CHALLENGES AND OPPORTUNITIES FOR LATIN AMERICA'S SUSTAINABLE ENERGY DEVELOPMENT

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Sectoral energy report
Energy: an Overview of Challenges and Opportunities in Latin America and the Caribbean

Legal deposit number: If74320133331558
ISBN: 978-980-6810-90-7

Publisher: **CAF**, development bank of Latin America

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This document is a summary of the study entitled *Hacia una agenda energética compartida*, which was prepared by the Bariloche Foundation and the University of São Paulo with institutional support from CAF.

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Thanks are due to the representatives of firms and countries who took part in the different revision committees and meetings. We are also grateful to José Félix García, former Executive Secretary of ARPEL, and Plinio Fonseca, former Executive Secretary of CIER, for their involvement in the early stages of the study.

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PRESENTATION

Energy is essential for economic and human development. Properly obtaining, developing and sustainably using energy sources by all citizens must be a priority for any nation that pursues progress and well-being.

The present report provides an overview of the factors affecting the global economic and energy situation and the impacts on Latin America and the Caribbean. It also analyses the legal, regulatory and institutional framework within which energy sectors operate, discussing progress towards and obstacles to energy integration and security of supply. Another important issue is the balance between resources and reserves as this affects the supply and consumption of energy.

Environmental implications and problems associated with climate change are unavoidable issues in the context of global energy development trends in the twenty-first century; particular emphasis is laid on the potential role of progress with technological development and innovation, energy efficiency and renewable energies.

Social equity and universal access to energy services are analysed in depth in the present study, since no real path to progress can be found unless this problem, an endemic one in our region, is given due consideration.

This diagnosis offers a broad and well-documented perspective on the current situation and the challenges that Latin America and the Caribbean will face in the short, medium and long run. The aim, then, is to provide regional actors with an overview that helps them to identify both these challenges and opportunities for improved regional energy planning that can make an integrated contribution to equality and inclusion, furthering the cause of sustainable economic development.

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ACRONYMS

ARPEL. Regional Association of Oil, Gas and Biofuels Sector Companies in Latin America and the Caribbean
BBOE. Billion barrels of oil equivalent
CARICOM. Caribbean Community
CELAC. Community of Latin American and Caribbean States
CIER. Regional Electrical Integration Commission
ECLAC. Economic Commission for Latin America and the Caribbean
EIA. Energy Information Administration
FDI. Foreign direct investment
GDP. Gross domestic product
Gtoe. Gigatons of oil equivalent
GW. Gigawatts
IAEA. International Atomic Energy Agency
IEA. International Energy Agency
LAC. Latin America and the Caribbean
LAIA. Latin American Integration Association
LGN. Liquefied natural gas
LPG. Liquefied petroleum gas
MMBD. Millions of barrels per day
MMm³. Millions of cubic metres
NAMA. Nationally appropriate mitigation action
NCRE. Non-conventional renewable energy
NRC. Nuclear Regulatory Commission
OAS. Organization of American States
OLADE. Latin American Energy Organization
PCT. Patent Cooperation Treaty
PDVSA. Petróleos de Venezuela
SICA. Central American Integration System
SIEPAC. Electrical Interconnection System for Central America
SINEA. Andean Electrical Interconnection System
TWh. Terawatt hours
UNASUR. Union of South American Nations
WEC. World Energy Council
WIPO. World Intellectual Property Organization
WTI. West Texas Intermediate

1

ENERGY AND THE WORLD ECONOMY

The global economic framework has undergone profound transformations in the past two decades, with powerful repercussions around the world and especially in Latin America and the Caribbean (LAC).

Important aspects that help towards an understanding of the context, depth, direction and scope of the changes that have occurred are:

- Vigorous growth in world trade.
- Higher GDP growth in developing countries than the developed world.
- Changes in the tendency of flows as a result of the increasing urbanization of China and India and the consequent emergence of a large middle class that is eager to consume.
- New demographic trends, with a contrast between the slow growth and ageing of the population pyramid in developed countries and the demographic dynamism of the Asian region.

All these things point to a geographical reconfiguration of the global balance of power.

Developing countries are currently the main engine of the global economy.

Developing countries are currently the main engine of the global economy (ECLAC, 2013). The world economy grew by 2.7% in 2011, as against 2.2% in 2012 and an estimated 2.4% in 2013 (United Nations, 2013). Barely a quarter of this growth is being generated in the industrialized countries, whose economies expanded by 1.4% in 2011 and 1.2% in 2012.[1] This rate masks a high degree of heterogeneity, as most eurozone economies are in recession while the United States and Japan are growing at rates of about 2%.

Conversely, developing countries maintained a degree of dynamism and provided the bulk of growth in the global economy in 2011 and 2012. The Asian countries, led by China with growth of 7.8% in 2012, made a particularly large contribution. Meanwhile, GDP growth in LAC , was 4.3% in 2011 and 3.1% in 2012, with 3.9% expected for 2013 (United Nations, 2013).

Nonetheless, growth in developing regions has been affected somewhat by the decline in GDP in the developed countries, especially in the areas of trade and finance. The result was that the overall rate for these countries dropped from 5.9% in 2011 to 5.3% in 2012.

Latin America and the Caribbean has had the highest export growth of any region in the world.

Within this overall picture, two points need to be borne in mind:

- At a time of slowing global trade, LAC had the highest export growth of any of the world's regions in 2011 and 2012. It achieved this result partly because it is the zone that is least dependent on the European Union as a destination market. Furthermore, demand from the United States and China, its two main trading partners, continued to grow. This mainly benefited Mexico and Central America in the first case and South America in the second.
- Commodity prices dropped during the second half of 2011 and were somewhat volatile thereafter. This decline was due to the negative outlook for

1 Preliminary figures.

global growth as a result of the debt crisis in Europe, concerns about the sustainability of economic growth in the United States and fears of a possible slowdown in emerging economies, particularly China. Despite this reduced dynamism, commodity prices are expected to remain above their historical averages over the coming years.

The importance of investment

Flows of foreign direct investment (FDI) were about US$ 154 billion in 2011, 28% more than in 2010. It was the second consecutive year of growth following the decline caused by the international crisis in 2009. Latin America was also the region of the world where FDI grew the most, with its share of worldwide FDI inflows reaching 10%.

We are confronting a new economic and technological development paradigm, known as the "green economy" and the "sustainable economy".

Sustained economic growth in the region, albeit at a lower rate than in 2010, has continued to act as an incentive for investment aimed at tapping the dynamism of local markets. All the while, international commodity prices that are above their historical averages, particularly in the case of metals, have driven investment in natural resource extraction and processing.

In the developed countries, the economic crisis has continued to drive business restructuring, relocation of operations and offshoring of manufacturing and remote business services.[2]

In the course of 20 years of rising FDI flows, transnational enterprises have consolidated a large presence in LAC. Meanwhile, repatriation of profits to parent companies has grown substantially, from an average of about US$ 20 billion between 1998 and 2003 to some US$ 90 billion in 2007-2010. Consequently, the returns obtained by foreign firms in the region are a key variable when it comes to analysing FDI inflows and rents alike in the balance of payments of the region's economies.

2 Brazil accounted for most of the increase, with a figure of US$ 66.6 billion, almost half the regional total, but FDI inflows also increased in most of the South American countries (US$ 17.3 billion in Chile, US$ 13.2 billion in Colombia and US$ 2.5 billion in Uruguay). ECLAC (2011).

The social aspect

Something else to consider is the emergence of a global middle class, implying historically unprecedented levels of consumption and demand for raw materials as hundreds of millions of people are incorporated into urban lifestyles. This has been forcing up the prices of commodities (minerals, food and energy). Although some prices dropped in 2012, everything points to the conclusion that the structural factors behind rising prices will remain in place for some time to come, at least until new supply thresholds are developed.

Different studies and analyses of evolving global energy demand agree that the largest increase in this demand will come from developing countries. They stress the difficulty, at least in the next 20 years, of replacing fossil fuels, whose use is burgeoning, this being particularly true of oil, gas and coal, which are expected to account for some 65% to 70% of the global energy mix for the foreseeable future. The assumption here is that the great bulk of easily discoverable, low-cost oil sources have now been found and developed.

Hydrocarbons, alternative sources and the environment factor

New sources of supply will need to be explored and developed in more testing environments, and as a result the potential for using non-conventional hydrocarbons has become an important part of the search for solutions that can meet future energy demand, which will have a major impact in emerging economies with large populations.

This argument has been strengthened by the earthquake and accident in March 2011 at the Fukushima-Daiichi nuclear plant in Japan, which raised a number of questions about the future of nuclear power and its share of the global energy supply. Safety arrangements at nuclear power stations around the planet were immediately reviewed, although the measures taken by the different countries did not all tend in the same direction.[3]

Considering the short time that has passed since the Fukushima accident

3 In the United States, the Nuclear Regulatory Commission (NRC) argued that American nuclear power plants were designed to withstand the effects of tsunamis, earthquakes and other hazards. President Barack Obama subsequently confirmed that the planned programme of new power station construction would continue. Similarly, Russia announced that it would double its installed nuclear capacity by 2020, subject to strict supervision of safety measures, while Korea will expand its capacity with five new power stations.
In Germany, conversely, mass demonstrations against nuclear power forced Chancellor Angela Merkel to halt the operation of seven power stations built before 1980 and to phase out nuclear-generated electricity by 2022, although this decision will force Germany to import nuclear-generated electricity from France. Switzerland is likewise planning to close its three nuclear power stations by 2034.
China is an example of a country in an intermediate position, as Prime Minister Wen Jiabao suspended the awarding of licences for new reactors until a review of safety systems at existing power stations and those under construction was completed, although he has declared that China will maintain its civilian nuclear option as set out in the twelfth five-year plan, which provides for the construction of a further 40 GW by 2015.

and the stances adopted by the member countries of the International Atomic Energy Agency (IAEA), a degree of caution is called for when assessing likely developments in the supply of nuclear-generated electricity. The Declaration of the IAEA Ministerial Conference on Nuclear Safety includes 25 measures for improving nuclear safety and asserts the firm commitment of the organization's member States to ensuring they are implemented. The member States have spoken of the urgent need for the lessons of Fukushima Daiichi to be learnt and their determination to take appropriate action in five main areas:

- Review and strengthen the IAEA Safety Standards.
- Systematically review safety at all nuclear power stations, including an expanded programme of IAEA peer reviews.
- Strengthen the effectiveness of national nuclear regulatory bodies and ensure their independence.
- Strengthen emergency preparedness and the global response system.
- Enhance the body's role in gathering and disseminating information.

"Sustainable cities" imply major industrial and technological restructuring challenges, plus increasing use of renewable energies.

The Director General of IAEA estimates that the number of nuclear reactors around the world will continue to climb over the coming years. He has also warned of the importance of enhancing plant safety, while recognizing too that the pace of expansion will not be as quick as before.

In this context, while the possibility that international oil and natural gas prices may ultimately trend downward cannot be ruled out,[4] the contention of the present analysis is that there are good reasons to factor in rising prices, as set out in the baseline scenario of the United States Department of Energy (EIA, 2011), which explains that upward price pressure is being driven by dominant structural factors.

In recent years, the Asia region has become more dependent on oil supplied by the producing countries of the Middle East, while Europe is most dependent on Russia. Conversely, the United States has been diversifying its sources of supply.[5] An important development has been the decoupling of gas prices

4 A prolonged slowdown in the global economy combined with other factors such as the appearance in the United States of a new supply of unconventional oil and gas could have the effect of consolidating this scenario.
5 The United States imported 11.4 MMBD in 2011 from various countries, with the largest volumes coming from Canada (29%), Saudi Arabia (14%), the Bolivarian Republic of Venezuela (11%), Nigeria (10%) and Mexico (8%). EIA (2011).

at Henry Hub from the price of West Texas Intermediate (WTI) crude (and of the latter from Brent crude), which seems to be due to changes in the composition of the gas supply (the impact of United States shale gas production) and to point towards differentiation of regional demand by blocs.

The global energy debate often focuses on the impact of rising greenhouse gas emissions (which have climbed considerably), but this is only part of a broader global debate on possible development styles and social, institutional, political and production models.

Energy efficiency is an immediate option and the most cost-effective one in the short term.

Doubts are increasingly being raised about the sustainability of the prevailing growth pattern, particularly in the energy sector, and this has been giving rise to a new paradigm of economic and technological development variously termed the "green economy"[6] and the "sustainable economy". Concepts such as "sustainable cities", for example, entail major challenges of industrial and technological restructuring, together with growing use of renewable energies.

This emerging new paradigm in the developed countries is seen by some analysts as the sixth Kondratieff wave,[7] which implies that its increasing adoption transcends the issue of energy and climate change and enters the realm of a new long-term investment cycle.

The matter of the carbon footprint has been introduced as a further element in possible future goods trade patterns. Aspects associated with leadership in the production of renewable energies and the provision of technology and new types of devices are undoubtedly one of the cornerstones of development in the advanced countries, and this is a market that can also be competed in by some developing countries and other emerging economies.

Efforts to promote a wide variety of non-conventional renewable energies and energy efficiency, including discussion and development of concepts such as smart grids, electric and hybrid cars, institutionalization of the recycling industry, alternative forms of public transport, carbon capture in the energy industry itself and ecological building design, are some of the manifestations of this new paradigm.

6 See United Nations (2012).
7 See Allianz Global Investors (2010).

In this perspective, there have been very significant technological advances in wind energy that have resulted in improved capacity factors, increased average power and a downward trend in costs per megawatt installed and generated. Progress with wind monitoring, sensor utilization and other technological improvements have also enabled barriers to synchronized network operation to be overcome.

The development of solar energy has been particularly significant in recent years. The main increase has been in Europe, essentially relying on the development of grid-connected projects.[8] Technological improvements have been essential to this effort, and projects are expected to be commercially self-sustaining in the medium term.

In the case of geothermal energy, installed capacity growth in recent years has been fairly modest (2.8% a year).

Biofuel production increased rapidly between 2003 and 2010, representing the equivalent of 2.3% of crude production in terms of barrels per day in 2010.[9] The region is a pioneer in this area, mainly because of the involvement of Brazil.

It is globally acknowledged that energy efficiency is the most cost-effective option in the short term. Improvements in energy productivity are estimated to have yielded a saving of 3.6 Gtoe since 1990. Efficiency gains have been greatest in consumption sectors (which account for about 20% of the global total), while losses at transformer substations have increased because of the ever-rising use of thermal plants for power generation.

Industry is the economic sector that has made the best use of efficiency measures in the industrialized countries, while in developing countries it is the residential sector that evinces the greatest improvements.[10] The transport sector continues to progress least. Global trends do not reflect neither improvements in vehicle efficiency nor the results of public policies. Non-technical factors such as congestion and increases in vehicle numbers and size have largely cancelled out technical gains.

The various processes and changes seen in the global economic and energy situation have been making themselves felt in very diverse ways in the countries of LAC, depending on their basic export orientation, destination markets, natural resource availability and domestic policies.

8 By contrast with the projects typically implemented in Latin America, Asia and Africa, where priority has traditionally been given to using energy from solar panels to supply isolated rural areas with basic electrical services. This has been changing in the past two years.
9 The proportion was just 0.4% in 2000 and 0.7% in 2007.
10 In the most energy-intensive industrial activities (steel, aluminium, cement, pulp and paper), the tendency towards globalization and concentration has brought about convergence in efficiency gains.

2

THE SITUATION IN THE REGION

In the last decade, countries exporting commodities, and especially foods, minerals and fuels, enjoyed an unprecedented boom that also had positive effects on their economies (particularly in the South American nations). Trade balances in the Meso-American countries, on the other hand, worsened significantly, and the same was true of the Caribbean countries, this due to deficits on energy products.

A notable development is that the geographical reconfiguration of production, consumption and trade has resulted in greater intraregional trade in manufactures (especially in South America), making Latin American exports somewhat less dependent on outside economies.[11] It should be stressed that there is still great potential for trade and productive integration between the countries of LAC, which would create major economies of scale if realized.

11 Whereas 85% of the increase in exports between 1995 and 2002 was due to demand from developed countries, between 2002 and 2009 these accounted for just 49% of export growth. Even so, over 60% of exports from the region as a whole depended on demand from the central countries, indicating a need to review the interdependencies of the world economy and assess the real extent of decoupling.

It is vital to build infrastructure (including ports, airports, highways and an expanded energy supply) without neglecting investment in social policies, vocational training and research and development.

The short- and medium-term economic performance of LAC depends heavily on the form taken by global adjustment processes, particularly the way the eurozone exits its crisis, and the slowdown in China. It will also depend on the region's ability to respond appropriately to external shocks. Analyses by international organizations all find that the measures adopted in most of the region's countries have created fiscal space for the use of countercyclical policies to react to adverse developments in the international economy. In the last five years, these measures have made it possible to stabilize employment, investment and growth.

Similarly, improved export indicators have substantially increased currency inflows and international reserves growth, taking them to historic highs. This situation, along with other causes, has not only affected the relative position of local currencies (appreciation against the United States dollar) but has also created regional financing strengths whose consequences have yet to be clearly ascertained.

There is still great potential for trade and productive integration between the countries of LAC that would create major economies of scale if realized.

Intraregional trade

The potential for trade between developing regions (South-South) needs to be studied very carefully, as it could be placed on a progressively sounder footing. This would mean not only that trade of greater added value could take place, but that it could be based on more complex technological learning processes requiring integrated and flexible planning. Greater maturity and consolidation in subregional integration processes and more joint integration of these blocs is a

priority that the countries of the region and their trade representatives need to work on, overcoming the short-term constraints of protectionism.

Oil shale production is transforming the outlook for the sector, and LAC will need to work out more active policies to attract investment.

For as long as so many of the regional benefits of the current growth model remain highly sensitive to international price shifts, it seems indispensable for revenues to be channelled into strategic investments, which can be progressively centred on the domestic market, to achieve future development that is less dependent on technology imports and commodity exports. For this to happen, it is vital to build infrastructure (including ports, airports, highways and an expanded energy supply) without neglecting investment in social policies, vocational training and research and development. This will mean working out a desirable development path and analysing viability strategies, and importance will have to be attached to the energy sector in its role as both producer and supplier of energy.

The United States was a major importer of LNG, but now, thanks to the development of non-conventional hydrocarbons, not only has it reduced imports, but it may consolidate an export profile. Should this situation be sustained over the long term with what are comparatively very low prices, there will be a powerful impact on the regional and global context. Shale oil production is transforming the sector's outlook, facing the countries of LAC with the need to work out more active policies to attract investment. Non-conventional hydrocarbons thus represent a major challenge for the region. Developing their substantial potential in a number of countries will require the adoption of a regulatory regime that encourages exploration, development and production of these resources, which in turn require technologies, corporate structures and personnel different to those needed for conventional hydrocarbon production.

At the same time, the region needs to become a user of technologies associated with the sustainable development paradigm, and for this it has to make preparations in the form of technology creation and adaptation, while at the same time laying down clear strategies for the most appropriate energy mix in accordance with the natural, technical and financial resources available.

The inclusion of elements of the sustainable development paradigm (particularly the introduction and spread of non-conventional renewable energies) should be

seen in LAC as a development opportunity if they contribute to the creation of new production chains, value added and improvements in the region's positioning in the global economy. This can represent a substantial burden, however, with financing needs that compete with other priorities (public-sector social spending and investment), and can have negative impacts on energy costs.

It is vital for revenues to be channelled into strategic investments so that future development is less dependent on technology imports and commodity exports.

Energy development is unquestionably taking place in the region, and while it may be limited to a few countries, the impact is being reflected in regional indicators, which show LAC as being quite favourably placed as far as the use of renewable energies is concerned. It would be advisable for the energy sector to coordinate with those parts of the Government that carry out negotiations in international environmental forums in order to arrive at a position that better matches the reality of energy development. The progress of hydropower (which still has great unrealized potential) and biofuels in the region offers an example of global relevance and represents a level of acquired experience (not least with technology) that should not be underestimated in prospective studies.

Which energy source?

The Latin America region will also need to engage with the debate about the future of nuclear energy. In the event of changes in the global energy supply mix, the International Energy Agency (IEA) predicts higher energy prices, including electricity prices, which will weigh on efforts to combat climate change.

Nuclear energy currently accounts for 7% of the world's primary energy consumption and 15% of its electricity production. The share is larger in the industrialized countries (19% of electricity production in the United States, 28% in the European Union, 30% in Japan and 75% in France). New power stations are being constructed mainly in China (28 plants), Russia (11) and Korea (5). In Latin America, in addition to the six already operating, the Atucha II power station in Argentina was inaugurated in September 2011, while Angra 3 is under construction in Brazil.

The progress of hydropower and biofuels in the region offers an example of global relevance.

There are two scenarios for the role of nuclear energy in efforts to stabilize CO_2 emissions. The first is that the share of nuclear power in electricity generation falls from 13% in 2010 to 7% in 2035, with 332 GW of installed capacity in the latter year (counting 69 GW currently under construction, 91 GW of new power stations and, crucially, the retirement of 218 GW). In the more optimistic scenario, nuclear power retains its 13% share of overall generation, with 629 GW of installed capacity (69 GW under construction, 277 GW of new additions and retirement of just 107 GW, half as much as in the first scenario). In either case, the capital cost of building new plants is expected to increase by between 5% and 10% of the cost assumed before the Fukushima crisis, and the greatest dynamism will be in developing countries.

The reduction of nuclear energy in the generating total will mean that gas and coal, and to a lesser extent renewable energies, could play a more important role in electricity generation. Worldwide gas consumption could increase by at least 5%, as could that of coal and renewable energies. According to the IEA, this recourse to fossil fuels could entail a rise of 0.5 to 0.9 extra gigatons of CO_2 by 2035, compromising the prospects of limiting the rise in temperatures to 2°C by the end of the century. To prevent such an increase in CO_2 emissions, the IEA estimates that renewable energy investment would have to increase by US$ 1.5 trillion. This is 10% more than would be needed in the alternative scenario. For reasons of long-term energy security, LAC should carry out a more thorough review of endogenous technological development options for electricity generation based on intraregional cooperation but open to cross-fertilization with leading-edge developments anywhere in the world.

3

ENERGY SUPPLY AND DEMAND IN THE REGION

The energy mix

At 25%, the share of renewable energy in the energy mix of LAC is currently above the global average and higher than in other areas of the world such as Europe, North America and Asia, mainly because hydropower and biofuels are heavily used in a number of South American countries. Similarly, the region has considerable renewable energy potential (including hydropower, solar energy, wind energy and biomass) that could allow this percentage to be considerably increased. Nonetheless, the energy mix is dominated by oil and its derivatives (41%) and natural gas (28%).

The region is now strategically placed where oil reserves are concerned. This is mainly because the Venezuelan State enterprise Petróleos de Venezuela (PDVSA) has carried out a major exercise in reserves certification in the past 10 years, with many of these reserves being located in the Orinoco Belt. This lifted

the region's known oil reserves to 335.7 billion barrels (10^9 bbl) in 2011, a rise of 172.8% from 2000.

The largest final energy consumers in Latin America are transport (35%) and industry (33%).

In the case of natural gas, not only have the region's proven total reserves declined as a proportion of the world total (from 6.5% in 1986 to 4.0% in 2011), but reserves have dropped in absolute terms in several countries. Reserves stood at 7.97 Tm^3 (10^{12} m^3) in 2011, a drop of 3.4% from the 2000 figure.

Coal accounts for 4% of the region's energy mix, far below its 27% of the global energy mix. Proven reserves in 2011 were 13.8 billion tones, mainly (73%) in Colombia and Brazil. Coal production that year was 107 million tons; Colombia was the largest producer (80%) and exported most of its output. Coal represents 8% of generating inputs in the electricity sector, ranking fourth behind hydropower (34%), natural gas (29%) and fuel oil (11%).

Demand and consumption

Final energy demand in the region was 4.353 BBOE in 2011. Growth was more dynamic in the decade from 2000 to 2010 (34.23%) than in the decade from 1990 to 2000 (31.36%), with the trend being interrupted in 2009 because of the global economic crisis already referred to.

The sectors with the highest final energy consumption in LAC have traditionally been transport (35%) and industry (33%). Residential consumption is about 16%, and all other sectors between them account for the remaining 16%.

Regarding the sources used, almost two thirds is from hydrocarbons (with 51% coming from oil and oil derivatives and 14% from natural gas), followed by electricity (16%). There has also been a large change in the shares of solid fuels, with that of wood and charcoal dropping from 11% in 2000 to 9% in 2011.

Trends in consumption patterns in the transport sector, characterized by a rising share for diesel vehicles and relative stagnation of refining capacity, have resulted in the region becoming more dependent on imported petrol and diesel. Although the region is a major global energy exporter, this situation presents considerable challenges, and there are marked differences between countries and subregions. In fact, the region's export position is essentially underpinned by the reserves of the Bolivarian Republic of Venezuela, assuming these are brought on stream, and by those of Brazil, with its potential for greater development of pre-salt oil. There must be doubts about the situation of Mexico, Colombia and Trinidad and Tobago, given recent developments in reserves to production ratios. To complete the analysis, it will be necessary to see how non-conventional resources will impact these reserves.

Cumulative growth in refining capacity has been just 0.3% annually in recent years, while average demand growth has been 2.4%.

Challenges

Different prospective analyses have indicated that the region can expect to have to cope with rising energy demand as its economies grow under the effects of exogenous factors (the global market) and endogenous ones (social inclusion, industrialization, larger urban centres). In view of this, the need for an increased energy supply has been identified in a number of the region's countries, particularly with regards to electricity, natural gas and the production of oil derivatives, and so has a need for long-term energy planning. In some cases, holding down tariffs has resulted in disinvestment or hindered the creation of a suitable framework for the financing of new supply.

There should be sustainable policies to coordinate the way the region produces and consumes energy, and one outcome should be greater regional economic integration with higher investment, all coordinated as far as possible with industrial consumers such as the automotive, petrochemical, agrifood, mining and service sectors.

Although the region has a relatively clean energy production mix based on its abundant natural resources and is a low emitter of greenhouse gases in both relative and absolute terms, its future in the world economy may depend on the progress it makes in adapting its products to restrictive environmental standards and global markets. While this should not be seen as an energy priority, it does merit balanced consideration with a view to identifying straight away what current or future export products might be most vulnerable in view of their main destination markets.

In 20 years' time, the region will need to be able to meet demand of no less than 5.8 million barrels per day (MMBD) of oil for domestic consumption (giving incremental demand of no less than 2 MMBD), between 600 and 700 million cubic metres per day (MMm^3/day) of natural gas (giving a minimum increase of 200 MMm^3/day) and between 1,400 and 1,700 TWh of electricity. Major investments will be required in the sector to achieve these scales, which are in excess of historical growth rates for energy supply and demand, and to maintain the region's position as a net energy exporter.

In 20 years' time the region will have to meet demand for some 5.8 million barrels of oil and 700 million cubic metres of natural gas a day.

The main adjustments needed to maintain the equilibrium between energy supply and demand concern the growth in demand for gas for electricity generation, which may be much greater than the projected supply and than the reserves replenishment capacity of natural gas. Meanwhile, cumulative growth in refining capacity has been just 0.3% a year, as compared with demand growth of 2.4%. Although refineries in countries such as Chile, Argentina and Brazil have an advanced degree of conversion and complexity, reflecting the large investments made to improve the quality of derivatives in the last two decades, most nations in the region are still faced with major challenges in this area, as strongly reflected in the investment projects currently under development for the next five years.

The inadequate quality and quantity of refineries have resulted in a greater need to import derivatives such as diesel and petrol, creating exportable surpluses of fuel oil, which commands a lower price in the market.

Another challenge for the region's countries from the environmental point of view is to reverse the trend towards growth in installed thermal generating capacity, mainly accounted for by the penetration of natural gas, which rose by 66.4% between 2000 and 2011, exceeding the expansion of renewable energies (29.1%). Only about 23% of a potentially usable 694 GW was in production in 2011, and greater usage will undoubtedly depend on developments with the socioenvironmental licensing process.

4

REGIONAL INSTITUTIONS

Since the early 2000s, an integration process has been established, first in South America and more recently throughout the LAC region, through new institutional forms and mechanisms: the Union of South American Nations (UNASUR) and the Community of Latin American and Caribbean States (CELAC).

UNASUR, created in 2004 as the Community of South American Nations and formalized in 2008 with the signing of the Constitutive Treaty, is one of the South American integration organizations. Its most important organs are the Council of Heads of State and Government and the annual Chair Pro Tempore held in turn by its member States. CELAC, which was created in 2010 at the Summit of Latin America and the Caribbean on Integration and Development and became operational in Caracas in 2011, is a forum for regional dialogue and political coordination. Its organizational structure is under development, and its main institutions for the time being are the summits of heads of State and Government and the Chair Pro Tempore.

These new regional integration mechanisms, while recognizing a number of earlier processes (heavily focused on trade between countries) as predecessors,[12] have inaugurated a new integration paradigm. The aim is to move forward with a process of political coordination underpinned by a strategic vision in a number of basic sectors that are critical to endogenous development.

The energy sector is considered one of the cornerstones of the new integrationist paradigm.

Of these sectors, energy is considered one of the cornerstones of the new integrationist paradigm, and is particularly emphasized by UNASUR, given the existence of major strategic renewable and non-renewable energy resources, even though these resources are distributed unevenly between countries.

The process of coordinating a strategic vision is being consolidated within the different mechanisms. In the context of CELAC, for example, it has been proposed that the guidelines for a South American energy strategy should be incorporated into the organization's energy strategy (2012 Caracas Action Plan). At the first Meeting of Ministers of Energy of CELAC (Lima, 16 November 2012), it was suggested that this body should be incorporated into the Central American Energy Strategy and into the energy strategies of the Caribbean. Also emphasized at CELAC is the sharing of information and experience in the area of biofuels.

It has been suggested that the South American Energy Strategy and the energy strategies of the Caribbean should be incorporated into CELAC.

The South American energy strategy guidelines take account of the need to respect national policies, the legal frameworks operating in each country and existing international agreements. There is a particular interest in pursuing the industrialization of energy-related value chains and encouraging relationships

12 These processes take account of and recognize the different integration initiatives of LAIA, ARPEL, CAF, ECLAC, CIER, OAS, OLADE and WEC.

between State energy firms with a view, among other things, to the creation of transnational enterprises through systems of partnership whose composition will depend on each country, and in particular on its policies and regulations.

The energy negotiations now under way in the context of UNASUR depend heavily on progress with a South American energy treaty. This instrument has an approved structure whose main objective has been to establish basic definitions and rules for energy trading between member countries and regional positions on critical issues such as energy security, the environment, technological development and technical cooperation.

Where energy trading is concerned, the topics to be dealt with include the free movement of energy, non-discrimination, contractual stability and legal security, freedom of access (albeit regulated) to leftover capacity, tariff principles, competition and complementarity.

Although CELAC has not yet adopted the South American energy strategy guidelines, everything indicates that in the near future it will combine elements of that strategy with those of the other subregions.

5

THE ELECTRICITY SECTOR

The electricity sector has undergone significant changes in recent years as a result of adjustments in political orientation and the different approaches used to deal with existing difficulties.

The region's electricity systems are usually characterized by a large role for hydropower, high rates of demand growth and the risk of supply failures during droughts. To this may be added volatile but upward-trending prices for hydrocarbons and their impact on generating costs, which has led energy authorities to take planning, electricity policy and regulatory measures to secure the long-term expansion of systems.

Some countries have implemented new reforms in the sector's structure to increase the role of the State or of State enterprises.

Some country examples

In Ecuador, the Constitution provides that the State is to have complete control over strategic sectors and responsibility for providing public services through its enterprises.

The Plurinational State of Bolivia introduced provisions whereby State involvement in the electricity sector resumed as part of the reforms initiated in the sector by the national Government in 2008, providing that the State firm ENDE was to participate in all electricity industry operations. In addition, many of the firms in the sector were nationalized between 2010 and 2012.

A single vertically integrated enterprise is the legal framework applied in the Paraguayan electricity sector.

In the case of Argentina, in 2002 the authorities began to establish a variety of mechanisms to encourage the building of power stations and other infrastructure with public or public-private funds.

Rising generating costs have led the energy authorities to take planning, electricity policy and regulatory measures to secure the long-term expansion of systems.

Other countries have consolidated changes in generating regulations, especially with respect to the awarding of long-term contracts, with the involvement of private-sector and/or public-sector firms. This has happened in Brazil, Chile, Colombia, El Salvador, Guatemala, Peru and Uruguay. The terms and conditions for participating in the bidding processes initiated by the energy authorities reveal an increased emphasis on planning for expansion.

Long-term markets: securing supplies

The trend is towards the coexistence of long-term contract markets and spot markets for energy. Generally speaking, the tendency since 2004 has been for long-term contract mechanisms to be reformed and strengthened as a way of securing supply.

What the designs and changes described have in common is an interest in securing an adequate long-term supply. All the South American countries other than Brazil make payments for generating capacity separately from energy payments, and spot prices are calculated by the marginal costs obtained from operation optimization models that work with the variable costs of power stations

(with the exception of Colombia, where prices quoted by generators are used). In Argentina, Brazil and Uruguay there are explicit upper bounds on spot prices. In Ecuador there are rules setting regulated prices for contracts, calculated as reimbursements for fixed and variable costs.

Investment efficiency needs to be pursued with the whole chain in view: generation, transmission and distribution.

The renewable energy option

The incorporation of non-conventional renewable energies (NCREs) into the energy mix is also being done in a planned fashion, with a growing interest being seen in some of the region's countries. By way of example:

- Brazil and Uruguay are conducting auctions to buy in energy of this type.
- Chile established that firms had to cover 5% of their supply with NCREs from 2010 or pay a fine.
- Ecuador has set special prices by technology type.

Large-scale connection of power from NCREs to grids is giving rise to major challenges, particularly in the case of wind energy. There are many potential sites for wind energy facilities, and when they are chosen freely by bidders in tendering processes, as in Brazil and Uruguay, grid connections cannot be planned in advance. In Chile, the Government has presented the legislature with a draft amendment to the transmission regulations, one of the goals of which is to facilitate connection to the backbone for these energies.

The electricity supply: centralized or liberalized?

Transmission has long been centrally planned, but using competitive tendering mechanisms. As for regulation, almost all the region's countries have centralized planning procedures for expansion decisions. In many of the countries, there are arrangements for competitive procedures to tender out the construction, ownership and maintenance of new installations to whoever requires the lowest annual remuneration. In Ecuador, Paraguay, Argentina and Uruguay, a single enterprise or group of enterprises is responsible for expansion.

Where distribution is concerned, regulatory standards encompassing methodologies for determining recognized costs, tariff reviews, service quality regulations and operating procedures for customer-facing processes have usually been developed and implemented. Business efficiency has been improved, albeit electricity losses are still high, and so has service quality, although there is scope for further improvement.

The challenge for Latin America and the Caribbean is to achieve universal access to electric services so that it covers the least privileged groups.

As regards liberalization in terms of customers being able to choose their energy supplier, there has been little progress beyond the changes incorporated into the regulations in the first stage.

Challenges

- To carry on increasing coordination between energy policy, planning and regulation in order to deal with structural situations. This needs to include consistent policies in the fuel chain (hydrocarbons, gas and electricity).
- To promote investment efficiency with a comprehensive approach to the generation, transmission and distribution chain on the basis of different ownership arrangements (the State, or public- and/or private-sector enterprises), accepting the diversity of approaches and situations in each country, on the basis that the idea of having a single model is utopian.
- Secure expansion and stable or lower prices through mechanisms adapted to each country's circumstances and energy sources, such as energy procurement at pre-set prices, tendering processes with quotas for purchases of energy from primary biomass, wind and solar facilities and small hydroelectric stations, advance sales of energy and power and/or the signing of supply contracts.
- Resolve the challenges posed by the incorporation of power stations that run on intermittent renewable energies, especially dispatch priority, the need for frequency to be regulated by intermittency, and seasonality.
- Ensure that regulations are objective, clear, predictable and transparent so that risks can be identified and managed by project developers.
- Adapt regulations to changes in technology in the interests of better exploitation of renewable energies, electricity system efficiency, development of distributed generation and distribution tariffs.

- Continue with the transmission system planning role, which has proved crucial in expanding these systems, especially as non-conventional sources have been developed. The region should continue along this path, which has often proved successful in attracting investors and lowering costs.
- Urgently attend to problems with the coordination of non-conventional renewable energies and transmission projects.
- Continue adopting cost plus or "regulation by incentives" tariff mechanisms for distribution. With the incentive model, tariffs are reviewed periodically after four or five years, depending on the situation. These periods are usually between the third and seventh phase, so that there is a greater amount of information, accumulated experience and forms of relationship. This has permitted continuous improvements in methodologies, adaptation to energy policies and new technologies and tariff review processes aimed at striking a balance between the goals of universalization, cost recognition and service quality.

The challenge for LAC is to achieve universal access to electrical services by extending it to the least privileged, which have hitherto been uncovered. Social policies, regulation and tariffs should be coordinated so that services are affordable for users. Where subsidies are employed, targeting is the responsibility of the competent authorities.

With regard to efficiency, there must be continuing efforts to reduce energy losses and improve processes. In addition, the electricity sector, in concert with educational institutions, needs to establish policies to maintain "know-how" and the skills needed to introduce new technologies.

6

THE HYDROCARBON SECTOR

There is no one model for the oil industry in the region, and nor are regulations identical, with rules having been adapted over time in each country in accordance with varying national policy criteria and goals.

Hydrocarbon exploration and production operations raise issues of strategy, such as:

- The availability of hydrocarbons creates a need for institutions responsible for renewing the stock of geological and forecasting knowledge.
- There is a long wait for the expected return following the initial commitment of the copious investment, technology and human resources that are required, with long investment maturities and the risk of capturing extraordinary rent.
- The large contribution of hydrocarbons to the balance of trade and fiscal revenues provides a basis for political, economic and social sustainability.
- A role for industry in ensuring security of supply means that inputs will be available to other chains, such as the electricity chain.
- Different political outlooks have led to a range of positions being taken in the various countries. No less important is the geopolitical aspect when exportable resources that underpin consumption in other countries or regions are at stake, but also because policies to attract foreign investment (or constraints on such investment) can affect capital movements and investment in non-energy sectors.

Security of supply of hydrocarbons ensures the availability of inputs for other chains such as the electricity chain.

Successful experiences with legal security and the design of exploration and drilling contracts suggest that any contractual alteration can be sustainable in the medium and long term provided it is arrived at by agreement between the parties concerned, namely the State and the operator.

The application of pricing policies in the liquid and gaseous hydrocarbons chain has not followed a single pattern in Argentina, the Bolivarian Republic of Venezuela, Ecuador and the Plurinational State of Bolivia, a group of producing and exporting countries that have set prices well below opportunity costs in their domestic markets since 2003. Other producing and exporting countries such as Brazil, Colombia and Mexico, on the other hand, have aligned their domestic prices with international ones, despite differences in the way they manage their hydrocarbon resources (public or public-private management).

Any contractual alteration can be sustainable provided it is arrived at by agreement between the parties concerned, namely the State and the operator.

The reserves situation varies from country to country. This issue is important when it is considered that the region looks set to play a new role in the global energy supply, with all the geopolitical consequences this entails.

Challenges

The main future challenges for the oil and gas industry are:

- Firms' positioning as the demand for energy evolves, since fossil fuels will continue to provide energy for the planet and our region during the twenty-first

century. The questions are to what extent, at what cost and with what impact.
- The transparency and stability of regulatory frameworks.
- Reducing the socioenvironmental impact of fossil fuels in the energy mix.
- Growth in the biofuels market.
- The level of oil and natural gas reserves.
- The potential of (unconventional) shale gas and oil.

National energy planning requires clear, stable rules based on national and energy policy goals.

- Declining oil output and levels of exportables.
- Integration of the gas and electricity markets and the investment required.
- Hydrocarbon transport infrastructure constraints and the investment required.
- The development of gas transportation and processing capacity and the investment required.
- Growth in hydrocarbon production and reserves and the reserves required.
- The refining deficit, infrastructure development and the investment required.
- Social tariffs (prices and subsidies) and their impact on consumption and investment.
- The development and impact of sustainable energy chains in the region.
- Management of human talent.
- New technological developments and mastery of existing technologies to operate at new frontiers in a socially and environmentally responsible way.

Integrated analysis of institutional, legal and regulatory aspects suggests that the region's countries should consider at least the following:

- Natural gas scarcity signals have been passed on to the electricity generating link in some countries, resulting in losses of reliability and higher costs that could have been avoided had there been a planning and early monitoring system, responsive decision-making arrangements and clear signals to encourage investment.
- National energy planning should have clear, stable rules based on national and energy policy goals that include oil policy and institutional and regulatory mechanisms to facilitate the public-private investment process.
- Mechanisms to secure high-risk investments that are sustained over time on the basis of a long-term strategic outlook, rather than one guided merely by short-term signals.
- The need for gas supply contracts that cover the coordination of supply and transport capacity.
- When domestic prices are set in countries with plentiful resources, there should be precise targeting on the segments to which rent or subsidies are transferred, as the contradiction between resource abundance and a lack of development indicates the persistence of signals unfavourable to stronger market growth.

7

RENEWABLE ENERGIES AND THE ENVIRONMENT

The energy mixes of the region's countries are generally cleaner than those of other regions,[13] owing to a large hydropower and bioenergy component. The environment for renewable energy development looks very favourable. The reasons adduced are the need to diversify electricity generating sources, reduce fossil fuel dependency, employ native resources and reduce greenhouse gas emissions in a context of rising marginal electricity generating costs and growing concern over environmental issues.

Hitherto, the introduction of non-conventional renewable sources has required State policies.

13 Renewable energies account for over 25% of the total energy supply in Latin America and the Caribbean, a larger share than in the world as a whole or the developed countries. Only Africa exceeds this, owing, however, to the crucial role of firewood and biomass.

Conventional hydropower has proved the best complement to the integration of intermittent renewable energies.

Progress with the implementation of non-conventional renewable energies was associated until recently with two main factors:

- Direct employment of energy sources that arise as a by-product of different production activities: bagasse, rice husks and forestry residues for process heat or boilers.
- Rural energy based on the use of small-scale renewables for scattered sites and to a lesser extent power generation and the development of biofuels.

Hitherto, the introduction of non-conventional renewable energies, and especially wind generation, has usually required State policies.

Promotional measures have been important, confirming the gap between the market cost of providing energy with traditional sources and the cost of developing non-conventional renewable technologies. However, high international prices for liquid fuels, the questions around nuclear energy, the technological maturation process and the economic crises since 2008 have stimulated the development of renewable energies.

A diversified energy mix needs to be created to support sustainable economic development in the region, without neglecting any source.

In recent years, a number of Latin American countries have begun to promote the development of projects using non-traditional renewable energies on larger scales, in view of the region's ample resources and potential. Accordingly, a group of nations are developing long-term contracts (15 to 25 years) to incorporate renewable energies into electricity generation by way of auctions. At the same time, technological development has allowed wind generation to catch up – and in some cases compete – with hydrocarbon-based generation, as a result of high international prices for the latter.

Another factor that needs to be considered in the region is that conventional hydropower generation has proved to be the best complement to the integration of intermittent renewable energies into the system, since it allows fluctuations in demand to be adjusted to fluctuations in non-conventional renewables generation. However, civil society has held out against the development of this kind of generating infrastructure, and this has been reflected in delays and in a tendency to reduce or avoid dams, with energy storage capacity being diminished as a result.

Despite technological and regulatory progress, there are still regulatory and technical obstacles to the incorporation of electricity from intermittent renewables into the grid.

Other types of non-conventional energy

So-called thermal and motor uses and the direct employment of renewable energy (biomass in process heat, solar water heating) have not yet received the attention they deserve. There are some gaps in the law that are preventing all the potential benefits and cost-effectiveness of currently available options from being realized. The standards for buildings and homes adopted by some countries (such as solar water heating), together with specific policies to encourage the penetration and employment of renewable energies in basic non-electrical uses (cooking and heating), could be a good start in the right direction.

Similarly, the development of small-scale generation and microgeneration in urban areas has not gone very far, even though some countries have legislated for this.

With current conditions of uncertainty in the carbon market and the price of certificates at levels below 0.5 euros per ton, there is a need to design new incentives to offset this reduction in cash flow and thus help to sustain the development of renewable energies in the region. It is also necessary to involve new instruments such as nationally appropriate mitigation actions (NAMAs) for low-carbon expansion of the sector and to take advantage of the opportunity to direct international resources towards the establishment of policies and strategies of this type, and even into direct project investments. This will not only help to combat the problem of global warming but will make it possible to modernize and transform production and services sectors allied to the electricity sector.

Climate change also entails challenges, as it increases the vulnerability of energy infrastructure to extreme climate events. Systems that depend on water become more vulnerable to phenomena such as La Niña and El Niño, affecting the potential for reliable, timely provision. Generating infrastructure must be built to adapt to the new climate scenarios of water scarcity or abundance. The severe temperature changes seen in recent years – waves of extreme heat or cold – also pose a challenge for energy consumers and suppliers, who have been experiencing extreme swings in demand.

A number of biofuel issues transcend the area of energy to encompass the automotive and agroindustrial sectors as well.

Challenges

- To create a diversified energy mix that can support sustainable economic development in the region, without neglecting any potential source.
- To develop the huge potential of unexploited hydropower resources (particularly large-scale ones), to which end particular stress will need to be laid on the issue of socioenvironmental licensing to ensure that this does not become either a real environmental threat or a check on energy development. This will require more vigorous adoption of protocols for good environmental management practices and communication with different interest groups.
- Despite recent technological and regulatory progress, the incorporation of power stations based on intermittent renewable energies (wind and solar power) into the grid still presents regulatory and technical challenges. For these to be introduced, auctions may be the best way forward to achieve greater price competitiveness, but these need to be coordinated with hydroelectric development, energy integration and other forms of conventional generation that are environmentally sustainable.
- The legal and regulatory frameworks for biofuels in LAC are of relatively recent date (except in Brazil, which has a long track record) and have undergone modifications in the light of experience with their implementation and the problems that have arisen.
- A number of issues transcend the area of energy to encompass the automotive and agroindustrial sectors, examples being:
  - Issues that involve integration or linkage, such as quality characteristics and standards for biofuels and mixtures thereof (compatibility between countries).
  - Adaptation of the existing vehicle stock and the characteristics of vehicles

manufactured to use biofuels (compatibility with biofuel mixtures).

- The manufacture, export and import of flex-fuel vehicles. At present, only Brazil manufactures vehicles of this type on a large scale in LAC and is in a condition to export them.
- The manufacture, export and import of technology for the production and use of biofuels. Argentina, Brazil and Colombia are the countries of the region that have made inroads in this area.

8

ENERGY EFFICIENCY

"...The adoption of an energy efficiency policy centred on measures to improve spending efficiency, reduce waste and promote regional integration (while developing renewable generating sources) is among the immediate challenges on the energy agenda in Latin America..."

Twenty-first Ibero-American Summit

Energy efficiency actions are highly recommended, as they are clean, often cost very little and allow of short-, medium- and long-term measures (and results) in all consumption sectors as well as the energy supply.

Energy efficiency actions often cost little and allow of short-, medium- and long-term measures.

There are impediments to these options, but there are also opportunities, and these need to be tied in with energy efficiency and conservation strategy, if there is the political will to do so. Overcoming obstacles requires appropriate institutions, technology transfer and development, political support and determination, suitable regulatory frameworks, financing that fits needs, and international cooperation, i.e., public intervention policies that modify the course of decentralized decision-making in consumption and supply sectors.

Despite some successes, there is still much unfulfilled potential, as attention to energy efficiency in the Latin America region is both recent and limited. Efficiency has been the subject of State policies in a few countries, but elsewhere the issue has not been fully incorporated into the public policy agenda with all the range of actions, regulations, institutions and economic and regulatory instruments needed to implement declared programmes and/or plans. Institutional supporting arrangements are generally limited and there are virtually none of the national energy saving targets that are increasingly common in the developed countries.

There are few of the national energy saving targets that are increasingly common in the developed countries.

The array of actions and measures to be implemented within a public policy framework (designed and implemented in accordance with national circumstances in each case) is very wide, and they may be of a legal or regulatory character, compulsory or voluntary, and be based on economic, fiscal, information and demonstration, training or awareness-raising mechanisms.

The conditions for success and positive results in energy efficiency gains depend on a set of conditions or principles being fulfilled, although even partial moves in this direction can lead to results that entail a genuine energy saving impact.

Challenges

The experience with energy efficiency actions already carried out in the region yields some conclusions and provides a basis for recommendations, which may be summarized as follows:

- Efficient energy use policy is a component of energy policy and should be properly coordinated with it, as it should keep its goals consistently in view at all stages of the energy chain and consumption sectors.
- The programmes, actions and measures to be implemented should have short-, medium- and long-term goals, while a gradual implementation timetable for actions and measures will contribute to fulfilment, follow-up and monitoring of outcomes.

Regional agreements on common specifications for equipment and standards could aid the penetration of energy efficiency measures by providing economies of scale.

- The institutional framework should be specific about the authority responsible for implementing the plans and achieving the goals set and about endowment with the necessary instruments, resources and capacity. It is also advisable for legal frameworks to be accompanied by dynamic regulatory frameworks capable of adapting to evolving technologies and market conditions.
- Programme design and implementation should allow for proper follow-up of progress towards targets, monitoring of instruments for effectiveness and the possibility of verifying outcomes, taking into account the need to isolate these from other causes unconnected with the policy implemented. This requires the development of diagnostic, follow-up and results indicators to measure impacts, effectiveness, coverage and quality.
- Market size is a very significant barrier for many countries. Where minimum scale is lacking, it becomes very unattractive for suppliers to provide, operate and transport certain types of equipment. Regional agreements setting

common specifications for equipment could aid penetration by expanding market size and offering economies of scale. Regional agreements identifying common criteria or the development of infrastructure to provide regionwide services (laboratories, for example) would be very helpful. This also applies to labelling and minimum standards, where a need to develop certain capabilities and infrastructure that might be beyond individual countries' reach has been identified.

Energy losses in Latin America are about 14%, which is more than in other regions of the world. Each percentage point represents about 500 million dollars a year.

- Energy efficiency is a cross-cutting issue, and many actions are beyond the scope of energy policy and require the cooperation of other areas, such as transport, industry, housing, health care and education. The coordination of different sectors, which is termed systemic or organizational capacity, is another necessary condition.
- Programme sustainability largely depends on an appropriate economic and financial equation being maintained. The resources required to make programmes viable need to be guaranteed in the long term. Financing must be a priority, and its availability must form part of the programme or strategy itself.
- The region's countries must pay special attention to energy losses, an issue that can be approached from the standpoint of business and from that of society as a whole. In the first case, it entails issues of profitability and the enormous efforts required to manage energy losses, constraints on firms' normal operations and staff safety problems. From society's point of view, energy losses entail issues of safety, increased system costs, cost redistribution, energy efficiency and social inclusion.
- Electricity losses in LAC, both technical and non-technical, are of the order of 13% to 14%, which is higher than in other regions of the world. This should be a cause for concern, given that one percentage point of losses represents about US$ 500 million a year. At the same time, there is a high level of dispersion by country, firm and geographical area, as there is with service quality indicators.
- Large technical losses are indicative of investment and/or management failures, essentially in distribution networks, although in some cases they may affect transport or transmission systems as well.
- Where non-technical losses are concerned, in the past few years most distribution companies in LAC have taken major steps forward in standardizing

installations with a view to combating or reducing these. A pending task is to do something about clandestine electricity connections, which are highly dangerous and reduce the profitability of the distribution business. Many users fail to appreciate that electricity has a value, and usage and consumption habits are poor. A culture of late payment, theft and fraud is quite widespread.

- The complexity of the issue means that it needs to be addressed comprehensively by public policies involving all actors in society, from the State to firms and different civil society groupings or organizations.

9

ENERGY ACCESS: SOCIAL ASPECTS

Estimates based on household surveys available as of 2011 put the regional poverty rate that year at 29.4%, including 11.5% living in extreme poverty or indigence (ECLAC, 2012). In absolute terms, these figures equate to 168 million poor people, of whom 66 million were indigent. Poverty and indigence rates thus continued the downward trend of the past decade. Projections of economic growth and moderate inflation for 2012 suggest that poverty should continue to trend down, although somewhat more slowly than it has so far. In particular, the poverty rate is expected to fall by at least half a percentage point, while the indigence rate is expected to hold steady at around its 2011 level.

Measuring poverty over a slightly longer period that includes the crisis undergone by the region in 2009 yields a favourable result for most Latin American countries. Between 2008 and the latest available measurement, the percentage change in the indicators most used to measure poverty reveals a perceptible advance.

At least a third of the rural population of Latin America and the Caribbean is still without access to electricity.

The percentage reduction in the poverty gap and poverty gap squared indices was usually greater than the reduction in the poverty rate. This reveals that, despite the crisis, not only did the percentage of people with incomes below the poverty line fall, but the average income of the poor and its distribution improved. A substantial proportion of the urban and rural poor and indigent are in a situation of "energy poverty", i.e. they lack access to modern energy sources (electricity, natural gas, LPG and kerosene)

Despite the substantial progress made in combating poverty and promoting universal access to modern energy sourcesin LAC (at 94%, the region's electrification rate overall is the highest in the developing world), over 30 million people still had no electricity supply in 2011, and 21 million of these were poor. It is estimated that at least a third of the rural population of LAC still lacks access to electric services. Increasing access is essentially a rural issue, therefore, although this does not mean that there are not multiple problems to be addressed in urban areas.

There is a direct relationship between energy and poverty.

Many factors have been contributing to a widening divide in equitable access to modern energy sources: low incomes, a lack of resources for building infrastructure, non-availability of suitable technologies, weak legal and institutional frameworks, and even a lack of political will and commitment.

Although it is part of the broader objective of attaining greater social inclusion and a vital plank in efforts to reduce poverty and improve the environmental conditions of the most vulnerable groups in society, access to high-quality energy services is not a prominent issue in official government policies.

The poverty reduction strategies and energy policies in the national development plans of a very large number of countries in LAC make no mention of the relationship between energy and poverty, and where these are mentioned, they are not dealt with in depth.

There is very considerable potential for redirecting subsidies aimed at relieving energy poverty so that they act more efficiently.

Challenges

- It is necessary to differentiate between the concepts of access and affordability. The data show that attaining a high degree of coverage does not necessary entail substantial levels of consumption in the residential sector. What does prove vital is access to the equipment needed to enhance the quantity and quality of energy services, and income levels are critical to this.
- Social policies dealing with access to modern energy sources have been dominated by electricity and fuel subsidies. In many cases, however, the application of generic subsidies that are not specifically directed at the target population and are not accompanied by adequate monitoring and follow-up has resulted in these subsidies also going to consumers who ought to be excluded from the benefit, to the detriment of higher coverage.
- Without denying the necessity, viability and advisability of subsidies as policy instruments for the alleviation of energy poverty, there is very substantial potential for reorienting them by designing subsidy systems with adequate financing via the mobilization of genuine, permanent funding. These should be applied using transparent criteria that enable them to be targeted on those beneficiaries who ought to be receiving them.
- Although many countries have programmes that include subsidized electricity tariffs, the rural poor usually have no electricity service and do not benefit from these subsidies, the result being a new inequality divide.[14] What are basically used in rural areas are “non-modern” energy services, such as firewood for cooking and heating, which are inefficient and harmful to health.
- In urban areas, the failure to provide adequate coverage of the energy needs of the poor also has implications for health, gender equality, child labour and education access opportunities. This is compounded by legal uncertainty, often the consequence of illegal land occupation, clandestine connections[15] to electricity services and lack of access to appropriate fuels for cooking and water heating.[16]

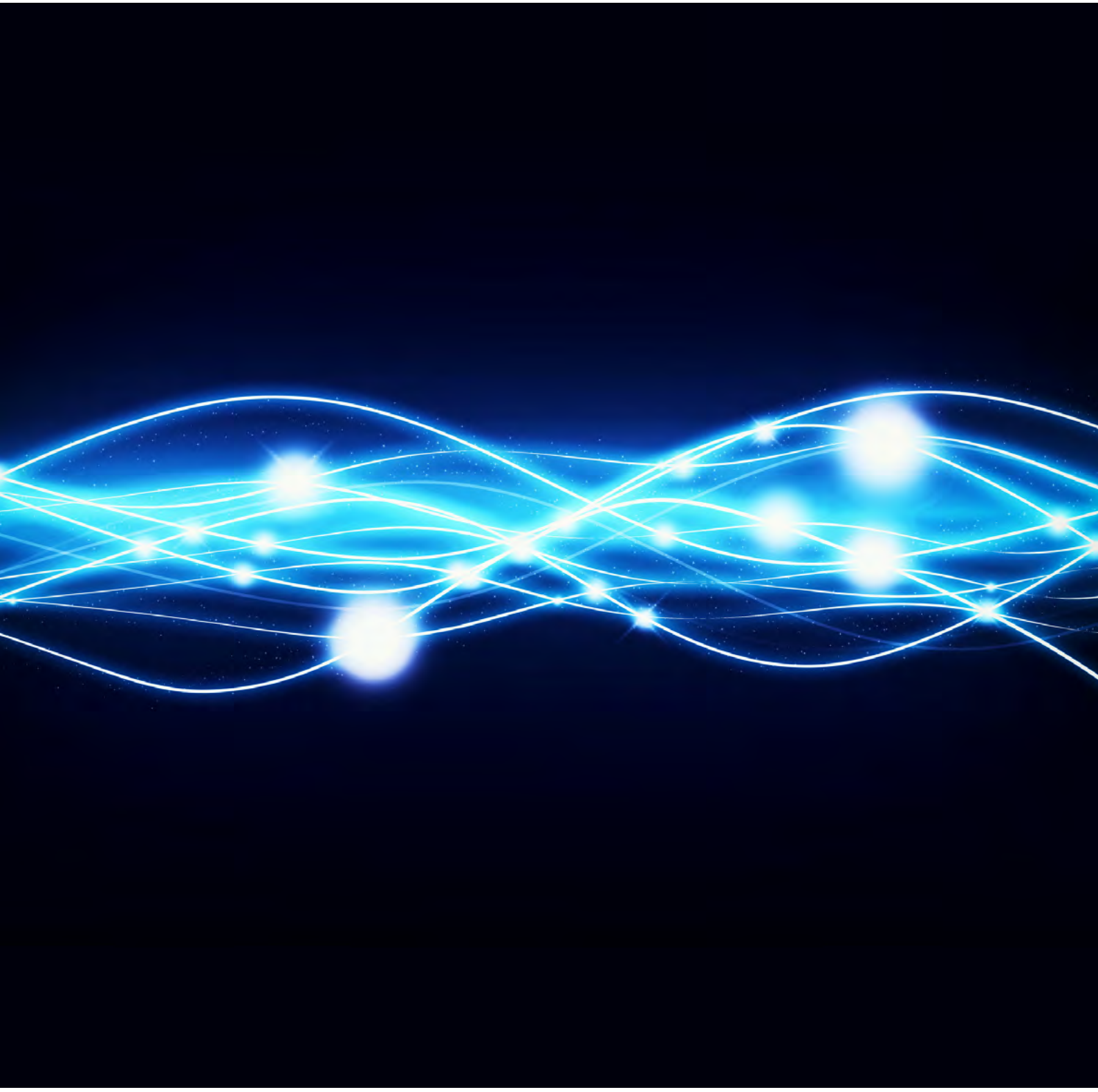
14 This means unequal access to what are now indispensable services, such as food preservation, the Internet, lighting, air conditioning, cooking and water use.
15 Which are not only illegal but place users’ lives at risk.
16 Poor households in urban areas do not usually have access to natural gas, with substandard housing and the legal uncertainty surrounding its occupation being potentially a barrier to this.

- They can also lead to problems of sustainability, both for the firms supplying electricity, if users are not regularized,[17] and for the environment, if these illegal users employ electricity for caloric consumption, for example, thus creating

Inadequate energy coverage of poor populations has effects on health, gender equality, child labour and education access opportunities.

greater generating requirements that increase CO2 to some degree.
- In some cases, there seems to be a need to implement a reform of tariff structures and subsidy systems with a view to meeting targets for coverage, cost, equity, efficiency and reduction of negative environmental impacts. This implies a need to coordinate and give simultaneous consideration to energy access strategies and efficient usage programmes that encourage greater coordination with the firms providing the service. The possibility of involving firms in the financing of efficient equipment and the destruction of inefficient equipment should also be analysed.
- More and better information will be needed to pinpoint problems of energy poverty and establish priorities and strategies (which are not currently on the political agenda in any organic way or as part of energy policy).

17 Many firms have started to implement some form of social pricing or some specific programme to mitigate this problem, as it is one that affects their image, operating capacity and profits.



10

TECHNOLOGICAL DEVELOPMENT AND INNOVATION

Going by the number of patents applied for per million inhabitants under the Patent Cooperation Treaty (PCT) system coordinated by the World Intellectual Property Organization (WIPO), LAC has very low productivity in technological innovation compared with other regions of the world. Thus, in 2011 the number of patents applied for under PCT per million inhabitants was 149 in North America, 76 in Europe, 56 in Oceania, 17 in Asia, 2 in LAC and 0.4 in Africa.[18]

The Latin American countries have the potential to generate advanced technologies that can contribute to sustainable development. There is an opportunity to generate patentable and potentially exportable innovations aimed at using the region's abundant energy resources and promoting energy efficiency. This would undoubtedly help the LAC region to participate in a practical way in the knowledge economy: through the development of patentable technologies, not just for use in the region but for export to other regions as well.

18 See [online] http://eventos.caf.com/media/16930/03_pct_lac_2005_2011-2.pdf.

Technology for renewables and efficiency

Given the limited financial resources available for innovation in the region and the competition for them from other priorities (health care, education, social infrastructure), it is important to decide the order of priorities for the technological developments these resources should go to. In the energy sector, two areas of interest for innovation are technologies relating to renewable energy resources and those relating to energy efficiency. A still tighter focus is required within these two subsectors, however.

Judging by the number of patents applied for per million inhabitants, Latin America has very low productivity in technological innovation.

In the case of generating technologies based on renewable resources, installation costs have fallen in recent years, especially for interconnected systems. Installation costs for solar technologies have been dropping dramatically, largely because of systems being manufactured in China, especially photovoltaic cells. The same can be expected to happen with wind generating technologies designed for interconnected systems. Wind power technologies have been making very substantial progress, and this has led to an improvement in capacity factors, an increase in average power and a downward trend in costs per megawatt installed and generated.

There are two areas of interest for innovation in the energy sector: technologies relating to renewable energies and those relating to energy efficiency.

At the present time, increasing access to electricity in LAC is essentially a rural issue. Considering that the challenge for the region is to achieve universal access to electrical services, especially in isolated areas, there is consequently a need to concentrate on technological innovation in this sector. For

firms based in Latin American countries, the size of these markets may be of interest. Concentrating on the development of new technologies in the region aimed at these niches (rural electrification) would also create opportunities for exporting these technologies to similar markets in Africa, the Pacific and Asia.

Many poor and/or isolated communities in LAC are close to renewable energy resources such as hydrokinetic, coastal marine and geothermal resources for which low-capacity technologies are not commercially available.

It is globally recognized that energy efficiency is an immediate option, and the most cost-effective one available in the short term. It has been noted that industry is the economic sector that has taken greatest advantage of efficiency gains in the industrialized countries, whereas in developing countries it is the residential sector that shows the greatest improvements. It is highly advisable for energy efficiency actions to be undertaken to deal with the challenges associated with the region's energy system.

There is a need to concentrate on technological innovation aimed at the supply of electricity in isolated areas.

Some successes notwithstanding, there is still much unfulfilled potential, as the Latin America region has paid very little attention to energy efficiency. The potential for technological innovation in this sector is immense, especially in urban areas, with a growing middle class eager to improve its quality of life by acquiring components and equipment that have high energy consumption, especially air conditioning and food refrigeration appliances.

Challenges

- Technological innovation in the LAC energy sector needs to be based on the development of new generating technologies to achieve universal access to energy in rural areas and new, more efficient technologies for the urban residential sector and the hotel sector (in the Caribbean), especially as regards air conditioning technology.
- Although a policy to improve countries' technological innovation requires a systematic approach (institutional, academic, regulatory and budgetary impro-

vements), this requires a time and planning horizon that exceeds the typical periods of government in the region.

- In the case of patentable technological innovation in the sectors mentioned, i.e., for rural electrification and improvements in the energy efficiency of urban consumption, technological development based on clusters of small and medium-sized enterprises may be the most important.
- The implementation of specific showcase projects using successful technologies in the short term would have a major replication effect that would catalyse technological innovation in the sector yet further.

11

REGIONAL INTEGRATION

Integrating the energy sector

LAC possesses abundant but unevenly distributed energy resources. Consequently, the potential benefits of full integration are substantial compared to what can be obtained in other regions.

Different studies have indicated that the scale and structure of energy supply and demand in the region present major strategic complementarities, especially in certain subregions. In addition, many energy resources, and electricity in particular, are not commodities.

In view of the aspects mentioned, energy integration as an option for meeting concrete needs is a powerful instrument for securing energy sustainability in the region and opens the way to structural benefits as well as short-term ones.

Throughout history, integration processes have followed different methods and patterns in different periods depending on the current political, economic and regulatory paradigms.

Although some important results have been achieved, there are still barriers of different types that have prevented integration from being pursued as a benefi-

cial option in the broadest sense. The greatest barrier may well be the contradiction between self-sufficiency goals and the concept of integration, something that can be observed in most of the countries' expansion plans and/or energy policies. Security of supply and reduction of energy dependency is the core concern for Governments. There is also a marked tendency for countries that have energy resources to protect them, as they are now perceived as scarce and dear, so that there is less of a willingness to share them with other countries. What is lacking is a vision of a "common energy region".

The energy integration of Latin America and the Caribbean needs to take account, first, of common and general objectives within the framework of the broader regional process (CELAC) and, second, the specificities of subregional processes (CARICOM, SICA, UNASUR, etc.) and the conditions and realities of the countries in these subregions. Different actions implemented by these regional and subregional processes in the energy area in pursuit of their own strategies are being complemented by the numerous hemispheric and extraregional initiatives.

Mexico is faced with two different energy integration situations. First, there is its relationship with the United States, heavily centred on natural gas, of which Mexico is a net importer, with the potential to become a larger one. Second, there is its relationship with Central America, to which it exports energy.

Energy integration is a feasible option for meeting concrete needs and a powerful instrument for securing energy sustainability in the region.

The case of South America is unusual, partly because of its large and plentiful renewable and non-renewable energy resources, unevenly distributed as they are across the region, and current structural conditions. Since the 1990s, the 1980 Treaty of Montevideo establishing LAIA has provided a legal framework for different partial scope agreements on energy integration, on rules governing electricity interconnection and supply, on gas interconnection and on the commercialization, exploitation and transportation of crude oil, liquefied gas and other liquid hydrocarbons. These agreements, and bilateral treaties on hydroelectric plants in the River Plate basin, marked the beginning of South American energy integration. Optimal use could be made of these binational initiatives if progress were made in implementing a regional market, employing existing infrastructure and implementing new projects for improved, coordinated utilization of natural gas and hydropower. The proposed South American energy treaty, which is still at the internal discussion stage, looks like a major breakthrough here.

As a first step towards regionwide planning, the intentions of other countries in the region need to be considered when planning for the expansion and operation of electrical systems takes place.

The Andean region on the Pacific coast, meanwhile, has remarkable scope for electrical interconnection. Although there are regulations within the framework of the Andean Community, the mechanism needs to be extended to other countries outside it. This process, which could also take place in the area of natural gas in the future, poses considerable challenges in terms of joint planning, regulatory consolidation and pricing.

The Caribbean, and the insular Caribbean in particular, presents a degree of weakness because of its dependence on hydrocarbons. However, there are opportunities in the area of LNG for Trinidad and Tobago, one of the region's largest exporters, which is diversifying its LNG destinations as a result of changes in the availability of shale gas in the United States and the resulting fall in Henry Hub prices. As in Central America, furthermore, there is scope for implementing subregional programmes to promote energy efficiency and the renewable energy sources available in this area. The Petrocaribe mechanism should not be overlooked, given the importance of an initiative that has mitigated the impact of oil prices in many of the area's countries.

Electricity sector integration

The identified benefits of electrical integration are numerous and far-reaching. They include:

- Enabling optimum use to be made of the energy resources of the region concerned.
- Contributing towards optimum use of the electricity infrastructure.
- Postponing investment in generating capacity.
- Diversifying countries' energy mixes.
- Exploiting the complementarity of river basins by using energy surpluses in rainy periods.
- Taking advantage of differences in time zones (generating resources can be optimized because demand in the different electrical systems peaks at different times).

- Exploiting differences between regional climates and local habits to optimize the resources available.
- Making shared use of generating resources.
- Cutting electricity prices and hence tariffs for end users.
- Improving the chances of avoiding overloads and emergencies in the short term.
- Improving the reliability and quality of supply.
- Creating a broader market for supply, and thus fostering greater competition in power generation.

LAC already has a high level of electrical interconnection. Its average installed power capacity has grown since the 1980s, but only 5% of the energy produced is transferred between countries. With the Guatemala-Mexico line operational since 2009, all the countries of Latin America will be interconnected if the Panama-Colombia interconnection and the Andean Electrical Interconnection System (SINEA) project, which will connect the Andean countries of the Pacific with Chile, come to fruition.

Integration is conducive to optimal use of electricity infrastructure.

With the SIEPAC interconnection, Central America will increase its installed capacity for moving traded electricity, with major benefits in terms of the complementarity of resource use and potentially positive environmental impacts. The expectation is that renewable resources for electricity generation (mainly hydropower, geothermal energy and wind energy) can be optimally exploited and the burning of fossil fuels thus avoided or postponed. In Central America, conditions are favourable to progress towards consolidation of the regional electricity market and the corresponding regulatory structure. A major challenge concerns traded electricity prices. The aim here, as in domestic markets, should be to secure the lowest cost for users.

Despite this advanced level of interconnections, greater electrical integration has been hindered by a variety of factors which raise the need to consider innovative energy trading options that respect each country's own policies, do not require far-reaching regulatory harmonization in the domestic markets of the nations involved and make it possible to maximize benefits, prevent abuses of market power and establish mechanisms to cover risks and resolve conflicts.

Minimum standards need to be developed to make energy trading viable.

Under these circumstances, it is essential for the electrical integration paradigm to evolve. There is a need to apply flexible models that can be adapted to different situations and can operate under conditions of greater interdependence between countries and in multinational electrical systems, based on values that provide scope for convergence towards greater service efficiency, sustainability and security.

Challenges

- One of the basic challenges is for Governments and institutions to summon up a real political determination to include international energy trading on their agendas as a way of securing supplies and optimizing resources and of making better use of the major renewable resources in the region whose energy to environmental impact ratio offers the greatest returns. For this to happen, the intentions of other countries in the region need to be considered when planning for the expansion and operation of domestic electrical systems takes place, considering the opportunities for energy trading as a first step towards regional planning. Similarly, there is a need to establish mechanisms that create confidence and security in the countries, such as transparent information sharing, joint follow-up and evaluation of risks affecting project development (financial, contractual, environmental and other risks) and coordinated contingency planning.
- One aspect that has negatively impacted the development and use of interconnections has been the lack of policy stability and government support, with priority being given to local solutions to the sector's problems rather than to integration. It seems vital for the operation of interconnections to be backed by agreements between the countries involved and not just between agents, irrespective of the nature of ownership or control.
- These agreements should meet Governments' concerns about preserving each country's autonomy, requiring not a single regulatory regime but a minimum of clear rules for price formation and operational security. Each country will make independent decisions about its security criteria for energy exports and priority for local supply, while respecting the principle of risk sharing and non-discrimination where firm contracts are involved. These agreements should also provide robust, flexible solutions and include review clauses.

- Where the sector's regulatory standards and organization are concerned, major changes have occurred since the early 2000s as a result of the approaches taken to political and economic management in the different countries. This has resulted in heterogeneous methods of sectoral organization and changes in or non-compliance with regulations, which has increased the difficulty of using existing infrastructure and developing new facilities. An open, integrated market with a single set of rules looks difficult to achieve in the short term. In view of this new reality, there is a need to develop minimum standards to make energy sharing viable and regulate commercial and operating systems, cross-border trade, the duties payable and measures to be taken in exceptional situations.

The operation of interconnections should be backed by agreements between the countries involved and not just between agents.

- For the integration process to be sustainable over time, substantive aspects include the share-out of benefits between countries, trade price formation and its repercussions on local market prices, and financial security for agents, irrespective of ownership or control. Here, stress should be laid on:
  - The need to conduct comprehensive cost-benefit evaluations of new projects and analyse the historical issues that have caused countries to become dissatisfied.
  - Analyses of systems and mechanisms for sharing benefits equitably between consumers in both countries.
  - The development of financial and legal instruments for the purpose of building trust in the countries involved and sharing out congestion rents between them.
  - Trade price formation should not generate negative impacts on demand in the countries concerned. The short-term pricing system should ensure that consumers always benefit, and this could mean adopting solutions whereby supply curves are agreed on for willingness to export (price per quantity) and import, with a system of "local" and "export" prices. These curves could be different, as a country may have domestic fuel price subsidy policies, or other local schemes, which are not to be "exported". The maximum amount of energy offered on the export curve would reflect operating security policies. In short, the idea is to decouple marginal short-term prices and include readiness to trade in the short term.
  - The establishment of equitable remuneration schemes to secure investment in the development of interconnections and enhanced national transmission

systems so that energy can be moved between the different parties.
  - The establishment of mechanisms for guaranteed remuneration for interconnections, i.e., mechanisms that do not depend on variable revenues such as those from congestion pricing, as this would reduce their risk.
  - It should be possible for congestion revenues to be shared between countries in proportion to each one's share in the costs of building the interconnection, and not depending on the direction of flow.
  - Comprehensive project risk analysis, including operational, financial and commercial market risks and coverage options.
  - It is advisable for interconnections to be associated with long-term contracts and/or other instruments to ensure stability and predictability for revenues and contractual commitments, even if trading is only occasional to begin with.
- As indicated earlier, the situation at present is that the organization of the sector has become heterogeneous. There are countries that are more market-leaning and countries with a greater tendency to strengthen the State, with public, private and public-private agents interacting with one another. In addition, the sector requires major investment at every stage to expand, renew infrastructure and adapt technologically. In this context, it seems important to conduct a more thorough analysis of the sector with an approach that stresses the identification of clear roles and responsibilities and the enhancement of public-private relationships in a way that is flexible and does not depend upon harmonization around single models.

Many potential gas pipeline interconnections depend on new reserves being discovered or brought on stream.

Gas integration

As already specified, the region possesses unevenly distributed natural gas resources, which makes it advisable to pursue gas integration to optimize energy complementarity and security of supply.

A number of gas pipelines were constructed in the region in the 1990s at a time of major reforms in the energy sector in countries where integration was beginning to take place.

In the Southern Cone, Argentina built pipelines to export gas, mainly to Chile but also to Brazil and Uruguay. These ventures were undertaken both on the private initiative of Argentine gas producers and on that of electricity generating companies and other actors in those countries who saw an opportunity to develop markets. Argentina was seen to have surplus gas reserves and defined itself as a "gas country". Chile, meanwhile, adopted a strategy of expanding its electricity generating infrastructure on the basis of combined cycles, whose high efficiency, supposedly backed by cheap, plentiful gas, made this seem a reasonable option. The arrival of gas for this purpose also facilitated its penetration for uses in the industrial, residential, commercial and vehicle sectors. In this way, Chile diversified its energy mix.

Substantial risk capital needs to be invested to develop both conventional resources in unexplored areas and non-conventional resources.

In Brazil, the penetration of gas was based on a like assumption. The Plurinational State of Bolivia, with surplus reserves and plentiful gas at reasonable prices in the context of that time, looked like a good option for implementing a complex decision regarding the desirability and advantages of diversifying the Brazilian energy supply.

Circumstances altered radically in both Brazil and Chile because of their experiences with these external suppliers, which strengthened arguments for self-sufficiency or diversification of supply sources.

Likewise, exports through the Colombia-Bolivarian Republic of Venezuela gas pipeline experienced interruptions because of higher demand during the 2009-2010 El Niño.

As a result of this situation, there has been a proliferation of projects for LNG regasification plants or solutions in almost all the region's countries. These provide a guarantee of secure supplies, to the detriment of regional integration.

Trinidad and Tobago has been greatly diversifying its LNG export destinations within LAC (Brazil, Mexico, the Dominican Republic, Argentina, etc.). This has been possible because of recent years' increase in shale gas production in the United States, one of its main export destinations.

Challenges

- Special attention should be paid to the development of new gas reserves in some of the region's countries. This situation in the regional gas market means that many potential gas pipeline interconnections only make sense if new reserves are discovered or brought on stream. This being so, while there is potential for the development of conventional resources in unexplored areas, and indeed of non-conventional resources, such as shale gas in Argentina and pre-salt reserves in Brazil, major risk capital investment is required. The associated infrastructure needs to be developed simultaneously to exploit these resources.
- The context of uncertainty surrounding the regional development of gas reserves represents one of the main obstacles to the implementation of energy integration projects.[19]
- Political will is required on the part of Governments and institutions to see that planning is undertaken with a regional perspective, involving agreements between countries, agreements tailored to the characteristics of each project and a framework of rules that facilitates investment and integration.

While a number of organizations have identified major potential resources, the most recent analyses reveal a gradually increasing mismatch between gas supply and demand. Consequently, priority needs to be given to exploiting the potential of gas in the region and to developing integrated regionwide forward planning to analyse feasible integration potential and viable options for this given current patterns of regional integration.

19 Unless this assumption is based on rising extraregional trade in LNG, or potential developments with shale gas (Argentina and Mexico) and pre-salt oil (Brazil) are implemented in the coming years, radically altering the future outlook for the gas supply.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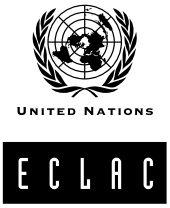
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