THE SOUTH AMERICAN DILEMMA: SUSTAINABLE DEVELOPMENT AND RENEWABLE ENERGIES—CAN TRANSNATIONAL POWER GRIDS ASSIST IN SOLVING IT?

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Despite common social and cultural heritage, development has been elusive to South America. It faces the critical dilemma of achieving sustainable development without going down the path of industrialized carbon-based economies. Most South American countries have individually focused on achieving the best configuration possible of their own energy matrices. Much less attention has been placed on seeking a unified solution in relation to the viability of interconnecting power transmission grids throughout the region. The paper addresses the relationship between energy matrix configuration and energy-supply policies, and the effect on development opportunities in South America. It explores whether, even though having dissimilar and even divergent regulatory frameworks, the idea of transnational transmission networks would assist in resolving the aforementioned dilemma through achieving a regional convergent policy's goal of sustainable development.

I INTRODUCTION

Sustained economic development in South American countries has been elusive. Despite common social and cultural heritages,[1] there is a history of mutual political suspicion, lack of capital investment[2] and disparate approaches on crucial regulatory decisions. The region has

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1 The paper assumes the homogeneous socio-cultural environment of Latin-America. Thus, the paper excludes only the consideration of Suriname, Guyana and the French Guiana's power systems and regulatory frameworks, in its analysis being deemed—respectively—neither relevant in terms of installed capacity, demand or power output; nor entirely representative of the socio-cultural evolution of Latin America. See generally Central Intelligence Agency, *The World Factbook* (November 2011) Central Intelligence Agency <http://www.cia.gov>.

2 This rather endemic lack of capital investment contrasts profoundly with the relative wealth and diversity of natural resources enjoyed by South America. Accordingly, the potential for

lagged behind economically and in attempting to stimulate economic growth these countries will face major environmental issues.

Critical to ensuring effective development, one key regulatory decision concerns the energy base upon which economic growth will be grounded. Particular consideration must be given to the rising international prices for carbon-based fuels and the significant climate change consequences of its burning. The pressing dilemma for South America is how to achieve sustainable development without necessarily going down the path of industrialized carbon-based economies.

Operating in isolation, the majority of South American countries have focused on achieving the best possible energy output for domestic development projects and energy matrices. Much less attention has been given to seeking a unified solution to optimise existing economic and environmental resources by integrating power transmission networks throughout South America. This paper addresses the relationship between energy matrix configurations and energy-supply policies, and the effect on development opportunities in the context of South America. By considering domestic and international policies, this paper explores the constitutional treatment of production, allocation and distribution of energy in the region along with relevant political, social and technical factors to determine whether cross-border interconnection of transmission grids could play a positive role in the region's efforts to achieve sustainable development.

The paper analyses South American experiences of cross-border power transmission and the opportunities and barriers for renewable energy sources integration and grid interconnection. In doing so, it will use a constructive-epistemic methodology. This means that its central proposition will be tested against facts, legal framework and selected case studies. Findings will be constructively drawn-out from the exercise in order to validate, discard or amend the original proposition.

The proposition to be tested is whether despite vastly different regulatory frameworks, the establishment of transnational transmission networks could assist in achieving a regional convergent policy's goal of sustainable development.

This paper concludes that as long as regional countries both promote the integration of, and give priority to, a greater share of renewable sources in their energy mixes they are capable of coordinating their energy policy instruments by removing relevant technical and legal barriers. Further, cross-border interconnection of transmission grids could play an invaluable role in addressing both the threats posed by climate change and the issues associated with sustainable development.

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renewable energy sources in the region is vast, particularly, in terms of world's water reserves. See *International Energy Agency* <http://www.iea.org>.

II THE SOUTH AMERICAN DILEMMA

A *Sustainable Development in a Climate Change Context*

A few decades ago, the answer to the problem of development in South America may have seemed easy. Presumably it would have entailed focusing on the lessons learnt by developed countries in relation to consumption, productivity and the depletion of natural resources, and adopting similar strategies tailored to South America. With the cumulative effects of climate change, the current geopolitical environment is vastly different and has resulted in the need to foster the concept of 'sustainable development'.[3] Unlike developed countries however, the region constantly struggles against the impediments caused by a lack of capital investment, a lack of strategic natural resources management plans and political instability.

This part looks at South America's energy policies and focuses on the way in which South American countries have addressed the integration of renewable energy forms in domestic energy matrices in dealing with sustainable development programs, climate change abatement goals and security threats to energy supply.

B *South American Approaches towards a Unified Energy Policy*

In analysing South America's regional policy-making processes, national sovereignty and the implications for energy policy must be addressed. Whilst in other places, sovereignty may convey a rather flexible and modular approach as to some supposedly inherent prerogatives of the State, in South America the understanding of its content and significance is formal and comprehensive.[4] This matters since the ideal of unifying energy-related transnational decisions under a common energy policy will have major impact on how the States approach territorial sovereignty and non-exclusive use of resources. In analysing constitutions in the region, the diverse and fragmented treatment of sovereignty over natural resources and ownership was uncovered. Under such a context the possibility of mutual cooperation, or even integration, is seriously constrained. In circumstances where concerns about national security take priority, the sovereignty question becomes even more restricted. Indeed, being derived mostly from very liberal principles of freedom for economic initiative, the Constitutions of Argentina,[5] Brazil,[6] Uruguay[7]and Chile[8] emphasise that property rights

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3 As defined by the Brundtland Commission Report: World Commission on Environment and Development, *Our Common Future,* 1987 published as Annex to General Assembly document A/42/427, Development and International Co-operation: Environment August 2, 1987; see generally Lila Barrera-Hernández, 'Sovereignty over Natural Resources under Examination: The Inter-American System for Human Rights and Natural Resource Allocation' (2006) 12 *Annual Survey of International & Comparative Law* 42.

4 This is so, mainly, for historical reasons. After the independence movement away the Spanish Crown in early XIX century, national States needed to emphatically assert their newly acquired sovereign status. Over time, political evolution toward both strong presidential regimes and highly centralized politic systems led up to an even more inclusive content of the sovereignty notion.

5 Constitución Nacional de la República Argentina [Republic of Argentina Constitution] art 14, 20.

6 Constituição da República Federativa do Brasil [Federal Republic of Brazil Constitution] arts 5(XXII), (XXIII), (XXIV), (XXV).

7 Constitución de la República Oriental del Uruguay, 1967 [Oriental Republic of Uruguay Constitution] art 7, 32.

attract an individual guarantee subject to no other limitations than those arising from their social function and do not assign to the State any particular role in the conduct of the economy. [9]

In general, in Argentina, Brazil, Uruguay and Chile, the subsidiary principle confines the role of the State more or less to that of regulator and watchdog. State economic activities are allowed in a few strategic sectors but are carried out under a general non-discriminatory regulatory framework. A less neutral approach towards private property, though still committed to an open economy model, can be found in the Constitutions of Perú,[10] Paraguay[11] and Venezuela,[12] in which the limitations that can be imposed on property rights and any of their related attributes ranging from national security,[13] public necessity[14] and public interest.[15]

A more radical approach towards restrictions on ownership is evident when precedence is given to socio-economic or ecological functions that are considered essential for economic growth and/or development.[16] Along with all previously-delineated material constraints on property from a social as well as a constitutional standpoint, such issues as native title and exploitation of natural resources—whether renewable or not—on indigenous lands become matters regulated by the Constitution as observed in Paraguay, Colombia and, more particularly, Ecuador and Bolivia.[17] In addition, in Venezuela the economic role of the State is strengthened and normally includes processes of redistribution of lands (agrarian reforms), public sector involvement in productive activities and reserved or state monopolies over exploitation of natural resources. [18]

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8 Constitución Política de la República de Chile [Republic of Chile Constitution] art 19(24).

9 Constituição da República Federativa do Brasil [Federal Republic of Brazil Constitution] art 5(XXIII), 170(III), 186; Constitución Política de la República de Chile [Republic of Chile Constitution] art 19(24).

10 Constitución Política del Perú 1993 [Political Constitution of Peru] art 2(16), 70.

11 Constitución Política de la República de Paraguay 1992 [Republic of Paraguay Political Constitution] art 128.

12 Constitución de la República Bolivariana de Venezuela [Bolivarian Republic of Venezuela Constitution] art 115.

13 Constitución Política del Perú 1993 [Political Constitution of Peru] art 70.

14 Constitución de la República Oriental del Uruguay, 1967 [Oriental Republic of Uruguay Constitution] art 32; Constitución Política del Perú 1993 [Political Constitution of Peru] art 70

15 Constitución de la República Oriental del Uruguay, 1967 [Oriental Republic of Uruguay Constitution] art 7, 32; Constitución Política de la República de Paraguay 1992 [Republic of Paraguay Political Constitution] art 109, 128; Constitución de la República Bolivariana de Venezuela [Bolivarian Republic of Venezuela Constitution] art 115.

16 Constitución Política de la República de Paraguay 1992 [Republic of Paraguay Political Constitution] art 109; Constitución Política de la República de Colombia [Republic of Colombia Constitution] art 58, 60.

17 Constitución Política de la República de Paraguay 1992 [Republic of Paraguay Political Constitution] art 64; Constitución Política de la República de Colombia [Republic of Colombia Constitution] art 329; Constitución Politica de la República del Ecuador [Republic of Ecuador Constitution] art 57(4)-(6); República del Bolivia Constitución de 2009 [Republic of Bolivia Constitution] art 30(4), (14), (17).

18 Constituição da República Federativa do Brasil [Federal Republic of Brazil Constitution] chps III (art 184-191), VII; Constituição da República Federativa do Brasil [Federal Republic of Brazil Constitution] chp VIII (art 231,232) in respect of Indians, these section provides for acknowledgement of native title over lands traditionally occupied by indigenous people declaring them inalienable and indisposable, though subjected to constitutional exceptions such as the one sets forth in Article 231(3) on hydro resources and energetic potential.

In a traditional understanding, the interplay between sovereignty and its application to the domestic territory and the natural resources contained within requires that national territory cannot be transferred, leased or alienated in any way to a foreign entity. In fact, most constitutional charters either restrict the extent of foreign ownership of land in the interior or in neighbouring border areas.[19]

However, over time this somewhat harsh and mostly theoretical view has been weakened by several factors including the pragmatism derived from trading necessities. Under pressure from transnational corporate action and international tender processes for infrastructure projects, concessions for exploration and/or exploitation of natural resources and foreign private and/or public investments upon lands involving property rights' attributes are being granted, particularly by developing countries. In practice, giving up theoretical constraints of sovereignty can be counterbalanced by reserving activities or territory for the State, pursuing termination rights and, obviously, optimised royalty regimes.

In order to establish transnational transmission networks, participating countries should not approach the change as being an erosion of their sovereignty. While some international frameworks for regional integration including UNASUR,[20] ALADI[21] and MERCOSUR[22] have been established in an attempt to explore joint paths to development, the extent to which individual nations are involved varies dramatically. In fact, for such goals to be achieved, the focus should precisely be upon highlighting the pragmatic benefits of furthering transnational power grids' interconnection and related infrastructure projects. Unfortunately though, a general overview on the regional constitutional framework over the last decade merely casts shadows upon such efforts, and a critical view on the politic and social history of Latin America reveals a tendency to rank political factors higher than potential economic advantages, making South America's development opportunities fail almost endemically. From the standpoint of development opportunities there is an obvious disconnection between the demand for energy from the growing industrialised economies of Brazil, Argentina and Chile, to the countries with the potential to generate vast amounts of power but which lack adequate infrastructure such as Paraguay and finally countries that lack safe foreign investment framework as observed in Bolivia or Venezuela.

The noticeable gap between South American countries is increasingly worrying, because instead of allowing power-surplus countries to take advantage of their current condition or realize their potential, their Constitutional framework on property rights over power generating assets or resources acts as an *a priori* barrier when combined with restrictive understanding of sovereignty. A single common transmission line project across South America would entail significant cultural, social and economic revision of entrenched legal

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19 See, eg, República del Bolivia Constitución de 2009 [Republic of Bolivia Constitution] art 262.

20 *The Constitutive Treaty of South American Union of Nations* (UNASUR), signed 23 May 2008 (entered into force 11 March 2011).

21 *Treaty Establishing the Latin American Integration Association* (ALADI), signed 12 August 1980, 1329 UNTS 225 (entered into force 18 March 1981).

22 *Treaty Establishing a Common Market between the Argentine Republic, the Federal Republic of Brazil, the Republic of Paraguay and the Eastern Republic of Uruguay* (MERCOSUR) signed 26 March 2011 (entered into force 29 November 1991).

concepts such as property rights and territory management, as much as the creation of new ways of governing common resources.

A further obstacle to the establishment of transnational transmission networks results from domestic regulations relating to energy mix configuration. In the liberal developing economies of Argentina, Chile, Colombia and Uruguay, the role of regulation is to safeguard their markets' proper resources allocation but also to fly flags to market participants about policy shifting to a more diversified energy matrix, including non-conventional renewable energies and interregional regulatory frameworks for interconnection. In centralized economies like those of Venezuela, Ecuador, Perú and Bolivia, the diversification of the mix is part of the energy sector planning which the State is devoted to carry out with or without a variable degree of private participation.

Border taxes, which are a common manifestation of the traditional sovereignty concept, are not only a permanent source of conflicts in the WTO's trading framework, but also a hindrance to importing new renewable technologies. Intellectual property issues must also be addressed to allow the fast dissemination of such technologies. Joint international legal arrangements for the standardization and granting of both international status and independent management to a network's operation centers are crucial for securing an unbiased and reliable power supply. It is important to agree on opening up and unifying the power market and to provide for a transparent, legally-binding tariff-scheme, independent operation and dispute-resolution mechanisms. It is worth recalling here that there is also a need for a technical revolution in the transmission sector ranging from the development of new superconductors able to increase transmission capacity and reduce losses,[23] through to the introduction of 'smart' meters (digital hacker-proof meters), and onto enhanced designs of grid balancing operating software as yet generally unavailable for most countries in the area.

It is therefore clear that energy policy-making in South America is still confined to national boundaries. There is no common policy, but there are a few multilateral initiatives conducting studies on the feasibility of international power integration between Latin American countries.[24] Moreover, very few nations, with the exception of Brazil, have implemented steadfast innovative energy policies. The question therefore remains, is the establishment of transnational transmission networks viable?

C *Transmission Networks and Renewables in Energy Matrices of South American Developing Countries*

Could the energy sector and power transmission in particular become one of those joint paths to development worthy of exploration? The answer is affirmative, indeed, to the extent that the policy-making process is multilateral, focussed both on efficiency and sustainability, along with steady and consistent implementation.

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23 The present high-voltage maximum capacity is 380 kV. New conductors are expected to have 740 kV of transmission capacity. Its loss rate is just 3% of the power conveyed for every 1,000 km of line.

24 See, eg, CIER conducting research on electric interconnections between Mexico, Central, and South America (CIER Project 15, phase II).

Why it is important to design a proper energy matrix? One of the main factors in answering this question is that energy investments have a maturation time in which the economic agents—either public or private—need to have an outlook of future energy offer and demand as accurate as possible. A matrix is a flexible strategic policy tool which serves that goal while at the same time advancing legal reforms. Its methodology encompasses regular up-to-date information gathering processes on energy resources available (whether in use or as a reserve), macro-economical projection models acknowledging annual growth-rate limitations (including economical activities or sectors), energy sector structure and sector growth estimates, coefficients of energy equivalence/product, and energy consumption models.

1 *Case Study: Brazil*

At the regional level, Brazil is a commendable exception for both integrating renewables into the energy mix and realizing the importance of cross-border power transmission interconnections. It highlights also the importance of a gradual and continuing public policy on renewables,[25] particularly biomass and biofuels.[26] Despite the economic setbacks associated with the fall of crude oil prices and the increase in the price of sugar, successive Brazilian governments have continued to focus on renewable energy sources.[27]

Among the emerging economies of South American countries, Brazil has the greatest potential to reach the status of developed country in terms of consumption, productivity and income.[28] Appropriate economic, legal and political decisions in the past have led it to an expectant situation, but new challenges lie ahead, particularly that of a sustainable economy with energy efficiencies. [29] In 2002, the Programme of Incentives for Alternative Electricity Sources (Programa de Incentivo a Fontes Alternativas de Energia Elétrica) was created with the aim to increase the share of wind power, biomass and small hydropower systems in the grid through Autonomous Independent Producers. Under similar auspices, the Brazilian Energy Research Corporation (*Empresa de Pesquisa Energetica* - EPE)[30] was established. The EPE is responsible for conducting research and estimates on the Brazilian energy mix,

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25 *Kyoto Protocol to the Framework Convention on Climate Change*, opened for signature March 16, 1998, 37 ILM 22 (1998) (entered into force 16 February 2005); *United Nations Framework Convention on Climate Change* opened for signature 9 May 1992, 31 ILM 854 (1992) (entered into force 21 March 1994).

26 *National Program of Biodiesel Production and Use* started 6 December 2004 and predecessor, PROÁLCOOL (Programa Nacional do Álcool) [National Alcohol Program].

27 *Programa de Integração Social/Programa de Formaçao do Patrimônio do Servidor Público* [Social Integration Program/Civil Servant Training Program] Institute for Agriculture and Trade Policy <http://www.iatp.org>.

28 The Brazilian economy is astonishing in many ways. For instance, it finished the year of 2009 with the IPCA (Consumer Price National Index) in 4.31% below the inflation target and with an economical growth rate near zero. See Eletrobrás, Administration Report 2009, <http://www.eletrobras.gov.br>. However, in only four months (from January to April) of the first semester of 2010 it was capable to create 962,000 new formal-sector jobs and in only a six-month period boost its annualised growth rate over 10%. Analysts forecast for 2010 a growth of 7%. See 'Flying too high for safety', *The Economist* (The Americas), 22 May 2010, 41-42.

29 'Flying too high for safety', *The Economist* (The Americas), 22 May 2010, 41-42; Decreto N^{o} 76.593 de 15 de noviembre 2006 [Decree No 76593 14 November 1975] (Brazil), 14 November 1975.

30 Lei n^{o} 10.847 de 15 Marco 2004 [Law No 10847 of 15 March 2004] (Brazil) 15 March 2004.

identifying and quantifying the potential of energy resources,[31] conducting research needed for planning electric power generation and transmission expansion plans,[32] performing studies to avail and increase the use of renewables,[33] and assisting and taking part in interconnections as well as authorizing energy integration with other countries.[34] In May 2010, a Ten Year Energy Expansion Plan 2019 (*Plano Decenal de Expansão de Energia 2019 – PDE 2019*)[35] was released to the public. Prepared by the EPE, the *PDE 2019* was designed to be the main federal-level planning tool for the period 2009–2019.

The Brazilian energy mix proposal places high importance on renewable sources of energy. By 2009, the national energy supply matrix consisted of hydropower (77.7%), thermo-power (12.8%), nuclear power (1.9%) and other renewable sources (7.4%) of the installed capacity in the National Interconnected System.[36] According to projections contained within the Ten-Year Energy Expansion Plan, the Brazilian government aims to maintain the current energy mix of renewable sources at 48% (the world's largest) by prioritising hydro-generation and grid interconnections, expanding the production of ethanol and biodiesel, and promoting forms of alternative energy sources including biomass and wind power.

The Brazilian electricity regulatory model is almost entirely deregulated, though power rates are dictated by the government, currently capped at US$0.47/MWh. This latter feature which normally implies low investment returns is, however, counteracted through soft loans schemes and tax-breaks to lure investors[37] in addition to ambitious public-investment programmes promoted by the government.[38]

As to the network, the National Interconnected System comprises the power transmission facilities[39] in four sub-systems: South including Rio Grande do Sul, Santa Catarina and Paraná; South-East/Centre-West including Espírito Santo, Rio de Janeiro, Minas Gerais, São Paulo, Goiás, Distrito Federal, Mato Grosso, Mato Grosso do Sul, Acre and Rondônia; North-East including Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe and Bahia; and part of the North Pará, Tocantins e Maranhão.[40] In total, 96.6% of the total electric energy production in Brazil is generated by the National Interconnected System.

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31 Ibid art 4 (III).

32 Ibid art 4 (VII).

33 Ibid art 4 (XIII).

34 Ibid art 4 (XIV).

35 Plano Decenal de Expansão de Energia 2019 [Ten-Year Energy Expansion Plan 2019] Ministério de Minas e Energia, Secretaria de Planejamento e Desenvolvimento Energético. Empresa de Pesquisa Energética (EPE), Brasília: MME/EPE, 2010.

36 Ibid.

37 Lei nº 12.111 de 9 de dezembro de 2009 [Law No 12111 of 9 December 2009] (Brazil) 9 December 2009.

38 Lei nº 8.666 de 21 de junho de 1993 [Law No 8666 of 21 June 1993] (Brazil) 21 June 1993.

39 Agência Nacíonal de Energia Elétrica [Brazilian Electricity Regulatory Agency] Normative Resolution 067 and 068, 8 June 2004.

40 By 2012, part of the Amazonas and Amapá will become part of this sub-system and by 2014 part of Roraima will also become part of this sub-system.

Until recently the transmission sector remained almost exclusively under public control through both federal[41] and state companies.[42] However, the Ten-Year Energy Expansion Plan has budgeted for a BRL$39 billion expansion plan[43] including interconnection between currently isolated domestic sub-systems,[44] and transnational interconnections with Argentina, Uruguay and Venezuela.[45] The expansion and interconnection of the transmission grid will enable the efficient large-scale integration of renewable energy in the power system throughout the country. Moreover, since Brazil's energy mix is based predominantly on hydro-generation, the transmission capacity becomes essential to take advantage of hydrological diversity among sub-systems, which can experience droughts or significant rainfalls. A decline in power production in one area could therefore be offset by increased production in a different region, irrespective of distance.[46]

In summary, Brazil's consistent policy on renewable power sources, coupled with a reinforced interest in transmission (through interconnecting sub-systems and regional power markets) not only allows it to meet demand for power, but also to promote power-price homogenization-processes among sub-systems thus averting 'bottle-necks' and optimizing the load dispatch of generating units.

III ENERGY AND TRANSMISSION POLICY IN SOUTH AMERICA

The regional constitutional framework, focussing particularly on property rights over natural resources and their impact on power generation capacity was analysed in Part II. Here, the emphasis rests upon the efficient use of power already generated irrespective of where its source is located. When looking at policy-making processes at an international level, one must be careful not to fall into the temptation to engage with the general proposition that things can always be better, and be done more efficiently, when acting jointly rather than separately. The energy sector (including renewables) must also pass this test. However, it generally does, because while generation sources (particularly renewable ones) are commonly dissociated from consumption centres, transmission networks are inextricably associated to both of them.

41 The state-owned Eletrobras holding (through its subsidiary transmission companies: Chesf, Eletronorte, Amazonas Energia, Eletrosul, and Furnas) owns 53.148 kms of transmission lines (above 230kV throughout Brazil) which represent 69% of the country's total transmission lines. See Electrobras *Administration Report* 2009. The rest of the lines, operated in circumscribed concession areas, are owned by Copel (in the State of Parana, with 7,045 kms), Cemig (state of Minas Gerais with 21,184 kms), Terna Participacoes (a subsidiary of the Italian company Terna, in Brazilian and Maranhao), and CTEEP (subsidiary of the Colombian ISA, in the State of São Paulo, Goias, and Bahia with 11,837 kms).

42 Sao Paulo-CTEEP, Minas Gerais-Cemig, and Parana-Copel. Currently, there are about 40 transmission concessions in Brazil.

43 *The Constitutive Treaty of South American Union of Nations* (UNASUR), signed 23 May 2008 (entered into force 11 March 2011).

44 Regional interconnections South-East/Centre-West (SE/CO), North/North-East (N/NE), South-East/Centre-West/North-East (SE/CO/NE), South/South-East/Centre-West (S/SE/CO). Interconnection South-East/Centre-West (SE/CO) - Acre/Rondônia, Tucurui-Macapá-Manaus, and Manaus-Boa Vista.

45 Setting aside the current Itaipú binational generation and transmission project involving Brazil and Paraguay.

46 The 2001-2002 power crisis which affected the South-East sub-system was not entirely due to a lack of generation, but also to an inadequate transmission capacity from the South sub-system, which could have set off the SE generating deficit.

A *The Security Approach and the Threats to Energy Integration*

The main considerations of South American countries when designing energy policies are domestic and industry-related power demand coupled with national security issues and sovereignty concerns.

From the regional policy point of view, transnational grid interconnection is still viewed as a means to overcome shortfalls of energy supply or to improve network reliability rate of the individual nation, rather than as a real alternative to energy integration based on the use of renewable sources scattered all over the region.

1 *Case Study: Bolivia and Chile*

The interactions between Bolivia and Chile are illustrative of the general approach in South America when it comes to sovereignty concerns. Over many years, even basic economic relationships have been strained due to opposing views on Bolivia's claim of access to the Pacific Ocean through Chile's territory.

The Bolivian National Interconnected System encompasses generation, transmission and distribution facilities which operate in the Wholesale Power Market. In 2009, the total power generation reached 5,632.7GWh, approximately 40% of which was produced by hydro plants and 59% which was generated from thermo-generation units. The hydro-generating cluster mainly consists of run-off-river stations in Zongo, Taquesi, Yura and Quehata [47] and dam power stations in Corani and Miguillas.[48] By contrast, the thermo-generation facilities based on vapour-based turbines, natural gas and diesel-fired units are mainly located towards the East.[49] Interestingly, while Bolivia has the second largest reserve of natural gas in South America, Bolivia is the main exporter of natural gas currently delivering to Brazil and Argentina.[50] Natural gas is not exported to Chile for political reasons.

It is technically feasible to connect the Bolivian National Interconnected System to Chile's northern transmission network via the high-voltage Sistema Troncal de Interconexión or Main Interconnecting System. However, political opposition seems to be insurmountable.

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47 *Memoria Anual del Comité Nacional de Despacho de Carga. Resultados de Operación del Sistema Interconectado Nacional* 2009 [2009 Annual Report of the National Load Dispatch; Results of Operations in relation to the National Interconnected System] *Ministerio de Hidrocarburos y Energía* [Ministry of Hydrocarbons and Energy].

48 Ibid.

49 Ibid.

50 The natural-gas pipeline to Brazil (GASBOL) entered into operation in 1999. Since then, natural gas exports have experienced continuous growth. In turn, as of 2010 Bolivia exported 7.7 million cubic meters a day to Argentine, but a deal signed last March would expand that quantity to 16 million cubic meters a day by 2013 and 27.7 million cubic meters a day by 2021. See Diego Ore 'Natgas exports to quadruple by 2021 under new deal' *Reuters* (Update) 26 March 2010. Exports of natural-gas to Chile has been in project for a long time; however, politic concerns mostly related with Bolivia's territorial claim to get a way-out to the Pacific ocean have hindered the materialization of such projects even though Chile's power deficit represents a trade opportunity for both countries.

At the international level, Bolivia is a State Member of the Andean Community of Nations, thus must abide by the Cartagena Agreement, which sets out to establish a Customs Union and Free-Trade Zone among other things.[51] On the other hand, the political and regulatory frameworks for the electricity sector in Chile, which is not part of the Andean Community of Nations, is dramatically different.

Chile's power production relies heavily on conventional energy sources (97.4%). In 2008, the energy supply mix consisted of 36.4% dam and run-of-river hydro,[52] 36.1% natural gas, 15.6% coal, 9.3% diesel and fossil fuels, and only 2.6% non-conventional renewable energies in the form of biomass, small-hydro and wind power.[53] The rise in international oil prices, increasing power demand, instability of supply and pollution concerns have compelled the revision and diversification of the energy mix with renovated interest in renewable energy technologies, as well as changes in the energy legal framework.[54]

From this case study, an electric interconnection between Chile and Bolivia, without regard to other kinds of energy integration, would require a radical change in the current political environment. Although commercial relationships are steady, at a political level, Chile and Bolivia do not have top-level diplomatic relationships with each other even though both countries would be better off by trading power. A potential trading scheme may involve interconnecting domestic transmission systems thereby taking advantage of Bolivia's energy surplus in order to alleviate Chile's power generation deficiency.

In hostile political environments, when it comes to energy integration and international cooperation to achieve sustainable development, three factors present an outstanding opportunity: domestic energy matrix configurations; promotion, investment in and use of transnational power networks; and natural resources share-management. All are consistent with development programs, climate change abatement targets and security threats on power shortages.

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51 *Andean Subregional Integration Agreement* (Cartagena Agreement) signed 26 May 1969 (entered into force 16 October 1969).

52 Comision Nacional de Energia [National Energy Committee, the Chilean Energy Regulatory Agency] <http://www.cne.cl/cnewww/opencms>.

53 *Energias Renovables:Capacidad instalada de Generación Eléctrica* [Non-Conventional Renewable Energy] Comisión Nacional de Energía [National Energy Commission] <http://www.cne.cl/cnewww/opencms/06_Estadisticas/energia/ERNC.html>. In 2007, hydro electricity amounted for 39.7% of the total generation (22,223.5 GWh), closely followed by natural gas and coal-based thermo generation with 36.7% (20,535.3 GWh), fossil fuel-fired plants reached 22.2% (12,408.7 GWh).

54 The Chilean Constitution guarantees the right to undertake any economic activity, see art 19(21). The access to the generation market, thus, is open to any developers, who must comply with the relevant legal framework, which is composed mainly by the *General Act on Electric Services*, as amended by *Acts 19,940* (dated on 13th February, 2004, Official Gazette), *20,018* (dated on 19th May, 2005, Official Gazette), and *20,257* (dated on 1st April, 2008, Official Gazette), and appurtenant *Regulations*. For the *General Act on Electric Services* see *Delegated Law-Decree 4*, Ministry of Mining, of 12th May 2006, which consolidates the Delegated Law-Decree 1, Ministry of Mining, 1982.

B *Energy Integration*

The exploitation of bordering natural resources does not always lead to problems between countries. Sometimes it helps to solve them. Here, a case will be analysed to illustrate how transnational power-generation and transmission undertakings can themselves constitute cooperative drivers of economic growth, shared-management, natural resource preservation and peaceful resolution of conflicts.

1 *Case Study: Brazil and Paraguay - The Itaipú Dam*

Historical territorial conflicts between Brazil and Paraguay over the Salto Grande de Sete Quedas, home to the Itaipú dam, date back to 1750. While the 1872 Peace Treaty failed to resolve the boundary claims, in 1966 both countries agreed to jointly explore the feasibility to exploit the hydro-electric potential of the De la Plata basin as part of the Iguazú Declaration.[55] A year later the Brazil-Paraguay Mixed Technical Commission was created to conduct feasibility studies for the proposed dam [56] and an international tender process was initiated to choose the contractors for building the 14GW Itaipú hydro-electrical dam on the Paraná River.

Late in 1973, the Parties entered into the Itaipú Treaty which literally overcame a long-standing territorial dispute, by flooding the area. Despite much criticism over time, the Treaty is interesting for several aspects. One of them is the treatment of sovereignty-sensitive water and territorial issues: firstly, it fully acknowledged the bi-national nature and co-ownership regime over hydro resources of the relevant track of the Paraná River. Secondly, it declared in a sovereignty-safeguard clause that the construction of the electric facilities shall neither alter the *status quo ante* in regard to border delimitation nor confer any Party jurisdiction or property rights over any part of the other's territory.[57] It is interesting too, that it created a bi-national entity: Itaipú, to which both Parties granted a concession to exploit the hydro potential of the Paraná River[58] in return for royalties.[59] However, the central point of it is the power distribution agreement enshrined in Article XIII. According thereto, the entire Itaipú power production shall be divided equally between Brazil and Paraguay, being recognized to each Party the right to acquire the exceeding power not domestically consumed by the other. They also agree to acquire the entire installed capacity.[60] In turn, Article XV paragraph 3 establishes as an element of the cost of the service provided by Itaipú a certain amount aimed to remunerate the Party assigning power surplus.[61]

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55 Declaração de Assunção sobre o aproveitamento de rios internacionais [Declaration of Asuncion on the Use of International Rivers] signed 3 June 1971.

56 Tratado entre a República Federativa do Brasil e a República do Paraguai para o aproveitamento hidroelétrico dos Recursos Hídricos do Rio Paraná, pertencentes em condomínio aos dois países, desde e inclusive o Salto Grande de Sete Quedas ou Salto de Guairá até a Foz do Rio Iguaçú [Treaty between the Federative Republic of Brazil and the Republic of Paraguay for the hydroelectric exploitation of water resources of the Paraná River, in a condominium belonging to both countries, from and including the Salto Grande Seven Falls or Salto de Guayra to Foz do Iguazu River], signed and entered into force 26 April 1973, art XXIII.

57 Ibid art VII

58 Ibid arts III, V.

59 Ibid art XV.

60 Ibid art XIV.

61 Ibid art XIV.

In 1984 the Itaipú hydro plant commenced operations and new problems began to emerge. Argentina feared Brazil's control over the floodgates and the threat posed to Buenos Aires in the event that the gates were to be opened. This external security issue was resolved through a tripartite agreement.[62] Paraguay claims that a rigorous interpretation of the Treaty on the exclusive nature of the power-surpluses acquisition right[63] adversely affects its commercial options as well as casts doubts upon the 'fairness' of the amount payable to the power-assigning Party. This is of utmost importance because, although Paraguay enjoys enormous power-surplus, it is not allowed, by the terms of the Treaty, to sell it to third parties even if they are prepared to pay higher prices. Under the terms of the Itaipú Treaty, Paraguay could only assign surplus to Eletrobrás (Centrais Elétricas Brasileiras SA) which is owned by the Brazilian government. As a result of diplomatic negotiations over the past few years, starting in 2023 Paraguay's state owned national electricity utility, Administración Nacional de Electricidad, will be able to sell power-surplus to Brazilian companies other than Eletrobrás and to third party countries.[64]

The relationship between Brazil and Paraguay may continue to improve with the realisation of the 500kV Villa Hayes transmission line, a project valued in US$400 million and intended to be carried out by Brazil, Paraguay, Argentine, and Uruguay once funding has been agreed upon.[65] It is highly remarkable that, despite its formal multinational nature, the project would be an improvement to Paraguay's poor power-transmission infrastructure. Paraguay's transmission network is made up of only seven 220kV lines totalling approximately 3,566 km. This scarce and unsophisticated transmission infrastructure sharply contrasts with its huge generation capacity. The reason why the network remains so simple is because the most important lines belong to the bi-national stations, and they mostly convey power away towards Brazil and Argentina, while the rest goes to feed the distribution system focused mainly on the eastern part of the country. In fact, the Paraguayan transmission capacity lies far behind that of Uruguay, [66] which has much less power capacity but enjoys a widespread transport network.[67] Apart from the transport coverage issue, the network is well-known for having serious efficiency and reliability weaknesses.

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62 Acordo Tripartite entre Brasil, Paraguai e Argentina para aproveitamento dos recursos hidráulicos no trecho do Rio Parana desde as Sete Quedas até a foz do Rio da Prata [Tripartite Agreement between Brazil, Paraguay and Argentina to Use of Water Resources in the Stretch of the Parana River from the Seven Falls to the mouth of the River Plate] signed 19 October, 1979.

63 Differences in the interpretation of this point goes back to a Treaty's antecedent: the Foz de Yguazú Statement, according to which both countries shall have a 'preferential right' to buy each other's power surpluses, which shall also be acquired in 'fair price'. However, this wording did get into the current Itaipú Treaty, leading to the construction of an exclusive power-surplus acquisition right.

64 Declaração de Assunção sobre o aproveitamento de rios internacionais [Declaration of Asuncion on the use of International Rivers](Asunción Statement), dated 3 June, 1971, art 5,6.

65 Through contributions to MERCOSUR's Convergence Structural Fund (Fondo de Convergencia Estructural, FOCEM).

66 *La energía eléctrica Paraguaya en un marco regional* [Paraguayan electricity within a regional framework] Centro de Estudios Económicos [Centre for Economic Studies], Union Industrial Paraguaya [Paraguayian Industraial Union].

67 See generally Comisión de Integración Energética Regional, [Regional Energy Integration Commission] <http://www.cier.org>.

Therefore, in the context of the bilateral relationships between Brazil and Paraguay in which the Itaipú issues are central, it is quite understandable why Brazil would be willing to promote the Villa Hayes' transmission line project and even to fund it either in whole or part. The Itaipú hydro-electrical dam represents not only an example of cross-border interconnection, but also the cooperative approach towards energy integration in the transmission area.

IV THE OPPORTUNITIES OF TRANSNATIONAL POWER TRANSMISSION

In a world in which the human population has reached 7 billion, of which approximately 396 million live in South America, the law of conservation of mass is inescapable. Although electric power is a commodity, under the present technological state of affairs meeting its demand depends on limited natural resources whose value varies according to locality, purpose and circumstance. [68] Being some resources finite, it is essential that remaining renewable resources be effectively integrated and utilised. Thus, in dealing with these challenges, transmission networks are called to play a decisive role.

Two main expressions of such a role will be analysed here. Firstly, the opportunity for transmission networks to assist on achieving sustainable development and serve as a Climate Change abatement mechanism. Secondly, its potential for enhancing market access and configuring a single transnational electricity market.

A *Sustainable Development and Climate Change*

Interconnection of power grids is economically desirable as it would result in a significant decrease in national operational cost. This is particularly true for countries choosing to design their matrices in respect of renewable sources, because it induces interconnected countries to export surplus power and thus generate income for their developing economy. Further, by means of the 'flexibility mechanisms' of Article 12 of the Kyoto Protocol, Annex I countries can invest in emission reduction projects in non-Annex I countries, therefore contributing to achieve or enhance sustainable development. Furthermore, under Article 6 of the Protocol, transmission projects could also qualify for Joint Implementation, i.e. emission reduction projects in other Annex I countries.

A highly controversial case can be found in Ecuador's Master Plan for Electrification 2007-2016 which, under a scheme of compulsory planning, contains projects to be carried out to overcome the country's seasonal power deficits and lack of investment in energy

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68 DLR. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), *Renewable Energy and the Clean Development Mechanism. Potential Barriers and Ways Forward. A Guide for Policy-Makers* (2007) Germany. Locality in that natural resources are not equally geographically distributed. Purpose is exemplified with water which has uses ranging from quenching thirst to activating hydro-electric turbines. Circumstance is the existing circumstances which lead to the available use of that resource. Consider, of global water resources, only 2.5% constitutes fresh water. Of this, only 0.4% is available as a surface liquid, of which only 30.5% is available as a resource (the rest is lost to evapotranspiration, the sea or underground aquifers). See World Bank, *World Development Report* 2010.

70 The Master Plan for Electrification 2007-2016 pledges for further 3,800 MW of installed capacity to be added to the system, of which 80% (3,040 MW) must come from renewable sources.

infrastructure. Despite the plan relying on renewable sources, particularly hydro, wind and biomass, as long-term energy supply solutions,[70] with a CO_2 abatement potential of 6.13 tons per year, and despite it advocating for a more active participation of the State in carrying out the projects,[71] it has been widely criticized for its failure to juggle both of the following requirements. On the one hand, part of the funds allocated to a project must be used for improving the global management of river basins, in specific programs for reforestation, and in establishing mechanisms for the preservation and enhancement of the biodiversity and local ethnics. On the other hand, the funding for such undertakings comes from the share that the Ecuadorian State obtains from contracts in the oil industry[72]and from the exploitation of sectors of the Ecuadorian Amazonia.

While the Latin America and the Caribbean region has the second lowest rate of greenhouse gas emissions, it is suffering the effects of climate change more than any other.[73] As such, there is an urgent need for technological innovation and financial support from developed countries to help bolster the region's adaptation, mitigation and sustainable economic recovery programs. The region needs to maintain strong growth rates over time while at the same time turn onto a path of energy decoupling through energy intensity and decarbonisation rates structures (like those of developed countries, like the USA or the EU) and maintaining low carbon dioxide emissions, increasing the share of renewable sources into energy matrixes and promoting transnational transmission networks.

Transnational power transmission projects represent a way to converge and make multi-renewables integration work to its full generating potential. Interconnected networks enable power to be transferred from one region to another, balancing load between time-zones and regional variations, thereby enhancing energy efficiency with minimal overall impact to the environment.[74]

The efficiency of an interregional policy depends upon its ability to generate GHG emission reductions at source and, preferably, through long–term, large-scale use of renewable energy technologies. The proposition of this paper is that one of the ways in which this could be achieved is through international interconnection of networks.

The contribution of expanding transnational interconnections of power grids to the abatement of the effects of Climate Change can be understood not only by acknowledging the integration of renewable sources into the grid and the dispatching of the most efficient generating units according to marginal cost considerations, but also because they can utilise existing power plants as a back-up and make inefficient existing units obsolete.

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71 Either in the generation, transmission, or distribution sectors. For instance, in the former one, the plan projects the construction of five hydro-electric dams: Mazar, Sopladora, Toachi Pilatón, Ocaña, and Coca Codo Sinclair. The environmental protection and the projects for rural electrification are also areas in which the planning conceives determined State's participation.

72 Decreto N^{o} 303 de 27 de octubre del 2006 [Decree No 303 of 27 October 2007] (Ecuador) 27 October 2007; Ley Orgánica para la Recuperación del Uso de los Recursos Petroleros del Estado y Racionalización Administrativa de los Procesos de Endeudamiento [Recovery of State Petroleum Resources for Public Use Act] (Ecuador) 3 April 2008.

73 *Economics of Climate Change in Latin America and the Caribbean. Summary* 2009 <http://www.eclac.org>.

74 Operation at high-transmission level voltages (110kV and above) in long distances reduces load losses. It also increases the power system reliability and improves load management.

As long as renewable energy sources can be integrated to an existing power grid on a wide-scale, renewable energies contribute to *slowing climate change* by providing power generation with none or only marginal direct and indirect GHGs emissions. In this way, it would contribute to a massive overall reduction in conventional oil-fired generating units, stranding many of the assets of the big agents and making it unnecessary to build new fossil fuel-fired plants. This explains why there is no great support from these big agents for the faster integration of renewable generation sources into the grid.

B *Natural Resources Share Management and Integration of Renewables into Transnational Networks*

At present, renewable energies only work efficiently on a large scale. Many countries have realized that they can have renewable sources of energy in operation, but if they are not integrated into an existing network, 'the bigger the better' makes it hard for them to achieve full efficiency and economic competitiveness. This acknowledgement is thus one of the major drivers which make countries enter into talks on network interconnection and energy integration. This is particularly true for those relying on renewables to achieve a relevant share of their energy mixes. In South America, the effect of all this, at this stage and at multilateral level, is just an external cooperation between governments to promote studies on electrical interconnections.

Attempts on share management and energy integration, however, have been more productive and faster at a bilateral level. This is due in part to location of natural resources that span the borders of more than one country. The need to exploit them as well as the want for sharing the benefits derived from such exploitation has always found a way out through bilateral political understanding. So it has been the case with Brazil and Paraguay as to the utilization of the river Paraná in the Itaipú dam, as well as that of Argentina and Uruguay as to using the river Uruguay to serve the bi-national 1,890MW hydro plant Salto Grande which production is distributed equally between both countries. Salto Grande constitutes itself an associated transmission system on 500kV operated by a bi-national body: the Mixed Technical Commission depending on the Foreign Affairs Ministries of Argentina and Uruguay.

Although natural resources are randomly allocated and hence locally appropriated and managed either exclusively or jointly (an undeniable geo-political factor), that does not prevent distant and non-local users from benefiting from them (particularly in situations of power-generation surplus). Transmission (or generating) facilities associated with the exploitation of common natural resources for which management and preservation for future generations is regulated by international instruments (like a treaty on bi-national frontiers) normally are also the subject of international bilateral agreements.[75]

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[75] See generally Alan Boyle, *International Law and the Protection of the Global Atmosphere: Concepts, Categories and Principles*, in Robin Churchill and David Freestone (eds), *International Law and Global Climate Change* (Nihoff, 1991). See also *Agreement Relating to the Implementation of Part XI of the UN Convention on the Law of the Sea of 10 December 1982*, adopted 28 July 1994 33 ILM 1309 (entered into force 28 July 1996) pt XI.

With the integration of renewables into transmission networks, the advantages will ultimately outweigh the obvious shortcomings. Indeed, apart from making renewables achieve their full efficiency by operating at large integrated scale, it is a fact that renewables placed into a network contributes to a gradual reduction in the still-high installation costs of their technologies. Wind-power costs, for instance, are already competitive in many countries. In this, the role to be played by the State is to ensure entry-requirements be equal and non-discriminatory for any source of power.

Moreover, integration of renewables might act as insurance against rising prices of other energy sources and as an incentive for domestic industrial growth. Once interconnected to a grid, the zero (or extremely low) operating costs of renewables start competing with those of conventional sources. The theoretical possible outcomes are that conventional sources are displaced out of the market or their pricing goes down to equal that of renewable sources. On the other hand, local industries might be better off by producing the equipments used or the spare parts required by the renewable technologies.

C *Enhancement of Market Accessibility and Potential for a Single Transnational Electricity Market*

In terms of market accessibility, the idea of a transnational transmission grid is appealing for many reasons. Primarily, new energy sources could access and get interconnected to the grid, thus allowing more competition between generators and cross-border power trading (free movement of goods). Secondly, this must not only be a matter for large power companies. In theory, a common widespread smart grid should also be prepared to integrate a multitude of small and very small energy sources: even an individual could become a producer, having access and interaction in the net when installing a solar panel or a co-generator. Thirdly, it could help by balancing supply and demand at a regional level, thus securing power supply needed not only for driving regular economic activities, but also contributing to enhancement of the stability and reliability of the domestic grids. Fourthly, a smart grid allowing widespread access also provides power storage capacity to offset low generation. Finally, multilateral energy interdependence (particularly between non-neighbouring countries) and the technical advantages of interconnection makes this interdependence politically desirable in an international context, and assists towards the development of enforcement mechanisms to ensure the energy supply. Therefore, a single transnational network could also play a stabilizing role in securing unsteady regions, because a transnational power grid would remove the cessation of power supply as a political bargaining token, during any political conflict in the region.

Up to the present, however, attempts to make a common electricity market a reality, like the proposed European Union's Internal Energy Market,[76] are still in progress. Despite many features of a common heritage, the task seems to be even more difficult for South America. Nonetheless, trans-boundary transmission constitutes a fertile ground for the development of internationally enforceable legal mechanisms. Indeed, being considered from the economic point of view as a series of monopolistic imperfect markets, the operation of power grids calls

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76 'Completing the Internal Market' (White Paper COM[85] 310 final, Commission to the European Council, June 1985). See also 'The Internal Energy Market' (Commission Working Document, COM[88] 238 final, 2 May 1988).

for detailed regulation ensuring fair and non-discriminatory access and use of its infrastructure.

V CONCLUSION

This paper was intended to advance the proposition that, in the South American region, transnational power networks could represent a step forward towards the regional common policy goal of achieving sustainable development.

In testing such a proposition, the first issue analysed was why so many countries might have such a common policy goal. The conclusion is that rather than being of a specific means-prescriptive nature, the sustainable development concept is of a general non-prescriptive one, thus allowing disparate sectoral policies be a fairly regular outcome. However, two options stand out as main ways to, on one hand, favour sustainable development, and on the other, decarbonise economies: energy efficiency measures in the short term and renewable energy technologies in the medium and long term. [77]

For a proper assessment of the proposition and the opportunities thereof presented in this paper it is necessary to provide, at least, a glimpse into the technical, economic and regulatory obstacles on the way to make transnational transmission networks a reality. Firstly, grids should become larger and 'smarter' thus allowing instantaneous consumption-data transfer and electronic device interaction giving feedback to the grid and increasing energy-efficient responses. In addition, better and more acute operation software are required to better strike the balance between surplus and scarcity in a grid to be characterized by integrating renewables where output is extremely difficult to predict. Secondly, transnational transmission networks in South America face big economic challenges. Apart from the inherent costs of research, testing and development of new technologies and the externalities of dealing with either monopolistic or oligopolistic features of the transmission sector, a new grid would also require more flexibility in its economic operation. At user level, for instance, the traditional pattern of supply based on consumption would evolve to adjust demand to an increasingly fluctuating load on the grid. Economically, this expresses itself through variable pricing models for electricity (instead of uniform prices), premium convenience schemes for consumption, freedom to change power providers and even prepaid power rates. At private developers' level, in turn, the cost of the construction of this kind of networks demands large capital investments. Similarly, for States engaged in centralized planning the funding of 'smart' transmission infrastructure expansion plans could represent a significant burden for domestic budgets. More broadly, renewable-based mixes must bear the cost of de-carbonizing existing economies (mainly phasing out fossil fuels-related subsidies and promoting clean energy sources). Finally, particularly in developing countries, a range of legal, institutional and political barriers stand in the way of energy integration. At present, while South American multilateral energy integration efforts are in embryonic state, bilateral agreements in line with national concerns on security of power supply have been successful.

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[77] The consideration and effects of implementing energy efficiency (EE) measures are outside of the scope of this paper, which rather focuses on that of renewable energy sources (RE) when integrated to energy mixes as well as on the suitability of transnational network interconnection to the furtherance of sustainable development. Both EE and RE are mechanisms viable and available for climate change mitigation.

Clearly, the interconnection of transmission networks throughout South America would represent several opportunities for achieving sustainable development. Not only would the establishment of such a system create the conditions for a common electricity market, it would help to meet the power needs of high-demand countries by making possible cross-border power transmission from generating units to consumer distribution centers. This is of particular relevance not only because of the growing rate of total power demand in South America but also most importantly, though not surprisingly, because the three power-deficit countries: Brazil, Argentina and Chile have the highest concentration of industrial-related power demand.

Transnational power integration works would also optimise the use of natural resources and thus would make a suitable climate change abatement mechanism even under the Kyoto Protocol. Indeed, network integration allows the interconnection of different power sources—most importantly, renewable sources—as well as taking advantage of the interaction of geographical regions with dissimilar energy potentials due to particular morphological features and/or timing in power generation. All of these combine to help countries get the most from their resources, economic advantages in producing goods and services, international trade and ultimately economic growth to achieve development goals whilst preserving the environment.

In addition, cross-border power transmission integration resembles shared-management of resources. As seen, some large bi- or multinational power undertakings would not have been executed if participating countries had not agreed on how to use common resources, how the facilities involved would be operated and how to distribute (and transport) power outcome. The latter does not mean much if it cannot be delivered where it is needed (the main problem of Paraguay, for instance). In fact, during the exploitation phase, the longest of any power project, the issue of distribution is critical and always involves the transmission system. It can fairly be said that once power is produced, whosoever possesses the transmission lines also controls the power source. If, on top of that, cross-border interconnections are involved, the matter becomes even more sensitive. Key issues that arise for examination are the identification of the transmission facilities involved in interconnection processes, the control of and access to those facilities, the consideration of choosing public, private or mixed property for them at a domestic level on the one hand or their straightforward characterization as assets under international status on the other, thus placing them above and beyond mere national interests. Translating all of this to the legal field results in a need, at international level, to consciously avoid ‘property-based’ mindsets, and secondly, to avoid others’ ideology-filled concepts and any language denoting exclusive use and absolute control of the new transnational transmission facilities. It also requires the finding of a clear, though non-exclusive, model of management over the power grid.

This explains why, either in regard to relatively simple operational issues or usually more complex outcome distribution, legal and practical arrangements between countries on the shared-management of transmission systems facilitate the joint management of the power source. The examples given of this case were those of Brazil and Paraguay in regard to the Itaipú hydro-electric station and the use of the river Paraná, and that of Brazil and Argentina in respect to the Garabí hydro-electric station and the use of the rivers Uruguay and Pepirí-Guazú.

International interconnections normally serve as a guarantee for a country's own network stability through the integration and interplay between the various components of the corresponding electric systems. The same configurations also improve domestic networks' reliability, for example, in terms of uninterrupted supply. On the one hand, countries enjoying power-surplus should fear nothing, whether conventionally produced (e.g. Venezuela) or coming from renewables (e.g. Uruguay). On the other, deficit or non-energy producing countries should welcome reliable and steady supply, and be prompted to develop and integrate renewable energy-producing units into the common network.

In most countries, particularly those facing the pressing sustainable development dilemma, all the analyzed barriers pose a considerable challenge. The lack of technical funding and institutional capacity make it harder. In South America particularly, the promotion of new renewable energy sources is recent, still limited and not always consistent. Although these renewables have been progressively making their way into many countries' energy mixes as the envisaged solution to such a dilemma, countries still need to jointly realize that the best chance for renewables to be successful is to integrate them into a single regional 'smart 'grid, rather than confine themselves to domestic realms.

In summary, energy policies are a crucial factor in South America realising its common regional target of sustainable development. Individually and with different emphasis and pace, South American generation schemes seemed to have internalized the urgent need to decarbonise their respective economies and integrate renewable energy sources. Colombia, Brazil and Paraguay lead the trend, allocating to renewable power a substantial share in national energy mixes, followed by Argentina, Chile, Uruguay and Venezuela and to a lesser extent Peru and Bolivia. In turn, the integration of renewable technologies is a central part of making the best and most efficient use out of renewable sources, with an acceptable risk and at a competitive cost level. Does the transnational interconnection of South-American power transmission networks represent such a technical, risk-acceptable and cost-competitive means? The opportunities analysed assists this research to answer the question affirmatively, though it also highlights the occurrence of both political and legal barriers which hinder its implementation.

This paper concludes, therefore, that transnational interconnection of transmission networks could function as a cooperative mechanism for energy integration and climate change abatement, in order to assist in solving the dilemma of sustainable development. By simultaneously focusing on energy matrix configurations at domestic level and on interregional power transmission networks within South America, transnational power grids can be made viable.