Measuring international electricity integration: a comparative study of the power systems under the Nordic Council, MERCOSUR, and NAFTA

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Abstract

Many regions of the world feel the pressure to interconnect electric power systems internationally. Regional integrations of the electricity sector have become part of free trade and common market initiatives, though the steps individual national jurisdictions take towards developing integrated systems vary. In this article, we review three regions concerned with common market initiatives and at different stages of integration processes that involve infrastructural, regulatory, and commercial decisions. First, we examine the North European countries in the Nordic Council, then countries in the Southern Cone of South America in MERCOSUR, and finally Mexico, the United States and Canada, linked under NAFTA. This comparative study highlights the potential, but also the many hurdles, that electricity sector integrations face. The study suggests a framework for measuring the level of electricity sector integration that could be applied to other regions.

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Keywords: Electricity; Integration; International trade

1. Introduction

In many regions of the world, neighboring countries feel the pressure to take steps towards interconnecting their electric power systems. Not all national and sub-national jurisdictions, however, follow the same steps towards, or achieve the same degree of, electricity sector integration. To what extent, then, have major regions, or major groups of countries, integrated their electricity sectors? One might expect that North America would lead the way in such a process, but that is not the case. Our review of the international literature on this topic, our analysis of recent electricity trade statistics, and our examination of market initiatives, show markedly different levels of progress in integration from region to region. By taking these supra-national contexts into consideration, we found that, unlike the Nordic countries that have almost fully integrated their electricity market and are more advanced than the other regions in infrastructure interconnection and regulatory compatibility, North and South American countries have only partially integrated these aspects of their electricity sectors.

El-Agraa’s (1989) conceptualizes regional trade and integration of markets as steps taken on a continuum towards full regional integration. We extend his insight to assess the steps that regions have taken to integrate key aspects (dimensions) of common electricity markets. In each region, by using a similar classificatory approach, we examine integrative developments such as infrastructure interconnection, progression towards regional regulations, and commercial integration as aspects of a common electricity market.

On our integration continuum, each region can be assessed as having developed its integration process along three select dimensions, each sub-divided into four stages (Table 1). For instance, in determining a particular region’s degree of physical infrastructure integration, one can categorize it as consisting of isolated national systems, as having cross-border transmission capabilities, as demonstrating coordinated...
effort in transmission investment (taking prices at generation and demand nodes into account), and as having developed a fully integrated regional systems operation. Such a fully integrated region would be managed with a common set of rules.

Furthermore, on this continuum, each region can be assessed as to what degree its regulation of the electricity sector has become integrated. Regulation in a particular region can be seen as having reached the stages of independent national regulation, compatibility in regulation, regulatory coordination, and establishment of the same regulatory framework consisting of a regional regulatory agency.

In addition, each region’s status of commercial integration can be assessed according to four stages: a national market wherein local ownership prevails, a market that trades electricity cross-border and allows international ownership, a regional spot market with unique price reference, and a fully regionalized power market in which electricity futures can be commercially exchanged.

Using international electricity sector documentation and data from the year 2000, we have discerned Northern Europe’s, South America’s, and North America’s situation by making more precise each region’s extent of infrastructure, commercial, and regulatory integration through employing several sets of indicators. We assess the degree of international infrastructure integration by employing two indicators: (1) cross-border transmission capabilities and (2) the ratio of each country’s share of cross-border capabilities over transmission capacity (Tables 2, 6 and 10). To show the extent of commercial integration, we employ a second set of indicators: (3) electricity trade, or more specifically electricity import and export statistics, and (4) the share of each country’s production capacity that can be exported or imported (Tables 5, 9 and 13). A third set of indicators we use to assess regulatory integration shows (5) the degree of coordination among national and sub-national regulatory bodies and (6) the main role such regulatory bodies play in regulating international electricity market integration (for example, in regulating exports and imports, approving transmission lines, insisting on international transmission line access reciprocity, and regulating wholesale and retail trading) (Tables 3, 7 and 11). In addition to identifying the stage each region has already reached, we highlight the obstacles each region faces in achieving full integration of its electricity market.

This article is divided into three main sections, each containing the analysis of a different region. Section 2 will examine the degree of integration among the Nordic countries, Norway, Sweden, Finland, and Denmark. As will become evident, the Nordic countries’ path of electricity market integration has been largely influenced by the policies of the Nordic Council and the practices of the Organisation for Nordic Electricity Power Cooperation (NORDEL) and the strong Nordic tradition of cooperation both among countries and between public and private enterprises. Such Nordic integration principles guided the progressive regional electricity market integration that accomplished economic efficiency and implemented both innovative energy and environmental policies in the absence of international regulation. Section 3 will examine the degree of integration among the countries of Argentina, Bolivia, Brazil, Chile, Paraguay, and Uruguay. We will show how significant transmission linkages and electricity trade, often involving imports and exports from major bi-national dam projects, have developed. Should MERCOSUR (Common Market of the South), which contributed to electricity market integration, again

### Table 1

| Integration continuum for regional electricity markets with location of each region along three dimensions |
|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| Infrastructural integration | Regulatory integration | Commercial integration |
| No regional integration | Isolated national power systems | Independent national regulation | National markets with local ownership |
| ↓ | Cross-border transmission capabilities | MERCOSUR NAFTA | Compatible regulation | NAFTA |
| | Coordinated effort in transmission investment | Nordic C. | Coordination of regulatory agencies | Nordic C. |
| Full regional integration | Fully integrated regional system operation | Regional regulatory agency | Regional secondary/futures market | Nordic C. |

*aWe recognize that long distances may result in different local prices at distinct transmission nodes.*
advance macroeconomic coordination initiatives, including both exchange rate and monetary policies, the region may move beyond these beginning stages towards more advanced forms of electricity market integration. Section 4 will examine how three North American countries—Canada, the United States, and Mexico—in the North American Free Trade Agreement (NAFTA) have taken initial steps towards trilateral trade in energy and electricity. Trilateral electricity sector integration, however, is at only the beginning stage. Our review of the development of transmission linkages, electricity trades, and national regulation reveals that electricity trade relations in this region remain bilateral Canada–United States and United States–Mexico.1

2. Nordic countries

Already unified by a common linguistic legacy (except for Finland) and by a largely shared history, the Nordic countries institutionalized their cooperation in 1952 through the Nordic Council. Norway, Sweden, Denmark and Iceland joined first, followed by Finland in 1956. The goals of the Nordic Council are to foster cultural, social, economic and judicial cooperation among member countries.2 However, it is not a supranational institution and does not create a new governance layer. Indeed, the Nordic Council is only a forum for inter-parliamentary cooperation. A similar organization in the electricity sector, Nordel (Organization for Nordic Electricity Power Cooperation), was created in 1963 by the five Nordic countries.3 Nordel provided a forum for discussion and advice among the electricity industry leaders until 2000, when it became the main body for coordinating systems operations and transmission developments in Nordic countries. It also gathers statistical information on the power exchanges among these nations which have a long tradition of trading, although initially not on a commercial basis: power exchanges were indeed oriented towards reliability goals and ruled by “gentlemen’s agreements,” rather than by an official set of common regulations and strictly profit-oriented motivations.

Until the 1990s, when integration of the sector really became significant, cooperation was encouraged, but each country remained largely independent from the others in the development of its electricity industry. Generation, transmission and distribution companies were active mainly in their respective countries, with very little involvement abroad. Also, there was less vertical and horizontal integration than in most other countries; for instance, there was no equivalent of the former UK Central Electricity Generating Board or the current Electricité de France. Indeed, many different types of organizations were involved in generation (state companies, municipal distributors, private industrial producers) and hundreds of local and municipal distributors were supplying electricity in each jurisdiction. In Finland, two parallel transmission networks had been in operation in certain periods.4

The Nordic countries’ drive for integration in the electricity sector is unique in the world. Integration has, in fact, been made through a decentralized regional framework, whereby each country has kept all its legislative sovereignty and no common institution has been created. Consequently, while moving towards the same market-based system, each country’s administration supported independent energy efficiency initiatives. As illustrative examples of such policies, one can mention the Swedish energy conservation policy in the late 1970s (see Sahr, 1985 for a complete analysis), the 1980 Swedish referendum on the phasing out of nuclear power and the Danish nuclear ban, Finnish leadership in combined heat and power (CHP) generation (representing 30% of the generated electricity in Finland, IEA, 1999); the creation of distinct CO₂ taxes in the 1990s in all four countries, or the Danish aggressive wind policy.5 This section on Nordic countries details, despite the disparities just mentioned, the current high level of electricity sector integration found within Nordic countries on the three dimensions of interest: infrastructure, regulatory and commercial.

2.1. Infrastructure integration

An important benefit of trading electricity, and consequently of integrating markets, is obtained when the generation mix and peak load hours of different jurisdictions are complementary.

As Fig. 1 shows, electricity generation in Nordic countries comes from different technologies and energy sources with an important variation of the generation mix between the four countries. These differences provide a natural incentive to have a shared system. Gains can easily be achieved in all jurisdictions when, for example, water levels are low and thermal production relatively cheaper or, conversely, when water is abundant and makes electricity from other sources less

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1We are not focusing in this paper on sub-regional exchanges, though we recognize that international exchanges can be concentrated in certain sub-regions of the countries involved.

2See Tunander (1999), for a complete historical overview of Nordic cooperation.

3For obvious geographical reasons, the case of Iceland is different from the other Nordic countries. This is why we concentrate only on Norway, Sweden, Denmark and Finland.

4See Pineau and Hämäläinen (2000), for more details on the Finnish case.

5Windmills represented 20% of the installed capacity in Denmark in 2000, producing 2381 MW, for a production of more than 12% of the generated electricity (Nordel, 2000).
profitable. The Norwegian and Swedish hydropower systems, therefore, supply electricity to other countries in periods of high water levels and become importers in periods of relative drought.

The complementary generation portfolios and the relative proximity of the four countries set the foundation for important international interconnections. Table 2 displays the transmission capabilities between countries and the percentage these capabilities represent compared to the total generation capacity on each country. The high percentages (from almost 10% for Finland to more than 30% for Denmark) show the importance of links between countries, and their degree of interdependence.

### 2.2. Regulatory integration

As mentioned at the beginning of this section, each country has its own legislation and institutions to monitor the market, and although necessary efforts have been made to harmonize the regulatory framework of the four countries, no official organization, committee or international structure has been in charge of coordinating the reform. In fact, Norway took the lead in 1991 with a new Energy Act, followed by Sweden in 1996. In 1995, Finland enforced the Electricity Market Act, and Denmark made effective some amendments to its Electricity Supply Act in 1998 to allow competition at the generation level to take place through an open access policy in the transmission network. Each country’s reform was made in such a way that it would be compatible with the initial Norwegian model. However, the Danish electricity sector, even if it should evolve towards the same model, has some distinct features, particularly the two transmission grid systems and the cooperative/mixed ownership structure characterizing most generation, transmission and distribution companies.

The ‘Norwegian’ model consists of a competitive generation sector, established through a voluntary spot market, and an open-access transmission network. This transmission network is owned and operated by a single company that has a monopoly in its country and is

**Table 2**

<table>
<thead>
<tr>
<th>Cross-border transmission capabilities</th>
<th>Total transmission capability over total production capacity (%)^a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission capabilities From To in MW</td>
<td>Total production capacity in 2000 was 11,940 MW for Denmark, 16,576 MW for Finland, 27,781 MW for Norway and 30,894 MW for Sweden. Source: Nordel (2000).</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>Denmark Norway 1040</td>
<td>30.82</td>
</tr>
<tr>
<td>Denmark Sweden 2640</td>
<td></td>
</tr>
<tr>
<td>Total 3680</td>
<td></td>
</tr>
<tr>
<td>Finland Norway 100</td>
<td>9.83</td>
</tr>
<tr>
<td>Finland Sweden 1530</td>
<td></td>
</tr>
<tr>
<td>Total 1630</td>
<td></td>
</tr>
<tr>
<td>Norway Denmark 1040</td>
<td>20.35</td>
</tr>
<tr>
<td>Norway Finland 70</td>
<td></td>
</tr>
<tr>
<td>Norway Sweden 4545</td>
<td></td>
</tr>
<tr>
<td>Total 5655</td>
<td></td>
</tr>
<tr>
<td>Sweden Denmark 2680</td>
<td>26.88</td>
</tr>
<tr>
<td>Sweden Finland 2130</td>
<td></td>
</tr>
<tr>
<td>Sweden Norway 3495</td>
<td></td>
</tr>
<tr>
<td>Total 8305</td>
<td></td>
</tr>
</tbody>
</table>

^aTotal production capacity in 2000 was 11,940 MW for Denmark, 16,576 MW for Finland, 27,781 MW for Norway and 30,894 MW for Sweden. Source: Nordel (2000).
regulated by a country-specific body. Other features of the market, such as the organization of the distribution and supply levels are left to each country. As Table 3 illustrates, each country has its own set of regulatory agencies. Their role is, nonetheless, quite similar. An energy authority oversees the aspects of the electricity sector that still need to be regulated (essential transmission and distribution), while a distinct competition authority monitors market power abuse. This latter agency is not specific to the electricity sector, but monitors competition issues for all economic sectors.

While the legislation allowing integration of the electricity sector in the Nordic countries was mostly enacted in the early 1990s, the Directive 96/92/EC of the European Parliament and of the Council of 19 December 1996 concerning common rules for the internal market in electricity gave a larger European framework to the Nordic electricity sector. The main requirements of the directive concern the separation of production and transmission activities and the access to the transmission network in order to allow consumers to select their energy provider. However, as Table 4 on market structures shows, the current situation in Nordic countries is far ahead of the requirements of the European directive as the sector is already unbundled.

Vertical integration is not an issue with the independent transmission companies, and competition at the wholesale level is implemented through either bilateral contract or trading in the spot market (Nord Pool).

2.3. Commercial integration

Although no power crisis has affected the Nordic countries since the start of the spot market, some concerns are regularly raised on the possible market power of the dominant generators (see for instance Johnsen, 2003). Table 4 gives some details on the market structure with the five biggest generators in Nordic countries, which control almost 50% of the generating capacity of the region.

Table 3
Regulatory bodies

<table>
<thead>
<tr>
<th>Country</th>
<th>Regulatory bodies (main role)</th>
</tr>
</thead>
</table>
| Denmark | Danish Energy Authority (developing and coordinating the Danish energy policy)  
Danish Competition Authority (applying the competition legislation) |
| Finland | Energy Market Authority (network operations, investment and pricing)  
Office of Free Competition (applying the competition legislation) |
| Norway | Norwegian Water Resources and Energy Directorate (network operations, investment and pricing)  
Norwegian Competition Authority (applying the competition legislation) |
| Sweden | Office of the Electricity and Gas Regulator, within the Swedish Energy Agency (network operations, investment and pricing)  
Competition Authority (applying the competition legislation) |

Table 4
Market structure

<table>
<thead>
<tr>
<th>Country</th>
<th>Vertical integration</th>
<th>Generation</th>
<th>Coordination of sales</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Horizontal integration</td>
<td>Key generator (owner)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No restrictions</td>
<td>Elsam (Danish distributors)</td>
</tr>
<tr>
<td>Denmark</td>
<td>Two transmission companies (Eltra and Elkraft, both linked to some distributors)</td>
<td>No restrictions</td>
<td>Fortum (State, private)</td>
</tr>
<tr>
<td>Finland</td>
<td>Independent transmission company (Fingrid, a mixed-ownership for-profit company)</td>
<td>No restrictions</td>
<td>Statkraft (State)</td>
</tr>
</tbody>
</table>
| Norway  | Independent transmission company (Statnett, state-owned) | No restrictions | Vattenfall (State)  
Sydkraft (Private, state) | Bilateral contracts Nord Pool |
| Sweden  | Independent transmission company (Svenska Kraftnät, state-owned) | No restrictions | Vattenfall (State)  
Sydkraft (Private, state) | Bilateral contracts Nord Pool |

All these companies also have direct subsidiaries or shares in distributing and supplying companies. That increases significantly the level of vertical integration in the sector, which can create some problems for consumer protection.

These producers trade in the Nord Pool, a voluntary spot market created in 1991 in Norway when that country introduced competition. Sweden joined in 1996, Finland in 1998, and finally Denmark in two steps: first western Denmark in 1999 and the eastern region in 2000. As a result in 2001, 111 TWh of electricity were traded in Nord Pool (Nord Pool, 2002). That represents more than 25% of the generated electricity in the four countries. The rest is sold through bilateral contracts or self-produced and self-consumed.

Table 5 illustrates the importance of trade among the countries. Between 1% and 25% of the total consumption level of these countries relies on imports, and between 1% and 23% of their total generation is exported to other countries.

### 2.4. Prospects

The history of cooperation in the Nordic countries with their focus on efficiency certainly contributed to the success of the integration process. The reasonable levels of price experienced, the continuous reliability of the supply, and the absence of consumer opposition to the process are clear signs of the positive achievements in the Nordic countries.

The most striking feature of electricity market integration in the Nordic countries is the lack of a need for a formal, jointly developed, unique body of laws and regulations, accompanied by the absence of executive multinational regulators. Compatible (and similar) trading, investment, environmental, and tax laws allowed such a development and avoided the creation of another layer of governance. This explains why Nordic countries are only halfway on the regulatory dimension towards full integration (see Table 1). The obvious limit of this approach will be the difficulty for further integration of their transmission infrastructures. Without a supra-national body, coordinating these developments could be more challenging, especially for investments in international transmission links, where the different participants may develop, over time, different interests and approaches under their respective legislation.

Other challenges will also interfere with Nordic electricity market integration. First, the slower but steady integration of the continental European electricity market will inevitably affect the Nordic one. The EU approach is now policy-led, as opposed to the market-led Nordic approach. Instead of building from the current commercial and physical integration, the European integration is driven by the EU legislators/regulators, imposing progress in other dimensions. It remains to be seen if Nordic and European regulatory institutions will be compatible.

The second test will come from the concentration of ownership. Until now, this has not been a significant factor in the determination of electricity price in the Nordic system. However, the tendency of the market to become more and more concentrated in the hands of fewer companies could have negative effects on the competition level and on consumers. The challenge will be for the various state regulators to handle the market power of these companies in a consistent way.

The future of government-owned companies in competitive markets might also create a third challenge. Although the Nordic state-owned power companies are examples of successful public companies in a competitive environment, international and market pressures will be felt to allow private ownership of shares of the companies. As some power over the energy sector remains in the hand of the governments through these companies, the challenge will be to balance this sovereign power against the market forces.

Finally, with the Finnish decision in the spring 2002 to allow another nuclear reactor to be built, Danish and Swedish policies on nuclear power become less significant, considering the level of electricity exchanges between the countries. This different policy choice, along with possible different emission constraints imposed by the Kyoto agreement (that all Nordic countries endorse), will create unbalanced market

### Table 5

Electricity exchange in 2000, by country, in GWh

<table>
<thead>
<tr>
<th></th>
<th>Total imports</th>
<th>% Of consumption imported</th>
<th>Total exports</th>
<th>% Of generation exported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>8,419</td>
<td>24.13</td>
<td>7,753</td>
<td>22.65</td>
</tr>
<tr>
<td>Finland</td>
<td>12,867</td>
<td>16.27</td>
<td>986</td>
<td>1.47</td>
</tr>
<tr>
<td>Norway</td>
<td>1,466</td>
<td>1.18</td>
<td>20,489</td>
<td>14.34</td>
</tr>
<tr>
<td>Sweden</td>
<td>18,292</td>
<td>12.48</td>
<td>13,605</td>
<td>9.59</td>
</tr>
<tr>
<td>Total/average</td>
<td>41,044</td>
<td>13.52</td>
<td>42,833</td>
<td>12.01</td>
</tr>
</tbody>
</table>

*Total exports and imports are not equal because of exchanges with other countries (Germany, Russia and Poland). Source: Nordel (2000).
conditions. As these last elements show, it is really the lack of a supra-national regulatory body that will be the strongest limitation on the Nordic electricity sector integration.

3. South America: the MERCOSUR

MERCOSUR includes Argentina, Brazil, Paraguay, and Uruguay, with Bolivia and Chile are associate members. MERCOSUR is a unique South–South free trade agreement that has been in place since 1994, and it functions more as a coordination mechanism than a supra-national organization. As we describe in the sections that follow, significant limitations exist in the three dimensions of physical infrastructure, regulatory, and commercial integration. Moreover, the Argentine financial crisis caps a period of relative stagnation in the progress of MERCOSUR relations. As we detail below, the electricity sector could become a centrifugal force for integration if certain steps towards macroeconomic policy coordination are first taken.7

Latin America, like other regions, has experienced a paradigm shift in terms of economic thinking away from nationally oriented import substituting industrialization towards a more outward model of neoliberal growth, including movement towards deregulation, improved investment climate, and privatization (Hira, 1998). Liberalization of trade and macroeconomic variables has now moved to include infrastructure industries, including electricity.

The founding of the MERCOSUR must also be seen in the context of the Americas, i.e., in terms of the development of the NAFTA which gave Mexico privileged access to the US and Canadian markets. More importantly, MERCOSUR should be seen in the light of the strategy of the Brazilian posture towards a possible Free Trade Agreement of the Americas (FTAA) in the future (Haggard, 1998; Phillips, 2001). Brazil is the key to the region, having not only the largest potential market (estimated population of 170 million in 2000), but also the most diversified industrial and agricultural base. Since Chile sees the MERCOSUR countries as lagging behind it in terms of the economic reform process and has always expected to follow Mexico in an exclusive free trade agreement with the US, it has chosen to remain only an associate member.8

3.1. Electricity reform follows macroeconomic reform

As Chile was the pioneer in neoliberal reforms in the region during the 1970s, it was also the first to privatize its electricity sector in 1982. Argentina’s macroeconomic reform process began in the 1970s under the military regime at the time, but was followed unevenly during the early 1980s until the government of Carlos Menem was elected in 1989. Menem’s government was the first to move beyond basic macroeconomic stabilization measures to privatization. Bolivia’s economic reform process began in 1985 with a shock therapy program to halt the then highest inflation rates in the world. Bolivia’s privatization process has been similarly thorough and deep. By contrast, Brazil has a long-standing history of industrial policy, with macroeconomic reform coming quite late in the 1990s, under then Finance Minister Fernando Henrique Cardoso. The Brazilian economic reform process continues to oscillate between the pro-industrial policy and the pro-reform wings.11 Paraguay’s fragile democracy is still dominated by the military, and with its relative resource abundance in terms of hydroelectricity exports, of which 90% is exported, so there has been no urgency to adopt neoliberal reforms. Uruguay finds itself increasingly burdened by pressures for neoliberal reforms due to its high debt load and faltering economy. Yet, Uruguay, once called “the Switzerland of Latin America,” has maintained from the 1930s its tradition of a strong democratic social welfare state.12 The strong unions of Uruguay’s civil service workers have made privatization and deregulation in every sector an uphill battle.13 Uruguayans strongly rejected in a plebiscite in 1998 (Hira, 2003), a move that would have privatized the state-run electricity company Administración Nacional de Usinas y Transmisiones Eléctricas (UTE). Nonetheless, the Uruguayan government has undertaken several reforms that have created more market-like features within the system. In 1997, the Uruguayan Parliament allowed for private generation and marketing of electricity, reducing for the

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6 This section expands upon recent work (Hira, 2001a, b; Hira and Amaya, 2003) to elucidate further the challenges in coordinating the domestic with the international regulatory systems for electricity in the MERCOSUR. A general overview of the MERCOSUR is found in Roett (1999) and Coffey (1998).

7 We refer broadly to the electricity sector, noting that electricity sector integration in the region may occur through both transmission lines and the development of gas pipelines for electricity generation.

8 Chile’s recent free trade agreement with the European Union underscores this independent foreign economic policy stance.

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9 The source of all dates is the Encyclopaedia Britannica.

10 There were various “heterodox” policy incidents, including wage and price controls under newly elected President Alfonso in 1983. These experiments consistently failed.

11 For example, fiscal reform, despite numerous efforts on the part of governing parties has never been accomplished in Brazil. The front-runner in the 2002 presidential campaign, Lula of the Worker’s Party (PT), and since elected President of Brazil had a platform that promised significantly greater movement back towards an industrial policy that has spooked foreign investors in the energy sector. In 2002, AES announced discussions of selling some of its significant assets in Brazil.

12 The strong democratic social welfare state dates back to the 1930s Battle era and continued until the military government of 1973–1985. The state employs an estimated 25% of the Uruguayan work force (Price Waterhouse, 1997). Some higher estimates than this one can even be found! A general plebiscite on privatization of state-run industries, including electricity, was rejected by 72% in 1992.
first time state control of the sector. UTE retains the option, however, of taking up to a 40% stake in any private power plant. The Parliament also created the ADME (Electrical Market Administration) to control the wholesale electricity market.

In sum, there have been “three generations” of electricity reform in Latin America, as pointed out by Fischer and Serra (2000), and the timing and nature of these reforms follow the macroeconomic developments described above. The first generation would include Chile (1982). The second stage includes Argentina (1989) and Bolivia (1994). The third generation includes Colombia (1994) and Brazil (1999). Paraguay and Uruguay do not intend to privatize their electricity systems, but Uruguay has adopted some reforms in its electricity sector.

3.2. Infrastructure integration

As Fig. 2 shows, the current generation mix in the region is not only dominated by the overall size of the Brazilian market, but also by its hydropower sources.

Fig. 2 shows that there is a natural market for energy integration in the Southern Cone. There is a complementarity of fuel sources and of surplus and deficit countries. Recent extensive findings of natural gas in Bolivia now complement those of Argentina to provide a surplus fuel source for Brazil, Chile, and Uruguay, which all need imports.

However, the regional energy market is still in a very early stage of integration, as demonstrated in Table 6. Indeed, at the moment, almost all of the regional electricity trade, as reflected in Table 6, below exists through the three large bi-national dam projects dating back two decades:

- the Itaipu dam, between Brazil and Paraguay, with a capacity of 12,600 MW, almost entirely dedicated to Brazil (and is counted as a Paraguayan export);
- the Yacyretá dam, between Argentina and Paraguay, with a capacity of 2700 MW, almost entirely dedicated to Argentina;
- the Salto Grande dam, between Argentina and Uruguay, with a capacity of 1890 MW shared between the two countries.

In Table 6, the transmission capabilities in bold are entirely dedicated to the electricity from the bi-national dam projects. Since they are controlled by distinct treaties between the two governments, and all the energy is generated and transmitted by state-owned enterprises, these projects should be seen as “working on a different track” from the market deregulation occurring in the rest of the energy sectors.

Additional transmission lines between Argentina and Brazil, Argentina and Chile, Brazil and Bolivia, Brazil and Uruguay and additional dams between Argentina and Brazil and Argentina and Paraguay are also planned or under study, but as we note in the commercial section below, an investment crunch has put them in question. A number of gas pipeline projects, if completed, will also shape the regional market and
may substitute for new transmission lines. In sum, the limitations of actual physical links among the MERCOSUR countries is a severe constraint on the possibilities for regional trading.

### 3.3. Regulatory integration

Beyond the basic problems with limited infrastructure, there is a more daunting challenge for energy integration in the MERCOSUR: harmonizing regulatory structures. The basic regulatory structure of each nation’s electricity sector is summarized in Tables 7 and 8.17

Table 7 points to the fact that the most daunting obstacle for further integration in the MERCOSUR is the key differences in regulation of the electricity markets, including whether there is a separate systems and market operator, how transmission is set up (ownership, tolls, and investment), the system for establishing contracts, how the wholesale market functions and operates, and who can participate, how the retail pricing system is defined, and what are the quality standards and contracting systems for distribution.

As Table 8 shows, in the Paraguayan, Uruguayan, and Brazilian markets, the state still plays a monopolistic or dominant role. In the case of Chile, there is neither an independent system or wholesale market operator, nor clear anti-trust guidelines. Thus, for the moment, the potential for integration is limited in the MERCOSUR region by both regulatory differences and the state’s role in each system.

### 3.4. Commercial integration

With the exception of Paraguay and Uruguay, due to the prominence of the bi-national dams, actual commercial exchange of electricity is quite limited in the region, as illustrated in Table 9.

On the surface, the market conditions would seem to be propitious for an increase in energy exchange, driven by huge and increasing Brazilian demand. Brazil needs to multiply existing generational capacity to meet growing demand. Indeed, a EIA (2003) report notes that while generational capacity grew 32% from 1990 to 2000, demand grew by 58%! In addition, a severe drought led to temporary power rationing from June 2001 to March 2002, leading to further calls for expansion of capacity. The Brazilian government’s long-term response has been to increase the importation of natural gas supplies, particularly from Bolivia, where state company Petrobras has major interests. Despite the new pipelines from Argentina and Bolivia, the Brazilian government has been unable to attract major new investments in thermoelectric plants to convert this gas, in part because of macroeconomic and political uncertainty, but mainly because of unclear regulation of the market. Moreover, developing a good market price mechanism for gas-generated electricity, given the important contributions of the Itaipu dam to Brazilian energy, is a considerable challenge for both further integration and investment in new domestic gas-fired generation capacity. Indeed, in heavy rainfall years, the marginal cost of hydropower may approach zero and negatively affect the profitability of gas-fired power plants. Furthermore, since Brazil’s state companies, Petrobras in gas and oil, and Eletrobras in electricity, retain dominant market positions, that further concerns potential investors. The problems of the volatility in the exchange rate have led the Brazilian government to experiment with various types of mechanisms to assure investors on this issue.

### 3.5. Prospects

If we anticipate the possibilities for a MERCOSUR agreement on electricity market integration, we can also
anticipate the market and social problems that might result. Unlike NAFTA, the primary vehicle by which MERCOSUR moves forward is the informal *Grupos de Trabajo* (working groups) that consist of groups of national level government officials who meet occasion-

**Table 7**
Regulatory bodies

<table>
<thead>
<tr>
<th>Country</th>
<th>Regulatory bodies (main role)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>Ente Regulador Nacional de la Electricidad (ENRE)</td>
</tr>
<tr>
<td>Bolivia</td>
<td>Superintendency of Electricity</td>
</tr>
<tr>
<td>Brazil</td>
<td>Agencia Nacional de Energia Electrica (ANEEL)</td>
</tr>
<tr>
<td>Chile</td>
<td>Comision Nacional de Energia (CNE)</td>
</tr>
<tr>
<td>Paraguay</td>
<td>Administracion Nacional de la Electricidad (ANDE) (regulatory and state monopoly producer)</td>
</tr>
<tr>
<td>Uruguay</td>
<td>Administracion Nacional de Usinas y Tramisiones Electricas (UTE) (state monopoly producer and electricity regulator)</td>
</tr>
<tr>
<td></td>
<td>Undidad Reguladora de Servicios de Energia y Agua (UREE) (utilities regulator- focused more on quality of service)</td>
</tr>
<tr>
<td></td>
<td>ADME (Administracion del Mercado Electrico) (regulation of new wholesale generation)</td>
</tr>
</tbody>
</table>

**Table 8**
Market structure

<table>
<thead>
<tr>
<th>Country</th>
<th>Vertical integration</th>
<th>Generation</th>
<th>Coordination of sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>Independent transmission company (TRANSENER, a private company run by National Grid (UK) that won public concession). Cannot have assets in generation or distribution</td>
<td>Firms with dist. assets are limited to 10% of the national gen. capacity. Firms with more than a 50%-stake in an elec. company cannot have a stake in any other.</td>
<td>No dominant owner (because of market share restrictions)</td>
</tr>
<tr>
<td>Bolivia</td>
<td>Independent transmission company (ETE, a private company). Companies may only participate in one sub-sector, generation, transmission, or distribution</td>
<td>Restriction of a 35% market share for generation.</td>
<td>Four generation companies (50% private, 50% govt.-owned)</td>
</tr>
<tr>
<td>Brazil</td>
<td>Transmission run by the vertically integrated state company Eletrobras. Gradual unbundling (and some privatization) of state companies into separate generation, transmission, and distribution entities over 10 years</td>
<td>Regulations unclear, but dominance of public enterprises</td>
<td>Eletrobras and other state firms control 80% of generation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chile</td>
<td>Independent transmission company (TRANSELEC, owned by Hydro-Québec) No restrictions</td>
<td>No restrictions</td>
<td>Endesa 50%, Gener (AES) 20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paraguay</td>
<td>Transmission run by the vertically integrated state monopoly ANDE.</td>
<td>Complete</td>
<td>ANDE (state)</td>
</tr>
<tr>
<td>Uruguay</td>
<td>Transmission run by the vertically integrated state monopoly UTE.</td>
<td>Complete</td>
<td>UTE (state)</td>
</tr>
</tbody>
</table>

**Sources:** EIA, CIER (1999) and USITC (2000).
preserved national standards for environmental protection and security of supply (see Hira and Amaya, 2003). Therefore, this memo seems to serve more as a description of intentions, rather than a plan of action.

In order to develop a real plan of action for an integrated energy market in MERCOSUR, a variety of issues must be addressed. Regional market operations issues such as coordinating systems dispatch, developing technical standards for quality, safety, and reliability, and the effects of increased price volatility and changes in prices levels, are probably less important than at first glance. The bi-national dams are governed well by long-standing bilateral treaties. The strong tradition of executive control in Latin American countries means a NAFTA-type international tribunal is highly unlikely for the foreseeable future. These issues could be worked out by the present working group, with strong input from the private sector and public sector companies involved, leading to new treaties for the new forms of trading. As pointed out, the complementarity of supply and demand across borders as well as of fuel sources, creates a natural momentum for integration in the region. On the other hand, vested interests can also be expected to resist such movement (see Hira, 2003).

The key bilateral relationship is Brazil–Argentina. However, resistance to integration has not arisen due to some crucial factors. These include Argentina’s abundant supply of natural gas, the fact that Argentine consumption has dropped along with its economic decline, and Argentina’s desperate need for export revenues to make debt payments. More importantly, the amount of exports to Brazil is still quite limited. The technical and systems issues could be handled by coordination among the different regulatory bodies, rather than a unified decision-making structure. Therefore, the short-term solution for the development of the MERCOSUR market lies in attracting new investment into infrastructure in the region.

The second set of issues for a regional electricity market centers on dispute resolution mechanisms, which would be a very strong attraction for new investment. These have never been a serious part of the MERCOSUR, and the contemplation of NAFTA-style supranational commissions seems only remotely possible. However, since this problem cuts across energy to other issues, the first step would be an effort to harmonize the legal code on contract law among the various countries. Since this could take years, perhaps the better step would be to attempt to create a MERCOSUR code that would take precedence over national codes. The second question would be one of jurisdiction. This could be a particularly sticky point since large state-owned companies such as Eletrobrás (Brazil) and UTE (Uruguay) will grow into regional giants. A possibility might include a mixed jurisdictional panel, which would have members from all countries, or one with members from countries not involved in the particular dispute.

The third set of issues would surround anti-trust measures in the region. Latin American nations historically have a very limited tradition of breaking up market concentration (Naim and Tulchin, 1999). However, the fact that there are major state-owned players in both the electricity and gas markets in the region will raise questions not only of market concentration but also of unfair subsidization through favorable tax codes, lower environmental regulations, outright subsidization, etc. Since MERCOSUR is set up to increase competitiveness vis-à-vis other regions of the world, it would not make sense to break up the large state or private companies that could potentially compete with Electricité de France (France) and other corporate giants who also receive important support from their governments. Therefore, a compromise may be to look to reduce the levels of collusion among these large regional corporate players, but at the same time to

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**Table 9**

Electricity exchange in 2000, by country, in GWh

<table>
<thead>
<tr>
<th></th>
<th>Total imports</th>
<th>% Of consumption imported</th>
<th>Total exports</th>
<th>% Of generation exported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>7,500</td>
<td>9.28</td>
<td>3,700</td>
<td>4.47</td>
</tr>
<tr>
<td>Bolivia</td>
<td>10</td>
<td>0.27</td>
<td>10</td>
<td>0.26</td>
</tr>
<tr>
<td>Brazil</td>
<td>42,300</td>
<td>11.73</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Chile</td>
<td>—</td>
<td>0</td>
<td>—</td>
<td>0</td>
</tr>
<tr>
<td>Paraguay</td>
<td>—</td>
<td>0</td>
<td>47,380</td>
<td>89.31</td>
</tr>
<tr>
<td>Uruguay</td>
<td>1,300</td>
<td>17.68</td>
<td>950</td>
<td>12.61</td>
</tr>
<tr>
<td><strong>Total/average</strong></td>
<td><strong>51,110</strong></td>
<td><strong>6.49</strong></td>
<td><strong>52,050</strong></td>
<td><strong>17.77</strong></td>
</tr>
</tbody>
</table>

*Total exports and imports are not equal because of small exchanges with other countries. Source: EIA (2002a) world energy database.*

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18 See also Memorandum de Entendimiento Relativo A Los Inter-cambios Electricos e Integracion Electrica en el MERCOSUR, XIV CMC 23/VII/98.

19 A brief perusal of US Country Commercial Guides reveals vast differences in the treatment of investment, for instance. MERCOSUR has an arbitral dispute mechanism, but it seems to be only open to member states as complainants.
allow them to capture significant portions of the domestic marketplace. Perhaps a solution would be to ensure that national champions such as YPF (Argentina), Endesa (Chile), UTE (Uruguay), ANDE (Paraguay), and Eletrobras (Brazil) remain strong. Each of these companies represents thousands of jobs as well as national pride in the marketplace. Therefore, anti-trust mechanisms in the MERCOSUR context have to accomplish a unique balancing act between competition and preservation of national priorities.

The last but not least important set of issues surrounding a regional electricity market will be harmonization of environmental standards. As noted above, there are wide variations in the environmental codes of the region. Therefore, the fear of many environmental activists will be that MERCOSUR will reduce its standards to those of the partner with the lowest standards. With the exception of Paraguay, each country in the region is heavily urbanized. The most likely scenario would be an informal agreement (perhaps with a formal declaration of intent) to begin to share information and harmonize national standards. Cooperation could begin with attention to important shared resources, such as the Rio de la Plata, and then could extend to the sharing of energy efficiency and alternative energy technologies. A most positive step in this direction was recently taken in the establishment of a mixed commission for energy matters by Argentina and Brazil. Initial talking points include markets (prices), operation (physical structures and interconnections), regulation (commercial and technical), financing and compatibility of regulations and bilateral projects. The goal of the commission is to reach compatibility and harmonization among the norms of the two countries.20

4. North America: the NAFTA

The three North American countries, Canada, the United States, and Mexico have in the NAFTA taken initial steps towards trilateral trade in energy and electricity. Trilateral electricity sector integration, however, is at the beginning stage. A review of North America’s regional electricity sectors integration as indicated by the extent of infrastructural, regulatory, and commercial dimensions of integration, reveals that electricity trade relations in North America are bilateral: Canada–United States and United States–Mexico. Up until the late 1980s, the key international trade agreement governing North American electricity trade was the multilateral General Agreement on Tariffs and Trade.21 Nevertheless, several historical influences have contributed to the particular North American pattern of electricity sector integration: (i) the differences in the size, wealth, and power of Canada, the US, and Mexico have tended to foster unilateral and bilateral, rather than trilateral, electricity policy initiatives; (ii) the differences in national and sub-national divisions of political powers over electricity system development have tended to make electricity sector integration difficult; and (iii) the particular history of electricity and energy exports has resulted in some protection of national interests. This historical legacy has been carried forward into the provisions for electricity trade in the 1988 Canada–US Free Trade Agreement (FTA, 1988) and into the electricity trade provisions in the 1992 trilateral NAFTA among Canada, the United States, and Mexico.22

Although most provisions in NAFTA extend to all three countries, the manner in which Mexico included energy and electricity in the agreement differed significantly from the way Canada had done it in the FTA. Whereas in the FTA, Canada granted importers proportional rights to access Canadian electricity should there be a need to curb exports because of a crisis, Mexico exempted itself from such a clause in NAFTA.23 Unlike Canada’s agreement in the FTA (in sections 902.5–905.2), Mexico, in its provision for energy and electricity trade in NAFTA (see NAFTA, 1992, sections 605 and 608.2), insisted that the US respect Mexico’s constitution, disallowed assured proportional access to US electricity importers, and restricted foreign ownership and restructuring in the energy sector (NAFTA 602.3; Plourde, 1993). Whereas Canada extended national treatment to foreign energy corporations in the FTA, Mexico restricted foreign-controlled electrical sector integration to intraregional and bilateral exchanges.

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20 Valor Economico, May 28, 2002, cited in Eletrobrás, Informe Eletrônico, no. 886; May 28, 2002. A rapprochement between Brazil and Argentina should be possible now that exchange rate differences are no longer a factor with the Argentine devaluation, and Argentine industry can begin to recover. But of course much depends on the political climate in Argentina, which remains volatile.


22 North America’s asymmetrical political and economic power relations, including the US tendency towards unilateral decision-making, Canada’s preference for bilateral resolution of issues, historical conflicts over the export of Canadian electricity to the US, Mexico’s strongly centralized political system, and the fear that trilateral cooperation would result in replication of US policies and institutional restructuring make trilateral cooperation in the formulation of North American electricity trade policy difficult (see Wilson-Forsberg, 2001; North–South Trade and Investment, 2001, p. 10; Grauer, 1961, pp. 249, 260; Froschauer, 1999; CEA and NRC, 2000, p. 62). For instance, in line with its more centralized tradition, Mexico reserved national energy sovereignty under the NAFTA treaty (Chapter 6, Annex 602.3). Canadian provinces and US states also have authority to regulate most electricity sales; however, as authorized by the 1935 Federal Power Act, the US federal government has jurisdiction over regulations of wholesale sales (Hunt, 2002, p. 253). This US federal wholesale sales jurisdiction continues to be important because the Federal Energy Regulatory Commission (FERC) practices in wholesale trading and in reciprocity in transmission access tend to be adopted by provincial utility commissions in Canada.

23Canada (1992, p. 6, Annex 602.3).
generation to own-use, cogeneration, and independent power production, so long as the electricity is not intended for public use.24 Unlike Canada’s NEB, which primarily regulates the export sales of surplus power, Mexico’s Comisión Federal de Electricidad (CFE) retains the authority to buy all surplus power.25 The Mexican government reserved for itself investment rights and the provision of services in such activities as the supply of electricity as a public service in Mexico, including “the generation, transmission, transformation, distribution and sale of electricity.”26 Nevertheless, Mexico allowed Canada and the US to bid for services and construction contracts in the Mexican energy sector (Plourde, 1993), and with the election of pro-business President Vicente Fox in 2000, as well as a projected supply shortfall amidst growing demand, the question of allowing private and foreign investment in the electricity sectors has been discussed more seriously.

However, in the year 2000, electricity sector integration in North America has shown little trilateral but mostly bilateral internationalization—Canada–United States and United States–Mexico—and, when compared with Latin America and Nordic countries on a continuum towards full integration, North America has developed only the beginning stages of its infrastructural, regulatory, and commercial integration (Table 1).

### 4.1. Infrastructure integration

The degree of integration of bilateral electricity markets in North America is indicated by the interconnections between Canada and the US and between the US and Mexico. For instance, the Canada–US border is crossed by more than 37 major interconnections with a capability of 18,977 MW, whereas the major interconnections between the US and Mexico are capable of handling only 944 MW (see Table 1).

Northern Mexico is currently connected in nine places to two US electricity power grids in California and Texas, though cross-border trade is relatively minor. The total imported power capability through the nine connecting US–Mexico border points is only 944 MW. According to a Canadian report the CFE imported 2000 GWh from the US, or about 1.37% of total power sales in Mexico (144,996 GWh) (North-South Trade and Investment, 25). Plans exist to increase electricity connections between Baja California and California (North-South Trade and Investment) and Mexico has been invited to join the Texas electric power pool (ERCOT).

In North America’s transnational regions that straddle both sides of the national borders, the trading of electricity generated from a variety of fuel sources is disproportional and bilateral. Decision-makers in these cross-border electricity markets can draw on a mix of modes of electricity generation—hydro, fossil-fuelled (coal, oil, and natural gas), nuclear, and geothermal—among other sources (see Fig. 3), creating incentives for trading electricity. For instance, Mexico can export surplus electricity generated from geothermal sources to California. Canada can energy-bank in its hydro reservoirs while buying low-cost electricity generated

#### Table 10
Cross-border transmission capabilities

<table>
<thead>
<tr>
<th>Transmission capabilities</th>
<th>To</th>
<th>MW</th>
<th>Total production capacity (%)a</th>
</tr>
</thead>
<tbody>
<tr>
<td>From</td>
<td>US</td>
<td>18,977</td>
<td>17.13</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>18,977</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(37 major transmission lines at 69-kV or higher between Canada and the US in 1999).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>US</td>
<td>Mexico</td>
<td>944</td>
<td>2.51</td>
</tr>
<tr>
<td></td>
<td>Canada</td>
<td>18,977</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>19,921</td>
<td></td>
</tr>
<tr>
<td>Mexico</td>
<td>US</td>
<td>944</td>
<td>2.42</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>944</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(9 major transmission lines at 115-kV or higher between the US and Mexico in 1999).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

aTotal production capacity in 2000 was 110,790 MW for Canada, 794,890 MW for the US and 39,000 MW for Mexico. Sources: CEA and NRCan (2000) and NAEWG (2002).

26 Plourde (1993, pp. 6–7).
from nuclear or fossil-fuel sources from the US, and then, water level permitting, flexibly run individual generating units to suit peak hour demands when electricity is more expensive in the domestic or export market. Indicators, such as the proportion of total capacity available in each country that could be exported, given the present transmission capability, show that Canada would be capable of exporting 17% of its electricity production, whereas the US and Mexico are capable of only 2.5% (Table 10). That shows that, for Canada, its export relationship with the US has become more extensive than that between Mexico and the US.

4.2. Regulatory integration

The international electricity trade in North America is regulated in each country at the federal level (Table 11). The US federal government does not regulate imports of electric energy, but its Department of Energy (DOE) regulates the international electricity trade, has exclusive jurisdiction over both the construction of cross-border electric transmission lines and the export of electric energy, and provides Presidential permits for power lines. In addition, the FERC approves rates for wholesale electricity and transmission in interstate commerce for private utilities, power marketers, power pools, power exchanges and independent system operators (NAEWG, 2002).

In Canada, the NEB (governed by the NEB Act) is an independent federal agency that regulates Canadian electric power exports in the Canadian public interest. It reports through the Minister of Natural Resources to the Parliament of Canada. It holds either written or oral public hearings where applicants and interested parties can participate. The maximum duration of export licenses it grants is 30 years. Provincial utility commissions hold jurisdictional responsibilities over

<table>
<thead>
<tr>
<th>Country</th>
<th>Regulatory bodies (main role)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>National Energy Board (NEB) (electricity exports, cross-border transmission lines, environmental assessment)</td>
</tr>
<tr>
<td></td>
<td>Natural Resources Canada (NEB reports to this department, policy)</td>
</tr>
<tr>
<td></td>
<td>Provincial Utility Commissions (generation, transmission, distribution, rates, electricity market reforms in provinces)</td>
</tr>
<tr>
<td></td>
<td>North American Electric Reliability Council (NERC) (cross-border system reliability)</td>
</tr>
<tr>
<td>US</td>
<td>Department of Energy (DOE) (cross-border transmission lines, exports)</td>
</tr>
<tr>
<td></td>
<td>Federal Energy Regulatory Commission (FERC) (wholesale and interstate transmission)</td>
</tr>
<tr>
<td></td>
<td>State Commissions (retail, transmission, distribution, electricity market reforms in States)</td>
</tr>
<tr>
<td>Mexico</td>
<td>Comisión de la Regulación de la Energía (CRE) (regulator for the energy sector)</td>
</tr>
<tr>
<td></td>
<td>Comisión Federal de Electricidad (CFE) (public monopoly supplier of electricity, manages exports and imports)</td>
</tr>
</tbody>
</table>

Fig. 3. Electricity generation by country and source in 2000 (Source: EIA, 2002b).
transmission, generation, distribution, rates, and electricity market reforms (such as introducing wholesale or retail competition).27

In Mexico, constitutional provisions (Articles 25, 27 and 28) set the legal framework for the electricity industry for the generation, transmission, distribution and supply of electricity. Most transmission lines are owned and regulated by the national government. In 1994, 2 years after NAFTA was signed, Mexico’s CRE was created as a consultative body reporting to the Ministry of Energy, and its role as an advisor was limited to the gas and electricity industry. The CRE Act (1995) transformed the Commission’s role to that of an empowered, independent regulator with technical and operational autonomy and provided the CRE with a legislative mandate to regulate the activities of both public and private operators in the electricity and gas industries (NAEWG, 2002). The CRE regulates the import and export of electricity, and by December 10, 2001 it had granted eight import and five export permits. However, the granting of these permits for up to 134 MW of imports and 2129 MW exports (NAEWG, 2002) does not mean that the applicants will export or import electricity in these volumes.

Not only government institutions, but diverse groups of transmission providers which formed their own regulatory body adhered to transmission reliability criteria. For instance, members of the non-profit corporation North American Electric Reliability Council (NERC) (Table 11), such as investor-owned utilities, federal power agencies, rural electric cooperatives, state, municipal, and provincial utilities, independent power producers, power marketers, and end-use customers, continue to concern themselves with the trans-border reliability of the transmission systems in three regions of the US: the Western Electricity Coordinating Council (WECC), the North East Power Coordinating Council (NPCC), and the Mid-Continent Area Power Pool (MAPP) (NERC, 2002). Canadian regions neighboring the US have formed peripheral attachments to the larger regional clusters of US States. The Western Canadian provinces of Alberta, and British Columbia, and the northern portion of Baja California Norte, Mexico, and 15 US states are part of WECC; Saskatchewan, Manitoba and seven US states are part of MAAP; and Ontario, Québec, the Maritime Provinces of Canada, New York and the six New England States belong to the NPCC.

The compatibility of the three markets is limited because of differences in the regulation and ownership structure (Table 12). In Canada, provincial governments also own most vertically integrated utilities, including Hydro-Québec, the former Ontario Hydro, Manitoba Hydro, and BC Hydro, and foster export initiatives. These public utilities also own their transmission lines (Table 12). Ownership varies in the US. In about half the States, transmission lines are owned by vertically integrated investor-owned electric utilities that are principally State regulated, meaning that State commissions set the retail power sales rates and the transmission and distribution rates of the utilities. However, some State commissions have ordered their vertically integrated utilities to restructure and divest their generation assets, leaving them primarily with only State regulated distribution service functions (NAEWG, 2002). In Mexico, the state controls all generation, transmission, and distribution.

4.3. Commercial integration

Canada’s international electricity markets, more than those of Mexico, have been integrated with the US markets. While for the US and Mexico, the exports are very small, respectively, 0.39% and 0.04% of the electricity these countries generate, electricity exports are far more significant for Canada, for they constitute 8.47% of all the electricity it generates (see Table 13).

As a percentage of consumption, electricity imports in the US constitute only 1.35%, but these imports are significant for the states bordering Canada and Mexico (see Table 13). That is especially the case in the summer when air-conditioning demand is high in the US and surplus electricity is available from Canada, whose electricity demands are highest during the winter months. Recently, imports of electricity from the US into Canada have constituted more than 2.5% of its consumption, suggesting that Canadian provinces are taking advantage of energy-banking in the cross-border market.

4.4. Prospects

Despite the initial steps taken in NAFTA towards trilateral trade in electricity, prospects of integration are likely to continue on a bilateral basis. Besides the large transmission distances, several obstacles to integration remain: the inequality between the countries are not bridged, the interconnections of transmission systems within each country are not completely integrated, and the national regulatory autonomy remains.

No coordination strategy in terms of infrastructure investment exists, especially one that would overcome

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27To date, two provinces (Alberta and Ontario) have initiated retail competition, although the Ontario government stepped back from it after the public outrage over soaring prices. The electricity markets in these two provinces account for nearly half the Canadian total. Open access to transmission has achieved broader acceptance, with most provinces having already initiated it or having identified a target date for its commencement. The wholesale competition dates for the various provinces are as follows: Alberta and British Columbia, 1996; Québec and Manitoba, 1997; Saskatchewan, 2001; Ontario, 2002; New Brunswick, 2003 (NAEWG, 2002).
the asymmetry or inequality that exists between the three countries. For example, to overcome regional inequality in North American markets, Mexico’s President Vicente Fox has proposed that initiatives be undertaken towards the long-term (20–30 year) goal of an integrated sub-region loosely modeled on the experience of the EU. He argues that inequality within NAFTA will inevitably require some kind of financial transfer mechanism, such as the EU cohesion funds for investments in infrastructure, funds that enabled Spain, Portugal, Ireland and Greece to meet EU convergence requirements (Wilson-Forsberg, 2001). Others argue that North American market integration should proceed at two speeds, that Canada and the US proceed bilaterally because they have similarly advanced economies, mature institutions and a longer history of managing integration, and that both should challenge Mexico to seek convergence with standards set in their bilateral relationship. Other skeptics maintain that NAFTA is a free trade area, a stage that the EU passed decades ago, and that EU member countries are of more equal size and power and, therefore, the EU is not a good model for North America (Pastor cited by Wilson-Forsberg, 2001). Nevertheless, at the more informal level of civil society (NGOs concerned with environmental protection, labor issues, human rights, social development, and consequences of NAFTA) and at the formal level in April 2000 between Fox, Bush, and Chrétien with the creation of the North American Energy Working Group, an issue by issue trilateral cooperation has emerged.

The electricity infrastructure within the three countries is not well integrated. ‘North America has major electric power grids but does not have an overall, comprehensive grid.’28 Northern and Southern Mexico’s transmission system is poorly integrated. And in Canada, the absence of inter-provincial electricity regulations—‘when power from one province simply enters another province there is no federal regulation’ (CAE and NRCan, 2000)—continues to leave trans-

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**Table 12**

<table>
<thead>
<tr>
<th>Country</th>
<th>Vertical integration</th>
<th>Horizontal integration</th>
<th>Key generator (owner)</th>
<th>Coordination of sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>Provincial jurisdiction</td>
<td>No restrictions</td>
<td>Hydro-Québec (Province)</td>
<td>Bilateral contracts</td>
</tr>
<tr>
<td>US</td>
<td>State jurisdiction</td>
<td>No restrictions</td>
<td>Many generators</td>
<td>Spot markets</td>
</tr>
<tr>
<td>Mexico</td>
<td>Federal jurisdiction</td>
<td>Restricted by Constitution</td>
<td>CFE (Nation)</td>
<td>Bilateral contracts</td>
</tr>
</tbody>
</table>

*Sources: NAEWG (2002); NEB (2001); Canadian Electricity Association and Natural Resources Canada.*

**Table 13**

<table>
<thead>
<tr>
<th></th>
<th>Total imports</th>
<th>% Of consumption imported</th>
<th>Total exports</th>
<th>% Of generation exported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>12,700</td>
<td>2.54</td>
<td>48,800</td>
<td>8.47</td>
</tr>
<tr>
<td>US</td>
<td>48,900</td>
<td>1.35</td>
<td>14,800</td>
<td>0.39</td>
</tr>
<tr>
<td>Mexico</td>
<td>2,200</td>
<td>1.18</td>
<td>100</td>
<td>0.04</td>
</tr>
<tr>
<td>Total/average</td>
<td>57,640</td>
<td>1.69</td>
<td>57,640</td>
<td>2.97</td>
</tr>
</tbody>
</table>

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28 ‘Within the area of the NERC councils there are three major systems—the Eastern Power Grid, the Western Power Grid, and the grid within the Electric Reliability Council of Texas (ERCOT)—that have limited cross-grid interconnection capabilities. […] In addition, interconnection compatibility issues exist outside the NERC councils, particularly between Mexico and the United States’ (NAEWG, 2002).
shipment of electricity across provincial power lines unresolved.29 Most Canadian electricity-exporting provinces and their utility commissions resist Canadian national (in the sense of federal or inter-provincial) electricity regulatory policies, but provincial commissions adopt US FERC regulations (which require open transmission access inside Canada) in order to achieve and retain wholesale marketing status in the United States (CAE and NRCan, 2000; Froschauer, 1999).

Although the three countries have made provisions for trilateral electricity trade in NAFTA, each country retains autonomous jurisdictions over regulation. Whereas Mexico’s regulation is more centralized, those of the US and Canada are more decentralized at the national and sub-national level. In Canada, however, provincial utility commissions tend to imitate US regulatory requirements, but these requirements do not extend to forced vertical de-integration of ownership (but they do extend to administrative de-integration). Commercial integration has proceeded to some forms of international ownership and international trading, but they are far from spot market or secondary future market integration. Trade irritants re-surface, such as financial settlements related to British Columbia exports to California during the recent major electricity supply crisis.

5. Conclusion: Comparative outcomes in the three regions

In this paper, we have studied the three dimensions of the integration continuum in three regions of the world. Tables 14 and 15 summarize the main findings of our research, where important (but not exhaustive) integration indicators are provided for comparative purposes.

Infrastructure integration, measured here as the ratio of the total transmission capability over the total production capacity, is compared among regions in Table 14. It can easily be seen that Nordic countries are more harmoniously intertwined, with almost similar potentials of export/import for electricity. In MERCOSUR, the same ratio (indicator) varies extensively, with extremely high ratios for countries that are only exporting under long-term contracts (Paraguay, Uruguay), and zero value for isolated countries (Bolivia). North America is also unevenly integrated; only Canada has an important exchange capacity. Although the interpretation of these indicators should be made with the geography and size of the country in mind, it provides an explicit method for evaluating the level of infrastructure integration.

It can, however, be seen that countries in these three regions are very reluctant to create common institutions, and even where integration is the most advanced, in Nordic countries, the common institution, Nordel, has no executive power. In the electricity sector (and even in the energy sector), no common regulatory institutions have ever been created to deal with regional issues, despite the open will, at least in Nordic counties and in North America, to better integrate in the long term the energy sector. Furthermore, both MERCOSUR and NAFTA member countries show striking differences in the way that their regulatory systems are set up and run.

Finally, Table 15 provides a comparison of two possible indicators of actual commercial integration: the average percentages of imports (over consumption) and exports (over production) for the three regions. Again, consistent with the level of the infrastructure integration, Nordic countries are ahead of other regions in that aspect. It is also important to consider other aspects of commercial integration: the existence of a common market price reference, the cross-ownership of companies among countries in regions, and the dominance of state-owned enterprises in some. But again, as covered in more details in our sections on the different regions (see especially Tables 4, 8 and 12 on market structure), the Nordic group stands alone in a very advanced position on these indicators.

Although limited in scope, we have provided a clear framework for measuring electricity integration and its progress across regions. Beyond the analysis of integration indicators, we have discussed the serious

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29 Canada’s federal government, by wanting to avoid political conflict with the provinces, avoids national regulation and enforcement of its jurisdiction over inter-provincial and trans-provincial shipment of electricity in Canada. In line with that policy, the National Energy Board focuses on exports and avoids its original national policy mandate.
obstacles electricity integration faces in North and South America, and how the Nordic countries have been more successful in this endeavor. The article suggests the presence of several key factors that might help to explain the differences in both the dynamics and outcomes of the integration processes. First, the general complementarity of generation fuel sources, peak-load consumption times, and the desire of certain nations or sub-national areas to export and/or import, seems to be the primary motivator behind integration. Second, physical infrastructure is a key to the shape of the integration process. The relatively small size and proximity of Nordic countries is an explanatory factor compared to the two American cases. Third, relative macroeconomic stability appears to be a necessary item for electricity integration. Both in the case of Mexico and the MERCOSUR, macroeconomic uncertainty inhibits investment flows. Conversely, it helps in the Nordic case to foster international cross-investment. Fourth, underlying norms, principles, and a history of cooperation seem to be crucial. This set the Nordic countries apart from other regions, where there is a much lower level of cooperation. In the case of North America in reference to the US and, to a lesser extent, South America in the case of Brazil, the asymmetries and strong differences among partners, as well as historical distrust, seem a formidable obstacle to creating a sense of cooperation.

While discussed separately, our three dimensions of integration therefore clearly work together in practice. Commercial investment in, and management of, connecting physical infrastructure begs for common and reliable regulatory and investment framework, as well as agreed-upon technical standards. The regulatory and investment framework, meanwhile, must be shaped in accord with the physical layout of the integrating countries, their fuel resource endowment, and their current and projected fuel supply and demand conditions. Commercial integration, even on a limited scale, such as cross-ownership across borders, can create powerful forces for integration and coordination of regulatory policies, even if done in an informal sense. Finally, a willingness and mutual trust on the part of the national governments to create formal and informal institutions for cooperation is the necessary precursor to moving forward from basic international exchange to creating more deeply integrated markets over time.

None of these key factors should be interpreted as saying that integration will not progress further. Both prospective improvement in generation and consumption mix, and the desire for international investors to trade are strong pro-integration forces in each of our cases. Rather, highlighting the dynamic factors, in relation to the three-dimensional integration framework introduced, provides a good basis by which to understand the different shapes and directions by which integration took place and could evolve within a region. The comparative work and the analytical structure used here will hopefully help the design of a sustainable integrated electricity sector, by offering a better understanding of its requirements and its path to success.

Acknowledgements

P.-O.P. is grateful to the University of Victoria for financial support for this research. Anil Hira is grateful to the Social Sciences and Humanities Research Council of Canada and to Simon Fraser University for financial support for this research. K.F. would like to thank the Program for International Research Linkages and the International Council of Canadian Studies for their support of this research.

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