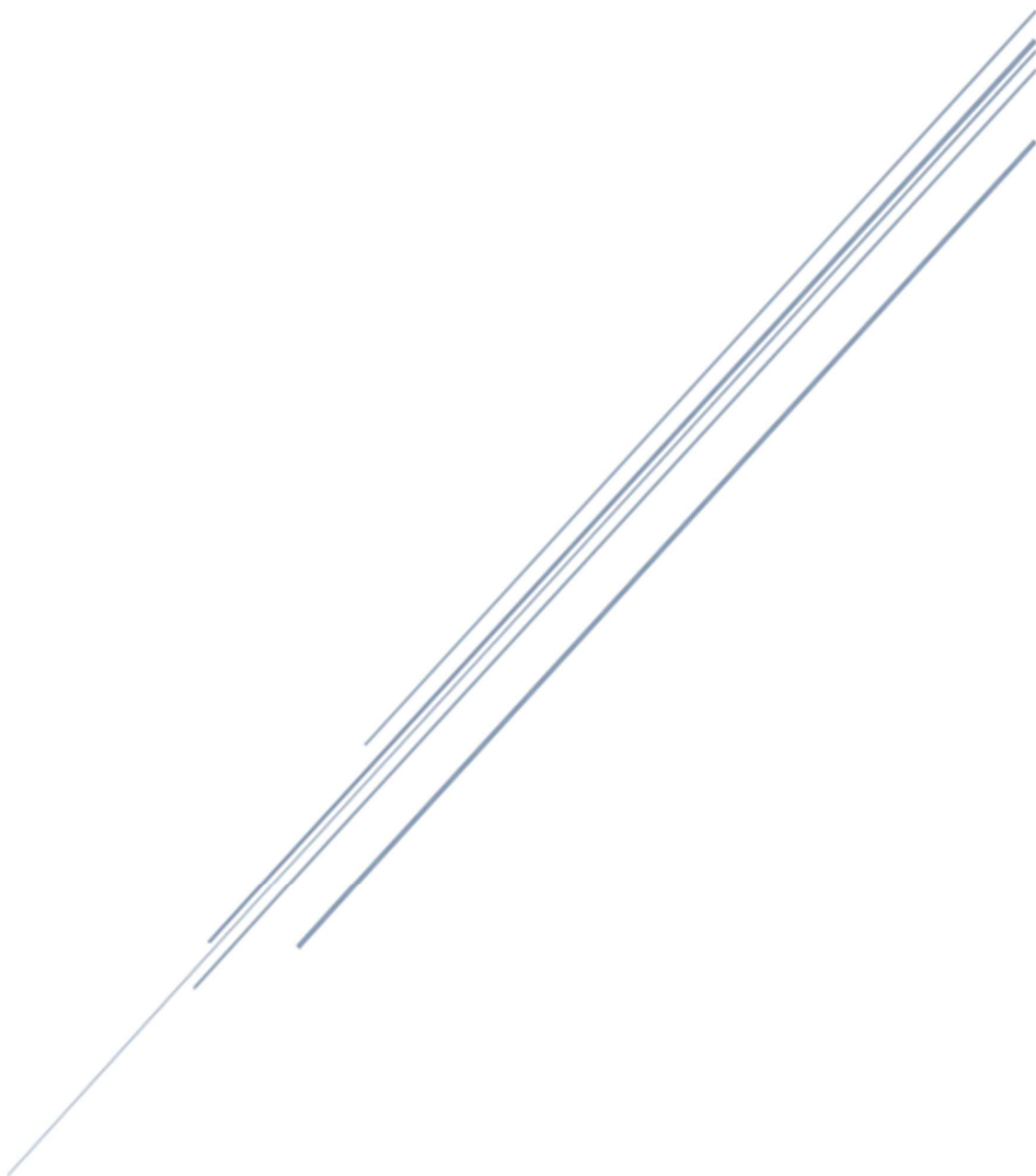


**Power Sector Internationalization and Transformations in Brazil,
Post-Covid 19**

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1. Introduction.

Since the 1970's, the world power sector has been the subject of far-reaching regulatory and structural changes. The introduction of competition in generation and commercialization of electricity was the key for the paradigmatic transformation of the United Kingdom¹ that started in 1983 and spread across many countries. It usually included the privatization of state-owned enterprises/utilities (SOE) and the introduction of consumers' free choices, starting from wholesale and progressively reaching retail.

In 1973 and 1979, after the oil prices shocks affected the energy sectors, the electricity generation segment saw the emergence of new possible plants, including nuclear, aero-derivative gas turbines and renewables. The latter included biomass, industrial and agricultural residues, waste, small hydroelectric units, and saw the slow emergence of new wind and solar plants. Continuously reducing costs since then, these last two, formerly considered 'alternative' sources, became nowadays part of the 'mainstream'.

Brazil experienced such changes² within a quite different context, sometimes not well accounted for when its power sector evolution is analysed. With one of the cleanest electricity matrices in the world, strongly anchored in a substantial hydroelectric park, with just a few thermal plants³, since early it had a large co-ordinated and optimized systems' operation.

The country also faced a different economic situation. In the 1990's, it came out of a long and tumultuous high inflation period, with compressed electricity prices and SOE surviving mostly on governmental subsidies. The need for change came not from high energy prices but rather for achieving a stable business environment.

With inflation controlled, in 1995 two concession laws disrupted the old cost-of-service regulatory system, introducing mandatory competition for the concessions of new

¹ After a pioneer experience in Chile, in 1973. The UK start may be assigned to the Electricity Act of 1983.

² The main impacts of the oil prices in Brazil were felt by the transportation sectors and gave origin to the ethanol program, and later to a renewed search for oil, resulting in large off-shore findings.

³ In addition to the hydroelectric plants, two expensive nuclear and some thermal plants complemented and guaranteed the system stability and a reliable generation.

generation and transmission projects. An initial privatization of SOEs took place to attract private capital to the power sector⁴.

Only in 1998 a new regulatory system was effectively implemented, preserving the centralized optimal operation, including a free market for larger consumers and artificially constructed prices (derived from marginal costs estimated by optimization algorithms) to be used for short-term adjustments. Due to the lack of long-range planning *and* contracts to facilitate the implementation of new greenfield projects, this model was further adjusted. From 2004 onwards, distribution companies had to start to contract their expected demand in advance, and a system of competitive auctions was put in place for new generation projects.

Different changes took place in other South American countries during this period, incorporating more competition and market-oriented procedures and leading to different regulatory solutions. The usually large participation of hydroelectric plants, resulting in strong systemic interdependencies, used to be an obstacle to the establishment of a day-ahead market and marginal costs as a basis for operational rules.

The differences among the Southern countries are easy to see. Brazilian electricity matrix, in 2014⁵, was 74.6 per cent renewable, while South America's was 65.9 per cent, in contrast to 22.3 per cent in the world. Only two countries had less than 50 per cent renewables: Argentina (31.5) and Bolivia (28.0), both with plenty of oil or gas reserves historically used for electricity generation. No wonder that Argentina implemented one of the most market-oriented solutions, while Brazil preserved the centralized optimal operation, introducing marginal competition only in the originally limited free market.

As part of these global changes, foreign utilities, mainly Iberian ones, came to South America and Brazil, taking advantage of the privatization processes that followed the regulatory changes. As electricity is typically non-tradeable, or at most marginally so, and the utilities provided a public service, their ownership remained domestic during many decades, be they SOE or private. Moreover, as part of these huge transformations, many also ventured abroad.

Nevertheless, the world trend in favour of globalization and the creation of large international production chains is being questioned. It is not clear how this will affect the

⁴ Initially the SOE were oriented to not participate in the new greenfield projects, 'privatizing' the expansion. But lacking new demand, and facing the more than announced 2001 crisis, they were allowed to get involved as minority players.

⁵ According to data by the Brazilian Ministry of Mines and Energy.

power sector, the strategies of the multinational enterprises/utilities (MNE) and the development of regional industries supporting the new electricity generation and consumption technologies.

Companies have also to face the challenges brought by global warming. In the energy sector, electricity became more essential and cleaning the generation matrices mandatory. Both the remaining SOE and private companies had to comply with these new conditions; when not imposed by the regulatory framework, they so are by society's increasing awareness of the climate disruptions.

The Covid-19 pandemic, with its several impacts and the ensuing world recession, renders the situation more complicated and, maybe, accelerates new changes, either foreseeable or unexpected.

Without the intention of predicting the new paths that will be followed, this Note tries to put this whole process, in the Brazilian case, into perspective, discussing the main choices for the evolution of the electricity matrix, the context of the possible MNE actions and the current will to privatize the still remaining largest SOE, Eletrobras.

The next section deals with the presence of the MNEs in the country, while section 3 outlines future scenarios for the energy matrix. The last section concludes, with a closer look at the likely next, post-covid steps in the sector.

2. Multinational Companies in the Brazilian Power Sector.

The internationalization of electric utilities can be seen as part of the huge increase in foreign direct investment in the world during the 80's, even if with specific characteristics. Breaking free from the limitations of the home market, diversification, gains of scale and scope were certainly among their reasons for moving abroad.

Many were European companies coming to Latin America to take advantage of shorter cultural distances and the new regulations and privatization that, in most cases⁶, took place with a few years delay in relation of those in their home countries, where fierce competition took place, under the pressures for integration.

⁶ With the exception of the pioneering transformations of the Chilean electricity sector.

In Brazil, (internalised) knowledge, time and capital were their main advantages, able to create value through acquisitions and other investments and allowing growth rates higher than at their home markets.

A detailed presentation of the international utilities operating in 2013 was made by Hall et al (2013). More than half of them were state-owned, but also private ones, often labelled as ‘national champions’, had the blessing of their governments. The Italian Enel, the French EDF, the Portuguese EDP⁷ and the Spanish Enel/Endesa⁸, Iberdrola and Union Fenosa, were among the first and foremost among them.

Brazil was one of the main locations chosen by the Iberian utilities⁹ that, nowadays, jointly supply 34.6 million consumers -about 41 per cent of the total Brazilian regulated market- through more than ten individual distribution companies. They also operate in other electric power segments, especially thermal and renewable generation, and, as Iberdrola (through its subsidiary Neoenergia), in transmission lines. The other European ones, the French-Belgian Engie¹⁰ and EDF, are both centred in generation.

US and Chinese companies are also present. The US utilities were allowed to invest abroad only after the Energy Policy Act of 1992; due possibly to this, most have not invested abroad. Even so, a few investors have engaged in greenfield projects and one of the largest US utilities is still active around the world – AES¹¹, with global assets including 3,348 MW generating plants in Brazil.

Chinese investors keep on increasing their participation. Three companies have acquired assets, investing in Brazil: State Grid, CTG and SPIC¹².

State Grid made huge investments in transmission line greenfield projects, including the two 800 kV lines joining the hydroelectric unit of (UHE) Belo Monte to Paracambi, in Rio de Janeiro, and currently has about 6,000 km of transmission lines. It also bought the distribution company CPFL in 2017 and is now supplying 9.8 million consumers (11 per cent of the Brazilian market), and has around 4,300 MW of generating

⁷ EDF - Électricité de France; EDP - Eletricidade de Portugal.

⁸ Endesa was bought by Enel, becoming part of the Enel Group.

⁹ See Pimentel (2020) and Toral 2008.

¹⁰ The Belgian Tractebel bought Gerasul in 1988, the only Eletrobras large generation subsidiary already privatized; later Tractebel was bought by GDF Suez, now renamed as Engie. It has 8,710 MW installed in Brazil, and a participation of 40 per cent in the UHE Jirau (3,750 MW).

¹¹ AES Corporation, originally an important US independent power producer, became one of the few utilities present in many continents, both in generation and distribution, including wind and solar assets.

¹² China Three Gorges – CTG; China Power Investment Corporation - SPIC.

capacity, mainly hydro and wind plants. CTG, has also an important presence, in part through its participation in EDP Portugal, and partnership with EDP Brazil. Considering both hydro and wind plants, it is involved in 8,230 MW of generation capacity. It includes the UHEs Jupia (1,550 MW) and Ilha Solteira (3,440 MW) bought in an auction in 2017. SPIC has a smaller participation, with 58 MW in wind plants and the control of the UHE São Simão, with 1,710 MW, acquired in 2017.

Local utilities did not succeed until now in their internationalization, with the exception of the Colombian ISA¹³ that has already made substantial investments abroad. Others, as the Chilean Colbun and the Brazilian Eletrobras¹⁴, were restricted to preliminary international investments.

As both wind and solar sources seem to be the new frontier of expansion, they have also attracted smaller players, local and foreign, diversifying the Brazilian institutional field with the involvement of new companies, lobbies and associations.

Many of the MNEs above have invested in wind parks, but not as much in solar centralized plants that, with their reduced costs, should be the next important wave. With weak economic growth along the last five years, an almost stagnated electricity demand has discouraged new generation projects and possibly postponed those of many solar centralized plants. The surge of the wind projects, even in the absence of investments in technology, gave way to an important industrial assembly park¹⁵ -the sole of its kind in South America-, as most of the important international industries have opened units in the country: Nordex-Acciona, Vestas, Siemens-Gamesa, GE-Alston, Enercon (Wobben), and the local WEG.

While different countries have significant participations in the world wind sector, the solar industry has been dominated by the Chinese. In Brazil, only BYD (a producer of solar panels, batteries, electric cars and buses, etc.) and Canadian Solar (also Chinese capital) are already assembling solar panels.

Wind and solar are at the forefront of the new generation profile of the power sector in Brazil, and the lack of investments in technology and human resources development remains a limitation to the effective incorporation of this revolution.

¹³ Interconexión Eléctrica S.A. (ISA)

¹⁴ Colbun owns assets in Chile and Peru. Being a SOE gave Eletrobras a privileged position in the establishment of country-to-country crucial agreements and treaties governing the interactions; it owns a wind park in Uruguay, in partnership with the local SOE, UTE.

¹⁵ See FGV IIIU (2016).

The solar equipment industry will possibly grow, similarly to the wind case, to supply the large and growing market needs. However, knowledge creation will depend on more than this, requiring the participation of technology centres and the availability of a properly trained work force.

Both a stronger Atlantic co-operation with the European/Iberian companies and a new type of involvement of the Chinese industries and utilities may open opportunities for the co-creation of knowledge to help promote local capabilities in these resource-based industries¹⁶ and a new development path for the sector.

3. The Brazilian Electricity Matrix: Present and Future.

After many years of absolute predominance of large hydroelectric plants in the electricity matrix, new such projects began to run out. With large plants near consumption centres not feasible any more, possible new options -each day further away until reaching the Amazon region- faced environmental problems, besides requiring longer transmission lines. It is not clear how far the exploitation of new hydro resources can still go; not much longer for sure. Not only the existing new projects have been stalled: they themselves are becoming scarce, as few feasibility studies are nowadays made.

Even if large hydro-projects could still be considered, they face a strong popular reaction. The Brazilian society seems against new projects in the Amazon region, as both popular movements and legal actions demonstrate. Usually, not only technical issues are involved in such decisions, but the political actors traditionally supporting the developments, as Eletrobras and the big construction companies, are much weaker now.

Under these circumstances, replacing radically new large hydro power plants poses difficult questions, as fossil fuels should be avoided even if they may be locally produced. Part of the answer may come from renewable sources, wind and solar -both very abundant in Brazil-, that have their costs levelled down sharply and are becoming very competitive. A continuous increase in their participation in the supply side may help to replace the need for additional large hydro plants.

Growth of these new sources has been steady. Through a sequence of specially designed auctions, Brazil has contracted 15,174 MW of wind on-shore parks and 2,652 MW of solar PV, during 2004-2015. While the wind parks gave room, as said, to a large

¹⁶ See Pérez (2008).

local industrial base, solar -centralized or distributed- is expected to be the next wave, but a reduction in electricity consumption, caused by the last decade recession, interrupted this process.

These renewables require however a large storage capacity or complementary generation from the rest of the system, to deal with their intermittency. In many countries, this need has been dealt with a parallel growth in natural gas generation, able to follow the demand curve; gas generally replaces oil or coal, and reduces by half their greenhouse gases emissions. This is not the case in Brazil, as the electricity matrix is already clean and new gas turbines will increase the GHG emissions.

Fortunately, the already installed hydro storage capacity can, at least partially, cope with the incorporation of these new renewables, dealing with their daily and seasonal variations. As the share of new intermittent sources grows, the existing hydro reservoirs' capacity is not going to be enough. Additionally, the last few large plants built had their storage capacity radically reduced, to keep the flooded areas at a minimum. Large batteries and/or new pumping storage plants must be among other possible solutions.

The structural changes in the generation sources also transforms the number and type of players, together with some important characteristics, as the time responses of supply to demand growth. In the recent past, with gas turbines, the size and delay needed to implement new projects had already changed, as gas replaced oil, coal and nuclear; smaller units could be built faster. Wind and solar use even smaller units, easily implemented and providing answers to higher demand faster than the response time of large hydroelectric solutions. Moreover, their individual projects require less capital and shorter times to mature.

Looking ahead, wind, solar and natural gas are the main candidates to grow and replace hydro. Natural gas, however, although considered by many as a transition fuel, in Brazil represents a step back, against the goal of getting a cleaner matrix.

An ironic problem is that the country has found large pre-salt oil reserves mixed with natural gas, and intends to make use of them. The gas must be burnt, usually for electricity generation; its liquefaction to be exported as GNL could be a possibility, but may not be economically feasible. These options need to be studied, keeping the sustainability goals in mind and not forgetting that natural gas, in Brazil, does not enjoy the same virtues as in most countries.

Considering a longer horizon, and looking at the Southern continent, Brazil faces the same challenge as many other countries in the region: to keep a clean electricity

matrix. Other countries, as Argentina, while enjoying a comfortable availability of gas and oil, have to change more radically their energy matrices until the end of the century, to reduce GHG emissions. A more integrated solution for the continent as a whole should be pursued; for this, trust and co-operation are crucial factors.

Moreover, independently of temporary demand reductions, the domestic power sector is under continuous change, with new generation sources, new regulations, and still remaining privatizations under discussion. For 2021, it is expected the incorporation of hourly and locational costs, already being calculated by the ONS¹⁷, in the determination of market prices. Better information may help to reduce the distortions caused by the use of levelled individual prices, without the inclusion of the system costs. One thing Brazil has learned with the hydro dominance is the great interdependence between the individual generation units. To better deal with intermittent sources, hourly costs and prices is a necessary improvement.

A reduction on the lower limits required to consumers to be part of the free market, new types of auctions separating fixed load and energy, together with hourly prices, have been proposed and may be part of the new rules. New market regulations may turn the co-ordination of the operation more dependent on actual market prices and new commercialization patterns may have to be adopted.

A more radical change in the classical electricity business model may be quietly starting now and growing in ways hard to predict, thanks to solar distributed generation.

4. The Post-Covid Times: Questions and Suggestions.

The immediate impact of the Covid-19 on the Brazilian power sector has been a sharp reduction in the current electricity consumption, around 18 per cent¹⁸. This happened in a market already stagnated, reflecting the recessive economy of the past few years. During 2015-2019, demand grew at an average of 0.9 per cent a year, much lower than historical or expected figures. The length of the consumption trough and how the sector will behave in a recovery are both very difficult to predict.

Electricity consumption should keep growing with more digitalization, home office and virtual meetings replacing physical contact. The residential segment will likely

¹⁷ ONS = *Operador Nacional do Sistema*, the top operator/manager of the national (electricity) system.

¹⁸ A figure from the site of the ONS.

grow more than the industrial one, and even more than the commercial. As pollution must be avoided, electricity is to stand as the preferred choice for many uses, including transportation, progressively displacing other energy forms. Distributed solar generation should also grow concomitantly, as long as its costs keep falling.

Current revenue decreases will have to be compensated, as the main sources of cost in the renewables sector are capital and labour that cannot be promptly reduced. To keep the system afloat will require increases in regulated tariffs to cover the deficits. Eventually, losses will have to be distributed among shareholders and consumers. Estimates made by experts¹⁹ point to a 3 per cent surcharge during the next four years, assuming full recovery next year.

Covid impacts and related consumption and revenues gaps are taking place in a world where globalization retreated. Tensions have been rekindled as the Trump administration collides with the Chinese economic and technological growth model, under a closed political system. But, simultaneously, global co-operation is utterly needed for a variety of problems, many with profound consequences for the energy sector.

Though South American energy integration seems a distant future, it is important to pledge and remind that *development of renewable sources demands more integration towards common, cleaner solutions.*

With an expressive presence of international utilities in Brazil and South America, it is crucial to see *how they can help into bringing forth the needed transformations, including climate friendly solutions, while fostering a win-win technological leap.* This movement may also push cross-border investments, integrating the continent and optimally exploiting the renewable natural resources widely available.

The current reduction of electricity demand pressures in Brazil will diminish the speed of transformations in the country's generation profile, but may also facilitate rearrangements in the sector's model, as companies negotiating financial coverage for their losses may become more flexible towards changes in the rules of the game.

With new technologies playing a key role, knowledge is twice more essential. A co-operative stance by the international utilities seems essential to bring new internalized tacit knowledge and co-create alternatives in a virtuous cycle, making use of the large local market and the business opportunities being opened.

¹⁹ Dr. Wilson Ferreira, Eletrobras' CEO, in a public presentation to an investment bank, considered that, excluding the 30 per cent of the revenue corresponding to taxes, an 18 per cent one-year gap caused by the Covid could result in a tariff increase close to 3 per cent, to be spread during the next few years.

Many questions need to be answered.

Will, in this less globalized world, capital keep flowing in the same scale? and foreign utilities keep investing in Brazil? If so, how will the Chinese and the European - particularly Iberian- utilities here established behave in the new scenarios? Will they remain or, as the US companies did years ago, move back home?

Assuming they will keep on investing, the Chinese are clearly the world leaders in solar energy and went close to the installation of assembly plants in Brazil. With a right institutional framework, will they also participate in local knowledge creation through research centres?

As for the Iberian companies, will they use their clear cultural advantages and move one step ahead in the road of technological partnerships? Broadly, will the future scenario be of more co-operation -as EDP's example of a complex Iberian-Chinese co-operation which converged- or competition?.

In a more regionalised word, it is important to keep aware of the continent's electric integration as part of the pursuit for cleaner energy matrices. Investments in common projects should be encouraged, like Enel's and Iberdrola's significant investments in other countries in the region. The convergence between the EU and Latin American waves of liberalization was among the main factors promoting expansions in Brazil. With new opportunities coming into view and considering the global sustainability challenge, they may be motivated to keep investing under this novel framework.

A better positioning of Brazil in the technological revolution in the power sector cannot depend only on the market *and requires a clear institutional support from the government*. A specific case is the current discussion about the privatization of Eletrobras. Is it going to be seen only as a source of cash, or will its more in-depth consequences be duly weighed and considered?

It is not at all clear that the country should let go an executive instrument²⁰ that successfully acted as the guarantor of its electricity needs of all kinds. Why not learn from the experience of Portugal with EDP, slowly privatized along the years: able to improve its efficiency first, with some private capital protecting the company from undue political influence, while keeping a governmental orientation in its board?

²⁰ Eletrobras with the regional SOEs Cemig and Copel, together with the São Paulo State regional utilities, were the main responsables for the setting of the country's large generation and transmission system.

It is crucial to keep an active presence of local interests in the decision processes. In particular, will Eletrobras' research centre be kept or busted? If international utilities gain a strategic participation, effective co-operation in research should be an essential factor in the new organizational design. Efficiency gains and the acquisition of dynamic competences should have a bearing on the institutional choices.

It is possible to trace important national states' support behind the recent evolution of several European players, either SOEs or private utilities, in the promotion of their interest. In 2020 Brazil, the state should also articulate the power sector's evolution in a long-range view, considering not only the immediate cash effects but also externalities in terms of climate protection, security of supply and technological development.

With government support, and a properly designed strategic partnership with foreign utilities, in a next stage of transformation, Eletrobras could anchor the creation of knowledge and technological developments, clearly committed to fight global warming. This could act as a stepping stone to the construction of a co-operative, sustainable and integrated regional electric power network.

In the past, market failures in electricity supply were dealt through SOEs; in the near future, international partnerships must be recognized and wisely chosen.

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