LATIN AMERICAN COMPETITION FORUM

Session II - Electricity Markets in Latin America: Regional Integration and Competition Issues

-- Background paper by the OECD Secretariat--

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The opinions expressed and arguments employed herein do not necessarily reflect the official views of the Organisation or of the governments of its member countries.

Contact: Ania Thiemann, Global Relations Manager, OECD Competition Division,
Tel: +33 1 45 24 98 87, Email: Ania.Thiemann@oecd.org

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Session II - Electricity Markets in Latin America: Regional Integration and Competition Issues

-- BACKGROUND PAPER BY THE OECD SECRETARIAT --
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1. **Introduction**

1. This paper discusses the potential for the integration of electricity markets in the Latin American and Caribbean Region (LAC). There are plenty of reasons for Latin American energy producers and users to integrate the production, transport, and consumption of energy within the regional economy. Integrated markets can be demonstrated to provide supply and production stability and security to support more stable pricing, and to provide a significantly more attractive climate for large scale infrastructure investment. Without that welcoming climate, the resources required for large-scale infrastructure projects will be lacking, undermining the maintenance of efficient and secure supply. Especially in economies where the consumers of energy are unable or unwilling to fund the development of its production, the need to build competitive markets that are attractive to producers and consumers alike is vital. The paper will analyse the reasons why regional integration may be of particular interest to Latin America and what the conditions for successful integration are, including how to deal with competitive issues that may arise. Competition authorities in the LAC will have a role to play on the way to regional integration and in (an) integrated market(s). What this role may be and how far competition authorities will have to take over regulatory responsibility or co-operate with regulators will depend very much on the market model to be chosen. The same is true for the question as to which competition problems will likely arise and how best to deal with them. It would be beyond the scope of this paper to give comprehensive guidance. But what the paper will try to do is to provide a solid background for competition authorities on actual and potential frameworks for market integration. It is only with a good basic understanding of the markets in question that we will be able to design and advocate adequate competition law and institutional responses. For ease of analysis, this paper focuses almost entirely on Latin America, but the majority of findings would also be applicable to the Caribbean, where market integration may be between islands through undersea transmission cables or within larger islands (especially islands that are divided between jurisdictions).

1.1 **The electricity challenge in Latin America**

2. The LAC has experienced widespread electrification since the 1970s which has contributed to substantial economic and social development. There is ample evidence to demonstrate the links between economic development and the availability of electrical power. Indeed, the causality is dual, insofar as the availability of electricity determines GDP growth while GDP growth is a key determinant of electricity consumption.

3. Industrial and commercial activities require electricity, as does the development of modern cities, which need power, not just for heating, lighting and cooling, but also to power transport systems and so on. Modern information technologies, crucial for development and social integration these days, depend on the availability of steady, reliable and ever increasing energy provision. Electricity is also a vital component for rural development and for lifting poorer populations out of poverty. A study conducted in 2003 (Barnes et al, 2003) emphasises the importance in electrical light to allow for the pursuit of activities after dark such as reading, studying or carrying out household chores and operate small machinery for domestic cottage industries. Typically, women and children are the prime beneficiaries of electrification (several World Bank studies mention this).

4. GDP growth and electricity demand are closely correlated. As such, managing continuously rising electricity demand – resulting from economic growth – is expected to be an ever growing challenge for LAC governments. Using IMF forecasts for GDP growth and OLADE\(^1\) data for electricity prices, the

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\(^1\) The Latin America Energy Organisation, or OLADE, is a technical and political support organisation for Latin America and the Caribbean countries that are undertaking common efforts to achieve integration and development in the regional energy market. Among others it hosts a vast database with regional energy data. OLADE was formed in response to the energy crisis of the 1970s and groups together 26 countries of Latin America and the Caribbean. For more information see [www.olade.org](http://www.olade.org).
World Bank estimates that demand for electricity across the entire LAC region will reach around 2,500 TWh in 2030, almost twice as much as the 2008 level. A more recent forecast by the International Energy Agency (IEA) projects a more modest increase in demand from 1109 TWh to 1860 TWh over the period 2011-2030 (an increase of approximately 68%). The World Bank finds results fully consistent with economic theory, in so far as the demand for electricity is positively correlated with income and negatively correlated with prices in the long term (short-term electricity demand is relatively inelastic). The higher the national income of a country, the more power it consumes. For the LAC region (the study estimated the electricity demand for 17 LAC countries), the World Bank finds that the GDP-electricity demand elasticity is always greater than unity, with the exception of Paraguay and Venezuela. According to the World Bank, the GDP-electricity elasticities can be interpreted as a measure of energy intensity, as they represent the percentage increase in electricity demand for every percentage increase in GDP.

Table 1. GDP and Price Coefficients*

<table>
<thead>
<tr>
<th>Country</th>
<th>Coeff GDP</th>
<th>Coeff Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>1.02</td>
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<td>Bolivia</td>
<td>2.06</td>
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<td>Brazil</td>
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<td>Guatemala</td>
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<td>Uruguay</td>
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<td>-1.83</td>
</tr>
<tr>
<td>Venezuela</td>
<td>0.48</td>
<td>-0.05</td>
</tr>
</tbody>
</table>

* GDP coefficients were statistically significant for all countries. Price coefficients were not statistically significant for Chile, Colombia, Nicaragua and Venezuela. The results derived for the GDP and Price coefficients are fully consistent with economic theory: GDP growth is positively correlated with electricity demand and electricity prices are negatively related in the long run.


4 The IEA estimates are based on a projection of slower economic growth than the World Bank estimate.

5 To estimate electricity demand, the World Bank used a log-linear model using GDP and electricity prices as explanatory variables. Working with OLADE data (the most complete set of energy data), and IMF forecasts for long-term growth, an electricity demand scenario for the region was modelled to the year 2030. The supply scenario was then developed to meet the estimated demand. See World Bank, 2010 pp. 45-65 for a full discussion.

6 World Bank, 2010.
5. The same study estimates that an additional 239 GW of installed capacity will be needed in the same time frame in order to satisfy this demand. Installed capacity is a measure of the maximum hourly peak demands that can be satisfied. The amount estimated by the World Bank is roughly twice as much as the existing installed capacity in 2008 (295 GW). This is broadly consistent with the IEA’s estimate that 201 GW of additional capacity will be needed between 2011 and 2030, an increase of 80%. It is therefore indispensable for governments to be able to meet this need for power and to maintain a well-functioning electricity market which ensures the security of supply and the efficiency of the region’s electricity grids. To achieve this, the right regulatory framework needs to be found that allows for sufficient incentives to market players to invest in the capacity and the quality of transmission and distribution networks required to supply the populations across the region.

6. However, the very nature of electricity means that it is not a straightforward task to ensure comprehensive and reliable supply of energy across a vast and varied region. As yet, there is no fully efficient or affordable technology that allows for electricity to be stored. This means that at any moment in time, demand for electricity must be instantaneously met by an equal amount of supply. Moreover, transmission lines and distribution networks (which transmit the power generated to end-users) are natural monopolies. Hence the traditional response to the sector specificities used to be central planning and state-ownership to make sure supply met demand. In other words, the electricity sector developed within strict, government regulated frameworks. The sector has therefore tended to be either partially or wholly state-owned, with a central system planner assessing power needs and how to meet them, with costs covered fully or partially by consumers. Furthermore, most developed societies have an extremely low tolerance for blackouts and expect demand to be met fully at any time.

7. Even so, the electricity sector has gradually been liberalised the world over, starting with Chile in 1982. Although this was part of a broader trend towards deregulation in several state-controlled sectors in the 1980s and 1990s, within the sector itself the drive for liberalisation was also motivated by system inefficiencies, especially in power generation and at the consumer retail level, due to the lack of proper incentives and competitive pressure to invest sufficiently in infrastructure.

8. Despite wide-reaching liberalisation, the state remains an important player in the sector in LAC, notably through continued ownership of companies mainly involved in generation and transmission. In addition, the quality and efficiency of power transmission and supply is still problematic in LAC, either because of the technological features of the energy market or because many LAC countries lack the institutional development and the human resources implicit in the models that they have adopted. Across the region, there are therefore great disparities in the quality of supply, as well as in the regimes adopted by governments. Some countries (such as Costa Rica or Uruguay) – where the State has remained the only or main provider of electricity – hardly ever face blackouts or power-cuts. On the other hand quality of supply remains a serious problem in a number of economies. Cuba has reached almost universal coverage of electricity, but its electricity market almost collapsed between 2005 and 2006. Venezuela – which re-nationalised its electricity market in 2007 – also experienced a deep power crisis with long blackout periods throughout 2009 and 2010 (the main cause of the crisis was thought to be the over-reliance on hydro capacity).

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1.2 Market integration and regional trade

9. In order to address some of the challenges of the sector, and to make productive use of comparative advantages in electricity production and differences in consumption patterns, several countries and regions have moved towards market integration or opened up for cross-border trade to enhance the security and efficiency of electricity networks. Early examples of this are the Nordic countries in Europe (the Nord Pool); the PJM market (Pennsylvania, New Jersey and Maryland) in the US, and Australia. In the context of this paper, we define “market integration” to mean the cross-border interconnection (for the trade of electricity) of two or more formerly independent national electricity grids. We therefore do not mean for example the vertical integration of different levels of electricity supply (such as generation, transmission and distribution). The trend towards more trade or integration is also present in LAC, although this is still a big challenge for many countries in the region, especially in the Mercosur region. That said, some links already exist, especially among electricity firms through bilateral intergovernmental agreements, but deeper and more systematic integration through cross-border or regional trade can be a useful tool to prevent frequent power shortages. Integration is also likely to increase social welfare in all participating markets through the multiplier effect of access to a regular and secure electricity supply and through increased competition on formerly insufficiently competitive markets.

10. This paper discusses some of the issues related to market integration in LAC. After a short reminder of some the traditional market competition problems in the electricity sector, the second part will look briefly at the current power sector in LAC, and we discuss some of the challenges related to future expansion needs. In the third part, we discuss market integration (we use the phrases 'cross-border trade' and 'market integration' more or less interchangeably), especially the reasons why this has the potential to alleviate some of the difficulties that the region faces in meeting future power needs. In the fourth part we return to the prerequisites needed for market integration, including financing of infrastructure, structural policies, pricing and regulation. We also briefly discuss retail level competition to try and identify the potential benefits for LAC's consumers from market integration. Finally, we raise some questions about what role there is for national competition authorities to play in a regional market.

2. Competition issues in the electricity sector

11. The electricity sector has particular characteristics most of which have implications for the way the market functions, and in particular for the competitive issues which may arise. Among the central features, one should mention:

- **Power generation**: uses a variety of inputs, some of which are subject to large swings in international market prices (fossil fuels, especially oil and gas); or seasonal/climatic changes (hydropower, wind and solar energy); or may face political pressure (nuclear energy). Most importantly, there is no one source, and no one market for the fuel that is used for power generation; it will vary from country to country and sometimes even within a country, between regions and from one town to the next. Historically energy used to be produced and supplied by local or regional monopolists.

- **Constrained supply**: the limitation of inputs in conjunction with the individual capacity of each power generating firm, limits capacity at the point of generation. In addition, there can be congestion on the transmission lines, especially in meshed networks. The fact that electricity

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10 Full members of Mercosur are Argentina, Brazil, Paraguay, Uruguay and Venezuela; associate members are Bolivia, Chile, Colombia, Ecuador and Peru.

cannot be stored in an efficient and affordable way adds to the constraints. Transmission lines are
natural monopolies, akin to rail tracks or bridges.

- **Investment in capacity**, whether in power generation or transmission, is costly and needs to be
  planned over the long-term. Often a lack of sufficient investment incentives means that this link
  is neglected, leading to transmission losses, insufficient generation and transmission capacity and
  eventually black-outs.

- **Supply and demand balancing**: owing to the absence of storage, electricity supply and demand
  must be perfectly balanced at any point in time, requiring forward markets (or planning), as well
  as back-up reserve capacity that can be drawn on at any time (also known as ancillary services).

- **Demand is inelastic** in the short run, but can vary significantly during the day, and in the course
  of a year with significant seasonal swings. As already mentioned it can be expected to grow
  significantly in the long run, in line with economic development.

- **Owing to the structure of the market**, where the delivery of electricity to the end-consumers is
  separated from the generation, and with the supply typically determined in forward markets (day-
  ahead or ½-day ahead markets), there are **no real-time price signals** for consumers who tend to
  pay monthly, quarterly or annually for their electricity. As such there is no direct price
  competition where demand meets supply; rather prices are negotiated at the wholesale level
  through a variety of mechanisms and by various players, leading to a degree of lack of
  transparency for end-consumers; and a concomitant resistance to increasing the individual
  elasticity of demand by intelligently adapting consumption to changing price signals.

12. These features are well known, and the typical competition problems in the electricity sector tend
  to be well understood. The OECD has devoted several roundtables to this issue.\(^{12}\) In brief, we note that
  liberalised electricity markets are prone to the exercise of market power, as a result of the factors discussed
  above.\(^{13}\) We will look at some of the consequences of this below.

13. Even in supposedly competitive markets where many power generators operate, the presence of
  capacity constraints prevents some firms already operating close to capacity from responding to increases
  in demand, and hence they cannot discipline the market by injecting additional supply, leaving the
  companies with larger, unconstrained capacities to exercise significant market power in peak demand
  periods. Congestion in the transmission system can have a similar effect, allowing some power generating
  firms to yield substantial local market power at peak demand times, even if a look at a conventionally
  calculated HHI does not suggest this.\(^{14}\)\(^{15}\)

\(^{12}\) Amongst others, see OECD (1996), Policy Roundtables on Competition Policy in the Electricity Sector,
Roundtables on Competition Policy in the Electricity Sector II., DAFFE/COMP(2003)14,
[http://www.oecd.org/regreform/sectors/6095721.pdf](http://www.oecd.org/regreform/sectors/6095721.pdf); with the full text published as "Competition Issues in

\(^{13}\) For a full discussion of the market power problem in the electricity sector, see the thorough Background

14. Since the level of market power can vary rapidly over time according to changes in transmission congestion and to fluctuating load levels, analysing the relevant market and market power requires careful study. As electricity cannot be stored, markets occur at the point of delivery and one needs to distinguish different market conditions at different times of day, month or year.

15. Market power in electricity markets may not be limited to peak demand periods. It is also possible for market power to arise at off-peak times. A large base-load generator that operates on a low-cost basis (for instance, an installed nuclear plant) may face competition from a fringe of smaller, higher cost generators. However, competition will only be present at peak times when strong demand can absorb the higher cost of generating electricity. The incumbent base-load generator will only face entry into its market if new entrants can match its low cost structure. Otherwise there may not be new entry even if there are supra-competitive profits at off-peak times.

16. The short-term inelasticity of demand means that withholding even small amounts of output can have a very substantial impact on consumer electricity prices. When the transmission network is congested, a separate geographic market may emerge, where some generators may have significant market power in their local area. Other generators may gain significant market power because their production is used to alleviate pressures arising from congestion in another area.

17. The deterrent influence of market power and its potential abuse are harmful for overall market efficiency. It distorts short-term production and distribution decisions and may lead to inefficient long-term investment decisions, for instance decisions over the location of a power plant; or the choice of technology of new generation. Market power may also adversely affect electricity spot market prices, undermining electricity market reform efforts by policy makers.

18. Faced with concerns over market power, policy makers have taken various actions to mitigate it, including liberalisation and regulation, improving transmission capacity, capping bids by generators and attempting to enhance the responsiveness of demand to electricity prices, for instance through the use of smart metering. In general, the remedies for market power in electricity markets are similar to the ones sought in other markets. These have been discussed in several OECD Roundtables\(^\text{16}\), and include:

- Increase competition from rival products—enabling consumers to use rival forms of energy (not always possible depending on market structure and the availability of alternative sources of energy);
- Increase competition between time periods—enhancing the storability of electricity (costly and impractical for retail consumers);
- Increase the sensitivity of demand to price—using time-of-day metering or self-generation (this is being rolled out in some countries, for instance in Italy);
- Promote the entry of new generating firms;
- Lower prices or increase quantities by direct regulatory intervention;

\(^{15}\) Biggar (2005) points out that as a result of these features, to capture market concentration in markets with capacity constraints the traditional Herfindahl-Hirschman Index (HHI) can be misleading, as markets that appear competitive (i.e. with many firms present) may in fact be highly concentrated at various points in the operating cycle. As such Biggar proposes an alternative measure (the "adjusted HHI"), which takes into account the market power exerted by a few firms (or just a single firm) at peak times to generate an adjusted index (See Biggar (2005) p. 111).

\(^{16}\) This particular list is from OECD (2002), Policy Roundtables on Competition Policy in the Electricity Sector II., DAFFE/COMP(2003)14. See [www.oecd.org/daf/competition](http://www.oecd.org/daf/competition) for more information.
- Structural separation of electricity companies (horizontally or vertically);
- Change the rules for electricity markets through regulation to reduce the incentive to withhold capacity; and
- Increase competition across geographical areas—in particular through the construction of transmission links between regions or across borders, or alleviate constraints on existing links.

19. While some of these solutions may be useful, others would appear impractical or difficult to impose and monitor by policy makers. However, especially the LAC countries with their large share of hydropower have great potential for the development of storage solutions (pumped storage plants) for exploiting natural energy resources like sun and wind; and for installing smart metering devices from the beginning. This paper however focuses mainly on the last policy proposal on regional integration which, if successful, could increase capacity and hence help mitigate market power. The next sections will discuss the particular features of the Latin America and Caribbean electricity markets, and some of their particular challenges\(^{17}\), before moving on to discussing the benefits and drawbacks of regional market integration.

3. **The electric power sector in the Latin America and Caribbean region**

20. The power sector in LAC has experienced steady growth since the end of the 1970s, well above the world average. Electricity production rose by 4.34% a year on average between 1980 and 2011, compared to a worldwide average growth of 3.18% over the same period. This was matched by the increase in electricity consumption which grew by an average of 4.25% a year in LAC between 1980 and 2011, compared to the worldwide average growth by 3.19% over the same period.\(^{18}\) Per capita electricity consumption increased between 1994 and 2011 by an average of 2.76% in the Latin-American region, according to the World Bank\(^{19}\).

21. Electricity production is unevenly distributed across the region. Seven countries account for 89% of total electricity production, but for only 75% of the population: Argentina, Brazil, Chile, Colombia, Mexico, Paraguay and Venezuela. Paraguay sells most of its output to Brazil. Brazil, with 32% of the region's population, produces 36% of all electricity in the region (2008 data).

22. The penetration or “electricity access” rates vary significantly between and within countries. Overall, the region's electrification rate stood at nearly 95% in 2011 (compared with a rate of 43% in Africa, and 82% for the world). Even so, the World Bank reports that the countries in LAC face significant supply-demand imbalances, and that there are large differences in connection rates and affordability. Despite the high average penetration rates, the World Bank estimates that 24 million people, or roughly 4% of the LAC population of around 591 million\(^{20}\), do not have access to electricity. There can be large disparities between rural and urban areas, as in Nicaragua which has an overall electrification rate of 78%, but only 50% electricity access rates in rural areas, compared with a rate of 98% in urban areas.

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\(^{18}\) U.S. Energy Information Administration [http://www.eia.gov/countries/data.cfm](http://www.eia.gov/countries/data.cfm)

\(^{19}\) World Bank (2010)

Table 2. Electricity access in 2011 – Latin America

<table>
<thead>
<tr>
<th>Country</th>
<th>Population without electricity millions</th>
<th>Electrification rate %</th>
<th>Urban electrification rate %</th>
<th>Rural electrification rate %</th>
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<td>Argentina</td>
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<td>98.5</td>
<td>81.1</td>
</tr>
</tbody>
</table>

Source: OECD/IEA, World Energy Outlook 2013, Electricity Access Database

23. Despite wide-reaching electrification, there are often problems with the quality of supply across the region with frequent blackouts around the national grids. Even Chile and Argentina have experienced power-sector problems in the last decade, though they are among the most illustrative examples of successful market-based reforms in Latin-America. Transmission and distribution losses as a percentage of output remain much higher in many Latin American countries than in Europe and Australasia, an indication that there is still significant potential for network efficiency improvements.

24. The installed generation capacity in the region has risen from 93 GW in 1980 to around 295 GW in 2008. According to OLADE (as quoted by the World Bank), 53% of total electricity generation capacity was hydroelectric in 2009, followed by 44% thermal (coal, natural gas and petroleum). Nuclear and other types together accounted for just 3% of the total installed capacity.

25. The generation mix has evolved over time, with a decline in the contribution of "oil" (fuel oil and diesel generation), and a concomitant increase in natural gas, from less than 10% share prior to 1992, to nearly 17% in 2012. Overall, hydroelectricity remains the single largest source, accounting for nearly 61% of production in 2012. Nuclear generation by contrast is restricted to Argentina, Brazil and Mexico.
Table 3. LAC electricity mix, 1972 - 2012

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>Coal</td>
<td>2.6%</td>
<td>2.2%</td>
<td>2.1%</td>
<td>1.9%</td>
<td>2.3%</td>
</tr>
<tr>
<td>Crude,NGL and feedstocks</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.3%</td>
<td>1.1%</td>
<td>0.6%</td>
</tr>
<tr>
<td>Oil products</td>
<td>34.2%</td>
<td>20.5%</td>
<td>13.3%</td>
<td>12.7%</td>
<td>12.4%</td>
</tr>
<tr>
<td>Natural gas</td>
<td>9.9%</td>
<td>8.9%</td>
<td>8.9%</td>
<td>12.1%</td>
<td>16.9%</td>
</tr>
<tr>
<td>Nuclear</td>
<td>0.0%</td>
<td>0.6%</td>
<td>1.7%</td>
<td>2.6%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Hydro</td>
<td>51.9%</td>
<td>66.1%</td>
<td>71.9%</td>
<td>67.5%</td>
<td>60.9%</td>
</tr>
<tr>
<td>Geothermal</td>
<td>0.0%</td>
<td>0.3%</td>
<td>0.3%</td>
<td>0.3%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Solar, tide, wind, etc.</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.1%</td>
<td>0.6%</td>
</tr>
<tr>
<td>Biofuels and waste</td>
<td>1.4%</td>
<td>1.4%</td>
<td>1.5%</td>
<td>1.8%</td>
<td>3.9%</td>
</tr>
<tr>
<td>Total</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Memo: Renewables total</td>
<td>53.2%</td>
<td>67.7%</td>
<td>73.6%</td>
<td>69.7%</td>
<td>65.8%</td>
</tr>
</tbody>
</table>

Source: IEA (2014), World Energy Statistics and Balances, online database, Paris

3.1 The electricity challenge in LAC

The power sector is characterised by the need for long-term planning and investment, which are further complicated by several risks and uncertainties. Among these are the fact that the input used for power generation is multiple; with each input having its own costs and benefits; uncertain and fluctuating short – and long-term demand and the environmental and social impacts of the choice of generation technology used. However, it is certain that demand for energy in LAC will continue to rise, as discussed earlier. This implies the following challenges for policy makers in the region:21

- Ensuring sufficient energy for economic growth, as well as access to electricity for the region's growing population.
- Ensuring that supply and demand are kept in balance, despite uneven growth rates.22
- Growing dependence on imported fossil fuels (especially natural gas) implies a degree of risk of supply interruptions, price fluctuations or price shocks; while the use of national or regional renewable sources (whether hydro-power or moving towards using wind or solar power) implies other constraints in terms of lack of predictability and the need for the right technology, including smart-grids and networks that can function with intermittent energy.
- Economic efficiency is a vital criterion for the region's policy makers, especially in the wake of the global financial crisis. The cost of new electricity needs to be contained for instance through the promotion of competitive tendering and financing by the private sector; the efficiency of supply needs to be ensured and transmission losses minimised; and demand-side efficiency and flexibility should be encouraged.

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21 See World Bank (2010) for a more detailed discussion.

• Although the LAC region has traditionally been a low-carbon emitter, environmental concerns need to be factored in when deciding on new capacity and investment in infrastructure and ancillary services.

• The regulatory framework needs to be conducive to meet these objectives, with policies and regulations that on the one hand allow the power sector to respond to growing demand while also addressing the growing environmental concerns and being able to attract private sector investment to reduce the pressure on public finances.

27. Most importantly, in planning future power generation capacity, policy makers need to take the long view: power sector planning takes years to ensure the right infrastructure is in place, including transmission lines and distribution networks. At present, the LAC region's reserve margins have shrunk, partly as hydro reservoirs see falling reserves while electricity demand rises faster than new capacity comes on-stream, and as the World Bank highlights: "an underestimation of electricity demand or under-investment in power supply can lead to brownouts or blackouts. Short-term disruptions can result from unanticipated demand (a hot summer...) or supply disruptions (drought), and are exacerbated by low reserve margins."

28. Many of these problems can be addressed or at least alleviated through regional integration and increased competition.

4. Benefits and drawbacks of regional market integration

29. Liberalisation of electricity markets has created new opportunities for market participants to trade between different areas, thereby increasing liquidity and contributing to the optimal use of existing network (and generation) capacities. However, in many regions, including in LAC, this has resulted in severe congestion as existing network capacities have been insufficient to satisfy the entire market demand.

30. Some countries, including island nations in the Caribbean, are also too small to allow for sufficient competition to develop. However, such problems may be overcome by merging individual countries, island groups, or areas into a single regional market. This reduces the scope for companies to gain market power and the market can support a larger number of players. Bergman (2002) finds that the integration of the national markets in the Nordic countries lead to a dilution of the market power previously held by the major generators on their respective national market, and in spite of significant entry barriers market power was not a problem.23 Moreover, regional integration further helps to optimise the operation of the overall system by removing boundary issues and in theory allowing optimisation of integrated production, network operation and trading. Regional integration also helps alleviate concerns about the security and efficiency of supply.24

31. Therefore the focus is increasingly on the integration of neighbouring markets or the creation of regional markets. There are already examples of successful market integration (such as the Nord Pool among the Nordic countries in Europe, or the Pennsylvania-New Jersey-Maryland interconnection in the US (the PJM market); and a number of comparative failures (such as in Southern Africa where regional integration has failed to take hold so far).25

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25 Several papers discuss the challenges of regional integration in the Southern African region. The FAO, for instance highlights the following obstacles to regional integration of markets (not just electricity, but also
Regional market integration has a number of benefits that respond to the challenges discussed. Typically market integration may be expected to respond to five objectives:

- ensuring a secure supply of electricity and profiting from comparative advantages;
- promoting competition in the electricity market;
- minimising transaction costs for participants and customers;
- fostering the use of renewable, sustainable or alternative energy sources;
- enabling demand side management; and

allowing for economies of scale, thereby increasing the attractiveness of the sector for investment.

We will briefly discuss these in turn.

- **Security of supply**: cross-border trade enables countries to benefit from a larger energy portfolio and to better handle congestion by broadening the sources of supply, as well as spreading risks by making use of comparative generation advantages between countries (i.e. much rain/little rain etc.).
  
  Sufficient interconnection between countries (or regions) has an important role in ensuring both short term and long term security of supply. Initially, interconnectors (transmission lines that link two nations or regions) were built to improve operational security and to reduce the cost of national network security. Today they are increasingly used for trading purposes in order to better utilise generation resources.

  Interconnectors can be used to replace peak generation units for ensuring security of supply. That said, there are two features that do not allow an interconnector to be a complete substitute of peak generation units: 1) since peak periods/loads typically are of very short duration, their mere existence does not necessarily provide policy makers with an economic rationale for the establishment of an interconnector; 2) interconnectors (to another country) may be considered less reliable in a situation of tight supply, than having a local reserve generator.


Short term security means to minimize blackouts and system disturbances, while long term security refers to the target to maintain sufficient generation and transmission capacity through investments in power plants and transmission systems (therefore it can be divided to a generation and a transmission adequacy target).
That said, there may be contradiction between national congestion management and cross-border capacity allocation systems: within the traditional capacity calculation framework national system operators are often accused of making available “too small” cross-border transmission capacity in order to avoid domestic congestion.

- **Promoting competition in the market:** Larger markets can support more liquid wholesale markets that encourage cost-reflective pricing. This may in turn entice investors to invest in technology that favours energy efficiency. Electricity trade allows for the substitution of higher-cost generators with lower-cost generators within the regional framework.

- In small countries where vertically integrated electricity systems are too small for intra-national competition, industrial and residential consumers and policy-makers are usually in favour of regional market integration since it is one very effective way to reduce market concentration and to put competitive pressure on dominant players. Given the uneven distribution of countries in the LAC region, in terms of size, natural endowments in power sources and stages of development, it may be in the overall interest of most economies to participate in some form of trading network.

- Expanding interconnection capacity may also be attractive, when there is enough generating capacity in each country. This is especially the case if there are complementarities in a region in terms of resources and generation technologies, or differences in seasonal swings, as it can make seasonal price differences among countries high enough to incentivise investment in interconnection expansion. This would be the case for instance if two countries of either side of the Equator (such as Brazil and Colombia) were to integrate their (local) electricity markets. Operating high-dams on either side of the Equator, they would be able to supply each other when either country experiences seasonal swings in water levels in the reservoirs.

- **Minimising transaction costs:** it may be cheaper and more efficient to build interconnections (i.e. transmission lines) between existing power generators on different sides of a border, rather than investing in new generation facilities, especially for smaller countries.

- Without investment in new or existing plants and improvement of interconnections among countries some regions risk becoming increasingly dependent on imported electricity or may face power shortages.

- Integration can also be reasonable for the handling of asymmetric prices and demand and/or congestion difficulties: it is rational for private operators to buy where prices are lower, congestion is low and demand load faces asymmetric peak loads.

- **Welfare**: Interconnectors between countries or sub-regions within one country can allow generators in a low-price zone to supply in the high-price zone. In addition to being efficient, this may also contribute to overall social welfare.

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30 Transmission congestion occurs when there is insufficient energy to meet the demands of all customers. The congestion is actually a shortage of transmission capacity to supply a waiting market, and the condition is marked by systems running at full capacity and proper efficiency which cannot serve all waiting customers.
- **Sustainability and environmental issues**: Interconnection allows for trade flows from regions with cleaner electricity generation to regions where it is more expensive to install more environment friendly generation capacities. The optimal fuel mix can be shaped better at the regional level, taking into account a broader variety of inputs which can help reduce CO₂ emissions, and facilitate or even spread the utilisation of renewable energy.

- **Demand-side management**: although the demand for electricity is inelastic in the short run, there are ways to increase the elasticity of demand. One way is to facilitate demand-side participation from buyers in the power exchange. Another is to incite customers to switch to other fuels. In a large integrated market with a broader range of generators (and fuels) available, it may be easier to do so.

Box 1. An example of successful market integration - NordPool

The Nordic electricity market (integrating the electricity systems of Norway, Sweden, Finland and Denmark) is an example for successful market integration and efficient retail competition. Electricity markets of the member countries were deregulated in the 1990’s. Ensuring regulated third party access to transmission and distribution networks and unbundling were common elements of the reforms. The annual electricity consumption of Nordic households is two to four times of the OECD average, which provides an incentive for customers to play a more active role in the market and which could have also contributed to the development of a flourishing competition. The Nordic retail electricity market is not very concentrated. There are roughly 300 suppliers, although one should note that around two-thirds of them do not supply outside their traditional territory.

The regulation of the retail electricity market is rather light in the Nordics. There is no price control on final retail prices; incumbents are usually only required to offer standard tariffs that are variable at two to four-weeks’ notice (standard variable tariff). There are no other constraints on prices or other contract terms that suppliers may offer outside their own areas. As a consequence of market entries and competition, suppliers have started to offer fixed-price and spot-price contracts as well, which has contributed to the decrease of electricity prices. (Spot-prices are directly linked to the NordPool market price.) Besides tariffs, electricity contracts can also vary for example in duration (e.g. guaranteed fixed-prices for 1, 2 or 3 years etc.) or the frequency of billing.

As a consequence of these product innovations, a significant proportion of residential customers has either switched away from the incumbent supplier or has changed/negotiated the terms of supply with their existing supplier (to apply different tariffs for example).

**Pricing in the Nordic electricity market**

A significant part of the electricity trade in the Nordic markets takes place in the Nord Pool spot exchange. In brief, the Nord Pool exchange was founded in 1996, by Norway and Sweden as a joint electricity power exchange, called Nord Pool ASA, Finland joined in 1998, and Denmark in 2000. In 2002 the day-ahead spot market activities of Nord Pool ASA were re-organised in a separated firm, called Nord Pool Spot AS (Nord Pool Spot), which is owned by the national Transmission System Operators (TSOs) of its member countries which at present also include Estonia, Latvia and Lithuania. Nord Pool Spot was the first multinational exchange for trading electricity and it is still the world’s largest market for day-ahead and intraday electrical energy trade. It reaches 14 million end users – both households and companies – in its member countries. Today, approximately 370 member companies from 20 countries trade through this platform in the Nordic and Baltic regions and in Germany and Great Britain as well.

The power price is basically determined by the balance between supply and demand. The main aim of the spot market is to create an equilibrium between this supply and demand, given the non-storable feature of electricity. Nord Pool Spot collects every day by 12.00 p.m. the bids of the sellers and buyers (how much energy and at which price do they want to sell/buy on an hourly basis) for the following day. Nord Pool Spot feeds this information into a special computer system which calculates the price, based on an advanced algorithm. There are different bidding areas in which bids are collected and prices are calculated separately in order to better reflect regional market conditions. These day-ahead spot prices calculated by Nord Pool Spot are regarded as the reference prices in the Nordic markets. Nord Pool Spot publishes hourly spot prices, volumes and other fundamental market data on its webpage to ensure transparency in the market.

Transmission capacity also plays a role at the determination of prices. When transmission capacity gets constrained, price is raised to reduce congestion in the affected areas. Nord Pool Spot has a monopoly for all available transmission capacity between price zones in the Nordic market for day-ahead trade (bi-lateral transactions can take place only within single price zones), so Nord Pool Spot collects all the congestion rents and allocates them later among the Nordic TSOs according to a pre-set formula.

However as most of the trade handled by Nord Pool Spot is traded on the day-ahead market, some unexpected circumstances (e.g. a nuclear power plant stops operating; extreme cold or drought) might occur in the planning. In such cases Nord Pool Spot ensures trade closer to real time to bring the market back in balance. This is called the intraday market and is becoming increasingly important with the spread of less predictable wind power generation in the regional energy mix.

For more information, see also: http://www.nordpoolspot.com/About-us/

4.1 Common obstacles to market integration

34. Despite the substantial benefits discussed above, there are some factors and risks that can hinder the evolution of the integration process. These include:

4.1.1 Costs and pricing

- The high costs of interconnection expansion and the lack of agreement on who should bear the costs is a major prohibiting factor. Smaller countries (such as Luxembourg in Europe) can be entirely supplied from neighbouring countries whereas larger countries need to some extent their own domestic generating capacity. As such establishing interconnections and market integration is likely to be more important for smaller countries, while large countries may not want to participate in an integrated market.

- A country can be adversely affected if tariff subsidies or end-user prices are not carefully set. Asymmetry in pricing across borders may significantly influence international trade and countries may find themselves subsidising external supply or demand.

- If a low-cost generation country supplies a country with capacity constraints, electricity prices may rise for the supplying country. Although this would entail rising profits for the power generators and would be overall beneficial for the region as a whole, it would also most likely lead to higher national retail prices, affecting the domestic population.

4.1.2 Securing supply

- As countries integrate their electricity networks, they may feel that they lose control of a strategic service, although arguably this has not been the case in the Nord Pool exchange (see box). Some countries that prefer to stay relatively isolated with few interconnections give reasons such as system reliability, security of energy and unwillingness to depend on third parties for their choice. 32

- When a country incentivises network expansion instead of new generation capacity, it may face a risk of facing insufficient supply if other countries do not supply their required power, as it relies on interconnections instead of its own generation capacity. Hence integration implies a degree of dependency that may be uncomfortable, especially in the absence of a strong regulatory framework and an overall tendency for national coherence. Again, this is a question that seems to have been reasonably solved by the Nordic countries participating in the exchange.

• Given that transmission lines have limited capacity, congestion can occur especially at peak-load times unless integration takes place in parallel with an expansion of capacity, especially of transmission lines.

• Capacity is not always supplied to all agents in the market place at the same price. So in order to assure the system stability and to rightly assign the available capacity, a mutually agreed regulatory framework must be in place to establish the rules of the game.

3.1.3 Regulatory and political issues

• Market integration involves higher opportunities, but also risks in case of technical problems, political instability or other issues arising, causing interruptions to international transactions (even relatively short blackouts carry high economic and political costs).

• Changes in the regulatory framework or policies of any country may have a significant impact on electricity availability and price in other countries involved.

• As prices are strongly related to market structure, in order to achieve the objectives of market integration, the market mechanism must be carefully designed so that it promotes the appropriate expansion of transmission capacity.

• The existence of monopolies (especially if they are also vertically integrated) and exclusivity rights may limit cross-border efficiency since they enable transmission operators to discriminate against the access of another party to their system. Again, this would require a good regulatory framework to address abuse of dominance and/or to regulate (state)-monopolies. For this reason, regional market integration is more likely to be resisted by large incumbents or dominant players.33

• A similar question is the incentive of large countries, or countries with a significant natural resource endowment for power generation. There is a risk that large countries prefer not to invest at all in building interconnection capacity, since it is not absolutely necessary for the functioning of their national electricity systems. This may be coupled with a political desire to keep a high degree of autonomy in electricity supply34.

5. Regional market integration in LAC – models of integration

35. To expand cross-border trade the development and availability of interconnection capacity and networks is essential. Transmission lines between countries and regions will have to be installed, or in some cases expanded for the creation of an integrated electricity market to have any chance of succeeding. Insufficient transmission or interconnection capacity can be one important reason for limited cross-border electricity trading. In this context it is important to stress that the increase of interconnector capacity always reduces the absolute price difference between the connected areas.

36. There are different stages of development of interconnection in moving towards cross-border trade and full market integration35:

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33 Note that the opposite also can hold true, i.e; the exporting of market dominance. If a dominant player is active in both sides of the interconnection, increasing interconnection capacity improves the possibility of the use of market power.


1. Systems where national grids operate separately from each other, and only emergency connections exist with neighboring regions (for instance between Mexico and Texas);

2. Systems where electricity flows are more continuous on a day-to-day basis, usually with long-term contracts for back-up services. In this case systems are not integrated, but costs of infrastructure are allocated to each country (this is the case for instance between the Mexican Baja state—which operates separately from the rest of the Mexican electricity grid—and California); and

3. Systems that are integrated and operate as energy pools where the critical problem is the share of the expansion costs of the transnational project (the most successful energy pool being the Nord Pool or the PJM system in the US).

37. Finally, there is a half-way house between stages 2 and 3 above, which is bilateral or "bi-national" power plants operated jointly by two countries, such as the Itaipu Power Plant, jointly operated by Brazil and Paraguay. There are several such examples in LAC, many of which are described in the annex to this paper.

38. Within integrated or trans-border markets, three trading models have been defined\(^\text{36}\): 1) the single buyer model (such as the one that has existed in Mexico); 2) the open-access or third-party model (qualified users in Europe and some part of the US and Canada); 3) and regulatory provisions for non-discriminatory access to the grid by any producers and market players, as in the Nord Pool. In some countries importing and exporting electricity is regulated or buyers and sellers of electricity need a permission which might hamper the development of cross-border trade\(^\text{37}\).

39. The Latin American electricity markets are organised around three major blocks with increasing co-operation within, but also among these blocks:

- **SIEPAC** (Central American Electrical Interconnection System: Panama, Costa Rica, Honduras, Nicaragua, El Salvador, and Guatemala), a genuine attempt at market integration;
- **CAN** (The Andean Community: Bolivia, Colombia, Ecuador, and Peru), moving towards a degree of integration through the Andean Electrical Interconnection System, SINEA; and
- **The Southern Cone** (Brazil, Argentina, Chile, Paraguay, and Uruguay); which is more loosely connected, but has several bi-national power agreements, effectively tying together power generation across borders.

40. The boxes below describe in some detail the SIEPAC, CAN/SINEA and Southern Cone systems. In addition to these regional initiatives, an interconnection project is under way in the Central American isthmus with the Central American Electrical Interconnection System (SIEPAC). This project involves joining up all the electrical systems of the isthmus, including hooking up Mexico via Guatemala, and Colombia through Panama. The Inter-American Development Bank (IADB) has granted funding to cover

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51% of the budget of SIEPAC’s electrical infrastructure (USD 253.5 million) and has offered USD 17.9 million in technical assistance for the development of the Regional Electrical Market (MER). Hence through the construction of various interconnectors the Andean Community is gradually being hooked up to SIEPAC and Mexico in the North, and the Southern Cone in the South, paving the way for further physical integration across the LAC region. However, full integration also requires having in place a sufficient and adequate regulatory regime to ensure transparent trading rules and competitive markets.

Box 2. CENTRAL AMERICA REGION
(Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica and Panama)

The Central American Electrical Interconnection System (SIEPAC)

The six countries of Central America have a population of roughly 40 million people and an energy market equal in size to that of Colombia. The entire region has struggled to achieve a reliable and cost-competitive supply of energy, and it is a net importer of hydrocarbons.

The region’s power generation mix has gone from 66% hydropower, 30% thermal, and 4% renewables in 1990 to 41% hydropower, 47% thermal, and 13% renewable in 2008. The region is therefore increasingly exposed to the volatility of the international oil market as the growing preponderance of thermoelectric generation leads to a dependency on imported fuel and diesel oil. There are currently no natural gas-fired power generation plants operating in Central America38.

In the region, the electric sector and the market structure differ greatly from fully competitive wholesale markets with integrated utilities acting as a single buyer with a monopoly position. The region is divided into six sub-markets, each with different levels of economic development, energy infrastructure and energy preferences. During the 1990s, Central America saw several electricity reforms. Four out of the six countries; El Salvador, Guatemala, Panama and Nicaragua opened their sector to private investments, unbundled the generation, transmission and distribution segments, and opened the resulting markets to competition. Costa Rica and Honduras kept a system based on the state-owned vertical monopoly. But Central America’s electric market has the potential to benefit from economies of scale. Indeed, in the long-term Central America would be best served by having a single regional market.

Incremental progress has been made from the initial reforms in the 1990s to an important regional energy interconnection project, the Sistema de Interconexión Eléctrica de los Países de América Central (Central American Electrical Interconnection System, SIEPAC). A fundamental SIEPAC goal (and challenge) is to set up a regional market and common regulatory system, and the construction of a transmission line from Guatemala to Panama.

SIEPAC was formalised as a system in the Tratado Marco del Mercado Eléctrico de América Central (Framework Treaty for the Electricity Market in Central America) signed in 1996 by the six countries involved.

The project

The transmission line. This is a project to create a regional power grid to interconnect the electric systems of all the countries of Central America involved in SIEPAC. The project consists of 15 substations and 230KV high tension transmission lines that will allow for capacity of 300MW in both directions at the outset, but will also include tower infrastructure to enable a future second circuit. Of the approximately 1,790 km length of the project, the countries of Central America will have the following respective segments of the SIEPAC project: Guatemala: 283 km; El Salvador: 286 km; Honduras: 270 km; Nicaragua: 308 km; Costa Rica: 493 km; and Panama: 150 km. The construction of the line began in 2007 and the project is in its last phase of construction and implementation39.

The regional market and the regulatory system

The Mercado Regional de Electricidad (Regional Electricity Market, MER) is based on the concept of the so-called “7th market”, that is to say a regional market to coexist with the six national markets or systems, to be governed by its own rules, where participants can do regional transactions of electricity. In the MER both markets coexist, the national and the international transactions. At its optimal functionality this would appear to be similar in its function to the NordPool exchange discussed previously.

Three main institutions have been created along with the MER:

- **The Empresa Propietaria de la Red** (Company Owner of the Net, EPR)
  
  EPR is a consortium of private and public companies from Central America, Mexico, Colombia and Spain. It was established in 1998 in accordance with the treaty. The consortium consists of national electricity companies in charge of transmission from each country in the region, and three extra-regional shareholders (Mexico’s CFE, Endesa from Spain and ISA from Colombia).

- **The Comisión Regional de Interconexión Eléctrica** (Regional Electric Interconnection Commission, CRIE)
  
  The CRIE serves as the regulator of the new regional wholesale market and its board is composed by one representative from each country.

- **The Ente Operador Regional** (Regional Operating Agency, EOR)
  
  The EOR is the system operator and acts as an administrator of regional power transactions and its board is composed by two members of each country. The total investment of the project is USD 494 million provided by the countries through the financing from multilateral banks (including USD 240 million from the IADB) plus four items of non-reimbursable technical co-operation from the IADB (worth USD 6.51 million).

### Additional Interconnection projects related to SIEPAC

#### Mexico-Guatemala transmission line.

The goal of this specific project is to create a transmission system between Mexico and Guatemala; promoting the market integration from southern Mexico with the Central America market through the SIEPAC and thereby make the market attractive to private investment.

The electrical interconnection between Mexico and Guatemala consists of a 103km 400KV transmission line (32km in México and 71km in Guatemala) and the expansion of two sub stations, one located in Tapachula, Mexico, and one in Los Brilantes, Retalhuleu, Guatemala. The interconnection allows energy transactions of 200MV. Although it is a bilateral agreement, it has an impact on the MER.

The companies involved in this project are Mexico’s CFE and INDE from Guatemala. The interconnection system has been in operation since 2009.

On 15 September 2010 Mexico and Guatemala signed a contract for the sale of power capacity and associated energy where INDE takes from CFE 120 MW of power with a possible extension up to two hundred MW. On the other hand CFE has the possibility to acquire energy from Guatemala if it is required for a contingency or any necessity.

The entry into operation of the electrical interconnection improved the Guatemalan energy system. The maximum frequency deviations in the Guatemalan system fell to 0.1 Hertz. To date, approximately 150 minor events and 11 events with risk of blackouts have been avoided whenever the interconnection participated favourably to keep the stability conditions.

#### Panama-Colombia.

The goal of this project is to build the infrastructure needed for the interconnection line between these two countries in order to consolidate the regional market integration between the SIEPAC and the South America Region. The project consists of the construction of a transmission line from the Panama II Substation (in the province of Panama) to Cerrromatoso Substation (in the Department of Cordoba in Colombia). The transmission line is going to be approximately 600 km long and will have a capacity up to 400 MV. The project will be developed using the technology known as HVDC (High Voltage Direct Current) which has benefits from the technical, economic and environmental view.

The company **Interconexión Eléctrica Colombia-Panamá** (ICP) is responsible for the project feasibility, construction and operation of the transmission line. ICP is based in Panama and their main shareholders are **Empresa de Transmisión Eléctrica, S.A de .C.V.** (ETESA) from Panama and **Interconexión Eléctrica, S.A. (ISA)** from Colombia. Since the creation of ICP and with the support of the IADB, the company has been working on the viability of the project activities, such as economic, financial, viability, basic engineering, environmental and social studies and developing the business plan.  

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Background

One of the achievements of the Andean Community (CAN) to date in energy has been in the area of electrical integration. For example, in 2002, Colombia, Ecuador, Peru, and Venezuela established a framework for electrical interconnection and exchange. While the framework was met with early success, disagreements reportedly arose, particularly regarding the division of (surplus) income when network congestion created inflated prices. In August 2009, the framework was suspended; however, a transitional regime was put in place between Colombia and Ecuador, and between Ecuador and Peru, and by the end of 2013 there was reportedly interest in establishing a new framework.41

Andean Electrical Interconnection System, SINEA

Taking integration further and enhancing electrical energy trading among the Andean countries, the Sistema de Interconexión Eléctrica Andina (Andean Electrical Interconnection System), SINEA, was formed in April 2011. The efforts of SINEA were bolstered on September 27, 2012, when energy officials representing Chile, Colombia, Ecuador, Peru, and Bolivia (as an observer) signed the Santiago Declaration, affirming their commitment to regional electrical integration and improved electricity exchange. These countries have pledged to work towards a new framework for exchange of electrical energy in the Andean region.42

Interchange of energy between Colombia, Ecuador and Venezuela

Colombia and Ecuador trade energy through the TIEs (international electricity transactions scheme) through short-term spot transactions. The vast majority of transactions are energy transfers from Colombia to Ecuador, due to lower marginal costs of production in Colombia.

Venezuela has two interconnection lines from Colombia. The first transmission line covers contingencies in the Caribbean area; whereas the second is reportedly in use under a bilateral contract between players of the two countries were Colombia makes the sale of energy and power to Venezuela. Since September 2008 electricity trade between Colombia and Venezuela have amounted to a daily export average of 2.5 GWh.43

MERCOSUR

Mercosur is composed of Brazil, Argentina, Paraguay, Uruguay and Venezuela, while Chile and Bolivia are associate countries. The member countries of MERCOSUR have interesting experiences in electrical interconnections which have traditionally been associated with the development of bi-national hydroelectric projects on rivers that are part of their common borders such as Salto Grande, Itaipu and Yacyreta (see the annex for more description of the existing bi-national agreements).

One of the most important decisions of MERCOSUR on electrical interconnection is the MERCOSUR / CMC / DEC Decision No.10/9844 in which the following agreements were reached:

- Ensure competitive generation market conditions, avoiding subsidies and discriminatory practices, with prices that reflect the real costs,
- Distributors, marketers and large consumers located in any Member State of MERCOSUR, can contract freely their sources of supply.

44 http://www.sice.oas.org/trade/mrcsrs/decisions/DEC1098.asp (in Spanish only)
Allow the purchase and sale of electricity freely agreed between buyers and sellers according to national legislation and within existing international agreements, without applying restrictions.

Respect the principle of free access to transport network including international interconnections, without any discrimination and forcing users to pay the regulated network fees.

There are 15 international interconnections between member countries, including Argentina and Chile. The first of them as already noted, are associated with the development of large bi-national hydroelectric projects; however over time there have been others that are not necessarily linked to these projects.

**Argentina-Uruguay**

The interconnection between Argentina and Uruguay has been in operation for almost 30 years. It has its legal basis in the Energy Interconnection Agreement signed by both countries in 1974 and its Implementation Agreement signed in 1983, and a bi-national entity: *La Comisión de Interconexión* (The Interconnection Commission) which administrates the operations and ensures compliance with the agreements.

After the restructuring of the electricity sector in Argentina, both countries have adopted new commercial agreements which include allowing open access for the transit of energy produced by third parties (Brazil and Paraguay).

Of all the interconnections currently in service in the MERCOSUR, the more relevant for its volume of transactions is the one that connects the city of Santa Maria in Argentina with Ita in Brazil, which consists of a double circuit line 500 kV, with a capacity of transport of 2,000 MW and a frequency converter unit, as the two countries work with different operating frequencies.

The lines became fully operational in 2000 supplying electricity from Argentina to Brazil using natural gas for generation. There is another transmission line connecting an Argentinean 600 MW combined cycle power plant (Provincia de Salta) to the Chilean *Sistema Interconectado del Norte Grande de Chile*.

41. As the examples above illustrate, the LAC region has made great advances in interconnection, both regionally (especially in SIEPAC), but also bilaterally, especially in the Southern Cone. Within SIEPAC and in CAN, competition is actively promoted, and the national electricity sectors are (at least partly) privatised, a contributing factor for successful cross-border trade. SIEPAC is by far the most advanced of the markets, and has been operating commercially since 2013. As such it has provided electricity to the member countries’ national grids during local power shortages. An important milestone was achieved on 1 June 2013, when the regulatory framework of the Central American Regional Electricity Market (MER) entered into effect, providing the impetus for regional exchanges of electricity and stimulating private investment in the sector.

42. To illustrate the usefulness of an integrated market, when Panama’s hydroelectric dams were depleted due to prolonged drought in 2013, it was reportedly able to rely on the SIEPAC network to import substantial quantities of electricity generated in Central America, thereby stemming a potential energy crisis.

43. Most noticeably from the discussion above is the absence of an overarching regulatory framework, apart from that which exists in SIEPAC. The other regional projects are governed by treaties and declarations, but no formal regional regulatory institution appears to be in place. As such, the existing systems are more akin to simple cross-border trade, than more formal integration of markets, similar to the existing cross-border agreements in North America (see box). Despite bilateral intergovernmental agreements which have established strong links between several electricity enterprises in the region frequent power shortages continue to occur across the LAC region, indicating that all the conditions for successful integration are not as yet in place.

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Box 4. Examples of cross-border trade in North America

There is co-operation in North America between the US and Canada, and between Mexico and the US. The NAFTA agreement sets up the legal framework for the constitution of an integrated electricity market in the North America Region. However, so far the scope of the market integration is limited to bilateral agreements between the US and Canada and the US and Mexico.

The transmission infrastructure among these three countries is not well integrated. The electric system in the North of Mexico is poorly connected with the Southern region, while in the US the three existing electric systems within the North American Electric Reliability Council have limited capabilities of interconnection among them; also these systems are incompatible with the Mexican electrical system.

There are strong differences between the regulatory frameworks in these countries. In Canada, the provincial governments are the owners of the vertical integrated monopolies and control the transmission lines to export, while in the US they are mostly investor-owners utilities, most of them vertically integrated and ruled by the state regulations that fix the prices for the use of transmission and distribution lines. In Mexico, before the energy reform of December 2013, the former state monopoly Comisión Federal de Electricidad (CFE) controlled the generation, transmission and distribution of electricity.

The interchange of electricity has been more active between the US and Canada. The US exports 0.4% of total generation while for Mexico this figure only represents 0.04%. Canada exports to the US on a regular basis 9 or 10% of his total production¹. In 2010 the two latter countries decided to discuss the creation of a bi-national “Electricity Task Force” to explore the obstacles and opportunities of a more tightly integrated network for electricity trade, but after that the initiative has been neglected, since electricity was de-prioritised by both administrations.


6. Requirements for successful regional market integration

As we have seen, development towards regional market integration varies both in the degree of integration and in the concepts or instruments being used. Different market models and legal and regulatory examples can be used, as well as a large variety of organisational, technical and procedural models. Successful regional integration therefore requires a wide range of conceptual analyses and decisions, such as:

- choice of the type of integration (such as market coupling or market splitting);
- full mapping of network capacities, including the use of transmission capacities;
- transition towards co-ordinated allocation of cross-border capacities; including
- the establishment of regional balancing markets and regional exchange of reserves;
- the choice of a pricing model, such as nodal or zonal pricing;
- market modelling, economic analysis, including demand forecasts; and
- risk management.

In this section, we will look at some of the requirements for putting in place adequate infrastructure, before looking at structural policies, pricing issues and market regulation for integrated markets. The final part of the section will briefly discuss the impact on retail competition from market integration. Regional integration certainly requires first of all a political decision. For this paper, we will assume that the governments of the LAC region are willing to commit to regional integration, setting aside any political issues that may interfere with the process. To incentivise the market players, be they power generators, system operators, utilities and end-users, as well as investors, the various regional systems need to evolve to encompass a clear set of rules, and to provide the right pricing incentives. This section focuses on the necessary elements for regional integration to be a meaningful pursuit for everyone concerned.
6.1 Ensuring sufficient investment in generation capacities and in physical interconnection

46. Building interconnections and distribution networks is costly. It is also a prerequisite for any market to exist: Electricity is transported via power lines and if there is no physical connection between two regions, then those markets cannot interact unless they are indirectly connected via another region. Interconnector networks are needed to allow cross-border electricity trade, stimulate competition (reduce market power) and connect different energy sources to the national grid, including renewable ones. If there is agreement and political will to establish closer co-operation between countries, one of the main questions then becomes the financing of the construction of necessary infrastructure, since it involves huge fixed and sunk costs. This includes the need to establish the mechanisms to deal with the free-rider problem, as some countries may benefit from new transmission infrastructure without contributing financially to the construction. International organisations and development agencies have a role to play here, to co-ordinate the financing of such investments and to incentivise co-operation – this role is played in Europe by the EU. In a typical chicken-and-egg fashion, a large, integrated and more predictable market, once established or credibly planned, will also be more attractive to private investors.

47. Having sufficient transmission capacity is not only an LAC problem. In many liberalised electricity markets the investment in transmission networks, especially in interregional transmission capacity, has not kept pace with the expansion in demand, generating capacity or the volume of wholesale trade. This has led to an increase in congestion on the transmission networks, leading to the emergence or re-enforcement of existing market power. The lack of adequate transmission investment is also a problem in Chile according to Joskow. Lack of investment was similarly a problem in Brazil after liberalisation, but the authorities learned their lesson from the supply crisis. Subsequently, they changed to a more auction-based system to ensure adequate extensions of the grid. Electricity distribution networks (grids) are equally demanding, being highly capital-intensive systems that require regular investment to maintain, upgrade and expand the assets to ensure the long term reliability of supply.

48. Investing in renewable energy, cleaner sources of generation and wider energy efficiency programmes is also vital to the long-term sustainability of the power system, and has become a political priority in a number of LAC countries. An interesting undertaking can be seen in the Chilean market concerning the establishment of new generating hydropower plants by the two largest generating companies in Chile (Colbún S.A. and Endesa S.A) within the framework of the HydroAysén joint venture project to share the risks and costs of the establishment of new power plants.

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46 By ‘question of financing’ we mean who (which country, and which private or public investor) and in what proportion provides the necessary monetary sources for the construction of the physical interconnection between two countries’ electricity grid.


48 This increasing congestion can be a hurdle to the further development of efficient competitive wholesale markets for electricity (World Bank, 2010).


49. There are different ways to ensure the optimal expansion and operation of a public service infrastructure:\footnote{Araújo, S., Sutherland, D. (2010), ‘Public-Private Partnerships and Investment in Infrastructure’, \textit{OECD Economics Department Working Papers}, No. 803.} either through full public provision in which case the asset is built using a public procurement process, financed by the government and managed by the public sector, or through full private provision of the asset, where a build-own-operate contract can be established with a private contractor. Many power stations are built on this model. Another model is the concession, where the concessionaire operates and finances the maintenance of the asset, but is not involved in construction. The infrastructure remains in public hands throughout the contract and the private operator pays for the government to operate the system. Finally, the government might want to enter into a public-private partnership (PPP).

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\textbf{Box 5. Public-Private Partnerships as a driver for investment in electricity infrastructure} \\
Evidence shows that PPP\footnote{PPP agreement is a long term (on average 30 years) contractual relationship between a public institution and a private firm for the construction and operation of infrastructure, where the private party is reliable for the financing of the construction and maintenance of the infrastructure and service provision in exchange for long term regular payments by the government. The asset is typically owned by the private party.} investments have successfully been applied in OECD countries to provide investment in public infrastructure services. The involvement of private capital can be especially beneficial in the case of large, long-term and expensive infrastructure projects in markets where supply and demand conditions or technology do not change fast. In the electricity sector PPP consortia can be used especially to provide investments in generation, transmission systems or interconnectors\footnote{While transmission investments are necessary to connect generation (power plants) with the distribution network; investing in interconnectors – though they would be very important for the expansion of regional integration – is not indispensable for the functioning of the electricity system.}.

Private sector involvement in a public service has several advantages, among them the know-how and technical expertise, innovative approaches and managerial abilities to co-ordinate the building and maintenance of the infrastructure; financial expertise and better risk management brought by private firms, the introduction of competitive pressure and in the best scenarios a reduction of pressure on the state budget. PPP agreements usually bundle the construction and operation. PPPs are best suited when there is a positive externality between the construction and the operation phase that gives an incentive for the private party to internalise operational and maintenance costs on its investment decisions during the construction phase and take into consideration the asset’s long term performance. Evidence shows that PPP investments have been successfully employed in the case of roads, bridges and prisons, while they have had negative outcomes in the information and communication technologies sector (ICT). For hospitals and schools, the evidence is mixed.

However this focus on the alleviation on budgetary pressure can give the wrong incentives to choose the PPP model. Hence a thorough cost-benefit analysis is essential before making a decision on the financing of an infrastructure project. To decide on whether to make a PPP agreement or to use other methods for financing an infrastructure investment, the following should be considered\footnote{Araújo, S., Sutherland, D. (2010), ‘Public-Private Partnerships and Investment in Infrastructure’, \textit{OECD Economics Department Working Papers}, No. 803.}:
\begin{itemize}
  \item A thorough cost-benefit analysis to see whether a PPP agreement is more advantageous compared to traditional procurement.
  \item Determining the appropriate size of projects in order to minimise transaction costs (PPP is inappropriate for low-value projects).
  \item Identifying the most efficient bidder\footnote{It implicates for example allowing international companies or consortia participating in tenders to increase the number of bidders in order to reduce the probability of collusion.} and allocating the risks effectively and properly between the parties\footnote{This is especially important since the public party bears significant risk being the provider of last resort.}.
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• Determining the proper length of the contract that needs to provide a sufficient stream of revenues for the private partner in compensation for their investment, but that does not incentivise overinvestment. In sectors where demand risk is low contract length should be longer, while in sectors where it is hard to forecast demand conditions it shall be shorter.

• Tendering: in PPP, the number of bidders is limited owing to the complexity of the project, which makes collusion easier among bidders. Measures should be taken to prevent bid-rigging.

• Pricing policies should reflect investments needs (especially in case of gas and electricity sectors). They should be able to compensate the private party for its investment throughout the concession period, without creating incentives for over-investments. Ensuring the verifiability of quality and setting output specifications to improve quality both during the construction and operation phase.

50. The involvement of private capital is however one of the best forms of ensuring increased generating capacity and network expansion. The key factors affecting private investors’ decisions to enter in electricity transmission and generation are:

• The existence of sectorial regulatory governance and an independent regulatory agency to ensure reliability, transparency and predictability in regulatory and environmental policies;

• The existence of economy-wide governance factors (including measures to control corruption and political influence);

• The introduction of renewable capacity in the power system can also attract private investment (countries that have integrated renewable energy in their systems are more likely to attract PPPs in electricity transmission and distribution, typically because these energy forms benefit from more favourable tariffs (such as feed-in-tariffs), or state subsidies in the start-up phase); and

• A sufficiently large market and an “affordability” level for consumers.

51. To grant a level playing field for private enterprises and investors, governments must ensure that they do not use their power opportunistically to favour their own companies or otherwise powerful incumbents. It is also important to build up strong and complementary institutions to ensure the enforcement of the rule of law, such as a credible judicial system, competition authorities, and other adequate policy bodies. Regulators have a key role to play in overseeing transmission systems, as transmission systems such as interconnectors are natural monopolies, and hence tend to remain under state or (independent) regulatory control. The regulatory framework and the pricing rules should incentivise the building of interconnectors with the use of private capital.


58 It might be remarked that countries where electricity remained in the hands of the state have sometimes equal or better penetration than those countries that privatised the sector. One explanation for that can be that private firms are sometimes not incentivised to invest in market expansion in rural areas and/or unprofitable localities. (The latter was also the reason for nationalisation of electricity markets in many countries between the 1930’s and 1960’s.)


6.2 Structural policies – separating competitive and non-competitive elements

52. Integrated markets are more likely to succeed if they are competitive. The IEA points out that the first requisite to introduce competition in the electricity sector is to separate or unbundle the natural monopoly network activities from all other activities. The discussion goes on to say that if an incumbent generator or a retail company maintains control over an affiliated network and can exclude or limit access to that network by competing generators or retailers, the network monopoly can be extended to an effective monopoly in the whole value chain. The question should therefore be asked whether the competition authorities in the LAC region would consider imposing structural separation of electricity companies across the board as a prerequisite for integration, as a competition-enhancing policy. The IEA (2005) is quite unambiguous on this point: it states that "transmission and distribution networks must be operated independently of generation and retail. While it might seem possible to slowly tinker with a vertically integrated industry in small steps, in fact, the very first step towards building a competitive market is the big step of deciding effectively to unbundle." The division of an integrated company into its competitive and non-competitive parts is known as structural separation and forms a central element in the OECD Recommendation on Structural Separation in Regulated Industries (2011).

53. To optimise the chances for the emergence of competitive markets, such unbundling should therefore focus on enhancing competition among generators, and at the retail level. The OECD 2002 Roundtable points out that the regulator should focus on separating unconstrained generators, especially when the unconstrained generators have similar marginal costs (for instance if they use the same fuel source). Structural separation should also and especially focus on the separation of generation and transmission. The main challenge is to ensure that all generators have equal opportunity to feed into the transmission grid, and all consumers share the same ability to extract electricity. For instance, the main competition to a generator in a specific geographical area may be an outside generator via a transmission cable. Hence the control of a generator over a transmission link may give it control over its main rivals. Within the European Union, the guidelines agreed at the European Regulatory Forum seek to promote non-discriminatory use of transmission lines, especially in the case where financial transmission rights are enhancing the market power of generators. The logical step is thus to separate generation and transmission. As discussed by the OECD (2011), the crux of separation is not merely a wholesale/retail divide; rather, the objective is to isolate those assets that cannot be replicated and are considered natural monopolies from generating and trading activities.

54. The separation can take a variety of forms, from behavioural to structural measures. Accounting separation constitutes the weakest form of separation available, and ownership separation the strongest. In between these two extremes, there are a number of functional/operational separation options: creation of a

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62 There is however often information-asymmetry among market participants and the regulator, so the dialog among market participants (or an independent, competition oriented monitoring agency) and the regulator shall be promoted to compensate for such asymmetries.


64 Ibid.

65 See footnote 62.

66 On 26 April 2001, the OECD Council adopted a Recommendation concerning Structural Separation in Regulated Industries. It calls for governments to consider structural separation, in particular the pros and cons of separating the structure of a regulated firm's activities. Two reports on countries' experiences with structural separation were compiled in 2006 and 2011, leading to a revision of the recommendation in 2011. See: www.oecd.org/daf/competition/recommendationconcerningstructuralseparationinregulatedindustries.htm

67 See also the section on pricing issues and FTRs.
wholesale division; virtual separation; business separation; business separation with localised incentives; business separation with separate governance arrangements; and legal separation involving separate legal entities under the same ownership. However, Hilke (2001) points out that "independent, non-discriminatory control of grid access and connection standards is a fundamental element of effective competition", and (...) "behavioural rules are not sufficient to promote non-discriminatory grid access".

6.3 The system operator

55. When the electricity markets are unbundled, the non-competitive parts are usually brought under the management of a system operator, and subject to strict regulation and/or state control. Centralised system operation is a necessary natural monopoly which must also be fully independent of generation, trade and retail. In Ireland, for instance, the northern and southern electricity markets were integrated into a Single Electricity Market (SEM) effective 1 November 2007. Prior to integration, the incumbent operator in the Republic, ESB, was restructured into "heavily ring-fenced business units". These business units primarily covered ESB Power Generation (PG), ESB Networks, (which owns, but does not operate the transmission network and is both distribution network owner and operator), and ESB Customer Supply. In addition, ESB National Grid became a legally separate entity, EirGrid plc, which took over the role of transmission system operator (under the ISO model) in July 2006.

56. More generally, a central body for system operation will manage the interface between the market processes and the actual physical outcomes, especially the balancing of supply and demand in the whole electricity system. Effective operation of the system therefore is an indispensable part of the financial incentives in a liberalised market (IEA, 2005). Note that this management of real-time supply and demand balance means that the system operator delivers something akin to a public good. The response to this in a liberalised market with rational actors is to commit individual actions in advance (forward markets) and meter the outcome to ensure fulfilment. The system operator therefore must have full overview over consumption and generation, and this can only be achieved through an extensive set of rules for how generators, retailers, traders and consumers must interact with the system, also known as regulated third-party access (Europe), or open access (US, Australia).

57. The system operator function may be owned by the transmission grid company, or may be fully independent. They are often wholly or partly owned by state or national governments. If the sector has been unbundled, they will be independent of electricity generation companies (upstream) and electricity distribution companies (downstream). They are financed either by the states or countries or by charging a toll proportional to the energy they carry. Note that despite regulation, it is impossible to prescribe rules for every action taken by a system operator (IEA, 2005). Therefore system operators still maintain certain discretionary powers, regardless of careful efforts to regulate grid access.

58. The system operator is required to maintain a continuous (second-by-second) balance between electricity supply from power stations and demand from consumers, and also ensure the provision of reserves that will allow for sudden contingencies through the management of ancillary services. In addition to its roles of real-time dispatch of generation and managing security, the system operator also carries out investigations and planning to ensure that supply can meet demand and system security can be maintained during future trading periods. Examples of planning work may include co-coordinating generator and

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transmission outages, facilitating commissioning of new generating plant and procuring ancillary services to support power system operation.

59. Deciding how to tackle the system operator function in the integrated markets remains to be settled in LAC. The IEA points out that co-operation between neighbouring systems operators is critical to the development of trade between neighbouring jurisdictions. Such development is only likely to take place if the involved system operators all have incentives to co-operator. In the US, the Federal Energy Regulatory Commission (FERC) has defined Regional Transmission Organisations (RTO) and Independent System Operators (ISO). Independent System Operators resulted from the Commission suggesting the concept of an Independent System Operator as one way for existing tight power pools to satisfy the requirement of providing non-discriminatory access to transmission. Subsequently, the Commission encouraged the voluntary formation of Regional Transmission Organisations to administer the transmission grid on a regional basis throughout North America (including Canada). 70

60. As part of a wider structural separation effort to enhance competition, the regulatory authorities in the LAC region will therefore need to define regional system operators. That said, negotiations about the rules and principles for cross-border trade can take place between policy makers and regulators, but the day-to-day co-operation will be managed by the involved system operators. For the establishment of an effective market with a truly level playing field and effective co-operation across jurisdictional borders, it takes fully independent and effectively regulated system operators (IEA, 2005). In the US, an RTO is required to be independent of any market participant; it must serve an appropriate region; must have operational authority for all transmission under its control and it must have exclusive authority for maintaining the short-term reliability of the grid it operates. In addition, an RTO has functions such as tariff administration and design, congestion management, parallel path flow, ancillary services, market monitoring, planning and expansion, and interregional co-ordination, in addition to the management of total capacity in its markets.

61. In LAC to date, there have only been a few cases of structural separation in the electricity markets. Chile, as the first country in the world to liberalise its electricity market, continues to be regarded as a successful example of electricity market reform. 71 Structural unbundling took place early in the liberalisation process. The Chilean OECD delegation reports that, under the reforms, the largest state-owned vertically integrated electricity company, Endesa, was split into 14 companies: six generation companies, six distribution companies and two vertically integrated electricity companies serving isolated areas in the south. Chilectra, the second largest state-owned electricity company, was similarly separated into a generation company and two distribution companies. These unbundled companies were subsequently privatised, and generation, transmission and distribution infrastructure in Chile remain entirely privately owned. However, since then, vertical re-integration has also occurred, so that some generators now also own transmission and distribution assets. 72

62. The Chilean OECD delegation goes on to say that despite its success in electricity market reform, Chile has faced a number of challenges, affecting market performance. Severe droughts have reduced

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70 See also the website of the FERC: [http://www.ferc.gov/industries/electric/indus-act/rto.asp](http://www.ferc.gov/industries/electric/indus-act/rto.asp)


hydro generation capacity (Chile's main source) while gas imports from Argentina have been curbed, which has had a similar effect on generation. Concerns have also been raised about market power, owing to the continuing high concentration in the generation sector as well as the lack of independence of the transmissions system operators from other market actors.  

6.4 Pricing issues

63. Generators, traders and retailers meet in the market. If the conditions and products are standardised and well defined, market players have only to agree on the price. Thus transaction costs will be kept at a minimum and the price becomes the signal that directs all actions, linking all decisions. If the prices reflect the real values at stake and if incentives are right, the resulting actions will lead to efficient outcomes. The problem with electricity is its nature, and the fact that consumers nonetheless expect electricity to be delivered in a timely, stable and reliable manner. At the same location, demand fluctuates wildly, over the course of a day (even hourly), and in a year. In addition, supply and transport capacity are variable, and the cost of generation is strongly dependent on its source which may either be subject to swings in international market prices (hydrocarbons), or depend on the climate (hydro and other renewable sources).

64. In a competitive market, prices are based on marginal bids. Some technologies have very low short-run marginal costs (hydro and wind power, and nuclear power); thermal power tends to have higher marginal costs. The problem is that short-run marginal costs (which determine competitive prices) only compensate a fraction of the long-run marginal costs. For nuclear, hydro and renewable energy, the largest share of costs is from the initial investment. This means that those technologies only recover investment costs during those hours when the market price is determined by other resources with higher short-run marginal costs. Each technology has its own price considerations, and we will not discuss them here. However, these will determine if a plant will be used for base-load or peak-load generation. For instance, the profitability of a plant intended for peak loads relies on payment in the very few hours of annual operation that compensate for both variable and fixed costs. In other words, such a plant relies on a scarcity rent in order to be profitable. Other pricing constraints may be imports, a price cap or the willingness or ability of consumers to modify their consumption. Finally, there are also costs involved in transportation of electricity. Prices that reflect the real costs of generating, transporting and consuming electricity should therefore also account for the costs of networks and network losses. In many electricity markets, including in the LAC, this is not currently the case.

65. The expectation of market-driven reforms was to increase the transparency of the market and to better reflect the real cost of generation and transport in the prices; but also to see a reduction in electricity prices thanks to competition, while reducing pricing distortions such as cross-subsidisation. The problem is that for many, especially developing countries, electricity prices have been kept artificially low through state subsidies to the sector, not covering the prices of electricity generation and supply. In these cases, liberalisation and market integration will and should lead to higher consumer prices.

66. Hence many countries still apply price regulation in order to ensure the “affordability” of electricity, which is also a highly political issue. As a consequence in some countries electricity prices remain too low to cover costs and support system expansion through private investment, and the sector still suffers from persistent cross-subsidisation among domestic and industrial customers. In those case prices do not provide correct signals to market players and being artificially low will result in a lack of new network investments, which are crucial for energy safety and the proper operation of networks. This results

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73 Ibid.
in a vicious circle in some places of poor infrastructure and a lack of private interest in investing in upgrading the system.

67. There are different regimes to ensure the “affordability” of electricity supply, for example:
   - price regulation: default tariffs (France), price caps (Slovakia)
   - targeted regulation (the concept of vulnerable consumers, UK)
   - through competition: no regulation (the Nordics; Czech Republic)

68. Note that if the last option was not deemed to be feasible by a state, however, from a competition point of view direct subsidies to consumers would be the least distortive way of solving the “affordability” problem.

69. Some Latin-American countries (Argentina, Chile, El Salvador, and Peru) have introduced performance based regulation for setting multi-year tariffs and monitoring compliance with service quality standards by distribution companies.

70. The conditions and costs of electricity supply can differ within a country as well, so applying unified price regulation can distort supply conditions among different regions of a country. This has been solved in some countries, such as Sweden, by so-called market splitting, fragmenting markets into different pricing areas that better reflect the generation and transport cost of electricity, and the prevailing demand conditions in the market.

### 6.5 Congestion management

71. All locational pricing gives incentives to trade. Two neighbouring areas with different prices will see a net benefit from trade. In general, these benefits will be on the consumer side in the high price area and on the generating side in the low price area. But the distribution of benefits will also depend on how the trade is organised. In the US access to this revenue is called *financial transmission rights* (FTR); in Australia this is called *settlement residue*, and in the Nordics it is known as *congestion rents*. A first pre-requisite for realising the benefits is the act of linking the two areas with a transmission line (discussed above). The owner and manager of this line becomes the "gate keeper" and acquires the potential power to collect (all or some of) the benefits. The actor who controls the flow will be able to collect the price differential. How to allocate the FTRs that arise in Lac will be a crucial part of moving towards market integration.

**Box 6. Financial Transmission Rights**

FTRs provide two main opportunities: market players can use them to hedge for risks associated with price differences between areas; and FTRs can provide a signal to the market for efficient investment in new transmission capacity. In the US, the PJM allocates the FTRs to transmission owners, holders of old contracts and builders of new transmission capacity. The owners of the FTRs can in turn use them to hedge for price differentials in bilateral trade, or they can trade the FTRs directly. PJM conducts yearly and monthly FTR auctions.

In the Nordic market, the Transmission System Operators (TSOs, the Nordic system operators) grants the Nord Pool a monopoly to all available transmission capacity between price zones for the day-ahead trade. In other words, all the FTRs are allocated to Nord Pool which collects the congestion rent. It is up to the TSOs to manage any deviations between the transmission capacity made available for trade, and the actual physical transmission. Following the trade, Nord Pool allocates congestion rents to the Nordic TSOs, who own Nord Pool, according to a formula. Note that the TSOs are bound by the EU regulation on network access for cross-border exchanges. This stipulates that congestion rents can be used for three purposes: to guarantee actual availability of allocated capacity through out-of-merit order dispatch; to network investment; and as a part of the regulated income base which must be taken into account when network tariffs are regulated.
72. Price regulation can also affect regional market integration. If prices differ significantly among (neighbouring) countries it can lead to cross-subsidisation between countries in the regional market. Finally, the pricing structure must also provide sufficient incentives for generators to want to enter the market, but without excluding some consumer groups.

73. Price structures vary significantly from system to system. Many countries (among them most European countries) constitute single price areas, so borders of a country usually are identical to the price zones (although in some case, as in Sweden, the ISOs have fragmented the markets to let prices reflect market conditions in order to deal with congestion issues). Problems can occur when neighbouring electricity markets have different prices. There is a rationale though for differing price zones. The aim of the EU is the creation of a single European electricity market by fostering regional market integration; however the European Commission admits that market splitting can create a level playing field for industrial customers in the EU, since different price zones reflect the true market conditions and send the proper signals to the market, thereby leading to more homogenous conditions in the long-run.

74. In the EU cross-border congestion management is regulated at the EU level, while transmission system operators are free to choose their methods to deal with internal congestion. On a national level there are usually three ways for network operators to handle internal congestion: 1) by market splitting; 2) by congestion shifting; 3) by counter-trading (it means the network operator affects consumption patterns of market participants on both sides of the congested line by taking actions on the balancing market75). Congestion shifting (which means reducing trading capacities with neighbouring markets/countries) is prohibited in general in the EU, because it reduces cross-border transmission capacities in favour of national network users, but it can be justified on grounds of operational security, cost-effectiveness and the minimization of negative impacts on the internal electricity market.

75. In LAC, the high cost of electricity remains an important issue. Estimates place the wholesale price in Central America at around USD 150 per megawatt-hour compared to USD 50 for other, comparable systems—making it three times as expensive. With SIEPAC fully operational, a significant reduction in that cost is anticipated for both households and business users, along with increased security and greater reliability, according to the IADB.

76. These advances are expected to occur on various fronts. SIEPAC and MER will enable the development of larger and more efficient regional generation projects, while also facilitating the preparation of a larger number of renewable energy projects, traditional and non-traditional, thus contributing to a diversification of the regional energy matrix. The system is also expected to allow countries to reduce their need to maintain reserve capacity, leading to additional savings.

77. This suggests that regional market integration can be successful with integrating differing price zones in one market, but prices should be set carefully not to send wrong signals to transmission operators and investors.

6.6 An appropriate regulatory framework: Market power mitigation

78. The rules governing the operation of the electricity market will have a substantial impact on the incentives of the market players. This was borne out by the early experience of the joint electricity market between England and Wales in the 1990s. Biggar (2002) quotes Wolak and Patrick who point out that the market structure and the details of the market rules governing its operation will determine whether or not the market “will deliver benefits to consumers in the form of lower electricity prices”.

75 For example it pays generators on the surplus size to reduce their production, while generators on the other side of the bottleneck are paid to generate more.
They go on to say that "Subtle differences in the rules of the market can dramatically enhance the ability of generators selling into the market to set prices substantially in excess of the marginal and average costs... [T]he rules governing the market can present opportunities for the large producers to exploit their market power and many of these modes of exercising market power are subtle, but high-powered in the sense that they can yield high rates of return. These strategies can be difficult to detect and even more difficult to correct."  

A key concern for an integrated market will therefore be how to deal with market power. Although regional integration is supposed to be a remedy for market power (as it has proven in the Nord Pool), over time and once capacity becomes constrained, or transmission links are found insufficient to alleviate congestion, market power is likely to rear its head.

The OECD has discussed some of the factors that should be chosen for appropriate market design of a wholesale electricity market (WP2 Roundtable, October 2002) to help mitigate market power. These factors include: a) whether participation in the market is compulsory or bilateral trades are allowed; b) whether demand-side bids are allowed; c) whether bids are simple prices and quantities or include other terms such as plant flexibility; d) whether prices are calculated ex-ante (and the basis of forecast demand and supply) or ex-post (on the basis of actual demand and supply); e) whether bidders are paid on the basis of their bid (pay-as-bid) or on the basis of the market-clearing price; f) whether or not there are special payments for capacity availability; and g) whether or not bids are firm or non-firm.

Conlon (2009) discusses the response used in Ireland's integrated market where the regulatory authorities developed a market power mitigation strategy to prevent the abuse or distortion of the market by dominant players as part of the development of the single electricity market (SEM). The major focus of the market power mitigation strategy has been the imposition of Directed Contracts on all generators with a significant level of market power, the imposition of a licence condition on generators to adhere to a bidding code of practice and the establishment of a Market Monitoring Unit to monitor participants’ bidding behaviour. The directed contracts mandate that generators with a significant market share must enter into forward contracts with suppliers (i.e. the buyers of electricity) for a specified volume at a price based on a pre-determined formula. It is the aim of the directed contracts to reduce the market power of those generators so that capacity is not withheld, nor bids submitted above competitive levels to affect prices. ESB Power Generation and NIE Public Procurement Board (a subsidiary of the Viridian Group) have been mandated to enter into directed contracts. Participants may also enter into Non Directed Contracts. Both sets of contracts are financial in nature, known as Contracts for Difference and are used as a means to hedging price exposure in the pool. Both sets of contracts are auctioned quarterly.

Other policies to mitigate market power will be necessary in an integrated market, including policies to promote entry, policies to promote the use of long-term contracts and policies that make adequate use of public ownership as a tool to balance the market. The difficulty in designing the regulatory framework for an integrated market in LAC resides partly in the fact that there is no uniform framework for implementing reform in the electricity sector (in many countries reforms are still incomplete, sometimes moving backwards). There does not appear to be any established ‘best practice’ either, since electric power systems vary significantly in size, structure and resources (hydroelectricity, wind, geothermal energy, nuclear energy, coal, oil, gas and biomass for instance) making the comparison and

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77 Market oriented reforms can have significant benefits, but it is important to remark that incompletely or incorrectly implemented reforms can result significant potential costs and lead to performance problems.
transfer of experiences of sector reform and regulation more difficult. That said, the three most common components of the “textbook model” appear to be:

- vertical separation or unbundling of the potentially competitive segments from the natural monopoly segments as discussed above;
- privatisation (private ownership of the competitive segment as was done in Chile, for instance);
- the creation of (ideally) powerful new institutions in the form of independent regulators and regulatory agencies; and
- ensuring that the regulatory authorities, whether the market regulator or the competition authority, be given sufficient power and independence to be able to intervene in the markets to prevent dominance (ex-ante) or to impose remedies (ex-post).

84. The rationale behind the creation of independent authorities lies in the attempt to insulate regulators from political interference aimed at influencing the conduct of regulated firms, their investment or employment decisions or price setting processes, particularly when the government has ownership stakes in electricity.

85. There are considerable differences in the extent of independence of regulatory and competition authorities across countries, including LAC. In many countries inadequate attention has been paid to create good regulatory institutions. However, the attractiveness of a market tends to increase if it is well-regulated. The credibility of the regulator tends to be enhanced if it is independent both from the government, and from the market players; similarly the regulatory framework is more credible in countries where an independent regulator exists. Empirical evidence suggests that developing countries face higher opportunity costs in establishing effective regulatory agencies relative to market size, compared with developed countries. Finally, if tariff setting remains in the hands of the central government, it limits the effective decision making powers of regulatory authorities.

86. In LAC the vast majority of countries have established a separate regulatory body for the electricity market, with varying degrees of independence from government. The institutional design of these electricity agencies varies. While the majority resemble the US-style system of governance by independent commission, others are different. For example, Chile and Colombia have adopted models that divide regulatory responsibilities across two agencies, one carrying out regulatory functions (National Energy Commission) and one in charge of enforcement, including sanctions and the monitoring of service quality standards (Superintendencia).78

87. All the agencies have decision powers on tariffs, with the exception of Mexico, Chile and Uruguay.

6.7 Retail competition

88. It is vital that consumers also reap the benefits from liberalisation in the electricity market, and from market integration. The IEA stresses that “effective retail competition creates a natural protection for consumers. Retail companies under pressure from competition may develop innovative contracts and

products that create even more added value from liberalisation. Nonetheless, retail competition is more challenging to install in the market place than upstream competition. Installing the necessary infrastructure to make retail competition feasible (such as the local loop), may be more costly than the benefits it can reap in the short term.

89. The IEA proposes that smart metering helps monitor electricity use on an hourly basis, thereby helping consumers adapt their consumption patterns, is an important tool to both boost retail competition and to help manage demand. Some metres can also be read remotely, on a daily basis. However, rolling out such technology to households is costly, although these options add most value. The IEA (2005) finds that the alternative for small consumers is a system that uses calculated load profiles based on monthly, quarterly or annual meter readings. However, this can create distorted incentives, and it also fails to enable the pass-through of hourly prices, the most attractive part electricity liberalisation for consumers.

90. That said, the first step to retail competition is to allow consumers to switch suppliers freely, as is possible in many jurisdictions including UK and Australia (to name a few). This is a crucial feature of retail competition. Evidence suggests that residential consumers are more reluctant to change suppliers than industrial users. The IEA notes that non-residential consumption typically represents about 50%-70% of total electricity consumption and that industrial users with higher consumption have substantially higher switching rates. This has also had some incidence on prices. Following the liberalisation and integration of the Nordic markets, electricity prices for large consumers fell. For residential consumers the picture is more mixed, partly because many factors including inertia or a lack of understanding of the market among others may cause residential consumers to remain with their supplier. Evidence from the UK however suggests that in the wake of substantial price spikes, consumers are more willing to shop around for new suppliers (Littlechild, 2002). In the LAC, this is still some way away in most countries. It might however be a way to alleviate social pricing concerns – if it leads to a lower retail price level, as would be the expected result from competitive markets.

7. The role of competition authorities

91. Competition law and policy aim at keeping anti-competitive behaviour at bay and at fostering economic efficiency. They form an indispensable pillar of the policy framework of a market economy. As such, they are naturally subject to the interdependency and reciprocal influence that exists between the different parts of a country’s policy framework and its translation into laws and other forms of regulation.

92. In an integrated electricity market, it will be essential to enable and encourage competition to reduce wholesale and retail prices, widen consumer choice and encourage innovation in delivery and energy efficiency across the entire regional market. Competition can be introduced by unbundling in the integrated electricity product markets for power supply and retail distribution, and by discouraging anticompetitive behaviours, such as limiting capacity or exploiting congestion. In a liberalised market where businesses have been separated, production and supply will then most likely be controlled by

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competition law, whereas transmission and distribution will remain regulated. This already gives an indication of how to apportion the responsibility between a sector regulator and the competition authority (where such exists); both nationally and in the integrated, regional market.

93. How to divide the responsibility between the sector regulator and the competition authority will vary from one legal system to another. It may be possible to reconcile competition considerations and regulatory functions through a shared division of labour.\(^{83}\) Competition law and sectoral law may operate in parallel, with competition authorities overseeing competition considerations and sector regulators dealing with regulatory considerations, in a conventional \textit{ex ante} and \textit{ex post} control and supervision of the markets. This would imply that the sector regulator would be given \textit{ex ante} control powers whereas the competition authority would intervene \textit{ex post} UNCTAD (2006) suggests that licencing issues would therefore be under the responsibility of the regulator here as whereas anticompetitive practices in the relevant market would require an \textit{ex post} review.

94. In addition to the division of tasks mentioned above, a number of other models exist; each posing their own challenges from a competition point of view:

- Competition authorities and the sector regulator may have shared jurisdiction over competition considerations;
- The sector regulator may be granted exclusive authority to also deal with competition issues;
- Finally in some jurisdictions the electricity sector (and other utilities) may be exempt from the application of competition law, as is the case for instance in Costa Rica.

95. From the discussion above we see that it is not easy to identify a “one-size-fits-all” model for the integrated regional market. A number of factors need to be taken into consideration when designing the regulatory model for the future electricity markets of the LAC, bearing in mind in particular the need to also enable consumers to benefit from a larger, more secure and freer market. Where regulators and authorities already exist, there need to be a clear set of rules, clearly apportioning responsibilities and delimiting the areas of jurisdiction; or at the very least, a framework for co-operation, where the rules of engagement are clearly defined. OECD (1998)\(^{84}\) discusses many of the issues that the builders of new regulatory and legal frameworks need to take into account. Most importantly, rules need to be clear, transparent and non-discriminatory for regulators, market players and consumers alike.

96. A number of key issues need to be resolved to identify the most appropriate relationship between the sector regulator and the competition authority (or in some case, the role of a joint authority). These can best be addressed as questions to the region’s competition authorities. Answering these would help pin down what the institutional and regulatory relationship should be:

- What sort of relationship currently is there between the Competition Authority and the domestic Electricity Regulator? Do any of the models outlined above fit your national jurisdiction?


• Can the authority and the regulator interact on electricity competition matter, and if so, are the boundaries of their respective powers clearly defined?

• If they do not interact, then why not, and should they be able to do so?

• Has there been co-operation with market regulators on market power issues? Was it successful? Which problems have you encountered?

• What model of co-operation between the sector regulator and the competition authority would be best suited to the market conditions in Latin America and the Caribbean?

• Would this be different in an integrated market?

• Does the Competition Authority have the power to take independent action over energy matters, such as the enforcement of competition law, the unilateral launch of market studies, or to do advocacy work? Is there a difference in treatment between the generation, transmission and retail segments in this respect?

• How do you ensure that consumers’ rights are protected in an integrated market?

• How would you expect to see the role of your national Competition Authority change in a regionally integrated market compared with its current role in the domestic electricity market?

• Which model for regulation would you consider adequate for a regionally integrated market? Would you consider the EU Single Market regulation in the energy sector as a model? 85

• Do you currently have any instruments in place to allow for cross-border integration of network markets? Would the telecoms regulation be a useful proxy?

• Would an integrated market have a sufficiently strong regulator to deal with such issues?

97. Providing or merely looking for answers to these questions should help the competition authorities in the LAC region to move forward on designing adequate competition law and institutional responses to regional electricity market integration, and finding the necessary advocacy tools to make the project succeed.

8. Conclusion

98. This paper has discussed the potential for the integration of electricity markets in the Latin American and Caribbean Region (LAC). Integrated markets can be demonstrated to provide supply and production stability and security to support more stable pricing, and to provide a significantly more attractive climate for large scale infrastructure investment. Without that welcoming climate, the resources required for large-scale infrastructure projects will be lacking, undermining the maintenance of efficient and secure supply. The region faces a significant energy challenge over the next couple of years, not least to secure sufficient and adequate electricity supply to a growing population and expanding economy, and integrating the region’s electricity markets can offer an attractive part of the solution. Some countries have already started this process, but progress is uneven between the integrated market of SIEPAC and the much looser co-operation across the Southern Cone.

To advance with regional integration, a number of issues need to be resolved, not least with respect to regulation, and to define the role and boundaries of competition law and policy, in order to ensure that the new markets do not give rise to market power, and the abuse thereof. Such markets need above all to be competitive. OECD (1998) highlights that there are four tasks typically needing careful attention during and after the transition from government ownership or heavy regulation to much greater reliance on market forces, as would be the case in an integrated market. These are:

1. Competition protection: controlling anti-competitive conduct and mergers. We have seen how this was done in Ireland and the paper also discusses the use of congestion rents as a solution;

2. Access regulation: In an unbundled market there must be mechanisms to ensure non-discriminatory access to network infrastructures. The main challenge is to ensure that all generators have equal opportunity to feed into the transmission grid, and all consumers share the same ability to extract electricity. The role of the system regulator here becomes vital, and we have looked at models, including in the Nordic countries in Europe and in the US, for how this is done;

3. Economic regulation: adopting-cost based measures to control monopoly pricing and incentivise market players. Arguably this may be difficult in markets where consumer prices are subsidised, but direct subsidies to low-income consumers may be a solution; and

4. Technical regulation: setting and monitoring standards to assure compatibility and to address privacy, safety, and environmental protection concerns.

This last point in particular is where regional integration may represent a significant opportunity for the region; allowing it to take advantage of its natural endowment in hydropower, to harness and share it across country borders. Governments would then be able to prioritise renewable energy. Renewables typically require very flexible system responses, smart grids and so on. One way to come to terms with very volatile production and consumption patterns would be the introduction of smart metering, setting price incentives for flexible, adapted energy use. This would be a demand side approach to peak problems. Hence the creation of a “new” market in Latin America where countries and regions are still in the process of installing meters and infrastructure, it might then be highly recommendable to go for smart metering at the outset; far cheaper than installation afterwards. Provided the right regulatory framework can be found to provide the best incentives, regional integration of electricity markets offers plenty of opportunities for the countries of Latin America and the Caribbean.
ANNEX A. BI-NATIONAL POWER GENERATING COMPANIES

I. Bi-national Itaipu Power Plant (Brazil and Paraguay)\(^1\)

The Itaipu Dam, currently the world’s largest hydroelectric power plant, is located on the Parana river on the border between Brazil and Paraguay. In 2013, Itaipu produced 98,630,035 megawatt-hours (98.6 million MWh), surpassing the world’s highest generation of 98,287,128 MWh reached also by Itaipu in 2012. The plant operates 20 generator units, each with a rated capacity of 700 MW. With its installed capacity of 14,000 MW, the plant produces around 17% and 75% of the energy consumed respectively in Brazil and in Paraguay. While Itaipu ensures 75 million MWh of power, the plant actually delivers over 90 million MWh every year. Careful maintenance and operation allowed the plant to produce power in excess of the generators’ rated capacity. It is therefore unsurprising that Itaipu’s availability indicators are among the best in the world.

Itaipu is a bi-national company (run by Brazil and Paraguay), and it operates on the basis of the treaty that was signed in 1973 and which expires in 2023. The governments of Brazil and Paraguay appoint the Executive Board of Directors through Eletrobrás or the Administración Nacional de Electricidad (Ande). The Board has to comply with company by-laws as well as the Itaipu Treaty. Among its various functions, the Board runs the company and submits administration guidelines and regulations to the Supervisory Board. Itaipu also has a twelve-member Supervisory Board, consisting of six members from Brazil and six from Paraguay and including among them one representative from each country’s Ministry of Foreign Affairs.

Itaipu delivers electricity generated by the power plant through the Interconnected System to the connection points that are located at the Foz do Iguaçu sub-station (Brazil), and at the Right Bank substation (Paraguay). The latter is located within the area of the Itaipu power plant. Furnas Centrais Elétricas and ANDE (Administración Nacional de Electricidad) are respectively responsible for transmitting power to the load centres in Brazil and Paraguay.

Table 1.A Itaipu transmission system connecting three substations of the plant to the interconnected systems of Brazil and Paraguay: technical data

<table>
<thead>
<tr>
<th>Substation</th>
<th>Insulation</th>
<th>Frequency</th>
<th>Transmission Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substation A</td>
<td>Gas insulated – 50 Hz</td>
<td>Six 500 kV transmission lines: two 2km-long lines connect the plant to the Right Bank substation; other two 10km-long link the plant to the Foz do Iguaçu substation, while the last two (8km long) connect both substations.</td>
<td></td>
</tr>
<tr>
<td>Substation B</td>
<td>Gas insulated – 60 Hz</td>
<td>Four 500 kV transmission lines connecting the plant to the Foz do Iguaçu sub-station</td>
<td></td>
</tr>
<tr>
<td>Substation C</td>
<td>Conventional – 50 Hz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Furnas and Copel are responsible for transmission of energy from Itaipu to the Brazilian system. The energy at 60 Hz is transmitted over the 765kV system of Furnas and the 525 kV system of Copel whereas the energy at 50 Hz uses the direct current system of Furnas. Eletrobras distributes the energy generated by Itaipu.

\(^1\) [http://www.itaipu.gov.br/es](http://www.itaipu.gov.br/es)
The main features of the transmission systems are presented in the table below.

Table 2.A Transmission systems main features

<table>
<thead>
<tr>
<th>Direct Current System (Furnas)</th>
<th>- necessary to integrate the energy produced in the 50 Hz sector into the Brazilian system which has 60 Hz frequency.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Two transmission lines of 810km connect the substations of Foz do Iguaçu and Ibiuna;</td>
</tr>
<tr>
<td></td>
<td>- Transmission voltage: + 600 kV;</td>
</tr>
<tr>
<td></td>
<td>- Eight converters at each substation</td>
</tr>
<tr>
<td>Alternating Current System (Furnas)</td>
<td>- three transmission lines of approximately 900 km connect Foz do Iguaçu and Tijuco Preto, in the metropolitan region of São Paulo;</td>
</tr>
<tr>
<td></td>
<td>- each line has around 2000 transmission towers</td>
</tr>
<tr>
<td></td>
<td>- two substations at Ivaiporã and Itaberá;</td>
</tr>
<tr>
<td></td>
<td>- transmission voltage: 765 kV;</td>
</tr>
<tr>
<td></td>
<td>- Seven transformers in Tijuco Preto for 500 kV and 345 kV</td>
</tr>
<tr>
<td>Alternating Current System (Copel)</td>
<td>- transmission line between the substations of Foz do Iguaçu and Cascavel Oeste</td>
</tr>
</tbody>
</table>

2. Bi-national Yacyretá Power Plant (Argentina and Paraguay)

The Yacyretá Dam is a hydroelectric power plant built over the waterfalls of Jasyretâ-Apipé in the Paraná River, between the Argentine Province of Corrientes and the Paraguayan City of Ayolas.

In December 1973 the Yacyretá Treaty between Paraguay and Argentina was signed. The Yacyretá project was one of Latin America’s major public sector projects of the 1980s. The project was stalled for years as a consequence of regional manoeuvring, lobbying by the Argentine nuclear and oil industries, and political instability in Argentina. After ten years of delay, the first major engineering contract finally was awarded in June 1983. Like Itaipú, Yacyreta was hindered by the general lack of physical infrastructure at the dam site. Construction of the dam and the hydroelectric plant continued throughout the 1980s, but the major construction phase did not begin until the late 1980s, and the project only became fully operational in the mid-1990s, more than twenty years after the treaty was signed and at a cost of around USD 10 billion, five times the original calculation².

The shareholders of Binational Yacyretá Power Plant are ANDE from Paraguay and EBISA from Argentina with equal equity, and the operation is governed by the rules established in the treaty, its annexes and other diplomatic instruments. It is administrated by a Board of Directors and composed of equal number of nationals of both countries. The company has their premises in Buenos Aires and Asunción.

The Power plants have 20 Kaplan hydraulic turbines and an installed capacity of 3200 Mw. Through each turbine can spend 2,630 million litres of water per hour. With the 20 turbines per hour it is a water volume equivalent to the one used by Asunción for drinking water for 13 days or 2 days of the city of Buenos Aires.

With the planned works to finalise the project (83 meters above sea level), the turbines will be able to operate at their maximum potential and annually produce 19,000 GWh of energy. If three more turbines are installed, this figure will exceed 20,000 GWh.

The flow of energy from Yacyretá to Argentina goes through three lines of 500Kv to Rincón de Santa Maria substation and from there to Salto Grande national grid through 2 lines of 500Kv, and to Paraguay through one line of 220Kv to Ayolas substation.

3. **Bi/Tri-national Corpus Christi Power Plant (Argentina, Brazil and Paraguay)**

In 1971, Paraguay and Argentina created the *Comisión Mixta del Río Paraná* (COMIP) (River Parana Joint Commission) which stated to carry out different studies (pre-feasibility, environmental and so on) for the Corpus Christi project, to be located upstream of the Parana river close to the towns of Corpus in Argentina and Puerto Bella in Paraguay. In the mid-1980s, Argentina, Paraguay and Brazil signed a tripartite agreement that established the operating height of the project, which would allow the partners to bring into line the operation of Corpus with those of Yacyreta and Itaipu. The different alternatives for this project are still under study.

4. **Bi-national Salto Grande Power Plant (Argentina and Uruguay)**

The *Comisión Técnica Mista de Salto Grande* (Salto Grande Technical Joint Commission) is a bi-national organisation created by Argentina and Uruguay in order to make some necessary modifications to the use of the Uruguay river rapids in the Salto Grande area. Since its creation, the *Comisión* has been in charge of studies and setting up projects, and later on also for the construction and commissioning of the Salto Grande Hydroelectric Complex, which was the first hydraulic-purpose use in Latin America.

The complex is located a few miles upstream from the cities of Concordia (Argentina) and Montevideo (Uruguay) 470 km from Buenos Aires, the capital of Argentina, and 520 Km from Montevideo, the capital of Uruguay.

The turbines convert the constant movement of the river into energy, which is then transported to the substations. The power plant is equipped with fourteen Kaplan turbines.

Since its creation in 1980, it has generated a total of 265,605 GWh, and produces 7% of the energy consumed in Argentina and 50% of that used in Uruguay. The annual average of energy production is 7,812 GWh, reaching over 17% of the energy originally provided for in the design, which was 6,700 GWh.

The Salto Grande Hydroelectric Complex supplies to Argentina 161 339 GWh and 97,950 GWh to Uruguay, totaling 259,289 GWh.

5. **Bi-national Garabí Power Plant (Argentina and Brazil)**

EBISA and the Brazilian company ELETROBRÁS ended the Hydroelectric Inventory Study of the Uruguay river basin, on the border between Brazil and Argentina. The study was aimed at the identification of two bi-national hydroelectric resources.

The whole process of studies for the project is based on the provisions of the Treaty of 1980, and on 1st and 2nd Co-operation Agreement between EBISA and ELETROBRÁS subscribed in 2008 and 2009.

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The two companies agreed that when they act jointly in hydroelectric projects they will be known as the Garabi Executive Unit.

A call for tender for the procurement of services related to engineering and environmental studies, as well as for the social communication services plan, was published in the Official Gazette of Argentina in January 2011.

The treaty indicates that the execution of the studies and works will be in charge of EBISA and ELETROBRÁS. These companies have integrated it a Co-ordinating Commission, in accordance with the provisions of the Treaty. The Commission is composed by members of both countries. To expedite the process if differences arise between the two companies, the Joint Technical Committee, representing both countries was created.6

<table>
<thead>
<tr>
<th>Countries</th>
<th>Company</th>
<th>River</th>
<th>Installed Capacity</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Br-Py</td>
<td>Itaipú</td>
<td>Parana</td>
<td>14000MW</td>
<td>Operating</td>
</tr>
<tr>
<td>Ar-Uy</td>
<td>Salto Grande</td>
<td>Uruguay</td>
<td>1890MW</td>
<td>Operating</td>
</tr>
<tr>
<td>Ar-Py</td>
<td>Yacyretá</td>
<td>Parana</td>
<td>3200MW</td>
<td>Operating</td>
</tr>
<tr>
<td>Ar/Br</td>
<td>Garabi</td>
<td>Uruguay</td>
<td>1500MW</td>
<td>Under study</td>
</tr>
<tr>
<td>Ar-Py</td>
<td>Corpus</td>
<td>Parana</td>
<td>3400MW</td>
<td>Under study</td>
</tr>
</tbody>
</table>


ANNEX B. REGIONAL ENERGY PROJECT DATA

Table 1.B  Most relevant future interconnection projects in Latin America

<table>
<thead>
<tr>
<th>Project</th>
<th>Year</th>
<th>Voltage (Kv)</th>
<th>Longitude (Km)</th>
<th>Capacity (MW)</th>
<th>Cost (MUSD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peru-Brazil</td>
<td>2015</td>
<td>500</td>
<td>3,470</td>
<td>2,200</td>
<td>2,370</td>
</tr>
<tr>
<td>Bolivia-Brazil</td>
<td>2015</td>
<td>500</td>
<td>2,850</td>
<td>800</td>
<td>792</td>
</tr>
<tr>
<td>Colombia-Panama</td>
<td>2014</td>
<td>400</td>
<td>614</td>
<td>300</td>
<td>207</td>
</tr>
<tr>
<td>Bolivia-Chile</td>
<td>2014</td>
<td>230</td>
<td>150</td>
<td>180</td>
<td>30</td>
</tr>
<tr>
<td>C. Amer</td>
<td>2016</td>
<td>230</td>
<td>1,800</td>
<td>300</td>
<td>500</td>
</tr>
<tr>
<td>Brazil-Uruguay</td>
<td>2013</td>
<td>500</td>
<td>420</td>
<td>500</td>
<td>349</td>
</tr>
<tr>
<td>Argentina-Paraguay-Brazil</td>
<td>2014</td>
<td>500</td>
<td>666</td>
<td>2,000</td>
<td>610</td>
</tr>
<tr>
<td>Bolivia-Peru</td>
<td>2014</td>
<td>230</td>
<td>215</td>
<td>125</td>
<td>65</td>
</tr>
<tr>
<td>Peru-Ecuador</td>
<td>2010</td>
<td>220/23</td>
<td>107</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>Chile-Argentina</td>
<td>2015</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Paraguay-Argentina-Chile</td>
<td>2011</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Brazil-Argentina</td>
<td>2010</td>
<td>500</td>
<td>490</td>
<td>2,000</td>
<td>-</td>
</tr>
<tr>
<td>Caribe</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>


Table 2.B  2012 Regional Electricity Market - Energy transactions

<table>
<thead>
<tr>
<th>Countries</th>
<th>Injection Grand Total GW/H</th>
<th>Withdrawal Grand Total GW/H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costa Rica</td>
<td>23</td>
<td>34</td>
</tr>
<tr>
<td>El Salvador</td>
<td>76</td>
<td>161</td>
</tr>
<tr>
<td>Guatemala (MER)</td>
<td>180</td>
<td>12</td>
</tr>
<tr>
<td>Guatemala (Mexico)</td>
<td>16</td>
<td>216</td>
</tr>
<tr>
<td>Honduras</td>
<td>1</td>
<td>76</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>Panama</td>
<td>58</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>357</td>
<td>536</td>
</tr>
</tbody>
</table>


Table 3.B  International Interconnections and SIEPAC (infrastructure)

<table>
<thead>
<tr>
<th>Region/Country</th>
<th>Location</th>
<th>Voltage</th>
<th>Capacity</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIEPAC</td>
<td>Regional Transmission System</td>
<td>230Kv</td>
<td>300MW</td>
<td>Last phase of construction (94% of advance in Nov 2012)</td>
</tr>
<tr>
<td>Guatemala –Mexico</td>
<td>Brillantes, Guatemala-Tapachula, Mexico. (101 Km, 71Km in Guatemala and 30 Km in Mexico)</td>
<td>400Kv/230Kv</td>
<td>200MW</td>
<td>Operating</td>
</tr>
<tr>
<td>Colombia-Panama</td>
<td>Cerromatoso, Colombia-Panama</td>
<td>-</td>
<td>300MW</td>
<td>Under study</td>
</tr>
</tbody>
</table>

Source: Comisión de Integración Energética Regional (2012), ‘Información del sector energético en países de América del Sur, América Central y el Caribe’.
<table>
<thead>
<tr>
<th>Countries</th>
<th>Location</th>
<th>Voltage</th>
<th>Capacity</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colombia - Venezuela</td>
<td>Cuestecita (Co) – (Ve)</td>
<td>230 kV</td>
<td>150 MW</td>
<td>Operating (60 Hz)</td>
</tr>
<tr>
<td>Colombia - Venezuela</td>
<td>Tibú (Co) – La Fría (Ve)</td>
<td>115 kV</td>
<td>36 / 80 MW</td>
<td>Operating (60 Hz)</td>
</tr>
<tr>
<td>Colombia - Venezuela</td>
<td>San Mateo (Co) – El Corozo (Ve)</td>
<td>230 kV</td>
<td>150 MW</td>
<td>Operating (60 Hz)</td>
</tr>
<tr>
<td>Colombia - Panama</td>
<td>Cerromatoso (Co) – Panamá (Pa)</td>
<td></td>
<td>300 MW</td>
<td>Under study</td>
</tr>
<tr>
<td>Colombia - Ecuador</td>
<td>Pasto (Co) – Quito (Ec)</td>
<td>230 kV</td>
<td>250 MW</td>
<td>Operating (60 Hz)</td>
</tr>
<tr>
<td>Colombia - Ecuador</td>
<td>Jamondino (Co) – Santa Rosa (Ec)</td>
<td>230 kV</td>
<td>250 MW</td>
<td>Under construction</td>
</tr>
<tr>
<td>Colombia - Ecuador</td>
<td>Ipiales (Co) – Tulcán (Ec)</td>
<td></td>
<td>138 kV / 230 kV</td>
<td>35/113 MW</td>
</tr>
<tr>
<td>Ecuador - Peru</td>
<td>Machala (Ec) – Zorritos (Pe)</td>
<td></td>
<td>100 MW</td>
<td>Operating (60 Hz)</td>
</tr>
<tr>
<td>Brazil - Venezuela</td>
<td>Boa Vista (Br) – El Guri (Ve)</td>
<td>230 kV / 400 kV</td>
<td>200 MW</td>
<td>Operating (60 Hz)</td>
</tr>
<tr>
<td>Bolivia - Peru</td>
<td>La Paz (Bo) – Puno (Pe)</td>
<td>230 kV / 220 kV</td>
<td>150 MW</td>
<td>Under study (50/60 Hz)</td>
</tr>
<tr>
<td>Brazil - Paraguay</td>
<td>Binational Itaipú</td>
<td>500/220 kV</td>
<td>14.000 MW</td>
<td>Operating (60/50 Hz)</td>
</tr>
<tr>
<td>Brazil - Paraguay</td>
<td>Foz de Iguazu (Br) – Aracay (Py)</td>
<td>220/138 kV</td>
<td>50 MW</td>
<td>Operating (60/50 Hz)</td>
</tr>
<tr>
<td>Argentina - Paraguay</td>
<td>El Dorado (Ar) – Mcal. A. López (Py)</td>
<td>220/132 kV</td>
<td>30 MW</td>
<td>Operating (50 Hz)</td>
</tr>
<tr>
<td>Argentina - Paraguay</td>
<td>Clorinda (Ar) – Guarambaré (Py)</td>
<td>132/220 kV</td>
<td>80/90 MW</td>
<td>Operating (50 Hz)</td>
</tr>
<tr>
<td>Argentina - Paraguay</td>
<td>Binational Yacyretá</td>
<td>500 kV</td>
<td>3.200 MW</td>
<td>Operating (50 Hz)</td>
</tr>
<tr>
<td>Argentina - Paraguay</td>
<td>Rincón S.M. (Ar) – Garabí (Br)</td>
<td>500 kV</td>
<td>2.000 / 2.200 MW</td>
<td>Operating (50 Hz)</td>
</tr>
<tr>
<td>Argentina - Brazil</td>
<td>P. de los Libres (Ar) – Uruguayana (Br)</td>
<td>132/230 kV</td>
<td>50 MW</td>
<td>Operating (50/60 Hz)</td>
</tr>
<tr>
<td>Argentina - Uruguay</td>
<td>Binational Salto Gde.</td>
<td>500 kV</td>
<td>1.890 MW</td>
<td>Operating (50 Hz)</td>
</tr>
<tr>
<td>Argentina - Uruguay</td>
<td>Concepción (Ar) – Paysandú (Uy) 132/150 kV</td>
<td>100 MW</td>
<td>Operate in emergency (50 Hz)</td>
<td></td>
</tr>
<tr>
<td>Argentina - Uruguay</td>
<td>Colonia Elia (Ar) – San Javier (Uy)</td>
<td>500 kV</td>
<td>1.386 MW</td>
<td>Operating (50 Hz)</td>
</tr>
<tr>
<td>Brazil - Uruguay</td>
<td>Livramento (Br) – Rivera (Uy)</td>
<td>230/150 kV</td>
<td>70 MW</td>
<td>Operating (60/50 Hz)</td>
</tr>
<tr>
<td>Brazil - Uruguay</td>
<td>Pte. Médici (Br) – San Carlos (Uy)</td>
<td>500 kV</td>
<td>500 MW</td>
<td>Under construction (60/50 Hz)</td>
</tr>
<tr>
<td>Argentina - CI</td>
<td>CT TermoAndes (Ar) – Sub.Andes (CI)</td>
<td>345 kV</td>
<td>633 MW</td>
<td>Operating (50 Hz)</td>
</tr>
</tbody>
</table>

Source: Comisión de Integración Energética Regional (2012), ‘Información del sector energético en países de America del Sur, América Central y el Caribe’. 
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