventional distribution system and operational procedures are designed for transferring energy from generation sources to passive consumption points. Small distributed generation changes this dynamic as reverse flows from these loads to the distribution system become possible. Therefore, together with strengthening the medium- and low-voltage network, new protection and measurement methods, as well as new operational procedures, are required.

Some challenges related to the limitations of the prevailing metering technology do exist. The current approach often consists of running the meter backward in case of reverse flows. However, this practice overcompensates the small distributed generators because, unlike the distribution utilities, distributed generators do not provide a distribution service with all the costs involved. This practice results in revenue erosion for the distribution utilities, which will seek to recover the shortfall from other customers. To avoid these complications, the utilities may try to oppose distributed generators. New smart meters allow pricing distributed generation more efficiently. In many countries, however, such meters are not widely deployed, so the problem persists.

**Cases of Reintegration.** Just as resistance to unbundling is an obstacle to open access, so is the reversal of unbundling (i.e., “rebundling” or “reintegration”). In some countries in Latin America and the Caribbean region, effective competition in the generation and retail segments has been hampered by creeping monopolization and vertical reintegration in the past two decades. A few major investors, through a series of strategic investments and mergers, gained a significant degree of market control. In these instances, the return of horizontal and vertical integration has created serious concerns about possible abuse of market power.

In recent years, reintegration tendencies have been observed in Turkey between generation and distribution. Regulators view this as a relatively minor threat to competition as long as reintegration does not include transmission. However, the opportunity for utilities to “self-supply” exists, potentially distorting prices and creating barriers to entry for new IPPs, since the utility may discriminate between its own and other parties’ generation in providing distribution grid access.

## POLICY AND INSTITUTIONAL COMPONENTS OF AN EFFECTIVE APPROACH TO OPEN ACCESS

Both the starting conditions and the objectives of power sector reform are unique in every country. However, the experience of countries that have implemented nondiscriminatory open access to power grids points to the critical role of political commitment to implement a number of specific steps requiring the introduction of supporting legislation, and a series of enabling actions in the areas of sector regulation, pricing, system operation, and system planning.

- 1 | **Political Commitment.** Government commitment to liberalization and competition in the electricity sector is necessary. Measures to introduce open access are an integral part of a substantial power sector reform package that requires a considerable legislative effort and usually takes several years to implement. The government should commit to allowing multiple generation companies, including private generators, to operate in the sector.

A proper communication strategy may be required to get popular support for reform, with an emphasis on the benefits of competition for the consumer. The example of Brazil shows the importance of an inclusive public consultation process in balancing the interests of consumer groups with those of investors in energy generation, supply, and distribution (Tolmasquim 2012).

**2 | Legislation.** Countries that have successfully introduced open access usually have adopted authorizing legislation that mandates open access and supports competition, as well as regulations such as grid code and transmission pricing (see Annex 1 for the relevant legal and regulatory milestones in Brazil, Peru, Turkey, and the United States).

Law on power sector concessions, or similar legislation, typically governs the roles of the public- and private-sector parties in the electric power business and defines the types of concessions and licenses granted to such parties as well as the rights and responsibilities involved. These laws must have specific provisions for open access to T&D, including provisions for tariffs.

Licenses issued for economic activities in the sector should be activity-specific, respectively covering transmission, distribution, supply, generation, and, ideally, metering and billing. This way the regulators have the authority to enforce and reinforce unbundling and limit rebundling. The distribution and retail sale (supply) of electricity are generally covered by different licenses, although a distribution company can hold a retail license as the default supplier to customers in its franchise area.

In some countries, such as Brazil and Peru, a significant step toward more transparency and more powerful incentives for efficiency has been legislation requiring separate contracting for energy and network services, combined with a prohibition for T&D companies to engage in generation (see Box 10 on Brazil's approach).

Anti-monopoly legislation is often needed to set essential limitations on the monopoly power in various segments of the market by regulating vertical and horizontal integration. Restrictions on vertical concentration are especially important when referring to transmission, since the unbundling of this component is considered essential to

### **Box 10 | Brazil's Approach to Introducing Open Access to Power Grids**

Brazil introduced open access legislation in 1995 with the objective to pave the way for a free electricity market. This market would consist of new generation utilities (classified as independent producers) and major electricity consumers ( $\geq 3$  MW) rated as free consumers that could choose their own suppliers. In 1998, other generation utilities also gained the right to participate in this market. Furthermore, incentives were issued for generation utilities working with alternative and renewable energy sources to service consumers with loads of  $\geq 0.5$  MW, rated as special consumers, under the same open access conditions as major consumers.

Brazil's Law No. 9648 of 1998 was instrumental in establishing separate contracting and pricing procedures for energy supply and grid services. Furthermore, the suppliers of electric power had to choose between selling energy or transporting it, rather than doing both. The law called for the purchase and sale of electricity between concessionaires or licensees to be contracted separately from the access and use of T&D systems. The regulator (ANEEL) was charged with regulating tariffs and establishing general conditions for contracting access and use of the T&D systems by concessionaires, permit holders and licensees, and free consumers. The combination of open access and separation of energy contracts from network contracts allowed generators to sell energy directly to free consumers, regardless of where they were connected to the T&D systems.

*Source | Ellery 2012.*

open access and the development of a competitive wholesale energy market (see Box 11).

The law should establish the power sector regulator's role and special status in relation to the executive bodies of government. While full independence of regulators—similar to that of the FERC in the United States—is rarely found in other countries, both Peru and Brazil have passed laws granting the regulator an ample degree of institutional autonomy.

**3 | Sector Regulation.** The role of design and enforcement of an open access regime, along with a broader set of market rules for the power sector, is usually delegated to the energy sector regulator. Such a regulator should serve as a trustworthy, technically strong, and autonomous regulatory body committed to expanding and protecting competition.

Ideally, the regulator is operationally and financially independent from the government, and its governance structure is designed to support such autonomy. The regulator's functions include regulating and overseeing power generation, transmission, distribution, and trading activities; responding to claims and complaints from agents and consumers while maintaining an even balance among the parties; granting of concessions, permits, and authorizations for electricity facilities and services; ensuring fair tariffs and quality services; requiring investments; *encouraging and maintaining competition among operators*; and *ensuring universal access to services*.

To effectively fulfill its functions, the regulator has to be granted a number of legal powers and authorities. In addition, for an effective open access regime, the regulator must have the control and enforcement powers in a number of areas, including: (a) the authority to audit and monitor regulated parties, and the power to compel them to disclose relevant information and data; (b) enforcement authority, including conditioning, suspension, and removal of licenses; (c) meaningful processes for adjudicating compliance, assessment of penalties, issuance of injunctions and cease-and-desist orders, and providing remedies to injured parties; (d) rule-making authority regarding operations of all central

### **Box 11 | The Key Role of Transmission Unbundling**

The presence of multiple sellers and buyers of electricity interacting in the market is an indispensable feature of an open access regime. This requires, first of all, ownership separation (legal unbundling) or, at a minimum, a clear accounts separation (functional unbundling) of T&D facilities from generation and supply. In particular, transmission must be unbundled from generation and supply to ensure a level playing field for generators and the development of a competitive market.

Strong circumstantial evidence exists for the effectiveness of ownership unbundling in achieving nondiscriminatory access to the transmission system. The study of market opening in network industries of the European Union presents statistical evidence that, for the electricity sector, the degree of opening of the retail market, the presence of third-party access in distribution and transmission, as well as the wholesale trading system and the sophistication of congestion management, are all correlated with transmission unbundling.

*Source | Copenhagen Economics 2005, Pollitt 2007.*

network facilities and behavior of market participants; and (e) independence from market participants and political interference.

In the United States, FERC has strong powers that have left utilities with little choice but to accept the open access regime. In particular, these include: (a) the power of withholding market-based pricing rates from vertically integrated utilities that failed to provide open access; (b) the power to impose price caps in transmission-constrained regions where a single generating company has market dominance; and (c) the power to require filing pro forma open access tariffs from the utilities.

The level of regulation should be commensurate with the level of market served and service provided. In a federal state, this means that a national facility should be regulated by a national regulator rather than state by state. The national regulator should be fully in charge of regulating the entirety of the national transmission grid, including wholesale market operations. In open access, it is important to make sure that infrastructure is allowed to evolve free from parochial influences.

- 4 | **Pricing.** Separate pricing of “carriage” and “content” is essential. With the content, or energy, viewed as a contestable market commodity, free-market incentives prevail over monopolistic practices. Pricing the grid services, or “carriage,” is the regulator’s responsibility, with T&D being a natural monopoly.

Box 12 presents the transmission pricing mechanisms commonly used internationally. In addition to setting costs separately from the cost of transported energy, T&D pricing must be cost-reflective, efficient, and transparent. “Cost-reflective” refers not only to capital, operation, and maintenance cost recovery by the operator, but also implies the incorporation of location-specific congestion costs in the price signals. The cost of compensating grid users for constraints due to congestion can either be socialized across the system or allocated to the cost causers and beneficiaries. Socializing costs removes meaningful price signals, while the latter methodology provides more accurate signals to all users of the grid—suppliers and consumers alike.

Ideally, transmission prices should reflect three sets of costs of transmission network operations: (a) the capital, as well as operation and maintenance expenses, incurred by the system operator in building and operating grid assets; (b) the costs of system operation and wholesale market administration; and (c) location-specific congestion costs, such as those imposed on generators required to reduce their output to accommodate other system users or to protect system security.

For distribution services, the objectives of pricing are more basic and focus mostly on cost recovery and appropriate pricing of distributed generation to reflect its energy value and the resulting transmission savings. In the future, however, as new technology such as plug-in hybrid cars comes along, it may be necessary to implement pricing mechanisms similar to those pertaining to transmission.

- 5 | **System Operation.** The presence of an independent and efficient system operator is essential for an open access regime. System operators have enormous power to influence competition. Therefore, avoiding conflicts of interest in dispatch decisions, as well as grid-expansion planning, is critical. It is essential to establish that the system operator is independent from generation and supply interests, and that transmission businesses do not intervene in electricity sales. Ideally, the neutrality of system operators toward all seller and buyer agents should be established in the country’s legislation.

## Box 12 | Transmission-Related Cost Components and Recovery Mechanisms

Transmission pricing is a well-studied subject, but both terminology conventions and the actual implementation techniques may vary in different country contexts. For example, locational pricing signals may refer to a component of the transmission system used in the context of Brazil, while it may be a separate, congestion-related component in the price of energy in the United States where locational marginal price (LMP) or nodal prices are used. Therefore, the table below explains the meaning of the basic cost components and the prices involved.

	What It Is	Who Pays	Who Receives	Charging Methodologies
<b>Connection</b>	Grid costs related to the physical connection of the customer to the grid	Users: generators, distributors, large end users	Transmission company	Shallow (pay only the connection cost to the nearest connection point) or deep (also includes grid reinforcement costs)
<b>Use of Transmission System</b>	Grid costs related to capital expenditure and operation and maintenance	Users: generators, distributors, large end users, marketers	Transmission company	Payment based on MW, postage stamp, or locational
<b>Congestion</b>	Opportunity costs of energy due to suboptimal dispatch of the power system	Ranges from pure socialization (all market participants) to zonal (all in a zone) to nodal (participants in a particular node)	Generators and ancillary service providers in constrained-on and constrained-off situations	Socialized via a system service charge across all customers, zonal (few spot prices), or LMP (each node)

*Note | A constrained-on situation occurs when a generator or an ancillary service agent is dispatched and the final price is lower than the price they offered. A constrained-off situation occurs when a generator is not dispatched or not dispatched to the level expected, despite the generator's offer being lower than the final price.*

*Source | Email correspondence with Luiz Maurer 2013.*

Two successful models of independent system operation are utilized internationally (see Box 13). The transmission system operator (TSO) model, found in the United Kingdom, other European countries, and Turkey (see Box 14), is the creation of a single entity that owns and operates the grid and is provided with incentives to reduce congestion and other grid constraints.

Under the ISO model, found in parts of the United States and in some emerging economies, including Brazil and Peru, the ownership of grid assets is separate from



### Box 13 | The United States and United Kingdom Models for the Grid System Operator

**The United States.** An important development in the United States in the late 1990s was the emergence of Independent System Operators (ISOs) as a result of FERC Order No. 888. ISOs must be not-for-profit entities, with no proprietary interests in the outcome of competition among energy market players. ISO principles include fair and nondiscriminatory ISO governance and tariffs, financial independence, responsibility for the reliability of the system, incentives for effective ISO management, and the use of dispute resolution. While ISOs own no transmission assets, they manage the grid, operate the market, and serve as a kind of regulatory authority with powers delegated by FERC, subject to the commission's oversight.

At the same time, partly due to the existence of ISOs that ensure financially disinterested, competitively neutral dispatch and control operations, the United States stopped short of requiring a complete unbundling of T&D from generation. Instead, for a variety of legal, tax, and political reasons, the United States proceeded with a number of alternative measures. Specifically, "functional unbundling" was introduced, in which transmission costs were strictly segregated from other costs, and in which transmission managers were subject to a strict code of behavior.

The U.S. ISO model is arguably one of the most effective ways to ensure system operator neutrality. However, the transmission system operator (TSO) model is effective as well, as long as there is no cross-ownership of grid and generation assets.

**The United Kingdom.** The England and Wales TSO model was implanted a decade previously and was distinctly different from the U.S. ISO model. In the British model, National Grid (a private, for-profit company) not only performed the functions of an ISO, but was also the owner of the physical assets. As in the U.S. model, it was required to be financially disinterested in the outcome of competition among suppliers. It was also given financial incentives to reduce congestion. This is different from the U.S. model, where congestion prices provided incentives to actual market participants, not the system operator.

*Source | Brown 2012.*

### Box 14 | The Transmission System Operator Model in Turkey

In Turkey, the transmission system operator (TSO) model has been implemented. Ownership and operation of the grid are integrated in the same single state-owned entity, the Turkish Electricity Transmission Company (TEIAS), which is responsible for transmission system operation and maintenance, planning of new transmission investments, and construction of new transmission facilities. TEIAS also operates the market financial settlement center, as the market operator, and develops market mechanisms to foster competition.

TEIAS is responsible for identifying the system's transmission needs, the reinforcements that are planned accordingly, and their construction. TEIAS takes an active role in managing congestion by redispatching resources in short-run markets (day-ahead and real-time), based on market participants' bids and offers for balancing the system load and maintaining system reliability.

*Source | Dilli 2012.*

system operations, which are managed by a free standing, usually not-for-profit entity with no interest other than proper management of the dispatch and other grid-related services.

The question of ownership of the grid assets by the system operator relates to network congestion on the system. In the United Kingdom, National Grid has the incentive to fix the problem, either through physical extension of the grid or technological enhancement. In the U.S. model, more options exist to resolve the problem. These include physical expansion, investment in new technology, incentives to generators to locate in areas that support the grid, and enabling strategic demand response that reduces peak congestion in the system.

The governance structure of the system operator plays an important role in balancing the interests of grid users on both the supply and demand sides and in avoiding conflicts of interest in dispatch decisions, as well as in grid-expansion planning. In Peru, an important change was made in the composition of the supervisory board of the system operator during the second wave of power sector reform initiated in 2006. The changed composition incorporated distribution companies and large users as new members. Thus, what was once a “club” of generators, plus the transmission company, became an entity where all suppliers and consumers are now represented (Crousillat 2012).

Carefully designed market rules and pricing mechanisms can improve system operation efficiency, making open access more meaningful. System operators, even when functioning optimally, will have to make decisions at times that deviate from the merit order dispatch. Such deviation occurs to reflect security constraints, voltage requirements, and operating characteristics of various plants. Absent meaningful pricing of the costs associated with those constraints, the normal flow of a competitive market will be disrupted and open access impeded. Thus, market mechanisms are designed to give market participants economic choices, rather than subjecting them to administrative interventions, enhancing both the competitive nature of the market and the sustainability of open access.

Renewable energy generation targets introduce a new set of players in system operation. System operators, such as TSOs in Germany, are required to apply sophisticated scheduling techniques to integrate renewable energy sources. Significant wind generation tends to increase the cost of congestion management. However, improving forecasting techniques enable the successful integration of wind power. The United States has also refined its transmission planning policies to enable transmission investment supporting renewable energy projects.

**6 | Sequencing of Implementation Phases of Open Access.** The experience of countries that have successfully introduced a minimal open access regime suggests an emphasis on the early introduction of institutional components, such as the independent regulator and system operator, which allows proceeding to the market design phase incorporating open access. In terms of priorities for granting open access to various users of the grid, the first and simplest approach is to proceed by market segment based on the average size of respective market players.

According to the experiences of the United States, Brazil, Peru, and Turkey, allowing open access to the grid may be best organized from large-scale to small-scale market

participants. Roughly, this corresponds to a progression from wholesale- to retail-market levels. The underlying rationale is that, without introducing competition at the wholesale level, it is difficult to achieve meaningful retail competition. Therefore, open access may be prioritized for generators, distribution companies, and large (industrial) buyers, and subsequently extended to smaller retail customers.

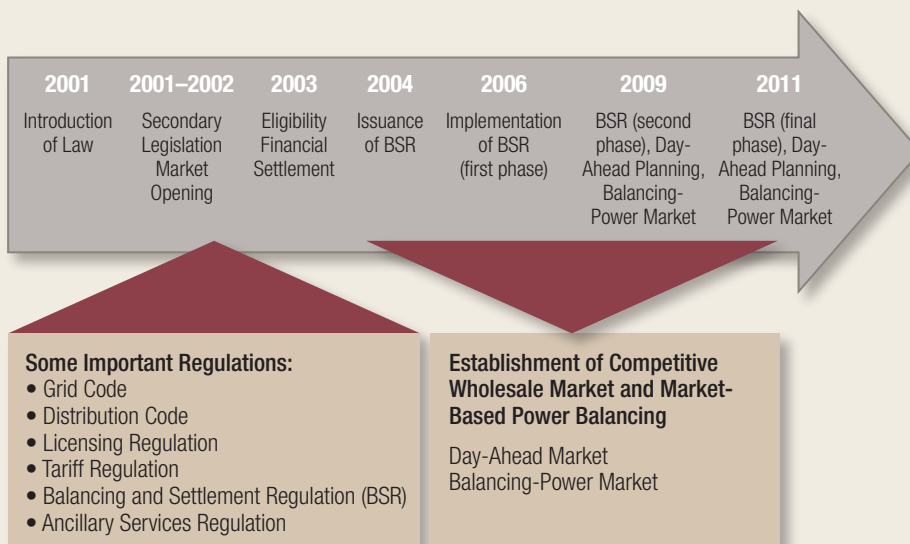
Once the initial version of the competitive wholesale market is launched, further development of the market follows with the introduction of additional features addressing congestion management, locational price signals, demand response, ancillary services, and higher standards of transparency.

The experience of Turkey (see Box 15) shows a steady progression through the initial institutional and market design phases toward some elements of a full open access regime, including market-based wholesale price-setting mechanisms and regulatory provisions for pricing ancillary services.

### Box 15 | Turkey: The Sequence of Open Access Implementation Phases

In terms of sequencing the implementation phases of open access, the approach taken in Turkey includes establishing a wholesale marketplace and enabling competition among generators and wholesalers for the electricity demand of distribution companies and eligible consumers. The definition of eligible consumers for open access was established in 2003 as consumers of energy in excess of 9 GWh per year or those with an existing direct connection to the transmission system. The eligibility threshold set by the regulator has been reduced rapidly over the past decade. Full retail competition for all consumers is the eventual aim.

Before the market was launched in its present form, the phases of wholesale market introduction included a number of steps, schematically illustrated below and detailed in Annex 1, including the day-ahead market and the balancing-power market.



Source | Dilli 2012.

7 | **System Planning.** While the emphasis in introducing open access is on greater competition, recent experience in several countries highlights the importance of properly balancing competition with centrally directed system expansion. The example of Peru demonstrates that private-sector investors in both transmission and generation react positively to the transparency and predictability of a well-organized system-planning framework (see Box 16).

The new package of measures in Peru introduces new competitive mechanisms and contributes to a more efficient functioning of the open access regime. For example, large consumers can participate in energy auctions as part of an aggregate demand, together with the distribution companies; the generation prices resulting from the auction process are incorporated into the methodology for setting the regulated tariffs. The latter feature means an important shift from a purely administrated regulated tariff to a more market-oriented tariff system (Crousillat 2012).

In the United States, the planning function in power system development has also received a new impetus with the introduction of FERC Order No. 1000 in July 2011, mostly in the context of regional system development overseen by regional transmission organizations. The order requires public utility transmission providers to participate in a regional transmission process that has both: (a) a cost allocation methodology for the cost of new facilities selected in regional transmission plans; and (b) an interregional cost

#### **Box 16 | Peru: Second-Generation Reforms of 2006 Reinforce System Planning**

After a drop in private investment and a severe drought from 2003 to 2004, legislation passed in Peru in 2006 introduced a set of measures to ensure future energy supply, the strengthening of planning, a more inclusive organization of the system operator (known as COES), and improvements in the pricing policy for generation and transmission. The measures included:

- Formalization of centralized and binding transmission planning, undertaken by COES, aimed at identifying system expansion needs, and, thus, resolving cost allocation disputes (transmission investors vs. the general public)
- Establishing 30-year concession (Build Own Operate and Transfer or BOOT) contracts under competitive bidding procedures to develop planned transmission projects, allowing predictable return to investors
- Revising certain components of the transmission pricing system (replacement value) to reduce year-to-year tariff variability
- Changing the composition and governance of COES to incorporate distribution companies and large users as new board members
- Establishing a system of energy auctions, where distribution companies must meet the demand of the regulated market with long-term energy supply contracts competitively awarded

The 2006 reform had a rather slow start since a large part of the mandated procedures was not completed until 2008 and 2009. However, the subsequent marked increase in transmission and generation private investments provides clear evidence of the positive impact of these second-generation reform measures.

*Source | Crousillat 2012.*

allocation methodology for the cost of certain new transmission facilities located in two or more neighboring regions.

The planning process in an open access regime must be as transparent and open as possible. It is all the more important to make the expansion plan public, in order to provide information for new connection opportunities. In addition, it is helpful to set up a planning process that invites input from a broad group of stakeholders, including IPPs, multiple buyers, and demand responders.

Similarly, transparency of information on the real-time availability of the transmission system's capacity is crucial to open access. The U.S. experience with the introduction of the Open Access Same-Time Information System (OASIS) is instructive in this regard. OASIS requires utilities to fully disclose the real-time availability of transmission system capacity.



## IMPACT OF OPEN ACCESS ON FREE-MARKET DEVELOPMENT AND INVESTMENT

In countries that have successfully implemented open access, competitive markets expanded as new business opportunities emerged for several classes of users. The improved performance in the sector and greater transparency has, in turn, attracted new investment in generation and network development.

**Competitive Wholesale Market Expansion.** In Brazil, free-market consumers represented about 25 percent of total electricity consumption by 2010 (105,315 GWh), with industrial customers taking the overwhelming share of the market (see Table 1). Captive customers comprise the remaining 75 percent, with the main classes being residential, industrial, and commercial.

As of 2011, free consumers accounted for 61.4 percent of total consumption on the Free Trading Floor, followed by self-generators, accounting for 22.9 percent (see Figure 2).

In Peru, the market of large users, or the “free” market, has grown steadily since the introduction of the competitive wholesale market. Market sales have grown from 2,604 GWh in 1993 (31 percent of total sales) to 16,431 GWh in 2012 (44 percent of total sales). In fact, the wholesale market reached a peak in 2008 and declined the following year as the economy slowed and the more regulated, mostly residential market grew at a faster pace.

The beneficial impact of sector reforms, including market opening, has contributed to the sector’s capacity to attract investment. While the specific contribution of open access to the success in this respect is difficult to quantify, its role in combination with other components of the reform program is noteworthy (see Annex 2).

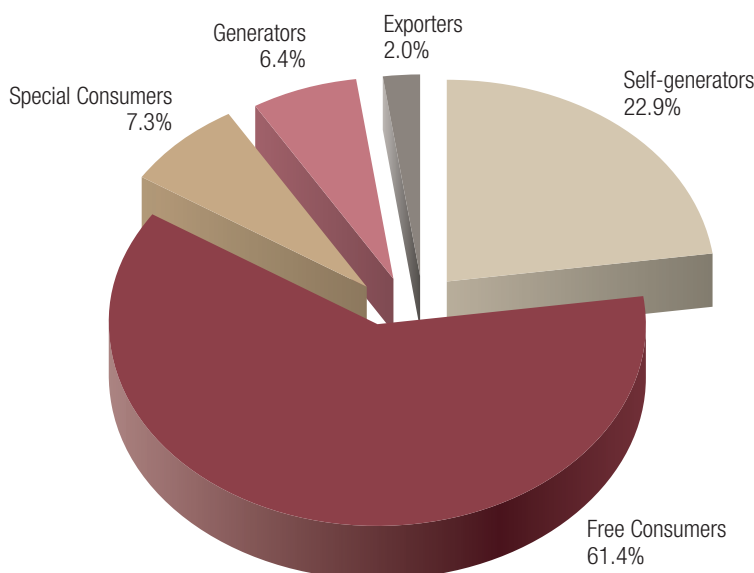
Also, a competitive energy market with open access to T&D in Peru has attracted many formerly isolated self-generators to join the market. For example, several self-generators were encouraged to invest in hydropower facilities because open access and a wholesale

Table 1 | Brazil: Free-Market Development, 2006 - 2010

	Free Consumption (GWh)				
	2006	2007	2008	2009	2010
<b>Industrial</b>	90,409	99,978	95,395	84,963	100,688
<b>Commercial</b>	1,123	1,566	1,750	1,857	2,540
<b>Rural</b>	11	11	3	-	3
<b>Government</b>	57	60	62	62	62
<b>Public Services</b>	1,913	1,974	2,023	1,994	2,019
<b>Self-consumption</b>	-	-	31	137	3
<b>Total</b>	<b>93,513</b>	<b>103,589</b>	<b>99,264</b>	<b>89,013</b>	<b>105,315</b>

Source | Ellery 2012.

Figure 2 | Power Purchasers on Brazil's Free Trading Floor of the Electricity Trading Chamber in 2011



Source | Ellery 2012.

market offered them the opportunity to sell their energy excess and to increase their returns on these investments. Such were the cases of Platanal, a self-generator linked to the cement industry, and Chinango, a mining company project (220 MW and 183MW, respectively; Crousillat 2012).

In Turkey, a sizeable and steadily growing proportion of the wholesale market operates on a competitive basis on the day-ahead market. The provisions of open access to the grid have been an important enabling factor. The public generation company, EUAS, and the public wholesale company, Turkish Electricity Wholesale Company (TETAS), are still dominant suppliers delivering roughly 68 percent of Turkey's electricity. Hence, the amount of energy subjected to competition is currently reported at around 30 percent, most of it traded in the day-ahead and balancing-power markets. It may be argued, however, that the share of competitively procured power in the market is already substantially greater than 30 percent, considering that TETAS mainly sells the private generation companies' power.

The number of eligible consumers exercising their right to switch to alternative suppliers, though still relatively small in Turkey, increased notably in recent years, accounting for about 16 percent of the eligible consumer market in 2012. Enabling factors for this increase include the reduction of the size of consumers considered eligible for open access, favorable market prices, and the policy of allowing "collective eligibility." To become an eligible consumer, it is possible to aggregate the consumption of facilities in the same commercial or industrial company.

In India, the power transactions by open access market participants reached about 15 percent of total energy generation in the country by 2012, according to preliminary industry estimates (see Table 2). In its present form, the Indian open access market is dominated by self-generators while bilateral transactions between independent parties have thus far been limited. Due to their exemption from the cross-subsidy surcharge, self-generators (captive generators) are in a relatively privileged position in India.

Table 2 | India: Power Flows Enabled by Open Access

Open Access Category	Estimated Annual Power Flow (TWh)
Interstate Self-Generators	40
Intrastate Self-Generators	70
Interstate Third-Party Sale (Bilateral)	Negligible
Intrastate Third-Party Sale (Bilateral)	6
Day-Ahead Power Exchange	7
Total Estimated	123
Percent of Total Energy Generation in India	15%

Source | Mercados EMI 2012.

Transactions through power exchanges in India have been a small but significant new submarket component in some states, allowing consumers to reduce their power supply costs (see Box 17).

**Investment in New Generation.** Such investment has been rising in countries that enabled open access to the power grids. While the mobilization of these resources is the combined result of a series of reform measures, not attributed solely to open access, it is unlikely that this investment would have materialized if open access were not granted (Crousillat 2012).

*Brazil.* With open access, nonutility generators, particularly those investing in alternative energy sources, have been able to access the grid more easily and have contributed robustly to both capacity expansion and a more diverse and reliable energy supply. Previously, large hydropower plants accounted for about 90 percent of installed capacity in Brazil. By 2008, this figure had shrunk to 74 percent, largely due to the

### Box 17 | India's Day-Ahead Power Exchange Transactions

Indian power exchanges permit open access customers to source a part of the requirements on a day-ahead basis. This helps such customers balance their power purchase portfolio by combining firm contracts with power exchange contracts. The power exchange prices in the past two years have been low on average, and the customers have found procurement from the power exchanges attractive. However, it is mostly in Punjab, Tamil Nadu, and, to some extent, Rajasthan, where the open access consumers and generators have actively participated in the day-ahead market on the Indian Energy Exchange (June 2012 data), whereas in most other states such transactions are minimal.

The volume of wholesale market transactions through the power exchanges is still limited but not insignificant. In recent years, the share of open access customers on the power exchanges has increased to as much as 40 to 45 percent of the overall trade on the day-ahead markets. This constitutes about 0.8 percent of the overall electricity supply in the country. While still low in relative terms, the absolute volumes, about 6 to 7 TWh per year, are significant.

Source | Mercados EMI 2012.



construction of power plants fueled by natural gas and biomass, built at a faster pace than hydropower. Alternative and renewable energy sources in Brazil received a 50 percent discount on grid access costs. It can be argued, however, that the provision of incentives for clean energy through grid-pricing interventions may cause distortions, and incentive schemes such as feed-in-tariffs or renewable portfolio standards may be preferable.

*Turkey.* Over the last decade, Turkey has attracted an impressive volume of private investment in new power generation, with the open access policy and the active wholesale market serving as important underlying drivers. From 2003 to 2011, the installed power in Turkey increased from 31,800 MW to 53,400 MW, with about 71 percent of the increase due to private generation investments. New capacity installed by the private generation companies was 15,100 MW. The share of renewable energy in this amount was 33 percent. The current major challenge appears to be for the transmission company, TEIAS, to keep up with the demand of numerous generators for grid connection, manage congestion, and maintain and strengthen its planning capabilities.

*The United States.* Evidence from the United States points to the existence of important synergies between open access to transmission and investment in generation. In the case of Texas, renewable energy generation is a good case in point (see Box 18).

### **Box 18 | Texas, United States: Generator-Friendly Interconnection Rules Attract Investment in Wind Power**

The Electric Reliability Council of Texas (ERCOT) is considered one of the most robust competitive electricity markets in North America (Brown 2012, based on Sioshansi and Pfaffenberger 2006). Regulated solely by the Public Utility Commission of Texas, ERCOT has a unique place in the U.S. electricity sector. Because it is not electrically synchronized with the Eastern or Western Interconnections, it is outside FERC jurisdiction. In 1995, Texas's Senate Bill 373 required that the rules guiding wholesale competition ensure nondiscriminatory access and creation of an ISO.

Intending to level the playing field among incumbent utilities and IPPs, the Public Utility Commission of Texas established generator-friendly interconnection rules and postage-stamp transmission pricing in ERCOT. As a result, many national energy and utility companies entered the ERCOT market, including Exelon, American Electric Power, Calpine, Constellation, Suez Energy, and American National Power, among others.

The Texas state policy on nondiscriminatory access to power grids has contributed to private investment in both transmission and generation, particularly in renewable energy, such as wind. This is an example of how the traditional "chicken-and-egg" challenge in transmission and renewable energy development can be solved. A recent news article (Sustainable Business 2013) reports that a US\$ 6.8 billion investment in new transmission lines will enable Texas to deliver double the wind capacity to its cities.

This, in turn, may lead to a new boom in wind energy; developers are expected to spend US\$ 3.3 billion to build 1,644 MW of new wind farms in Texas over the next two years. Texas leads the United States in installed wind capacity, which grew 18 percent in 2012, adding over 1,800 MW for a total of 12.2 GW across more than 40 projects. Wind supplies 9.2 percent of all electricity generated in the state.

*Source | Brown 2012; Sustainable Business 2013.*

## FINDINGS AND RECOMMENDATIONS

In recent decades, many countries have embarked on efforts to improve their electricity sector efficiency by introducing more competition through structural reforms that include open access to T&D grids.

The Brazilian electricity market model is one of the more advanced with respect to enabling open access fundamentals. Over the years of power sector reform, beginning in the early 1990s, Brazil developed a detailed and explicit legal framework for open access to T&D and successfully created the institutional structure required for a basic open access regime, including the creation of a strong regulatory agency (ANEEL) and an independent system operator (ONS). A competitive wholesale market now operates through bilateral contracts and through the Electricity Trading Chamber (CCEE), with two trading floors, one regulated and the other free.

On the Free Trading Floor, free consumers represent over 60 percent of all purchase transactions. The Brazilian model also provides for the participation of independent energy traders as intermediaries. However, for a full open access, some improvements are still required with respect to effective and transparent pricing signals for ancillary services, congestion, and demand response.

In Peru, open access to transmission has been particularly instrumental in the growth of the wholesale energy market, now accounting for almost half of the country's electricity consumption, and attracting major investments in power generation. Formerly isolated self-generators have actively joined the market and have reacted positively to the government's call for building up surplus capacity on their sites. The experience of the second wave of reform launched in Peru in 2006 also highlights the importance of government leadership in system expansion planning, along with fostering competition. A notable missing element in the current Peruvian model is a provision for independent energy trading intermediaries.

In Turkey from 2003 to 2011, installed power increased from 31.8 to 53.4 GW. About 71 percent of this increase is due to private generation investments, with the open access policy and the active wholesale market serving as important underlying drivers. On the buy side, Turkey has pursued open access for both wholesale and retail consumers. The eligibility threshold for retail consumers, initially set at 9 GWh per year, has been consistently reduced over the past decade. The experience of Turkey shows a steady progress through the initial institutional and market design phases toward some of the elements of a full open access regime, including market-based wholesale price setting and regulatory provisions for pricing ancillary services.

In India, the legal and regulatory framework based on the Electricity Act 2003 has important initial provisions for open access, and many large users of the grid, particularly self-generators, are actively taking advantage of the opportunity. However, the extent of market transactions through open access is still very limited and uneven across the country. The Indian experience highlights significant implementation challenges of open access, particularly at the distribution level, given governance issues in establishing system operator independence at the state level, as well as constraining cross-subsidies and related surcharges on open access users. The legal framework could also be improved as currently it does not recognize retail supply of electricity as a separate licensee function and subsumes it within the distribution licensee obligations.

No established rulebook exists for implementing open access, since both the starting conditions and the political preferences of every country are different. Nevertheless, the experience of a number of countries, including some major client countries of the World Bank, allows formulating some generic findings and recommendations.

**Finding a Suitable Model.** First of all, the country needs to decide on the model of open access it wants to pursue. Different levels of open access may be envisaged—from a minimalist approach, which simply establishes the legal right for generators to access the grid in order to sell their capacity and energy, to more sophisticated models, aiming to put pricing signals to work and remove arbitrary influences from the marketplace. In all cases, however, the objective should be a more efficient marketplace through increased competition.

**Sequencing Wholesale and Retail Open Access.** Access to the transmission grid by wholesale market participants is an area where markets can be put to work more readily, thus offering the best initial opportunities for improved market efficiency. This is also where opportunities for progressively more sophisticated market designs are found.

Retail open access, and especially access to distribution grids, appears to pose more challenges than wholesale access to transmission. Incumbent distribution utilities have often been found placing obstacles to the connection of new unregulated customers in an attempt to force these customers to buy directly from the utility. Cases of coercion are not uncommon, sometimes leading to legal disputes. While it is the sector regulator's responsibility to intervene, the dispute resolution process is often long and complicated. New consumers tend to yield to the utility's pressure.

The experience of countries with the most open and competitive power systems suggest initially focusing on areas where the greatest impact can be achieved with relatively limited effort. This suggests proceeding from large players to smaller players in the market, and from transmission (wholesale) level open access to distribution (retail) level open access. In allowing open access for retail consumers, careful consideration must be given to defining eligibility, including the minimum size of the market player (or the transaction size).

While there is no particular downside to giving the right to choose suppliers to even the smallest consumers, experience to date suggests that small retail consumers will rarely exercise this right. It would take much more aggressive policy intervention or stronger price signals to motivate small retail consumers to switch suppliers. At the same time, even an unrealized retail choice may carry a value for the consumer and may potentially increase the incentive for the distribution company to improve performance.

**Unbundling and Revenue Separation.** The starting point in many developing countries is the transmission services integrated with generation activities, with the costs of transmission embedded in the price of energy sold. Similarly, the price of electricity distribution services is bundled together with the value of the energy delivered to the final consumer. However, an effective open access regime requires a clear focus on the provision of the network services as a distinct area of business operations. This is best achieved by unbundling transmission from generation and precluding it from association with any other energy suppliers or traders. The transmission service provider should not be concerned with revenues other than those related to network service provision.

The benefits of vertical unbundling in the electricity sector include greater transparency and the ability to focus discretely on various segments of operation. In the context of

open access, another potential benefit of unbundling relates to the incentives of the grid service provider for inclusive, nondiscriminatory operation.

**Transmission Incentives.** When the transmission operation receives only revenues specific to the grid service provision, the owner's/operator's incentives are better aligned with the public interest. The transmission provider is interested in maximizing its throughput, and this incentive works well for the objectives of open access. Indeed, the service provider is interested in attracting more users (generators) to the available transmission capacity, rather than favoring some of them based on the price of energy they charge or arbitrarily excluding some generators.

To enhance the transparency of open access, access to real-time information via a website is necessary, detailing how the transmission grid is being utilized and how much capacity is available. Ancillary services, such as voltage support and reactive power, to the extent possible, should also be provided on a competitive basis, allowing open grid access to service providers.

**Distribution Incentives.** As with transmission providers, distribution companies should be neutral to energy-sales revenues. However, even when energy-sales revenues accrue to a generator or retail supplier, a distribution company is interested in maximizing its throughput, similar to the case of a transmission operator. In addition, unlike a transmission company, a distribution company operates in close interface with the end user. This interface may be potentially misused to maximize throughput at the expense of socially desirable objectives, such as demand-side energy efficiency.

Therefore, decoupling revenues (revenue capping) from energy throughput is recommended for distribution companies. In practice, this means that the regulator sets a total revenue requirement for the company for a certain future period. Tariffs are set in a way that allows the company to meet the revenue requirement. If there is a revenue shortfall due to demand-side energy efficiency, the regulator may appropriately adjust the tariff to allow the company to meet the revenue requirement. Customers' tariffs may go up, but they are not penalized because they are using less energy.

Due to its default service obligation, a distribution company typically carries two distinct licenses: a distribution license for operating the regional distribution system and a retail sale license. Thus, the distribution company has two distinct sources of revenue. However, while the distribution company can improve its financial results by being more efficient in the "wires" business, its electricity sales should be treated as a pass-through cost, so the distribution company is largely neutral to customers switching to other retailers.

The case of Turkey is a good illustration. The energy cost to the consumer is the buying price of the distribution company, plus a predetermined margin (2.33 percent). As eligible consumers switch, the only revenue loss is the margin over the buying price. If the distribution company buys energy from its affiliated generation companies, revenues of these generation companies will be affected; however this is the expected result of competition and no compensation is needed (Dilli 2012). Thus, it is not in the distribution company's interest to affiliate with an uncompetitive generator.

**Default Service Obligation.** In practice, it is difficult to achieve a complete unbundling of the distribution business from retail-sale business due to the default, or last resort, service obligation. There needs to be a last resort supplier for those retail customers

who do not elect to pick a supplier or choose a supplier who defaults on its obligations. Therefore, even under a distribution open access regime, a distribution company will typically have a double license.

However, the distribution company's supply license should be limited to that of the last resort supplier, with no possibility of making profits, since the revenue is essentially a pass-through from end users to generators or other suppliers (Besant-Jones 2006).

To maintain competitive pressure on the default service provider, distributors should be obliged to bid out the last resort supplier obligation on a parceled, periodic basis. For example, one-third of anticipated demand for a three-year contract can be bid every year for three years. For the default product, the consumer pays a blend, or weighted average, of the three prices of energy resulting from annual auctions. Under this arrangement, the incumbent distribution company may risk losing its retail supply franchise in just three years if it is not competitive, or keep operating as a retail supplier if it is.

**Product Differentiation.** In retail access in particular, attention should be paid to product differentiation. A more efficient retail market will emerge if market players are given an opportunity to offer different products other than the default product. This may include an energy service company offering a blend of demand-side services and energy, or a hedged product with a fixed price or a variable, time-differentiated, market-following price, depending on the buyer's preferences.

**Large Industrial Consumers.** On the buy side of open access, large industrial consumers usually care most about the price and quality of the power supply, making them the first candidates for switching to alternative suppliers if they are not satisfied. They are also large and creditworthy enough to require special consideration. While technically retail customers, large industrial consumers stand out in the spectrum of wholesale versus retail due to their size; as such, they are logical candidates for direct connection to the transmission grid. In addition, such market participants could bid demand response into the market, provided the availability of location-specific transmission prices at their place of business.

A policy decision to consider is whether or not to compensate the distribution company for losing such consumers to open access. The recommended approach is to allow large industrial consumers to buy off the local grid, but limit their ability to move freely between the regulated and deregulated markets. Allowing them to shop outside the incumbent distribution company franchise offers a potential benefit, while the distribution company's interests are not necessarily harmed. In fact, the reason why distribution companies cling to such customers is not always rational. Large industrial consumers require large investments for maintaining the peak-load capacity, and their demand patterns are often volatile, making them a relatively risky investment for the distribution system. Therefore, distribution companies should consider focusing on the relatively low-risk, moderate-return customers instead.

The rationale for limiting the ability of large consumers to move freely between the regulated and deregulated markets is the additional costs created for the system, and for the affected distribution company in particular, if large consumers return for energy available from the distribution company at a regulated price.

In several U.S. states, for example, a customer may return to the regulated market, but to do so, it must agree to pay all of the incremental costs incurred. In Brazil, customers

seeking to return to the regulated market may do so, but only after providing ample advance notice to the distributor.

**Smart Grid Technology.** The installation of smart grid technology for controlling the grid should be deployed at major sites of large customers and all distributed generators. In retail access, attention should be paid to who owns and operates the metering and billing operations. Though this capability will help enhance market transparency and efficiency, in some circumstances it can also be exploited to exercise market power.



## ANNEX 1 | Power Sector Reform Paths and Open Access Milestones in Selected Countries

<b>Brazil</b>	1988	Constitutional provisions on competitive procedures for electricity procurement and granting concessions
	1993	Legislation ending artificial equalization of tariffs and guaranteed fixed returns for utilities <sup>a</sup>
	1995	Public Utility Service Concessions Act introduces cost-based tariffs
		Concession legislation introducing: <ul style="list-style-type: none"> <li>• Provisions on IPPs</li> <li>• T&amp;D unbundling from generation/supply</li> <li>• Separate contracting for “wires” and energy sales</li> <li>• Prohibition for distribution concession holders to engage in generation or transmission</li> <li>• Definition of “free” consumers (3 MW or more) eligible to participate in the wholesale market</li> <li>• Establishment of the free-trading floor for competitive wholesale market operation</li> </ul>
	1995-2000	Privatization in the generation and distribution segments
	1996	National Sector Regulator (ANEEL) established, responsible for tariff methodology for system cost recovery, including location signals
	1998	National System Operator (ONS) and wholesale electricity market established <sup>b</sup>
	1999	ANEEL resolution establishing general conditions for access <sup>c</sup> and use <sup>d</sup> of T&D system
	2001	First private transmission development projects
	2003-2004	New model with power sector oversight committee (CMSE) put in charge of supply security, system planning, and strategy

<b>Peru</b>	1993	<p>The Law on Power Concessions, or LCE<sup>e</sup> leading to:</p> <ul style="list-style-type: none"> <li>• Privatization of most power-sector assets</li> <li>• Obligation of T&amp;D concessionaires to allow third-party access to transport electricity</li> <li>• Methodology for rate setting, granting of concessions, customer service guidelines, and accountability of operators</li> <li>• Designation of COES<sup>f</sup> as a quasi-ISO<sup>g</sup> following a cost-based, merit-order procedure</li> <li>• Two categories of users: large unregulated users (1 MW or more) and small captive users</li> <li>• Freely negotiated contracts between generators and large users within an energy wholesale market</li> </ul>
	1996	Creation of a sector regulator, OSINERGMIN <sup>h</sup>
	2006	<p>Second-generation reform package<sup>i</sup> leading to:</p> <ul style="list-style-type: none"> <li>• COES assuming responsibility for transmission planning<sup>j</sup></li> <li>• Expansion of COES board representation to distribution companies and large consumers</li> <li>• Large consumers allowed to participate in auctions for long-term energy supply contracts along with distribution companies</li> </ul>

<b>Turkey</b>	1994	<p>Turkish Electricity Authority (TEK) restructured leading to:</p> <ul style="list-style-type: none"> <li>• Distribution utilities separate from transmission and generation<sup>k</sup></li> <li>• Private-sector participation in generation and distribution</li> </ul>
	2001 2001-2004 (respectively)	<p>Electricity Market Law (EML)<sup>l</sup> and related secondary legislation providing for:</p> <ul style="list-style-type: none"> <li>• Unbundling state-owned transmission and generation company into generation, transmission,<sup>m</sup> and wholesale state-owned companies<sup>n</sup></li> <li>• An autonomous sector regulator (EMRA) to supervise the market</li> <li>• Separate licencing for different market segments<sup>o</sup></li> <li>• Principles for tariff mechanisms</li> <li>• Legal basis for competitive bilateral contracts and balancing markets</li> <li>• Nondiscriminatory third-party access to T&amp;D systems for generators/suppliers and eligible consumers</li> <li>• Definition of eligible consumers as those exceeding consumption thresholds set and gradually reduced by the regulator,<sup>p</sup> or those with an existing, direct connection to the transmission system (2003)</li> <li>• Eligible consumers can be supplied by private wholesale companies</li> <li>• Market rules for the wholesale market, including a settlement and balancing regime<sup>q</sup></li> <li>• Actions to be followed for privatization of generation and distribution assets</li> </ul>
	2009-2012	<p>Launch of the electricity trading mechanisms (2009-2012)</p> <ul style="list-style-type: none"> <li>• Currently operated mechanisms include the bilateral contract market, the day-ahead market, and the balancing-power market</li> </ul>



United States	1977	FERC created <sup>r</sup>
	1978	PURPA passed to promote alternative <sup>s</sup> sources of energy
	1992	Energy Policy Act allows wholesale market participants to apply to FERC for open access to transmission systems of electric utilities
	1996	FERC Order No. 888 on promoting wholesale competition through open access, aimed at lowering costs for consumers, requires: <ul style="list-style-type: none"> <li>• Functional separation of generation and transmission</li> <li>• Transmission-owning utilities to set nondiscriminatory rates for transmission access</li> <li>• Real-time information for all transmission users on availability of transmission capacity to accommodate transactions by third parties</li> <li>• States and industry participants create regional organizations and support the development of ISO principles<sup>t</sup> and ISO-type markets</li> <li>• The ISOs are not-for-profit entities with no proprietary interests in transmission assets or the outcome of competition among energy market players</li> </ul>
	1997	PJM Interconnection <sup>u</sup> power system in the northeast United States implements an integrated market design allowing real-time energy auctions leading to unit commitment schedules and LMPs; <sup>v</sup> PJM Interconnection also pioneers FTRs <sup>w</sup> that hedge locational congestion charges
	1990s-2000s	Financial products market in the power sector progresses, with traders actively engaged in the market: <ul style="list-style-type: none"> <li>• Multiple products available, including tolling and heat-rate contracts, requirements contracts, and various swaps</li> <li>• ISO markets established by late 1990s all have LMPs for transmission, competitive ancillary services markets, and FTRs as marketable assets</li> </ul>
	1999	FERC Order No. 2000 encourages the formation of regional transmission organizations to administer the transmission grid on a regional basis based on principles similar to ISO
	2009 (with later amendments)	Standards for demand response and energy efficiency products and services used in organized wholesale electricity markets
	2011	FERC Order No. 1000: <ul style="list-style-type: none"> <li>• Opens up the grid for new transmission developers, ending the utilities' right of first refusal in their territory, and allocating more costs to project owners/beneficiaries</li> <li>• Mandates transparent, participatory planning process for grid development</li> </ul>

Source | Authors.

<sup>a</sup> Law No. 8631 (known as the Eliseu Resende Act) of March 4, 1993. Importantly, this act introduced the mandatory signature of supply agreements between generators and distributors.

<sup>b</sup> The law provides that operating rules for transmission facilities be developed by ONS for approval by ANEEL.

- <sup>c</sup> Connection fees to the T&D systems cover the design and construction costs incurred, as well as equipment, metering, and operations and maintenance for each connection point.
- <sup>d</sup> Both T&D system use fees are payable by all users, divided about equally between generation utilities and consumers, and calculated on the basis of the amounts of use contracted or ascertained for each connection point (charge = amount x usage tariff + other applicable fees and taxes). About 70% of the transmission use charge is spread across the system as a "postage-stamp" amount to smooth out locational price inequalities due to congestion costs. Much of the location price signal is lost as a result. The distribution use charge is socialized across the distribution system at voltage levels equal to or higher than the consumer's level. This creates a strong incentive for large consumers to seek a connection at higher voltage level of distribution or, whenever possible, directly to the transmission grid.
- <sup>e</sup> LCE - *Ley de Concesiones Eléctricas*
- <sup>f</sup> COES - *Comité de Operación Económica del Sistema Interconectado*
- <sup>g</sup> COES is organized as a nonprofit private entity with a board of five individuals elected by its members (initially consisting of mostly generation and transmission company representatives) for five-year periods.
- <sup>h</sup> OSINERGMIN - *Organismo Supervisor de la Inversión en Energía y Minería*
- <sup>i</sup> Law No. 28832 is to "ensure the efficient development of electricity generation."
- <sup>j</sup> COES issues a binding plan for national transmission system development every other year.
- <sup>k</sup> Transmission and generation, however, were still not entirely separate since the state company TEIAS was engaged in both activities.
- <sup>l</sup> Law No. 4628, issued in 2001, amended in 2005, 2006, and 2008.
- <sup>m</sup> State-owned entity TEIAS is both the transmission grid owner and system operator (like in the European TSO model). It is responsible for transmission system operation and maintenance, planning of new transmission investments, and construction of new transmission facilities to meet market participants' needs. It also operates the financial settlement center, thus fostering competition.
- <sup>n</sup> Turkish Electricity Trading and Contracting Company (TETAS) is the state-owned electricity wholesale company.
- <sup>o</sup> Types of licenses are: generation, auto-producer, transmission, distribution, wholesale, and retail licenses.
- <sup>p</sup> The initial consumption threshold for eligible consumers in Turkey in 2003 was 9 GWh per annum but was reduced to a small fraction of this in less than 10 years. Thus, while the number of eligible consumers exercising their right had rapidly grown, it comprised still only 16% of the eligible consumers' market in 2012. The suppliers of eligible consumers are mostly private wholesale companies.
- <sup>q</sup> Balancing and settlement regulations in Turkey were initially designed in 2003, became operational in 2006, then were revised and relaunched again in 2009 and 2011.
- <sup>r</sup> Federal Power Commission, the predecessor of FERC, had existed since 1930.
- <sup>s</sup> "Alternative" was meant both in terms of the resources used to generate energy and in terms of nontraditional ownership, namely nonutilities.
- <sup>t</sup> ISO principles included: fair and nondiscriminatory ISO governance and tariffs, financial independence of the ISO, responsibility for the reliability of the system, incentives for good ISO management, and the use of dispute resolution as the first resort.
- <sup>u</sup> PJM Interconnection - a U.S. regional transmission organization
- <sup>v</sup> Locational marginal prices
- <sup>w</sup> Financial transmission rights

## ANNEX 2 | Factors Contributing to Power Sector Reform and Open Access in Peru

Factor/Driver for Success	Relevance			Comments/Association with Open Access
	Very Important	Important	Not that Important	
The country's fast and sustained economic growth	✓			A challenge but also an opportunity that attracted the interest of investors worldwide
The potential for cheap and abundant energy resources		✓		The availability of natural gas for power generation, plus a large hydropower potential helped the rapid growth of the power sector as a whole at relatively low prices
Ownership separation of transmission facilities	✓			An indispensable condition for open access, avoiding conflicts of interest in the transmission service
Privatization of most power sector assets	✓			Essential to depoliticize energy pricing and the operation of enterprises, as well as to attract additional resources and corporate dynamics into the sector
Legislation mandating open access to transmission facilities	✓			Essential to permit a wholesale market, i.e., to guarantee that the product reaches clients without any significant obstacle
Legislation mandating open access to distribution facilities			✓	The energy wholesale market in Peru is dominated by mining activities, hence, 85% of the market, in sales, is located outside of distribution concessions
Government's commitment to reform and ability to be flexible	✓			Government's sustained political support and capacity to amend laws and policies helped overcome obstacles
Solid and trustworthy regulatory framework	✓			An essential component in providing confidence to investors in all segments of the sector

Factor/Driver for Success	Relevance			Comments/Association with Open Access
	Very Important	Important	Not that Important	
Rules for entry for generators and large consumers		✓		Clearly established and accepted rules for entry are an important factor in defining access to the transmission system
Predictability of transmission prices		✓		Proved to be very important in attracting investment in transmission. However, it is argued that the somewhat alarming decline in investments did not affect open access or the energy market
Quasi-ISO	✓			An essential component in achieving the technical-economic operation of the system and, as such, guaranteeing the growth of the energy market
Electricity code			✓	While the electricity code establishes a set of preventive rules and safeguards that is essential for good sector performance, it is not considered instrumental to open access

Source | Crousillat 2012.

## ENDNOTES

- <sup>1</sup> Three criteria were applied in the initial selection of the countries to study: (a) a demonstrated level of success in implementing open access to T&D; (b) a potential for replication of successful models in a variety of country settings; and (c) availability of particularly valuable lessons.
- <sup>2</sup> Electricity Act 2003, Section 11: "The appropriate government may specify that a generating company shall, in extraordinary circumstances, operate and maintain any generating station in accordance with the directions of that government."
- <sup>3</sup> Spain's power market, which was completely liberalized in 2003, first saw a substantial rise in the number of consumers buying on the liberalized market the following year. However, in 2005 and 2006, the numbers grew stagnant and, in 2007, reversed. Consumers returned to the regulated market because it offered better prices than the free market, despite an 8 percent rise in the average regulated market price that year (ICIS 2008).
- <sup>4</sup> Based on an interview with Budak Dilli, 2012.
- <sup>5</sup> See the Philippines report (Tan 2012) in reference to *Report on the Retail Competition Regime in the Republic of the Philippines* by Jess Totten, Austin, Texas; November 10, 2011.

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## ACRONYMS AND ABBREVIATIONS

ANEEL	National Agency for Electric Energy (Brazil)
CCEE	Electricity Trading Chamber (Brazil)
COES	System Operator (Peru)
EMRA	Energy Market Regulatory Authority (Turkey)
ERCOT	Electricity Reliability Council of Texas (USA)
EUAS	Electricity Generation Company (Turkey)
FERC	Federal Energy Regulatory Commission (USA)
GWh	Gigawatt hour
IPP	Independent power producer
ISO	Independent system operator
KWh	Kilowatt hour
LMP	Locational marginal price
MW	Megawatt
NETA	New Electricity Trading Arrangements (UK)
OASIS	Open Access Same-Time Information System (USA)
ONS	National System Operator (Brazil)
PURPA	Public Utility Regulatory Policy Act (USA)
Rs	Rupee (Indian currency)
SLDC	State Load Dispatch Center (India)
T&D	Transmission and distribution
TEIAS	Turkish Electricity Transmission Company
TETAS	Turkish Electricity Wholesale (Trading and Contracting) Company
TSO	Transmission System Operator
TWh	Terawatt hour

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