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ENERGY SECTOR FRAMEWORK DOCUMENT

ENERGY DIVISION

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ABBREVIATIONS AND ACRONYMS

AGECC	UN Secretary-General's Advisory Group on Energy and Climate Change
Bln L	Billion liters
BOe/d	Barrels of oil equivalent per day
BP	British Petroleum
CAF	Corporación Andina de Fomento
CARICOM	Caribbean Community and Common Market
CO2	Carbon dioxide
ECLAC	Economic Commission for Latin America and the Caribbean
EE	Energy Efficiency
EIA	Energy Information Administration
ESMAP	Energy Sector Management Assistance Program
EU	European Union
FAO	Food and Agricultural Organization
GHG	Greenhouse gas
GW	Gigawatt
ICE	Costa Rican Electricity Institute
IDB	Inter-American Development Bank
IEA	International Energy Agency
IET	Institute of Engineering and Technology
IISD	International Institute for Sustainable Development
IMF	International Monetary Fund
IPCC	Inter-Governmental Panel on Climate Change
IWRM	Integrated water resource management
kWh	Kilowatt-hour
LAC	Latin America and the Caribbean
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
Mtoe	Million tons of oil equivalent
MIF	Multilateral Investment Fund
MW	Megawatt
NGO	Non-governmental organization
NSG	Non-sovereign guarantee
OECD	Organization for Economic Co-operation and Development
OLADE	Organización Latinoamericana de Energía
PCR	Project Completion Reports
PPP	Public-Private Partnership
PV	Photovoltaic
SE4All	Sustainable Energy for All initiative
SFD	Sector Framework Document
SDG	Sustainable Development Goals
SG	Sovereign guarantee
TC	Technical Cooperation
TWh	Terawatt-hour
UN	United Nations
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization
WEC	World Energy Council
WEF	World Economic Forum
WHO	World Health Organization

I. THE ENERGY SECTOR IN THE CONTEXT OF THE IDB'S SECTOR STRATEGIES

A. The Energy Sector Framework Document as Part of Existing Regulations

1.1 The Energy Sector Framework Document (SFD), prepared in accordance with the document "Strategies, Policies, Sector Frameworks and Guidelines at the IDB" (GN-2670-1), sets forth the Bank's goal and provides guidance for its work in knowledge generation, country dialogue, and the design and implementation of operations including loans and technical cooperation in the energy sector. For the purposes of this document, the energy sector is understood as the economic activities related to the use of renewable and non-renewable resources for the production, delivery, and consumption of energy in its various forms as electricity, heat, or fuels for further processing, as well as the optimization of energy use through energy efficiency and conservation.

1.2 Energy has a crosscutting impact on many of the IDB's activities, and in turn, depends on the products and knowledge from other sectors. This SFD complements a number of approved SFDs including: Agriculture and Natural Resources Management (GN-2709-2); Integration and Trade (GN-2715-2); Urban Development and Housing (GN-2732-2); Transportation (GN-2740-3); Tourism (GN-2779-3); Water and Sanitation (GN-2781-3); and Innovation, Science and Technology (GN-2791-3). In addition, the Gender and Diversity SFD (GN-2800-3) supplements this SFD. The Climate Change SFD (GN-2835-3) and the Environment and Biodiversity SFD (GN-2827-3) also complement this SFD with respect to integrated management of resources for mitigation and adaptation and safeguards for energy operations, and the Policy and Fiscal Management SFD, expected to be approved in 2015, will also complement this SFD, specially as it refers to the fiscal impact of subsidies.

1.3 The SFD is indicative rather than normative. Its application, both in the design and in the execution of operations, will take due account of each country's particular circumstances and specific needs, as well as the goals of key regional energy integration initiatives. It is expected that the IDB will update this SFD three years after its approval, as established in GN-2670-1.

1.4 The Energy SFD covers the seven elements to be included in sector frameworks. Once this SFD is approved the Energy Sector Policies (OP-733 [Energy] and OP-733-1 [Electric Energy]) will no longer be in effect, as indicated in paragraph 1.25 of document GN-2670-1. Furthermore, since the Energy SFD will be the last pertinent SFD to include aspects of maintenance and conservation of physical works and equipment, the Policy on Maintenance and Conservation of Physical Works and Equipment (OP-707) will no longer be in effect once this SFD is approved, in accordance with Annex II, C.6 and paragraph 1.25 of document GN-2670-1. The non-regulatory aspects of these policies that are deemed relevant have been incorporated into this document. Many of their relevant regulatory aspects are reflected in the Public Utilities Policy (OP-708).

B. The Energy Sector Framework as part of the Sustainable Infrastructure Strategy for Competitiveness and Inclusive Growth

1.5 The Energy SFD is consistent with the Sustainable Infrastructure Strategy for Competitiveness and Inclusive Growth (GN-2710-5) in its strategic principles and priority areas of action. Its objective is to guide the IDB's work in the sector with a view to supporting greater competitiveness and fostering regional integration. Under this strategy, infrastructure is viewed as a means to provide quality services that foster sustainability and inclusive growth in the countries, reduce income gaps, and contribute to the mitigation of climate change.

1.6 Similarly, the Energy SFD is consistent with the Integrated Strategy for Climate Change Adaptation and Mitigation, and Sustainable and Renewable Energy (GN-2609-1). The strategy calls for the introduction of policies and incentives to promote sustainable energy and emphasizes the importance of both public and private sector investments. It highlights the vulnerabilities of infrastructure to climate change and calls for adaptation measures that will lead to greater resilience in projects financed by the IDB, as well as plans to address vulnerabilities in the energy sector. It requires additional efforts in investments that mitigate climate change, particularly renewable energy and energy efficiency.

1.7 The Energy SFD is also consistent with (i) the Strategy for Institutions for Growth and Social Welfare (GN-2587-2), particularly with regard to management and financing of the public sector, since the provision of public services, in terms of quality and quantity, depends largely on the capacity of the public sector to mobilize resources and ensure they are used with maximum efficiency while reducing transaction costs; and (ii) the Strategy to Support Competitive Global and Regional Integration (GN-2565-4) through the development of regional platforms for market integration of services, in particular: (a) the interconnection of national electricity systems; (b) development of regional pipelines; and (c) planning and project financing of joint bi-national or regional energy projects.

1.8 This SFD establishes that Bank actions will be aimed at strengthening the region's energy sector, enabling its efficient, accessible, inclusive, sustainable, and secure operation. The IDB's actions in the energy sector will promote poverty reduction, improvements in the quality of life of the region's population, economic development, and regional integration.

1.9 The following section of this document presents a review of the findings of international studies regarding the efficacy of energy policies and programs. The third section discusses the evolution of the sector in Latin America and the Caribbean (LAC), and the challenges that the region faces according to the most recent research. In the fourth section, lessons learned from IDB's interventions in the sector are analyzed, based on recommendations by the Office of Evaluation and Oversight (OVE), Project Completion Reports (PCR), and Development Effectiveness Matrixes (DEM). The IDB's comparative advantages in the sector are identified. The fifth and final section sets out dimensions of success, lines of action, and concrete activities that are proposed as priorities for the IDB in the sector over the next three years.

II. INTERNATIONAL EVIDENCE ON THE EFFECTIVENESS OF ENERGY POLICIES AND PROGRAMS AND THEIR IMPLICATIONS FOR THE IDB'S WORK

2.1 The United Nations (UN) General Assembly unanimously recognized that *"energy is the golden thread that connects economic growth, increased social equity, and an environment that allows the world to thrive."* It declared 2014-2024 as the Decade of Sustainable Energy for All. The Sustainable Energy for All initiative (SE4All) aims to achieve the following three objectives by 2030: (i) guarantee universal access to modern energy services;[1] (ii) double the global rate of improvement in energy efficiency;[2] and (iii) double the share of renewable energy in the global energy mix by 2030 (UN General Assembly, 2013).

2.2 As reflected in the objectives of SE4All, the global energy sector is in a period of profound transition. Countries are strengthening commitments to ensure sustainability, inclusiveness, and security in the energy sector. A combination of policies and technologies is being used to reduce energy intensities and emissions, without constraining economic growth (Ruhl et al., 2012; Stern, 2011; WEC, 2013). Experience has demonstrated that energy efficiency and renewable energy can also enhance security and reduce vulnerability to volatile oil prices (Zoheir et al., 2014).

2.3 This section presents the major issues in the energy sector and available international evidence regarding the effectiveness of energy policies and interventions, as well as their impact on economic and social development. At the same time, the section discusses the transitions and innovations underway in the sector, where evidence is limited as yet.

2.4 The issues are presented along the following thematic lines, which are of relevance for the work of the IDB, and will also guide the energy sector work in LAC. These thematic lines have been determined based on the challenges of the sector in the region, are inter-related, and have different relevance to each country:

a. Energy access–coverage, quality, reliability, and affordability.

b. Energy sustainability–energy efficiency, renewable energy, and climate change adaptation.

c. Energy security–energy infrastructure and regional energy integration.

d. Energy governance–institutions, regulation, policies, and information.

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[1] Access to modern energy is defined as access to electricity and cleaner and improved cooking facilities/fuels, see OECD/IEA 2010.

[2] According to the International Energy Agency (IEA), energy efficiency is a way of managing and restraining the growth in energy consumption. Something is more "energy efficient" if it delivers more services for the same energy input or the same services for less energy input (see http://www.iea.org/topics/energyefficiency).

A. Energy Access—Coverage, Reliability, and Affordability

2.5 The World Economic Forum (WEF) states that energy is a crucial input to nearly all of the goods and services of the modern world, particularly in the mass industrialization phase that emerging economies face today. Stable, reasonably priced energy supplies are central to maintaining and improving the living standards of billions of people. Without heat, light, and power, it would not be possible to run the factories, small and large businesses, and farms that provide goods, jobs, and homes, or to enjoy the amenities that improve quality of life (WEF, 2012). The linkages among energy, economic growth and poverty reduction are well established (Aspergis and Payne, 2009; Khandker, Barnes, and Samad, 2012).

2.6 Acknowledging this, SE4All calls for universal access to modern energy by 2030, to address the needs of the 1.2 billion people worldwide who lack access to electricity, and the 2.8 billion people who do not have safe cooking facilities (United Nations General Assembly, 2013). The Sustainable Development Goals (SDG) that replace the Millennium Development Goals (MDG), for the post-2015 development agenda, also includes a goal to ensure access to affordable, reliable, sustainable, and modern energy for all (UN, 2014).

2.7 **Access to electricity**. In recent years, many countries, especially in Asia and the LAC region, have accelerated efforts to increase access to electricity. According to the 2015 Global Tracking Framework Report, the annual growth in access to electricity during 2010–2012 reached 0.6 percent globally, approaching the SE4All target rate of 0.7 percent required to reach universal access by 2030, much higher than the annual growth of 0.2 percent from 2000–2010. The global electrification rate rose from 83 to 85 percent from 2010–2012, and the number of people without electricity declined from 1.2 billion to 1.1 billion (World Bank and IEA, 2015).

2.8 The access deficit worldwide is overwhelmingly rural; rural areas accounted for 87 percent of people without electricity in 2012 (World Bank and IEA, 2015). After studying rural electrification programs in ten countries, Barnes identified eight principles for success (see Box 1). A number of LAC countries have raised electricity coverage substantially through programs that applied these principles using both grid extension and isolated or off-grid renewable technologies. Brazil's "*Luz para Todos*" program has provided electricity to 15 million people since 2003, reaching 99 percent coverage. From 2001 to 2013, Peru increased national coverage from 70 to 90 percent, providing electricity to an additional 4.3 million people.

Box 1. Eight Principles for Successful Rural Electrification Programs

1. Set up effective institutions to deal with problems.
2. Ensure government commitment to fairness and transparency.
3. Establish clear planning and selection criteria.
4. Provide subsidies for capital costs.
5. Charge a price for electricity that covers costs.
6. Lower the barriers to obtaining supply, such as connection costs.
7. Involve local communities to minimize friction and maximize benefits.
8. Reduce construction and operating costs, e.g. use single-phase wiring or off-grid electrification where appropriate.

Source: Barnes (2007).

2.9 While people lacking electricity are more rural, more dispersed, and have lower incomes, the technologies and business practices required to overcome these obstacles have been evolving rapidly. Local, more sustainable solutions are available that are often less costly than grid extension, including mini/micro-grids based on hydro; wind and solar energy for rural and industrial applications; off-grid renewables and lighting and charging systems, including solar lighting and LED kits; and self-contained systems that provide power when the grid fails (United Nations Secretary-General's High Level Group on Sustainable Energy for All, 2012).

2.10 **Social and economic benefits of electricity.** Evaluations of rural electrification programs worldwide have identified and quantified private welfare gains including longer hours for indoor activities, higher educational attainment that results in higher earnings, information benefits from watching television, and higher productivity in home business activities. Assessments have consistently shown that willingness to pay for lighting alone is higher than it costs to supply the service. Public benefits identified but not quantified include an increased sense of security, greater opportunities for social activities, and improved health and education facilities (Barkat et al., 2002; IEG World Bank, 2008; Meier et al., 2010.

2.11 Benefits of electricity access identified by beneficiaries in poor urban and peri-urban areas include improved household income from paying lower prices, health benefits from reduced indoor pollution from kerosene use, improved household security as a result of fewer fires and light indoors at night, better security from street lighting, and more investment in housing improvements as security improved (World Bank, 2010).

2.12 Additional investments have been shown to be necessary to fully reap the development benefits of electrification. Productive-use programs can help increase income generation (e.g., the processing of agricultural goods or crafts for sale), thus giving communities a means to pay for energy (Valencia and Caspary, 2008). Experience in Indonesia and Peru has shown that programs using business development services approaches for promoting productive uses of electricity increased productivity through use of electrical equipment such as lights; water pumps; processors of coffee, cacao, rice, grain, and dairy products; refrigeration; electric motors and saws, and more (Finucane, Bogach, and Garcia, 2013; Fishbein, 2003).

2.13 **Affordability of electricity**. Assisting the poor is crucial to ensure that they receive affordable and reliable electricity service to improve their economic well-being and quality of life. Many countries seek to make electricity affordable to all consumers through cross-subsidies on tariffs among different categories of consumers (e.g., residential and industrial), different income groups, and customers receiving electricity from different sources (e.g. the integrated grid, isolated grids and off-grid). Significant connection fees are often charged to households when they first connect. It is less common to provide connection subsidies or financing, although these connection fees present a major barrier to poor households. The paradox is that while the connection costs represent a small percentage of the investment required to expand access, the inability of the consumer to pay the connection fees keeps the access rate down (World Bank, 2011).

2.14 Policies to aid energy poverty in LAC have been dominated by subsidies to electricity and fuel that intend to benefit the poor but are often poorly targeted and not sustainable (Izquierdo and Manzano, 2012) and have also largely benefited rich populations (please also refer to the Policy and Fiscal Management SFD). Conditional cash transfer programs could incorporate a specific component for energy as an alternative to subsidies. Together with social assistance and human capital development, this mechanism could help reduce poverty and avoid passing the trend from one generation to the next (Stampini, 2012). More research and analysis are needed on effective and sustainable means of assisting the poor to access electricity.

2.15 **Electricity tariffs and financial sustainability.** The financial and operational viability of electricity providers depends on full cost recovery of an efficiently run operation while providing the right incentives to provide good quality services to customers (World Bank, 2011). Electricity needs to be affordable to consumers. At the same time, tariffs must be adequate to allow service providers to expand the grid as well as operate and maintain their facilities. Tariffs set below costs of efficient operation (e.g. from untargeted subsidies for which the utility is not fully compensated) result in poor utility performance and waste of electricity. In some instances, subsidies[3] have resulted in costly mechanisms that, due to high rates, excessive duration or poor targeting, fail to meet their original objective and do not reflect the true cost of energy (IISD 2014).[4] No single approach exists for fossil-fuel subsidy reform, yet the International Energy Agency (2015) provides some guidance for success from past experience, summarized as: prices reflecting the full cost of energy, introducing reforms in small steps, protecting vulnerable groups, and having a consultation and communication strategy. The case for adequate electricity tariffs also applies to urban distributed generation, where insufficient tariffs for the sale of surplus energy can reduce economic incentives to install individual renewable energy systems. Countries with electricity prices that are too low to cover economic costs create fiscal challenges and unsustainable utilities.

2.16 **Access to modern energy for cooking**. The World Health Organization (WHO) estimates that 4.3 million people a year die prematurely from illnesses attributable to household air pollution caused by the inefficient burning of wood, charcoal and other solid fuels. Their evaluation showed that these illnesses could be avoided by switching to stoves that use cleaner, more efficient modern fuels, introducing improved stoves for traditional fuels, and/or improving ventilation (WHO, 2014). Environmental damage from deforestation, land degradation and regional air pollution would also be reduced.

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[3] According to the World Economic Forum, subsidies are defined as any government action that lowers the cost of energy production, raises the revenues of energy producers, or lowers the price paid by energy consumers. However, there are costs to society, such as social and environmental externalities, that generate a cost to society (e.g., pollution, underinvestment in other sectors), which may also be considered as subsidies (IISD 2014).

[4] An example of a country's efforts to cover costly electricity sector losses from subsidies is Jordan. The government has a plan to reduce generation costs and raise electricity tariffs annually until 2017, when it plans to eliminate losses and the need for subsidies. The plan is done in a way to protect vulnerable groups (IISD 2014).

2.17 SE4All includes the following action areas that have proven effective in improving access to modern cooking fuels: building local value chains for improved cooking solutions; raising awareness of their benefits; investing in local supply chains for clean fuels; developing standards for efficiency, emissions, and safety; and designing cooking appliances that meet consumer needs (United Nations, 2012).

2.18 **Energy, gender and indigenous populations**. Benefits from electrification have been especially important for women, children and indigenous populations. Benefits from reducing health risks from burning biomass fuels have been shown to be particularly high among women and children (WHO, 2014), who bear the main negative impacts of indoor air pollution from these cooking fuels as well as fuel collection and transport (SE4All, 2013). One study cited evidence from South Africa showing that rural electrification resulted in a 9 percent increase in female employment outside the home (Kohlen et al., 2011). Use of improved stoves would also free time and effort from fuel collection, especially for women, which may allow women and girls to participate in more productive activities (ESMAP, 2011).

2.19 Indigenous peoples make up less than 5 percent of the global population, yet comprise 15 percent of the world's poor. The indigenous population of Latin America is estimated at 28 million. Indigenous populations can achieve greater benefits energy access by increasing productivity and diversification of income generating activities. Energy access enhances economic opportunities through increased access to health services and schools, and increases wealth by improving the returns from agricultural activities (Patrinos and Skoufias, 2007).

2.20 Access to electricity provides social services, particularly maternal care, thanks to the availability of electricity in health and education centers; increased security benefits in public spaces from street lighting that may help to decrease violence against women; and increased empowerment due to access to information from listening to the radio or watching television.

2.21 Experience has shown that action is essential to address barriers that women and indigenous populations face in benefiting from and participating in energy programs. This requires integrating gender and cultural elements into government policymaking and planning; supporting civil society organizations working on energy, gender and indigenous populations; training them on the design, installation, operation, and maintenance of renewable energy options; and incorporating gender aspects in the design and implementing of sustainable energy programs and projects (IDB, 2013; UNDP, 2014; UNIDO, 2013).

2.22 **Energy and synergies with other sectors**. Studies suggest that the simultaneous provision of services like electricity, transportation, water, sanitation, health and education, has led to major benefits for local populations (Toman and Jemelkova, 2009; UN, 2013). For example, a study in Peru examined the importance of various infrastructure services for poverty alleviation and social development; it showed that access to two or more infrastructure services simultaneously appeared to have greater-than-proportional impacts on household income (World Bank, 2009). Opportunities exist to deliver modern energy services to underserved populations, leveraging the growing telecommunication networks and mobile device ownership among populations,

for example, with the use of telecom tower infrastructure and use of mobile payments and mobile services (Nique and Jain, 2014).

2.23 The Food and Agricultural Organization (FAO) and the International Institute for Sustainable Development, among others, have been working on approaches for managing the important nexus among interventions in water, energy and food to improve the effectiveness of interventions (Bizikova et al., 2014; FAO, 2014; Hoff, 2011). Canales suggests that this nascent approach requires effective coordination mechanisms and joint planning between water, agriculture and energy authorities; improved and coordinated water and energy regulatory frameworks; integrated water resource management; conflict prevention and resolution systems, and protection of watershed ecosystems and environmental flows (Canales, 2014).

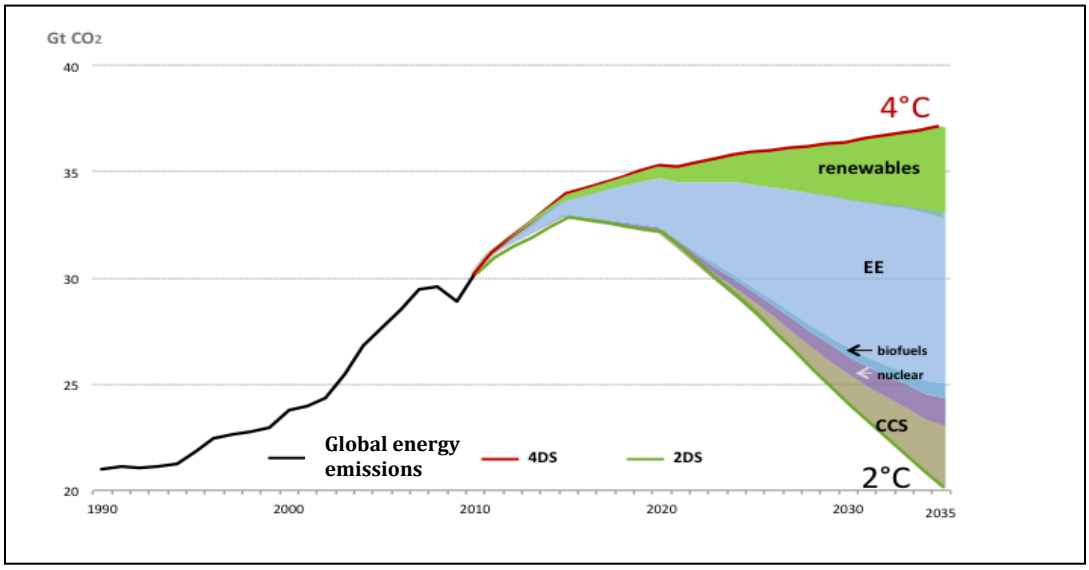
B. Energy Sustainability–Energy Efficiency, Renewable Energy, and Climate Change Adaptation[5]

2.24 Ensuring that energy is supplied in an environmentally sustainable manner, while meeting social and economic objectives, is a vital challenge in the region as well as globally. Two primary concerns in the energy sector are reducing its impact on climate change and urban air pollution. With respect to climate change, the 2014 Synthesis Report of the Inter-Governmental Panel on Climate Change (IPCC) stated that continued emission of greenhouse gases would cause long-lasting changes in the climate system, increasing the likelihood of severe, pervasive, and irreversible impacts (IPCC, 2014). It called for reducing energy use, decarbonizing energy supply, reducing net emissions, and enhancing carbon sinks. Since global energy use accounts for two-thirds of all Greenhouse gas (GHG) emissions (IEA, 2013) reducing emissions from the energy sector is key. The IPCC report concluded that ambitious mitigation would reduce global economic growth by only 0.06 percent.

2.25 Based on current knowledge of technologies and experience with programs to date, energy efficiency, renewable energy including sustainable biofuels and carbon capture play the largest role in reducing carbon emissions (see Figure 1), with energy efficiency being the most significant (IEA, 2012a; IPCC, 2014a; RSB, 2011). Many of these same measures would contribute to curbing local pollution that is causing increasing concern in cities.

[5] According to the Integrated Strategy for Climate Change Adaptation and Mitigation, and Sustainable and Renewable Energy (GN-2609-1), sustainable energy refers to a sector focus geared toward: (i) promoting universal, reliable, and affordable access to energy services; (ii) supporting the long-run sustainability of energy projects to meet current and future demand; (iii) ensuring quality and promoting economic efficiency in the supply of energy services; and (iv) contributing to the reduction of environmental impacts, including climate change. Sustainable energy is also aimed at reducing the vulnerability of national economies to variability in prices and supply of fuel in global markets, and at fostering technology- and employment-driven development that is both environmentally and socially sustainable.

Figure 1. Sources of Global Energy CO2 Emission Reductions



Source: IEA (2012a).

2.26 Since the industrial revolution, economic output and energy consumption have been strongly linked, that is, increased economic output is correlated with increased energy use (Stern, 2011). In recent decades, however, this link has been weakened; it has been shown that economic output can occur without proportional growth in energy use. This has been referred to as energy-economic growth decoupling. Energy efficiency plays a key role in this decoupling, as well as being fundamental for energy security, economic competitiveness, and environmental sustainability (Sue Wing and Eckaus, 2007).

2.27 In 2014, the IEA made estimates of global energy investments for regions and key countries. The IEA estimated that cumulative investments of US$48 trillion (in 2012 US dollars) would be required to meet global energy demand by 2035 in its new policy scenario that reflects announced policies:[6] US$40 trillion for supply, and US$8 trillion for energy efficiency. However, this scenario would result in a 3.6 degree Celsius rise in global temperature, almost double the 2 degrees Celsius agreed in Cancun in 2010. An alternative 2 degree Celsius scenario that meets the Cancun goal by emphasizing energy efficiency and renewable energy would require investments of US$53 trillion: US$39 trillion for supply, and US$14 trillion for efficiency.[7]

2.28 **Energy Efficiency**. As shown in Figure 1 above, energy efficiency is the single most important measure for increasing energy sustainability. An IEA study showed that energy efficiency has created multiple benefits, including higher GDP growth of 0.25 to 1.1 percent per year, improved trade balances, increased

[6] The New Policies Scenario reflects energy policies and measures that have been adopted as of early 2014, as well as those that have been announced including economic instruments; information and education; policy support; regulatory instruments; research, development and deployment; and voluntary approaches.

[7] The IEA refers to this scenario as the 450 scenario, the corresponding limit of parts per million (ppm) of carbon in the atmosphere.

industrial productivity and employment, higher disposable household incomes, reductions in carbon emissions and local pollution, and deferred investments in energy supply (IEA, 2014).

2.29 Evidence on the impact of energy prices on energy efficiency indicates that higher energy prices motivate energy efficiency, but other barriers need to be addressed. Studies that have focused specifically on factors influencing technology adoption, find that higher energy prices are associated with significantly greater adoption of energy-efficient equipment (Anderson and Newell, 2004). While experience shows that energy prices can motivate energy efficiency, high rates and prices alone, are not likely to overcome the well-documented barriers to cost-effective energy efficiency. External actors can play an important role in the promotion and dissemination of energy efficient technologies.[8] Policymakers and regulators should examine rate and pricing approaches that encourage customer energy efficiency, while recognizing their limitations and pursuing non-price approaches as well (Prindle, 2009).

2.30 To overcome the many barriers to energy efficiency investments, national governments drive energy efficiency programs that have set standards (e.g., for vehicles, equipment, and buildings); provided training, advice and promotional campaigns; and financed investments. Meeting energy efficiency targets has not been easy. In 2012, recognizing that it was not on track to meet its target of reducing energy use by 20 percent by 2020, the European Union (EU) instituted the Energy Efficiency Directive, requiring member countries to set targets, develop programs, and monitor programs to ensure that the target is met. Energy consumption now appears on track to meet 2020 targets. However, this was helped by the economic crisis; as growth picks up again, further efforts will be required (European Environment Agency, 2014).[9]

2.31 **Renewable Energy**. Renewable energy encompasses conventional hydropower and non-conventional renewable energy (including biomass, wind, geothermal, solar photovoltaic, solar thermal, and small hydropower). Renewable energy has gained momentum in the last decade, especially for power generation. Benefits identified by the IEA include strengthened energy security by diversifying energy supply and reducing fossil fuel imports; reduced emissions of GHG and local pollutants; provision of employment and contribution to sustainable economic growth; and provision of modern energy to remote areas or areas with dispersed populations (IEA, 2014).

2.32 Hydropower has been the largest renewable source of electricity, accounting for 16 percent of global generation and a much higher 64 percent in LAC in 2011

[8] SG and NSG activities have been an important catalyst for the adoption of energy efficiency technologies in the region. The IDB has completed numerous energy audits for companies and government in the region and supplied financing to enable the energy efficient investment. The IDB encourages including the installation of the energy efficiency technologies in the energy projects it finances. The Bank also has several private credit lines dedicated to the financing of the construction of LEED certified buildings. It promotes projects that create eco-systems through the introduction of energy services companies (ESCOs), which must be present in order for energy efficiency markets to be successful.

[9] Note that large investments are also required in energy efficiency. According to the IEA (2014), for example, a final energy demand reduction of 6% by 2020 in Germany, would require an annual investment of US$ 16 billion, and delivered an increase in GDP of 0.7%.

(IEA, 2013d). Hydro reservoirs often deliver services beyond electricity, such as water supply, flood control, and irrigation. While facing increasing social and environmental challenges, that require mitigation and benefits sharing, hydropower is technically mature and often economically competitive.[10] It is expected to maintain its share of generation in the future. The share of undeveloped technical hydropower potential ranges from 47 percent in Europe to 61 percent in North America, 74 percent in LAC, 80 percent in Asia and Australasia, and 92 percent in Africa (Kumar et al., 2011).

2.33 Small hydroelectric plants with a capacity under 20 megawatt (MW) and without storage have advantages over large hydro and fossil fuel based generation. Small hydro is often suited for rural areas; it can lower costs by avoiding the cost of fuel and can be maintained at low cost by a local community. In addition, small hydro has few emissions of GHG compared to low-efficiency diesel generators (Caratori et al., 2015).

2.34 **Non-conventional renewable energy**. Global investment in non-conventional renewable energy has grown rapidly, from US$40 billion in 2004 to US$214 billion in 2013 (REN21, 2014). Advances in electricity generation in 2013 included: (i) renewables accounted for 56 percent of additions to global generating capacity; (ii) China's new renewable capacity surpassed new capacity from fossil fuel and nuclear power for the first time; and (iii) Djibouti and Scotland aim to derive 100 percent of electricity from renewables by 2020, while Costa Rica aims for the same goal by 2021. Other trends include increasing renewable energy use in combined heat and power plants, district heating and cooling systems and for water heating and industrial purposes. The expansion of renewables has been accompanied by cost reductions in technologies such as wind and solar photovoltaic (PV) technologies.

2.35 Renewable energy has not competed with conventional energy on a level playing field. Factors that have impeded its deployment include fossil fuel subsidies[11], the lack of a carbon price that reflects the costs of environmental and social damage, fuel surcharges on electricity prices that transfer price risk from suppliers to consumers, and infrastructure that is designed for conventional energy. To counteract these factors, 144 countries had renewable energy policies with targets and incentives by 2013. With respect to biofuels for transport, 63 countries, including Brazil, Colombia, and Peru, used regulatory policies (Renewable Energy Policy Network for the 21 Century, 2013). Eliminating subsidies to fossil fuels reduces wasteful energy use and allows a more

[10] There are concerns about methane emissions from reservoirs in certain conditions and efforts are under way to develop common understanding and metrics for the issue (see http://www.hydropower.org/greenhouse-gas-emissions). New hydroelectric power plants follow ESG Safeguards to have a positive GHG balance.

[11] Subsidies to fossil fuels amounted to US$548 billion in 2013 globally (while subsidies to renewable energy were US4$121 billion that same year (IISD 2014). This translates to an implicit subsidy of US$115/tonne of CO_2 and countries like India, Indonesia, Malaysia and Thailand are taking the opportunity of lower oil prices to diminish fossil-fuel subsidies (IEA 2015).

conducive investing environment for energy efficiency and renewable energy (IEA 2015).[12]

2.36 Various innovations in policy mechanisms and financing structures, including portfolio approaches as mentioned in the next section (¶3.45), have made renewable energy projects more bankable. Common elements in renewable policies include feed-in tariffs for electricity, auctions to contract renewable electricity at premium prices, renewable portfolio standards, tradable green certificates, net metering that permits self-producers to sell to the grid, and mandated blending of biofuels with fossil fuels as well as tax incentives, in combination with policy targets, and support for training and research and development. In recent years, changes to market circumstances and policy priorities have resulted in successful policy innovations, including the use of policy hybrids that combine elements such as feed-in tariffs and auctions (Couture et al., 2015). Innovations have also occurred in the area of renewable energy and energy efficiency with the increased use of Smart Grids, as explained in the following paragraphs.

2.37 For all its benefits, the variability of non-conventional renewable energy generation and its distributed location have challenged its large-scale integration into electricity systems. This has resulted in a need for generation reserves to guarantee operational reliability and changes in network and electricity infrastructure planning that takes into account the short-term operational dynamics of the system and the uncertainty associated with management of renewable generation, including hydropower (Battle, 2014). Since the energy generated from wind and solar PV usually has priority in dispatch, mechanisms to follow and smooth out the variations in generation need to be implemented. These mechanisms include hydro generation combined with storage, fast response combined cycle gas turbines, hydro pumped storage and other storage technologies such as flywheels, batteries, and cold or heat storage. Investments in modern forecasting and control systems have been needed to allow fast response to variations.

2.38 Small-scale distributed generation by the final user faces additional challenges. It suffers from a lack of adequate regulatory frameworks, financing tools, and standards for grid access, as well as high installation costs and inadequate tariffs for surplus energy. There have also been institutional barriers, such as lack of streamlined permit procedures. Net metering, necessary for distributed generation, has issues as well. When the costs of the grid are allocated on the basis of net consumption, costs are borne by those consumers without distributed generation. Issues to be addressed nationally are the amount of distributed generation the grid can handle and the responsibility for payment for increased management and additional grid reinforcements (Climate Policy Initiative, 2014).

[12] Instead, IISD (2014) argues that subsidies granted to renewable energy generation are intended to capture the benefits of this type of generation, as opposed to the environmental and social costs associated with the burning of fossil fuels.

2.39 **Smart Grids**.[13] A smart grid is an electricity network that uses advanced telecommunications and control technologies to co-ordinate efficiently all generators, grid operators, end-users and electricity stakeholders. Smart grids have been shown to be powerful tools for achieving energy security, affordability, and sustainability because they have helped: (i) manage the energy flowing from renewable distributed generation; (ii) improve energy efficiency and minimize costs by managing consumption using storage devices; (iii) improve system stability, resilience, and reliability by helping to regulate power flows; (iv) reduce transmission and distribution losses by optimizing system configuration; and (v) optimize the use of infrastructure to meet peak demand (Institute of Engineering and Technology, 2013 and 2013a; WEF, 2012). A survey of the Joint Research Centre of the European Commission showed average electricity savings of 3 percent for wide-scale rollouts of smart metering systems. Peak-load shifting varied considerably, ranging from 1 to 9.9 percent, due to different customer engagement strategies and consumption patterns (Covrig et al., 2014).

2.40 Countries use smart grids for different purposes; emerging economies may leapfrog directly to smart electricity infrastructure, while OECD countries invest in incremental improvements to their grids (IEA, 2011). Two main challenges need to be overcome to achieve wider implementation of smart grids. The first is related to policies and regulations for implementation, including issues of standardization and certification, system testing, and consumer participation. The second is related to financing. Large amounts of funding are needed throughout the lifecycle of smart grid development. In the United States, a full smart grid could cost US$24 billion per year over 20 years (WEF, 2012).

2.41 **Climate change adaptation**. To improve the climate resilience of energy systems, governments need to encourage supply and demand-side adaptation, while the private sector needs to consider these impacts on its operations (IEA, 2013d). Energy system vulnerabilities include sudden and destructive effects to facilities caused by extreme weather events. Other impacts are gradual, such as changes to heating and cooling demand, sea level rise that affects coastal infrastructure, and the effects of shifting weather patterns on hydropower production and water availability for power plants.

2.42 Many actions to increase a system's resilience can be implemented at relatively low cost. However, increased awareness, knowledge, and capacity are essential to mainstream climate adaptation into the sector. This requires climate observations and predictions, experience in dealing with uncertainties and risks, and research and practice on energy sector adaptation. Work on these issues needs to be a high priority in emerging countries, where there is often a lack of hydro-meteorological data and limited capacity (Ebinger and Vergara, 2014).

[13] Smart grids include advanced metering that relay real-time information to a control center to coordinate loads, switches that modify grid configuration to more efficiently serve customers, and sensors that evaluate network parameters to optimize energy flows and power production, both centralized and distributed. For a primer, see IET (2013) (http://www.theiet.org/factfiles/energy/smart-grids-page.cfm).

C. Energy Security—Quality of Service Delivered, Energy Infrastructure and Regional Energy Integration

2.43 Energy security encompasses the management of the sustainable supply energy from domestic and external sources, the reliability of energy infrastructure, and the ability of energy providers to meet current and future demand. Energy infrastructure is key to competiveness and development; this has required steadily increasing investments by both the public and private sectors. Regional integration contributes to energy security at national and regional levels.

2.44 **Energy infrastructure and competitiveness**. The literature shows a strong relationship between quality of energy infrastructure, competitiveness, and economic growth (Aspergis and Payne, 2010 Toman and Jemelkova, 2003; WEF, 2012). The World Economic Forum, for example, includes electricity infrastructure in its evaluation of the competitiveness of countries (WEF 2013a). Similarly, the Global Manufacturing Competitiveness Index recognizes energy costs and policies together with infrastructure as drivers of competitiveness (Deloitte et al., 2012).

2.45 Poor quality electricity has negative effects on productivity, operating costs, and competitiveness of firms (IDB, 2013b). Electricity reliability has been an issue in both emerging and high-income countries where blackouts and brownouts have cost economies billions of dollars and provided a disincentive to invest in manufacturing (Nordas and Kim, 2013). Firms that have faced frequent scheduled and unscheduled power cuts have made inefficient use of both human and physical capital and have suffered productivity losses. Investments required to provide back-up generation lead to increased costs. Fluctuations in voltage and frequency of power also cause machine damage, financial and economic losses, and variations in product quality. As a result, production volumes, costs and output quality are often adversely affected; firms invest less and have lower productivity growth (Alby, Dethier, and Straub, 2013). Quality energy infrastructure and reliability of service are therefore crucial for competitiveness.

2.46 **Energy infrastructure investments.** Decisions to invest in the energy sector have been shaped by government policy measures and incentives. In many countries, governments have directly influenced investments through state ownership of production facilities, for example nearly half of the world's generation capacity belongs to state-owned companies. Pressure on public funds and the need for new technology, on the other hand, have created opportunities for substantial private investment, often in public–private partnerships. Mobilizing private sector investment, however, has required reducing political and regulatory uncertainties (IEA 2014e).

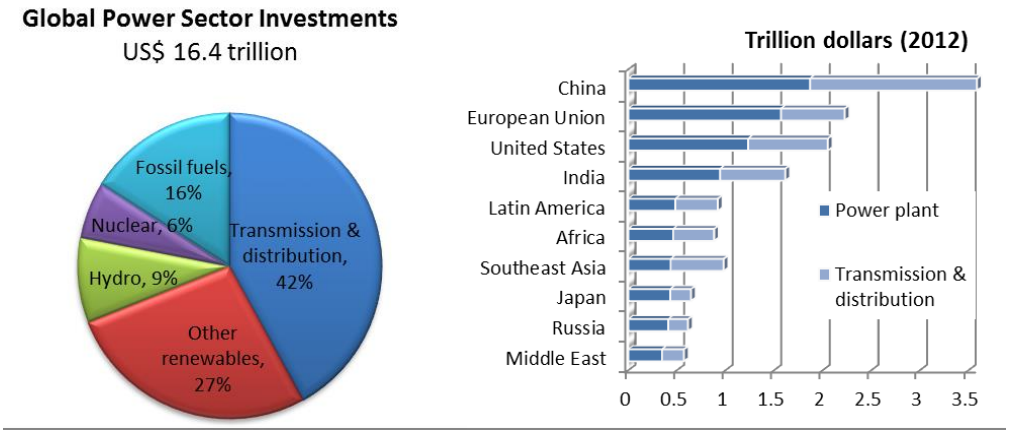
2.47 Public investment has also been provided though public development banks that can leverage public and private financing as first lender or a second-tier lender. This is an effective mechanism when there is close coordination between this financing mechanism and sector authorities, especially those responsible for planning. This public–private sector collaboration has been shown to be necessary for financing large investments such as hydroelectricity construction, with the public sector having a greater role of regulating and guaranteeing construction, and the private sector taking long-term construction and operation

contracts (Yepez-Garcia, Johnson, and Andres, 2011). Changes in public–private delivery of energy infrastructure and the processes of decentralization result in a need to strengthen the institutional capacities of the public sector (including strategic planning entities for better planning and use of public finances).

2.48 As it applies to other types of infrastructure, investments will be more sustainable when an assets management oriented operation and maintenance (O&M), and rehabilitation practices are adopted. O&M best practices, which apply to various sectors, base their activities on the following: (i) rather than expanding investment, utilities must adopt asset management approaches prioritizing maintenance and rehabilitation; (ii) infrastructure maintenance must be preventive, rather than remedial; (iii) asset management must be ongoing, with adequate trained staffed and financial resources; (iv) based on a management system for the activity; and (v) should consider not only the technical and economic aspects of the activity, but be performed with the highest safety and public security standards, minimizing the social and environmental impacts. It should be noted that maintenance requirements vary and are to be determined on a project by project basis (GN-2781-3).

2.49 Energy investments aimed at reducing climate change emissions will be increasingly necessary. The IEA forecasts total global cumulative investment in the power sector of US$16.4 trillion by 2035 in the new policy scenario, 36 percent for renewable generation, 22 percent for fossil fuel/nuclear generation, and 42 percent for transmission and distribution (see Figure 2). Investments in the 2 degree Celsius scenario would be higher, at US$19.3 trillion, with a greater share for renewable generation of 46 percent.

Figure 2. Cumulative Global Power Sector Investment in the New Policy Scenario, by Type and Selected Region, 2014-2035



Source: IEA 2014e.

2.50 **Reduction of electricity losses**. Electricity losses are key measures of the efficiency and sustainability of the power sector (Jiménez, Serebrisky and Mercado, 2014). Transmission and distribution losses are made up of: (i) technical losses that occur in the flow of electricity current; and (ii) nontechnical losses due to illegal connections, non-payment, or billing errors.

Poorly designed and/or maintained transmission lines, as well as long distribution circuits with inappropriate cable sections and overloaded transformers, result in high technical losses. Metering, billing, and collection to prevent nontechnical losses are integral to the efficient management of an electricity utility and its financial viability.

2.51 North Delhi Power Limited provides an example of a utility that succeeded in reducing total electricity losses from 53 percent in 2002 to 15 percent in 2009. Some of the most important measures used included: (i) advanced metering for consumers; (ii) installation of medium voltage distribution networks in theft-prone areas; (iii) replacement of electromechanical meters with accurate electronic meters; (iv) energy audits up to the distribution transformers level; (v) enforcement of collection; (vi) public participation in controlling theft; and (vii) collaboration with NGOs for creating awareness of the dangers of direct tapping from live wires (World Bank, 2009a).

2.52 **Natural gas systems**. Market conditions vary in different regions of the world, but the flexibility and environmental benefits of natural gas compared with other fossil fuels have contributed to strong growth that is expected to continue over the long term. While global annual oil consumption grew 16 percent between 2000 and 2012, gas increased at double that rate, by 36 percent. The main driver was the electricity industry, with the emergence of combined-cycle gas turbines as the cheapest and cleanest-burning type of thermoelectric plant.[14] Gas is seen as a transitional fuel—a bridge from fossil fuel-based energy to a sustainable future based on renewables (Brown et al., 2015).

2.53 The world's remaining reserves of natural gas are sufficient to meet demand for decades. Technically recoverable gas resources are estimated at 810 trillion cubic feet (Tcf), of which 42 percent are unconventional (including shale gas, tight gas and coalbed methane). While close to 60 percent of conventional reserves are located in Eastern Europe and the Middle East, unconventional gas is more broadly distributed (IEA, 2013d). Advances in technology have led to a surge in unconventional gas production in North America, holding out the prospect for a large-scale, unconventional gas industry in other parts of the world with resources. The IEA forecasts that unconventional gas will account for almost 40 percent of global gas output growth (IEA, 2013d).

2.54 **Numerous hurdles need to be overcome**. Producing unconventional gas has been shown to impose a larger environmental footprint than producing conventional gas. More wells are needed and techniques such as hydraulic fracturing are required to boost the flow of gas from the well. Serious hazards, including the potential for air pollution and contamination of surface and groundwater as well as induced seismicity, must be successfully addressed (IEA, 2012). The technologies and know-how have been developed to meet these

[14] The environmental benefits of natural gas are under evaluation, in particular the production of shale gas using hydraulic fracturing, Liquefied Natural Gas (LNG)'s lifecycle emissions (Jaramillo, Griffin, and Matthews, 2007), non-CO_2 emissions (McJeon et al., 2014), and system leakage of methane. The 30 percent reduction in life-cycle GHG emissions for new unconventional wells under EPA's 2012 New Source Performance Standards will help mitigate some concerns (NETL, 2014). Regulation can address the leakage problem together with detection and repair technologies (Brandt, et al. 2014).

challenges, but the industry needs to meet rigorous environmental and social standards. Governments need to devise appropriate regulatory regimes, based on high-quality data, with sufficient compliance staff and guaranteed public access to information.

2.55 The high costs of transportation of natural gas, conversion of gas to Liquefied Natural Gas (LNG), and its transportation in special ships, have constrained regional and global gas markets. LNG has the potential to create new links between markets and reduce price differentials, but only in a high fossil-fuel price environment (IEA, 2014e). LNG represents 30 percent of international gas trade and has grown at three times the rate of natural gas since 2000.

2.56 **Regional energy integration**. Regional energy integration is a cross-cutting theme and has been shown to create substantial benefits, especially related to energy security. Europe's experience in developing a well-integrated energy market resulted in the following benefits to date: (i) wholesale electricity prices declined by one-third and wholesale gas prices were stable between 2008 and 2012; (ii) consumers have a wider choice of energy suppliers; (iii) infrastructure links between EU countries have been built or are under construction; (iv) cross-border trade in gas and electricity between EU countries has increased; (v) gas pipelines are being used more efficiently due to common rules; and (vi) EU rules guarantee fair trading on wholesale markets and prevent price manipulation (European Commission, 2014).

2.57 A study of 12 international regional power sector integration projects concluded that persistence and flexibility are needed to deal with nonlinear progress and lengthy timelines but the benefits warrant the effort. However, regional integration can take decades to come to fruition. Key issues have included finding the right level of integration, optimizing investments on a regional basis, developing appropriate regional institutions, technical and regulatory harmonization, power sector reform and integration, and the role of financing agencies. While having many benefits, regional integration faces challenges that include concerns about energy independence and sovereignty (ESMAP, 2010).

D. Energy Governance—Institutions, Policies, Regulation, and Information

2.58 The global energy community has responded to the profound transformation of the sector underway by defining the pathways and investments required to meet access and sustainability goals (IDB, 2011; 2013a; IEA, 2013b, 2014e; WEC, 2013a; WEC, 2013). There is consensus that stronger governance is required at international, regional, and national levels to reach these goals. In 2012, industry executives had three recommendations for countries: (i) define a coherent and predictable energy policy; (ii) implement stable regulatory and legal frameworks to support long-term investments; and (iii) encourage public and private initiatives that enable innovation and foster research, development, and demonstration (WEC, 2013a).

2.59 **Energy institutions**. Strong and stable public-sector energy institutions operating within a clear legal and regulatory framework have been shown to be a key foundation for effective energy policies. Experience has demonstrated that policymakers need to engage with the energy and financial sector on emerging

technologies, financial opportunities, and effective regulatory frameworks to meet energy goals. The corporate sector has played a fundamental role in mobilizing the natural and human resources, financing, and technologies necessary to achieve energy policy goals (WEC, 2014).

2.60 The legal framework provides the foundation for the operation of the sector, especially the protection of property rights, openness to private investors, and minimal bureaucracy. Investors also consider the ethical standards of the public sector and the degree of political risk, especially in long-term energy projects. Even if the political risk can be mitigated, notably by political risk coverage guarantees issued by private and multilateral institutions, such guarantees add to the cost of the investment (Mia, Estrada, and Geiger, 2007).

2.61 **Energy policies**. The World Energy Council (WEC) notes that policy decisions, reached during the current historical moment of flux in energy systems, could make it possible for billions of people to experience sustainable energy systems for decades into the future, or they could prevent the goal from being reached. It defines three main dimensions of policies:

a. Energy security: The management of energy supply from domestic and external sources, the reliability of energy infrastructure, and the ability of energy providers to meet current and future demand.

b. Energy equity: The accessibility and affordability of energy across the population.

c. Environmental sustainability: The achievement of energy efficiency and the development of renewable and other low-carbon sources (WEC, 2013).

2.62 **Energy subsidies**. A relevant policy issue identified in recent studies is the need to phase out general fossil fuel and energy subsidies (Bast et. al, 2014; Allaire and Brown, 2009). General energy subsidies have significant economic consequences. While aiming to benefit consumers, subsidies might aggravate fiscal imbalances, crowd out priority public spending, and depress private investment, including those in the energy sector (Galiana and Sopinka, 2014). Reallocating some of the resources freed up by subsidy reform to other areas of public spending (e.g. health and education) could help boost growth in the long run. General energy subsidies without full compensation to suppliers undermine the performance and sustainability of energy suppliers. Targeted and temporal subsidies for marginalized populations or to provide support after external shocks may prove necessary and beneficial, if well managed and revised over time. Generalized subsidies induce changes in resource allocation by encouraging excessive energy consumption, promoting capital-intensive industries, reducing relative incentives for investment in renewable energy, and accelerating the depletion of natural resources. Higher-income households capture most subsidy benefits, reinforcing inequality. Even future generations are affected through the damaging effects of increased energy consumption on global warming (Di Bella et. al, 2015).

2.63 Pre-tax consumer subsidies arise when the price paid by consumers is below the cost of supplying energy. A worldwide study estimates global pre-tax energy subsidies at US$333 billion, or 0.4 percent of global GDP in 2015 (IMF, 2013). Post-tax consumer subsidies arise when the price paid by consumers is below

the supply cost of energy plus an appropriate corrective tax that reflects the environmental damage associated with energy consumption as well as a consumption tax that should be applied to all consumption goods (e.g., VAT). The post-tax amount of energy subsidies is considered the "truer" measure of cost and amounts to US$5.3 trillion in 2015 or 6.5 per cent of global GDP (Coady et al., 2015).

2.64 Based on analysis of international experience in energy subsidy reform programs, the following elements are key to effective reform: (i) a reform plan based on long-term objectives, analysis of impact, and consultation with stakeholders; (ii) a communications strategy, including information on the size of subsidies and the recording of subsidies in the budget; (iii) appropriately phased price increases that differ for different forms of energy (e.g., electricity, gasoline); (iv) improving the efficiency of state-owned enterprises to reduce producer subsidies; (v) targeted measures to protect the poor; and (vi) institutional reforms that achieve setting energy prices on technical and economic methodologies, including total cost recovery and automatic adjustment mechanisms (IMF, 2013).

2.65 Oil price volatility has been another important policy issue in many countries. Concern about upward price volatility has been strong among importers, especially small nations. Impacts of oil price increases on oil importers have included a deteriorating trade balance, inflation, and, in cases where the full costs are not passed to end users, a weakened fiscal balance. Effective short-term options to manage the risk of upward price volatility include risk management or hedging instruments. Long-term options include energy efficiency, use of local renewable energy, and increased regional integration with countries that have more diversified portfolios (World Bank, 2006 and 2013; Yepez-Garcia and Dana, 2012). On the other hand, the low oil prices since November 2014 threaten the balance of payments and fiscal balance of exporting countries, as well as investment in future production, especially high-cost production. Downward price volatility could also threaten investments in energy efficiency and renewable energy, unless strong policies are in place to direct markets.

2.66 Zoheir, Inderwildi, and King (2014) conclude that uncertainty created by oil price volatility will present a fundamental barrier to future sustainable economic growth worldwide, if left unchecked. They provide evidence that oil price volatility increases both inflation and unemployment and decreases economic growth, and recommend a combination of supply-side (e.g., concerted action in oil supply chain management and a facilitating framework for renewable electricity and fuels) and demand-side policies (e.g., removing subsidies and tax incentives favoring oil) to counter such volatility.

2.67 **Energy regulation**. Studies of energy sector regulation have shown that it contributes to effective sector performance, especially with respect to ensuring that prices reflect efficient costs and that companies comply with standards of performance. The results are consistent with the literature on the impact of private sector participation; they show the relevance of a regulatory agency and its governance, defined as the agency's institutional design and structure that allow it to carry out its functions as an independent regulator. The results indicate a significant improvement in utility performance through the involvement of a

regulatory agency even in the case of state owned enterprises. The highest achievements were reached with the combination of private sector participation regulated through a regulatory agency that exhibits good governance (Andres, Guasch, and Azumendi, 2008; Andres et al. 2007). Experience has shown that regulatory agencies should be formally separate from ministries, and have sufficient financial resources, preferably from sector levies. Accountability and staffing by competent professionals are essential (Fay and Morrison, 2007).

2.68 **Energy information**. Data and information on the energy sector are essential for analysis and planning, development of energy policies, and investment decisions. Availability of information on the energy sector varies by country and by subject. Areas in which data availability needs to be improved include production and use of traditional fuels for cooking, decentralized renewable energy installations, unsatisfied energy demand, energy efficiency, energy prices, and quality of energy infrastructure and services.

2.69 Studies show that an important factor affecting energy infrastructure investment by the private sector is the ease of access to information on regulations, statistics, and general government services. Particularly, valuable are well-developed e-government services, and the possibility of interacting with civil servants online allows investors to access relevant information and apply for permits and licenses in a more efficient way (Mia, Estrada, and Geiger, 2007).

III. MAIN CHALLENGES FOR THE REGION IN THE ENERGY SECTOR

3.1 With an average annual GDP growth of 3.6 percent in 2007-2014, the LAC region surpassed its GDP performance in the 1990s. However, the IMF is predicting slower growth in the medium term as a result of lower external demand for commodities and softer terms of trade as well as domestic supply-side bottlenecks and policy uncertainties. Supply-side bottlenecks include bottlenecks in infrastructure owing to long-standing underinvestment (IMF, 2014). In addition, the middle class in the region is expected to grow by more than 130 million people in the next 15-20 years (World Bank, 2012), presenting a challenge in meeting the energy demand of this population segment.

3.2 This section discusses the energy challenges in the region in relation to the main themes presented in the previous section, as well as actions required to meet those challenges. These areas will guide the work of the Bank in the region:

a. Energy access: coverage, quality, reliability, and affordability.

b. Energy sustainability: energy efficiency, renewable energy, and climate change adaptation.

c. Energy security: energy infrastructure and regional energy integration.

d. Energy governance: institutions, regulation, policies, and information.

A. Energy Access—Coverage, Reliability, and Affordability

3.3 Improving the coverage, reliability, and affordability of modern energy will be a major challenge throughout the region. Millions of people still lack electricity or suffer from poor-quality or unreliable electricity service, while many more still use traditional biomass for cooking (see Table 1).

Table 1. Access to Modern Energy in the LAC Region

Country	Electricity 2013		Non-modern Fuels 2013	
	People without access 2013 (million)	Percent with electricity 2013	People using non-modern fuels (million)	Percent cooking with modern fuels
Argentina	2.1	95	1.67	> 95
Bahamas	0.004	99	0.015	> 95
Barbados	0.001	99.5	0.011	> 95
Belize	0.023	93	0.039	88
Bolivia	1.8	82.6	3.02	71
Brazil	1.7	99.1	11.71	94
Chile	0.4	98	1.07	94
Colombia	1.7	96.5	6.82	86
Costa Rica	0.03	99.4	0.29	94
Dom. Republic	0.6	94	0.73	93
Ecuador	0.5	97	0.61	> 95
El Salvador	0.5	92.5	1.41	78
Guatemala	1.6	89.6	8.85	43
Guyana	0.2	80.4	0.054	93
Haiti	7.5	28	9.48	9
Honduras	0.9	89.2	4.12	49
Jamaica	0.2	93	0.3	89
Mexico	1.5	98.7	16.45	86
Nicaragua	1.4	76.2	3.22	46
Panama	0.3	91.1	0.66	82
Paraguay	0.1	99	3.34	51
Peru	3	90.3	10.99	64
Suriname	0.1	90.3	0.065	88
Trinidad and Tobago	0.05	96.6	0.054	>95
Uruguay	0.01	99.6	0.14	>95
Venezuela	0.1	99.7	1.23	>95
Other LAC	0.2	98.1	1.02	91
LAC	26.3	96	87.4	85

Source: IDB estimate based on OLADE data for electricity; for non-modern fuels Global Tracking Framework (GTF) 2013.

3.4 **Increasing electricity coverage**. Electricity coverage in LAC was estimated at 96 percent in 2013, with 26.3 million people lacking access, up from 88 percent in 1990. The region's urban electrification rate rose from 97 to 99 percent 1990-2012, faster than urbanization. Rural electricity coverage grew from 64 to 82 percent over the period. Seventy-five percent of the people without electricity in the region are in seven countries: Haiti (7.5 million), Peru (3.0 million), Argentina (2.1), Bolivia (1.8 million), Brazil and Colombia (1.7 million each), and Guatemala (1.6 million). Except for a few countries that have low coverage overall, most of the people without modern energy access in LAC are difficult to reach—the poor living in urban areas and cities' peripheries, or people living in highly dispersed communities in rural or isolated areas. Issues of energy access affect particularly women and children, as well as indigenous people and Afro-Caribbean populations.

3.5 The Bahamas, Barbados, Brazil, Costa Rica, Uruguay, Paraguay, and Venezuela have achieved access above 99 percent. The IEA forecasts that universal access to electricity in the region will be achieved by the mid-2020s (IEA, 2012a). Fast-moving electrification programs include those in Brazil (see Box 1 in Section II), Bolivia, Guatemala, Honduras, Paraguay, and Peru, all with increases of more than 30 percent in coverage from 1990 to 2013. However, once countries achieve about 95 percent in coverage, reaching the remaining, more remote households becomes difficult, costly and slow.

3.6 Increasing access requires extending the interconnected grid where possible while using isolated grids and off-grid technologies, often based on renewable energy, for remote areas or dispersed populations. Renewable energy technologies such as mini-grids that use hydro, wind, or hybrid systems, and individual systems using solar PV or wind are technically well proven. However, their delivery mechanisms are not as well established or regulated as the distribution companies that deliver electricity from the grid.

3.7 Establishing reliable delivery mechanisms for isolated grid and off-grid service will be an essential part of achieving universal access in LAC. Additionally, universal access plans with detailed time schedules and required investments will be required to reach universal access by 2030, as established in SE4All and the SDG. The IDB set a financing target of US$5 billion for 2012–2016 to support the pillars of SE4All and serves as the Regional Hub for the initiative in the region, in coordination with regional partners.[15]

3.8 **Increasing access to modern fuels for cooking**. While the share of the region's population with access to modern cooking fuels, such as kerosene, Liquefied Petroleum Gas (LPG), natural gas, and electricity, rose from 73 percent in 1990 to 85 percent in 2013, the challenge remains to provide modern cooking fuels to the 87 million people in LAC that still cook with traditional solid fuels such as wood and charcoal (see Table 1). The difficulties in penetration and adoption of clean and efficient cook stoves include a lack of awareness of consumers and slow behavioral changes. Argentina, Bahamas, Barbados, Ecuador, Trinidad and

[15] The IDB helped the UN launch SE4All in the region with a regional conference in 2014. Regional partners include UNDP and ECLAC

Tobago, Venezuela, and Uruguay have reached 95 percent coverage. In contrast, the challenge remains particularly significant in Haiti, where coverage is 9 percent, and in Guatemala, Nicaragua, and Honduras, where it is less than 50 percent. Six countries account for 80 percent of the people using traditional fuels in the region: Mexico (16.5 million), Brazil (11.7 million), Peru (11 million), Haiti and Guatemala (9 million each), and Colombia (6.8 million).

3.9 Brazil is one country that succeeded in increasing access to LPG for cooking from 18 percent in the 1960s to 94 percent in 2012, by creating a national infrastructure for distribution of LPG and a retail market with private entrepreneurs, as well as providing subsidies, first through LPG subsidies to households, then a specific subsidy targeting the poor as part of a broader social program (Halff, Sovacool and Rozhon, 2014).

B. Energy Sustainability–Energy Efficiency, Renewable Energy, and Climate Change

3.10 As part of the major transformation happening worldwide, countries throughout the region face the challenge of increasing environmental sustainability of energy systems, including reducing emissions of carbon and local pollutants. The main measures to improve sustainability are promotion of energy efficiency, renewable energy, and supporting technologies such as smart grids.

3.11 Achieving sustainable energy systems requires changing long-standing patterns of energy use and production. The IEA estimated cumulative energy investments for the region to 2035 based on the New Policies Scenario and the 2 degree Celsius scenario that emphasizes environmental sustainability (see Table 2 below). While the total investments for the two scenarios are similar at US$4 trillion, energy efficiency and renewable account for 36 percent of energy investments in the 2 degree Celsius scenario compared to 20 percent in the New Policies Scenario. Achieving such a substantial shift in investment in 20 years will require sustained efforts by government, industry, and consumers.

Table 2. Cumulative Energy Investments in the LAC Region, 2014–2035 (US$ billion)

	New Policies Scenario	2 degree Celsius Scenario	Average/yr New Policies Scenario 2014-2035	Average/yr 2 degree C Scenario 2014-2035	Historical average/yr 2000-2013
Energy efficiency	315	837	15	40	n.a.
Oil	2150	1709	102	81	42
Gas	537	435	26	21	13
Coal	36	23	2	1	1
Power	921	909	44	43	23
• Fossil fuels	69	38	3	2	2
• Nuclear	20	26	1	1	0
• Renewables	396	472	19	22	11
T+D	436	372	21	18	9
Biofuels	105	182	5	9	2
Total	**4064**	**4095**	**194**	**195**	**81**

Source: IEA (2014e).

3.12 **Increasing the efficiency of energy use.** The IEA forecasts that total primary energy demand in LAC in 2035 could be reduced by 4 percent in the New Policy Scenario from previous forecasts, and reduced further by 18 percent in the 2 degree Celsius Scenario through energy efficiency (IEA, 2013d). The investments needed were estimated to be US$315 billion cumulatively to 2035 in the New Policies Scenario; about 8 percent of total energy investments (see Table 2). To contribute to limiting the global temperature rise to 2 degree Celsius, energy efficiency investments in LAC would need to almost triple, to US$837 billion, which amounts to over 20 percent of sector investment (IEA, 2014e). Mobilizing this level of investment will be a significant challenge for the region, especially because energy efficiency investments must be made by a multitude of users of energy rather than by large-scale energy suppliers.

3.13 Brazil, Chile, and Mexico have effective energy efficiency programs that include institutional frameworks, financing and performance indicators (see Box 2). However, while some countries are making progress, ECLAC's assessment of programs in 26 LAC countries concluded that barriers remain to be addressed in many countries. These barriers include: (i) lack of continuity of the institutions involved in energy efficiency; (ii) insufficient knowledge in all sectors about energy efficiency; (iii) inadequate regulations to encourage energy efficiency; (iv) in some countries, energy prices that are too low to reflect costs; (v) reluctance of lending institutions to finance energy efficiency projects, resulting in high interest rates and/or more stringent requirements; (vi) the energy services company (ESCO) market is not yet fully established; and (vii) with the exception of Mexico and Brazil, countries have not developed indicators and monitoring systems that measure the concrete results of programs (ECLAC, 2013).

Box 2. Energy Efficiency Programs in Brazil, Mexico, and Chile

- Brazil's program aims to reduce electricity consumption by 10 percent by 2030. It includes a national energy conservation label for buildings, a mandatory appliance-labeling program, and vehicle efficiency standards, as well as efficient public transportation (IPEEC, 2012).
- Mexico's program includes funding for research, development, and deployment; a training program for specialists in electricity efficiency; replacement of old refrigerators and air conditioners; efficient lighting and thermal insulation of homes; a voluntary appliance labeling program and an efficient public transit system, as well as standards for efficient vehicles (Mexico SENER, 2014).
- Chile aims to reduce energy consumption by 12 percent by 2020 through a program targeting industry (cogeneration, voluntary accords, ESCOs), transport, appliance labeling, and lighting efficiency, among other actions (Chile Ministry of Energy, 2014).

3.14 **Increasing the role of renewable energy**. The second element required to increase the environmental sustainability of the region's energy systems is to increase the share of renewable energy in meeting growing energy demand. The IEA forecasts that the share of renewable energy in primary energy demand in LAC would increase from 30 percent in 2011 to 34 percent by 2035 in the New Policy Scenario (11 percent hydro, 20 percent bioenergy, and 3 percent other), and 44 percent in the 2 degree Celsius Scenario (13 percent hydro, 26 percent bioenergy, and 5 percent other).

3.15 LAC's renewable energy potential vastly exceeds demand; the region could produce 78,000 terawatt-hours (TWh) from hydropower and unconventional renewable energy (e.g., solar, wind, geothermal, biomass, and marine) compared to generation of 1100 TWh in 2011 (Vergara et al., 2013). However, a significant increase in the role of renewable energy will require that countries develop appropriate and effective policy frameworks, regulations, and incentives.

3.16 Hydropower plays an unusually large role in LAC, accounting for 10 percent of primary energy demand and 64 percent of electricity in 2011, compared to 2 and 16 percent globally (IEA, 2013d). The IEA forecasts that hydropower will continue to predominate in generation in LAC over the next 20 years, requiring cumulative investment of US$258 billion in the New Policies Scenario and US$276 billion in the 2 degree Celsius Scenario. Annual investments would be about 50 percent higher than the historical level.

3.17 Latin America and the Caribbean has ample hydropower resources, 25 percent of which have been developed (IEA, 2012). An estimated 35 gigawatt (GW) of hydropower was under development in LAC in 2013, 23 GW in Brazil, compared to 169 GW installed (International Hydropower Association, 2013). The predominance of hydropower creates challenges. Variability in hydropower production has resulted in power outages and driven increasing markets for natural gas and LPG (McCracken, 2014). This variability is likely to increase with climate change and more competition for water among sectors and countries (in international basins).

3.18 Affected communities and environmental groups increasingly oppose large-scale hydropower reservoirs since they require moving populations and affect ecosystems and land use as well as the flow and quality of water downstream (Mekonnen and Hoekstra, 2012). Development of future projects will require continually advancing sustainability guidelines and criteria, innovative planning based on stakeholder consultation and equitable benefit sharing with local communities.

3.19 Unconventional renewable energy (wind, solar, geothermal, biomass, biofuels, small-scale hydropower, and marine) has increased significantly in LAC in recent years due to its many benefits. An IDB study estimated the societal benefits from renewable energy in the region, over and above those normally considered in financial calculations, at US$14.7 cents per kilowatt-hour (kWh) without climate impacts and US$28.5 cents per kWh, including avoided climate impacts (Vergara et al., 2014). New and renewable energy resources are broadly distributed, including on many Caribbean islands.

3.20 Many LAC countries have taken action to increase the share of renewable energy in the energy supply mix. By early 2014, 19 LAC countries had renewable energy policies and 14 had targets for electricity generation (see Table 3). However, policies and targets are not enough; many barriers to adoption of renewable energy need to be removed to ensure that targets are actually met.

Table 3. Renewable Energy Targets for Electricity Generation in LAC

Country	Target of generation	2012% renewables	Country	Target of generation	2012% renewables
Argentina	8% b, 2016	2%	Guyana*	90%, no date	n.a.
Bahamas	15%, 2020; 30%, 2030	n.a.	Honduras*	60%, 2022; 80%, 2038	44%
Barbados	29%, 2029	0%	Jamaica	15% by 2020	5%
Belize	50%, no date	n.a.	Mexico*	35% by 2026	15%
Brazil	19.3 GW biomass, 8.8 GW small hydro, 15.6 GW wind by 2021	n.a.	Nicaragua*	74% by 2018, 90% by 2020	43%
Chile*	20%, 2025	38%	St Kitts and Nevis	20% by 2015	0.4%
Costa Rica*	100%, 2021	92%	St Lucia	5% by 2013, 15% by 2015, 30% by 2030	n.a.
Dominica	14%, no date	n.a.	St Vincent and the Grenadines	30% by 2015, 60% by 2020	17%
Dominican Republic	25%, 2025	14%	Uruguay*	90% by 2015 including 1GW wind	60%
Guatemala*	80%, 2027	64%			

* Includes conventional hydro. Sources: REN21 2014 and U.S. Energy Information Administration 2014.

3.21 Some countries are achieving notable results. Uruguay generated 96 percent of its electricity from renewables in 2014 using integrated dispatch where wind is baseload and hydropower follows its variations (Rodo, 2015). Wind power has experienced the fastest growth in the region, with Brazil adding 2.4 GW, Mexico 522 MW, Chile 506 MW, and Argentina 53 MW in 2014. Mexico and Central America lead in geothermal capacity, with 1 GW and 500 MW respectively (REN21, 2014). Solar PV, while important in off-grid and rural areas, has experienced a shift in focus from small domestic applications to large-scale power plants, including in Chile and Mexico (REN21, 2013).

3.22 Unconventional renewable energy is increasingly competitive for electricity generation in LAC, even without support mechanisms. In Brazil, wind projects won contracts in nine general auctions by pricing below coal and natural gas projects, reflecting favorable conditions including good wind regimes, efficient planning procedures with little opposition and backup from hydro storage (Cunha, 2012). In many Caribbean countries, renewable generation can compete with fossil fuels for high priced non-baseload power. In Mexico, wind projects in Oaxaca are competitive with natural gas and are a useful alternative for large consumers (IDB Multilateral Investment Fund, Bloomberg New Energy Finance, and UK Department for International Development, 2014).

3.23 Eleven LAC countries have mandated the use of biofuels in transportation,[16] including the world's second largest producer, Brazil, where biofuels account for 13 percent of transportation fuels. Argentina was the fifth largest biofuel producer

[16] Argentina, Brazil, Colombia, Costa Rica, Ecuador, Guatemala, Jamaica, Panama, Paraguay, Peru, and Uruguay.

while Colombia was the thirteenth. Solar thermal collectors are spreading beyond Brazil, one of the world's top markets. Chile's mining sector is installing solar thermal systems (parabolic trough and flat plate collectors) to meet heat energy needs in remote locations.

3.24 The MIF's Climatescope ranked 55 important developing countries ability to attract clean energy investments based on four parameters: enabling frameworks, finance and investment, value chains and GHG management activities. Nine LAC countries were in the top 20 including Brazil (2 after China), Chile (5), Uruguay (6), Mexico (8), Peru (11), Costa Rica (12), Nicaragua (14), Colombia (16), and Argentina (20). The top five countries listed attracted 90 percent of LAC's clean energy investment of US$14 billion. From 2006 to 2013, the region attracted US$93 billion for new investments in unconventional renewables. These investments provided about 6 percent of the energy produced in 2013 (IDB Multilateral Investment Fund, Bloomberg New Energy Finance, and UK Department for International Development, 2014).

3.25 Local renewable energy development is a high priority in Caribbean nations since they are vulnerable to oil price volatility, but they face difficulties due to the small size of their markets. Many Caribbean islands are aiming to derive 15 to 30 percent of their electricity from renewable energy by 2020–2029. A study of renewable energy in island states identified particular needs to foster renewables: institution building and training to create specialized skills, technology transfer and removal of import duties on technologies, and aggregation of projects to develop ownership between islands (Cottrell, Fortier and Schlegelmilch, 2015).

3.26 Biofuels have specific challenges, including the need to harmonize standards among countries, adapt existing and future vehicles to blends, and develop manufacturing, import, and export of flex fuel cars and biofuel technologies (CAF, 2013; Flavin et al., 2014). Additionally, biofuels face challenges related to land use and competition with food production, water use, and land use changes. Further developments in more advanced biofuels such as ligno-cellulosic biomass, waste, or non-food feedstocks could address the competition with food production (OECD/FAO, 2014).

3.27 **Smart grids**. The increasing role of energy efficiency and renewables will increase variability and/or dispersion of generation, requiring that smart grids be deployed in the region to enable the grid to maintain stability and reliability. Chile is developing distributed generation, net metering, and smart grid technologies. Brazil is also moving on smart grids, including the Cidade Inteligente Buzios Project, which will serve 10,400 customers and aims to make the city a model of energy efficiency. Panama is studying the legislative, regulatory, and operational actions needed to adopt smart grids (De Nigris and Coviello, 2012).[17] Adopting smart grids will require significant change in policy and regulatory frameworks as well as the commercial operations of electricity distribution companies and the behavior of customers.

[17] For a survey of the initiatives in the region, see Lee, Paredes, and Lee (2012).

3.28 **Ensuring climate change adaptation.** Particular attention is needed in LAC to mainstream climate adaptation to ensure quality and reliability of energy supply in the face of growing impacts of climate change. Energy infrastructure will be affected by the recession of glaciers in the tropical Andes, increased flooding of coastal zones, destabilization of the hydrological cycle in major basins, variability in availability of water for thermal generation plants cooling, and intensification of extreme weather events. Some of these changes will affect hydrology and therefore hydropower generation; others will increase risks of damage to energy facilities in areas subject to flooding, extreme weather events, sea level rise, and coastal erosion (Vergara et al., 2013). Caribbean countries and coastal areas less than 10 meters above sea level are particularly vulnerable to these impacts (ECLAC, 2012).

C. Energy Security—Quality of Service Delivered, Energy Infrastructure and Regional Energy Integration

3.29 Ensuring a secure supply of sustainable energy to reliably meet energy demand will be one of the greatest challenges for the region. This is a particularly difficult task given significant shifts in technology combined with a commitment to universal access and sustained if moderate economic growth. Four areas will be particularly important to the region's energy security: (i) improving electricity quality and reducing losses; (ii) developing natural gas production and transportation systems; (iii) greater regional energy integration; and (iv) increasing energy infrastructure investments and their efficiency.

3.30 **Improving electricity quality and reducing losses.** Improving the quality and reliability of electricity is an important task that must be achieved in many LAC countries to improve competitiveness. The 2014-15 World Competitiveness Report evaluated service quality through a survey of executives who rated electricity interruptions and voltage fluctuations. Measured on a scale of 1 to 7 (with 7 being very reliable), the LAC weighted average rating was 4.2 compared to the OECD average of 6.2 (see Table 4). Quality problems are widespread in the region, with 15 out of 23 countries rated less than 5, including major economies. Since these ratings reflect the opinions of executives, quality is likely worse in rural areas.

Table 4. Electricity Quality Ratings LAC Countries 2014

Country	Rating	Country	Rating
Barbados	6.3	Brazil	4.1
Uruguay	5.7	Nicaragua	3.9
Costa Rica	5.6	Bolivia	3.9
Guatemala	5.4	Honduras	3.6
Trinidad and Tobago	5.4	Suriname	3.4
Chile	5.4	Paraguay	3.2
Colombia	5.1	Guyana	2.7
El Salvador	4.9	Argentina	2.6
Panama	4.9	Dominican Republic	2.4
Peru	4.9	Haiti	1.9
Mexico	4.6	Venezuela	1.7
Jamaica	4.4	**Average**	**4.2**

Source: WEF 2014, Global Competitiveness Report 2014–2015.

3.31 Reducing high levels of electricity losses to improve the efficiency and sustainability of the electricity sector will be an additional challenge in many countries. Electricity losses in LAC averaged around 17 percent between 2007 and 2011, almost triple the OECD average of 6 percent. Eleven countries have losses above this average (see Table 5). After allowing for technical losses, this ratio translates into 100 TWh lost in 2012, representing revenue lost to the sector of US$11-17 billion. In spite of their economic and environmental importance, there have been no reductions in the regional ratio over the last three decades, and that private utilities tend to have lower distribution losses (Jiménez, Serebrisky, and Mercado, 2014).

3.32 Improving electricity quality and reducing losses in a number of LAC countries requires improved corporate utility governance, together with investments in transmission and distribution systems, including introduction of advanced metering systems, as well as improvements in commercial systems and maintenance. In countries with significant non-payment and theft, creating a culture of payment is crucial to reinforce these advancements.

Table 5. Electricity Losses in Transmission and Distribution in LAC (in percent)

Country	% loss T&D	Country	% loss T&D
Argentina	15[b]	Guyana	32[c]
Bahamas	12[c]	Haiti	60[d]
Barbados	6[b]	Honduras	32[b]
Belize	12[b]	Jamaica	26[b]
Bolivia	14[c]	Mexico	16[c]
Brazil	15[b]	Nicaragua	21[a]
Chile	7[d]	Panama	12[b]
Colombia	20[c]	Paraguay	27[b]
Costa Rica	12[b]	Peru	7[b]
Dominican Republic	32[a]	Suriname	8[c]
Ecuador	16[a]	Trinidad and Tobago	5[c]
El Salvador	12[b]	Uruguay	19[b]
Guatemala	13[b]	Venezuela	33[c]
LAC average (exclude Haiti)		**17**	
OECD average		**6**	

Notes: Letters correspond to latest available year: (a) 2014; (b) 2013; (c) 2012; (d) 2011
Sources: ENE calculations based on information from government agencies, ECLAC and EIA.

3.33 **Developing natural gas production and transportation**. Meeting the rapidly increasing demand for gas in the region, especially for power generation, will be a further supply-side challenge. Natural gas use increased from 18 to 26 percent of LAC's primary energy demand between 1990 and 2012, almost four times the global increase of 22 to 24 percent (CAF, 2012). The region faces the challenge of utilizing its natural gas resources as a transition towards sustainable energy while contributing to meeting the global 2-degree scenario.

3.34 Venezuela accounts for 70 percent of LAC's conventional gas reserves, followed by Brazil, Argentina, Trinidad-Tobago, and Peru, each with about 5 percent. Conventional gas reserves increased by 10 percent in the last ten years while production increased at twice that rate, resulting in a declining

reserves/production ratio (US Energy Information Administration, 2014). However, LAC, with only 4 percent of the world's conventional gas reserves, accounts for 22 percent of shale gas resources shared among Argentina at 11 percent, Mexico at 8 percent, and Brazil at 3 percent (EIA, 2014). While promising, development of the region's high cost shale resources constitutes a difficult task. Potential investors will consider gas-pricing regimes, regulations and the rule of law, access to technology and capital, and infrastructure. There are also environmental concerns, particularly with aquifer contamination from hydraulic fracturing using additives (Perkins, 2012).

3.35 Gas demand is expected to continue to increase in LAC, with the IEA forecasting 237 million tons of oil equivalent (Mtoe) in 2035 in the New Policies Scenario and 170 Mtoe in the 2 degree Celsius scenario compared to 129 Mtoe in 2011 (IEA, 2013d). Natural gas demand for electricity generation is lower in the 2 degree Celsius scenario because of energy efficiency and renewable generation.

3.36 IEA estimates that investments required for natural gas development in LAC for the next 20 years would range from US$537 billion in the New Policies Scenario to US$435 billion in the 2 degree Celsius Scenario. Expansion of gas markets will require additional domestic transportation capacity in countries like Mexico, regional gas pipelines to connect importing and exporting countries, and/or LNG terminals for gas in countries like Chile, Colombia, and Uruguay and in Central America. Since 2008, inter-country gas trade in LAC has developed mainly in the form of LNG rather than physical pipelines, a higher-cost option. LNG imports in Latin America increased by nearly 50 percent in 2012 alone.

3.37 **Greater regional energy integration**. LAC could realize substantial potential benefits by increasing regional energy integration, including lower energy prices, increased system reliability and improved competitiveness (WEC, 2008). Such integration could take advantage of the region's rich but unequally distributed resources, especially hydropower and natural gas. Energy security could be strengthened through diversification of the energy mix, including sourcing of supplies through regional pipelines or transmission lines. The potential for regional integration, applies mainly to natural gas pipelines, liquefied natural gas (LNG) facilities and electricity networks.

3.38 Significant efforts have been made toward regional energy integration with promising results. One notable example, supported by the IDB, is the Central American Electrical Interconnection System (SIEPAC) connecting Guatemala, El Salvador, Honduras, Costa Rica, Nicaragua, and Panama. SIEPAC has two parts: (i) a regional electricity market based on a standard set of rules, a regional regulator, and a transmission operator; and (ii) an 1800 km transmission line. Begun in 1987, SIEPAC entered into operation in 2013. Issues related to long-term transmission rights and guarantees of capacity are still being resolved, limiting transactions (Zarnikau et al., 2013). Other initiatives, such as the US$1.5 billion, five-project Andean Countries Interconnection (SINEA) that would connect Colombia with Chile through Ecuador and Peru, are being sponsored by the IDB.

3.39 Many other opportunities for regional integration have been identified. For example, the IDB has been supporting studies for interconnection between

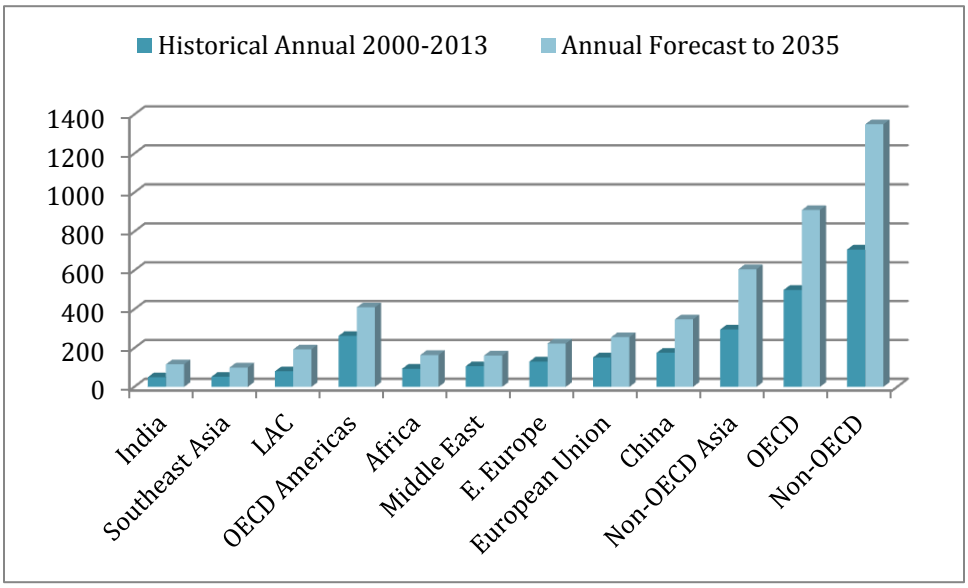
Panama and Colombia, between continental Caribbean countries and Brazil, and between Belize and neighboring countries. CAF studied 12 electricity interconnection projects, totaling 10,000 km of new power lines, 6,500 MW of capacity, and investment costs around US$5 billion. It concluded that 10 projects were economically viable, resulting in profits of US$1.5 billion and savings of more than 4 million tons of carbon dioxide (CO2) per year (CAF, 2012). However, one difficulty with regional integration in LAC is that, unlike in the EU, there is no single regional organization to coordinate energy development, but rather various initiatives. Other opportunities for regional integration exist in the Caribbean, which may help to reduce the cost of energy. For example, if a positive resource is identified and exploited, geothermal energy in the Eastern Caribbean may provide more than sufficient energy to the country with the resource that may allow it to export the energy to nearby island states through undersea cables. Opportunities for energy regional integration also exist with natural gas if countries are able to aggregate demand. Liquefied natural gas is being explored in Jamaica, for example, and this country or another in the region may serve as a regional hub for distribution of this fuel that may contribute toward the diversification of the energy matrix of the Caribbean region.

3.40 The most important requirements for increased regional energy integration include: (i) long-term availability of electricity and gas from exporting countries in excess of domestic needs; (ii) harmonization of the regulatory regimes of electricity and natural gas among countries; (iii) a regional accord to guarantee that energy supplies channeled through pipelines and transmission lines will not be arbitrarily cut, similar to that of the EU; (iv) stable energy policies and regulations that encourage both public and private investment; and (v) long-term commitment to integration projects that extends beyond the life of particular governments (Arriagada, 2010; CAF 2012).

3.41 **Increasing energy infrastructure investments and their efficiency**. A major challenge for the region will be to increase both the amount and the efficiency of investment in energy infrastructure, to meet growing demand as well as improve quality. The IEA forecasts cumulative investments in LAC's energy sector over the next 20 years of about US$4 trillion in both key scenarios (see Table 2). Examining IEA's global investment forecast in terms of annual average investments by regions, it is notable that LAC has the highest increase over historical levels, of 140 percent (see Figure 3).

3.42 This need for LAC to increase energy investment more than other regions is in line with studies that show that LAC has historically underinvested in infrastructure, including energy infrastructure, in comparison to its needs and to expenditures in other regions (CAF, 2013a; Calderon and Serven, 2010; Fay and Morrison, 2007).

Figure 3. Average Annual Energy Investments in Selected Regions, Historical and Forecast (US$ billion)



Source: IDB based on data in IEA (2014e).

3.43 Making investments more efficiently would reduce the amounts needed. The McKinsey Global Institute concluded in a recent study that infrastructure investments could be cut by 40 percent through measures including improving project selection and optimizing infrastructure portfolios; streamlining project delivery including speeding up approvals and land acquisition; investing in early stage project planning and design; and making the most of infrastructure assets through improved maintenance and demand-side management (McKinsey Global Institute, 2013).

3.44 The public sector will likely continue to be responsible for significant financing since it remains an important actor in the energy sector in several LAC countries (Balza, Jiménez, and Mercado Díaz, 2013). A study that analyzed the efficiency of public infrastructure spending in seven Latin American countries found substantial scope to improve the efficiency of government expenditure on infrastructure if the best practices of the most efficient countries were universally adopted (Clements, Faircloth, and Verhoeven, 2007). When public financing is provided indirectly, for example by working closely with financial agents, adequate provisions to ensure close collaboration with energy authorities responsible for planning and regulation are an imperative to ensure efficiency.

3.45 In a study of 10 countries in the region, CAF estimated the average percentage of GDP invested in energy infrastructure per year was 0.7 percent between 2008 and 2011, excluding petroleum production and refining, varying from 0.5–1.0 percent. Of total energy investments, 30 percent were by the public and 70 percent by the private sector. The share of private sector investment in countries ranged from 17 to 100 percent; the average for 10 countries increased from 60 percent in 2008 to 71 percent in 2011 (CAF, 2013).

3.46 Private sector participation will continue to be key to the sector to incorporate new technologies and operating arrangements, as well as improvements in

management and execution of projects, and to reduce the financial burden on government budgets (Yepez-Garcia, Johnson, and Andres 2011). Capital-intensive projects, like large hydroelectric, geothermal and gas projects, often benefit from a public–private partnership (PPP) that helps manage risks: the private partner brings management and technical skills and secures funding while the public partner secures timely licenses and permits, facilitates environmental mitigation and social benefit plans, and provides guarantees and other forms of credit enhancement to reduce project, market, and country risks (Byer, Crousillat, and Dussan, 2009). There are, in fact, portfolio approaches and PPP arrangements for sharing risk and encouraging investment. When upfront investment requirements are high and the public sector alone has limited fiscal and institutional capacity (including borrowing limitations) and the private sector is not willing to enter the project alone given associated risks (including regulatory uncertainty in some cases), PPP arrangements[18] can address the challenge.

3.47 According to Table 2, the size of the clean energy market in the region is estimated to be US$0.8 to US$1.5 trillion over the next 20 years. Therefore, new business opportunities will arise as firms in the region adopt more energy-efficient production and embrace energy generation technologies that are appropriate to their scale and needs.

D. Energy Governance—Institutions, Policies, Regulation, and Sector Information

3.48 While the situation varies from one country to another, strengthening governance will be a major and essential task for LAC countries in this time of sector transformation. This includes strengthening institutions, developing long-term policies and plans, building regulatory capacity, and improving sector information and analysis.

3.49 **Strengthening institutions**. Latin America's energy challenge over the next two decades is not lack of resources, but rather strengthening institutions (Tissot, 2012). Although reliance on market forces produce optimal allocation of scarce resources and would be preferred, strong competition is lacking in many countries in the region, particularly in small, isolated, lower income or island-states. Therefore, energy markets need to be complemented with administrative tools to allocate incentives and manage risks in the most effective way. While energy provision and delivery is organized through energy markets and regulated only to the extent needed (that is, avoiding excessive regulatory burdens), strong energy institutions are essential for developing and implementing energy plans and policies and regulations, ensuring effective operation of the sector and its infrastructure, and encouraging investment.

[18] The arrangements include Special Purpose Vehicles that may be led by a government or by the private sector. In the case of geothermal there are grants or loans that can be provided to developers for exploratory drilling, and which are repaid if drilling is successful (the IDB is currently preparing an operation in the Eastern Caribbean that proposes to use these mechanisms to address the risks associated with financing geothermal projects - RG-L1071, associated with RG-G1009 and RG-G1004).

3.50 To varying degrees, LAC countries need to build capacity in ministries, regulators, and local governments. Ministries must be able to develop sector policy and shape and oversee the legal, financial, and technical aspects of the sector as well as concessions and contracts, including risk management. Regional and municipal authorities also need strengthening, as they control a growing share of infrastructure as a result of decentralization. The importance of strong public institutions has only increased with the growth of public–private partnerships, due to the more extensive conditions and obligations involved (Fay and Morrison, 2007). The IDB has supported the LAC region with technical and financial assistance to improve the corporate governance of public companies, such as in the case of Honduras where there have been substantive energy sector reforms, including revisions to subsidies; and in the case of Colombia's *Empresas Públicas de Medellín*, where IDB financing included corporate governance support and collaboration in areas such as transparency, international standards, and external auditing, which are necessary for the services the company now provides internationally.

3.51 **Developing long-term energy policies and plans**. To meet all of the sector development challenges outlined above, long-term, predictable, and transparent energy policies must be developed and implemented in those countries that do not yet have such policies. Energy policies must define objectives as well as specific mechanisms designed to achieve them, all within short, medium, and long timeframes. Policies are most effective when developed through a process of consultation with stakeholders.

3.52 Another significant challenge will be to reform pricing policies in countries with untargeted energy subsidies and to replace them with explicit, well targeted, and sustainable subsidies for poor and marginalized populations. The IMF estimated that energy subsidies in LAC amounted to about 1.8 percent of GDP in 2011-2013, with fuel subsidies representing 1 percent of GDP, and electricity subsidies about 0.8 percent. Including forgone tax revenue and the cost of negative externalities would bring the region's energy subsidy bill to about 3.8 percent of GDP. The study shows variation in the size and types of energy subsidies across the region. Subsidies are larger in energy-rich countries and in those that rank lower on measures of institutional and policy quality, such as budget transparency, competitiveness, and the ease of doing business (Di Bella et al., 2015).

3.53 Long-term energy plans need to be developed by those countries that do not have them. They provide road maps for realizing energy policies and making decisions on major energy infrastructure investments. The trend in LAC has been for governments to contract major energy infrastructure through the private sector or public–private financing or to make such investments directly through public-sector entities. In most cases, the decision to develop major infrastructure is made directly or indirectly by the state through a planning process or the application of specific rules that determine future needs (CAF, 2013a). Such planning will become increasingly complex as energy efficiency and renewable energy are incorporated into the process.

3.54 **Building regulatory capacity**. Another necessary task in the region is to develop strong, independent regulators that operate under clear laws and

regulations in countries where such regulators are not yet established. This will be key to mobilize investments, especially private sector investment, as well as achieving policy goals such as affordable and sustainable energy supply. Effective and predictable regulation by an independent regulator is an important determinant of sector performance as well as sector investments. Reducing regulatory uncertainty is necessary to lower the cost of capital and increase returns, leading to more projects by the private sector.

3.55 **Improving sector information.** Data and energy sector analysis in LAC must be improved to provide a sound basis for energy policy and planning and regulatory decisions as well as corporate decisions in the region. Analysis of the effectiveness and impact of energy policies and programs needs to improve. Existing sector studies have focused mainly on sector forecasts and planning, project engineering, or planning aspects, rather than the impact of interventions on development. In LAC, this situation is aggravated by the lack of systematic and reliable data collection in the sector, especially in the Caribbean. The IDB will concentrate part of its efforts on improving the availability of results evaluation.

3.56 The region must also strengthen data generation and collection mechanisms (with disaggregated information, for example on income and gender). Although significant efforts have been made by organizations such as the IDB, ECLAC, OLADE, and the EIA to generate the relevant data for energy supply and prices, challenges remain in obtaining standardized, comparable, and easily available data in key areas. Data are inadequate on quality of energy, energy prices, energy demand by sector, traditional and decentralized renewable energy, and energy efficiency investments and results.

IV. LESSONS FROM THE BANK'S EXPERIENCE IN THE SECTOR

4.1 The IDB has been assisting countries in the formulation and implementation of policies, regulations and infrastructure projects in the energy sector that are sustainable in all its dimensions for more than 50 years. The Bank has ample experience gathered in multiple countries, conditions, different technologies and in most realms of the energy sector, either with sovereign and non-sovereign loans, technical assistance, grants and technical support. The extensive presence of the Bank in the field, the diversity of backgrounds of its members, and the complementation of other sectors such climate change adaptation and mitigation and environmental and social safeguards, guarantee an excellent performance of the activities in which the Bank participates. This section reflects the lessons learned, the advantages and the areas that need to be strengthened to continue successfully supporting our member countries.

A. Lessons Learned from Project Completion Reports (PCR)

4.2 To identify lessons learned from energy operations funded by the IDB, 23 projects were analyzed from the public and private sector, both fully disbursed and in an advanced stage of implementation (disbursements over 70 percent). The sample was representative of all areas where the IDB is involved in the energy sector. This exercise included a review of PCR, monitoring reports, and

loan proposals approved by the Board, as well as interviews with team leaders and members of these projects. The following are the main lessons obtained (see also specific lessons from the SIEPAC, ICE and Reventazón Projects in Box 3, below).

4.3 **Political commitment from the government for reform operations**. Energy operations, especially reform operations, have high implementation risk if they lack political support from the government. Commitment is achieved through ongoing dialogue with authorities throughout project implementation, not only during the preparation phase.

4.4 **Environmental and social management**. Environmental and social safeguards, impact studies, and plans for environmental and social management must be an integral part of the project for effective execution to meet program objectives. Factors that strengthen environmental and social management of projects are: (i) incorporation of environmental and social sustainability criteria at the project planning stage (i.e., through an optimization process); (ii) internal coordination of the executing agency during project construction and operation; (iii) independent environmental and social audits to assess compliance with commitments agreed with the IDB and the national environmental authority; (iv) environmental and social supervision missions, with the support of the IDB; (v) specialized support to monitor sensitive processes such as involuntary resettlement plans; and (vi) realistic timelines and budgets for implementation of environmental and social plans and programs.

4.5 **Institutional capacity.** During project preparation, it is necessary to assess the capabilities and resources of the executing agency and other institutions (in some cases, subnational governments) involved in the project. The commitment from the borrower to provide local counterpart resources, in the required amounts and on time, should be evaluated. Current instruments for analysis of institutional capacity, such as SECI, focus on procurement and financial fiduciary issues. It is necessary to update the analytical tools to assess the technical capacity and availability of resources to ensure implementation. The analysis would allow the development of plans for technical and organizational strengthening. In this context, one project reported institutional and managerial improvement of public enterprises by implementing corporate governance practices.

4.6 **Coordination with co-financiers**. The IDB co-financed several operations with other financiers, multilateral agencies, and private banks. Some operations do not have formal coordination mechanisms among financiers. Agreements or memoranda of understanding are needed that establish minimum coordination mechanisms, monitoring arrangements, and provision of resources. Coordination during all phases of the operations is fundamental for effective execution and fulfillment of program objectives.

4.7 **Lead Executing Agency**. Operations that include two or more co-executors usually experience delays in implementation. When there is more than one executor, one of them should assume the role of leader and become the interlocutor with the IDB.

4.8 **Slow start of execution**. The first year of implementation is usually slow in terms of disbursements and progress. One operation reported that the lack of prior planning, such as environmental impact analysis, surveying, and land and easements acquisitions, generated delays in meeting implementation deadlines. This highlights the need for: (i) detailed and conservative planning for implementation, with emphasis on the first year; (ii) goals that are explicitly agreed upon between the IDB and the executing agency; and (iii) initiation of activities (e.g., procurement processes) during preparation, especially before the declaration of eligibility. This requires greater dedication to planning and developing activities focused on implementation during the project's preparation and design phases.

4.9 **Amount and volume of tenders**. Executing agencies often use multiple procurement processes for small amounts to promote the participation of local companies, resulting in inefficiencies in terms of cost and time. Consolidating acquisitions in large tenders creates economies of scale and minimizes the execution and supervision costs. Additional effort is required to encourage local businesses to become more competitive and better able to participate in larger processes.

4.10 Several IDB lending programs included projections for loss reductions and financial health recovery of the public utilities that have failed to materialize after the projects ended. Lack of revenues (due to insufficient tariffs, excessive costs, political restrictions, or their combination) have not allows allowed utilities to continue investment programs initialized by IBD projects.

4.11 In the area of subsidies, for the last decade, many countries not only have failed to focalize subsidies on the populations or regions needing them the most, or during times of crisis, but have expanded generalized subsidies and allowed them to become permanent, long after the original motivation for setting the subsidy disappeared, at the expense of the countries' treasuries, and also at the expense of the financial conditions of the utilities themselves. Lack of revenues due to low tariffs, for example, reduce spending in maintenance and prevents utilities from investing in necessary replacement of equipment when it has reached the end of its useful life. This inability to recover costs also prevents upgrades equipment to better or more efficient technologies and investments in expanding coverage.

4.12 Other countries, although having significant potential renewable energy resources have failed to diversify the energy matrix to incorporate non-conventional renewable energy. More needs to be done to remove barriers to renewable energy, such as fuel surcharges, transmission infrastructure, or system technology upgrades to incorporate intermittent energy sources, such as wind and solar.

4.13 Another area where the policy dialog could be strengthened is energy efficiency. As mentioned above, EE is the most economical, has the largest environmental positive impact, and could be the easiest to implement. However, it might not be the most attractive to implement from the utilities point of view and therefore face restrictions, which with government support and incentives may receive political support to develop the market and therefore reduce costs for users. Appropriate

incentive mechanisms, standards, promotion of ESCOs, and clear and easy labelling for customers will facilitate the implementation of energy efficiency technologies.

Box 3. Lessons from SIEPAC on Creating a Regional Energy Market

One example that deserves special attention given its size and the IDB's role is the Electrical Interconnection System for Central American Countries (SIEPAC) Project. Following are the key lessons learned:

- Regional legal framework and political support: A solid legal framework and strong political support were essential. SIEPAC was implemented for 25 years, during which it received continuous support from the six countries involved, facilitating the harmonization of regional and the national regulatory frameworks.
- Stability of rules: For several years, only temporary regulations were in place. This generated uncertainty and postponed investment decisions.
- A regional enterprise: The execution of a project involving several countries requires a supranational organization. The interests of countries can be communicated through their representation on governing bodies. A supranational organization can facilitate acquisitions, financing, and implementation.
- Technological coordination: Effective coordination was required, given the different technologies used.
- Focus on core activities: To facilitate an efficient decision-making process, parallel projects (e.g., the backbone optical fiber network) should be executed by independent entities.
- Easements and rights of way: It is necessary to anticipate alternative mechanisms to obtain easements in countries where there is no adequate legislation.

Source: Project Completion Report.

Lessons from ICE and Reventazón on Energy Sector Coordination

IDB support to ICE is an emblematic case of successful collaboration of the Sovereign (SG) and Non-sovereign Guarantee (NSG) windows of the IDB. Since 2007, the IDB has focused its support on the strengthening and modernization process launched by the Costa Rican government to adapt ICE to changes in the legal framework for electricity and telecommunications. These changes have allowed ICE to compete on a level playing field with other operators, becoming a state-owned enterprise run on business principles with independent corporate governance. The strategy supported a gradual reduction in ICE's reliance on sovereign guaranteed financing and facilitated access to financing in domestic and international capital markets. In 2007, the strategy included two operations: (i) a Conditional Credit Line for Investment Projects (CCLIP) of up to US$500 million to finance ICE's investments in the electricity sector; and (ii) a non-sovereign guaranteed loan (CR-L1012) of US$381 million to improve ICE's debt profile by refinancing existing debt balances, which has been fully disbursed. The IDB has been instrumental in increasing ICE's access to the commercial debt market without relying on sovereign guaranteed loans. As such, between 2011 and 2012, ICE was able to issue a total of US$500 million, 10-year bonds in the international markets.

Continuing this collaboration the IDB approved a package in 2012 to finance the design, construction, operation, and maintenance of the 305.5 MW Reventazón hydroelectric plant and its associated facilities. This package included US$903 million in financing, anchored by a US$200 million NSG loan and US$98 million in SG financing to ICE, as part of the CLIP, to be used as equity contribution for the project's special vehicle. Once completed in 2016, the project will represent approximately 10% of total installed capacity in the country, and serve as the largest renewable energy project in Central America. The operation resulted from a close coordination effort between NSG's Structure and Corporate Finance window and the SG window, producing the first ever "Double Booking" project finance transaction at the Bank. An innovative financing structure attracted US$135 million in senior secured debt from institutional investors, crowding-in a new investor class to long dated infrastructure projects. The project also set a new standard for environmentally sustainable hydropower projects in the region. Environmental components included: (i) a river habitat offset that helps protect river eco-systems and native fish species; and (ii) the construction of a wildlife corridor that allows jaguars and other large mammals to move freely throughout Central America.

B. Lessons Learned from Non-sovereign Guarantee Loans

4.14 To identify separately lessons learned from the implementation of non-sovereign guarantee (NSG) projects, four projects were analyzed: Campos Novos Hydroelectric Plant (BR0370), Peru Liquefied Natural Gas (LNG) (PE-L1016), Bolivia's ISA Bolivia II - La Arboleda substation project (BO-L1022), and Mexico's Eurus Wind Power Project (ME-L1068, Box 4). Their team leaders and members were also interviewed. Below are the most relevant lessons.

4.15 **The Bank's framework for social and environmental sustainability**. In addition to financing, private sector clients benefit from the technical, environmental, and social expertise. During the course of a loan, the Bank provides technical know-how that helps mitigate operational and financial risks. Bank safeguards ensure that clients adequately address social and environmental risks that could threaten the long-term viability of projects. The Bank's policies generate confidence among private clients and their shareholders (sponsors), which is particularly important for politically sensitive projects.

4.16 **Coordination between SG and NSG operations**. Close coordination between sovereign guarantee (SG) and NSG operations improves the energy project's quality and impact. Coordination between the two windows improves regulatory frameworks and develops competitive private sector markets to support activities such as investment in renewable energy. This coordination is also important for mitigating the risk of concession reversals and nationalization of private investments.

4.17 **Link with climate-change mitigation strategies.** Renewable energy operations financed by the private sector arm of the IDB aim to reduce GHG emissions. In addition to financing, project developers seek support in quantifying emission reductions and receiving emission reduction certificates. Moreover, the IDB is helping with concessional financing facilities (e.g., climate funds).

4.18 **Value-added of NSG operations**. NSG energy operations can add value in the sector by: (i) crowding in private sector investment; (ii) providing social and environmental safeguards; (iii) ensuring that operations properly mitigate engineering and financial risks; (iv) introducing new technologies and best practices, particularly in energy efficiency and renewable energy; (v) providing access to concessional funds for green projects; and (vi) bringing together governments, civil society, and the private sector to address complex issues and help resolve differences between multiple actors.

Box 4. Lessons learned from NSG operations: Mexico's Eurus Wind Project

EURUS is a 250.5 MW wind farm with 167 wind turbines located in Oaxaca. Eurus is one of the first wind farms in Mexico and the largest operating in Latin America. It sells energy primarily to Cemex under a PPA at a fixed price; any excess is sold to the Comisión Federal de Electricidad, the national electrical utility.

Total project costs were financed with US$375 million debt comprised of IDB A and B loans and seven co-lenders including IFC, CAF, DEG, ICO, Proparco, Bancomex, and NAFIN. The IDB lent to this project in 2009 when credit was scarce in the wake of the 2008 Global Financing Crisis, and at a time when the local banking sector was inexperienced in financing such technologies and private international lenders were not available.

The most important lessons learned are highlighted below:

- ***Understanding the legal and regulatory framework related to land****:* Despite recent progress, delays due to land registration continue to be a fundamental issue in Mexico and LAC. The IDB must work with governments to improve land title and registration at the policy level. This issue is extremely important for large infrastructure projects.
- ***Organizing to deal with social and legal issues****:* Eurus set up a strong social and legal team at the local level. This group dealt with the community and the land issues at an early stage in the project, goings even helping with obtaining proof of ownership. This team has been critical to move the process along.
- ***The importance of in-depth intelligence****:* The best sources of intelligence on land issues are local counsel legal opinions and a detailed parcel assessment by the independent engineer. Eurus received a legal opinion on obtaining and assign the Usufruct Agreements to the lenders. The engineers' report discussed the specifications of the turbines, wake effect and turbine placement so that the lenders had a solid understanding of the issues.

Sources: Project documents and interviews with project teams.

C. Reports of the Office of Evaluation and Oversight (OVE)[19], [20]

4.19 The most recent thematic evaluation conducted by the IDBs Office of Evaluation and Oversight (OVE) relevant to the energy sector is titled Climate Change at the IDB: Building Resilience and Reducing Emissions (RE-459-1, 2014). This evaluation reviews operations from 2004-2013 and is backed up by a Sector Study on Energy. Other relevant evaluations are: Background Paper on the Energy Sector (2014, with review of operations from 2004–2013); Thematic Note: The Challenge of Integrated Watershed Management: Analysis of the IDB's Actions in Watershed Management Programs 1989–2010 (2012); and Country Program Evaluation: Barbados 2010-2013 (RE-460-1, 2014). OVE's evaluations highlight important lessons learned to be incorporated in future operations of the IDB in the energy sector, in the five pillars of this SFD.

4.20 **Access.** In view of the considerable proportion of the population in the LAC region without access to electricity, OVE views renewable energy as a feasible solution for rural and isolated areas where extending transmission lines is not economically viable. OVE also acknowledges that well-targeted subsidies can help low-income communities to access electricity. The IDB has made access to electricity, and the goals of SE4All, part of its fundamental objectives.

4.21 **Energy efficiency.** According to OVE, although energy efficiency projects have the greatest potential to reduce GHG emissions at low cost, IDB participation in these projects has been limited. OVE found that diffusion, training, and information about the benefits of energy efficiency through technical assistance may be more effective than loans in achieving results. The IDB is using other

[19] OVE's recommendations to the previous Public Utilities Policy (PUP) made in the document Evaluation of the Public Utilities Policy as Applied to the Electricity Sector (PUP-E) (RE-326, 2007) were incorporated into the Policy OP-708 (GN-2716-6 of 2013). Regarding the recommendation on measuring results, these are achieved though he processes within the Development Effectiveness Framework.

[20] OVE's Environmental Performance Review applied to the Energy Sector (RE-382, 2010) does not apply to this SFD, given that it reviewed projects designed before the strengthening of social and environmental policies; the formulation of comprehensive environmental rules, processes and procedures; the increase in funding for the preparation and supervision of social and environmental aspects of projects; and the creation of the independent Environmental Safeguards Unit (ESG) that fortified these aspects during project preparation and execution.

mechanisms, such as “green lending.” These are the most common instruments for energy efficiency projects. They allow local banks to expand the size of their portfolios. However, their success in expanding financing for micro and small firms has been low. Furthermore, the development of small-scale projects has proven particularly difficult, as small firms face high transaction costs and low returns on investments (partly because of energy subsidies). The IDB has several projects currently under execution with important energy efficiency components.[21]

4.22 **Renewable energy**. Early introduction of renewable energy can help countries and companies develop a comparative advantage in low-carbon technologies. This approach has been successfully followed by Brazil in wind energy and is underway in Mexico. OVE highlights that Nicaragua is one of the most attractive clean energy markets in LAC, with a growing penetration of renewable energy. In fact, in 2014 Nicaragua generated 21 percent of power from wind, placing it a select group of countries including Spain, Portugal, and Ireland, below only Denmark with one-third of its generation from wind.

4.23 **Regional integration.** OVE states that energy integration, particularly for transporting energy, can create economies of scale and increase efficiency in generation costs and GHG emissions. The IDB has been supporting (financially and through technical assistance) regional integration. The SIEPAC project and its Regional Electricity Market (MER), and the Andean Electrical Interconnection System (SINEA) are examples of regional integration initiatives. Furthermore, the IDB is studying regional integration of natural gas and geothermal power in the Caribbean. OVE indicates that even if LAC countries plan to continue to add fossil fuel capacity, the IDB could promote more efficient and cleaner fossil fuels, such as natural gas. The IDB is supporting Caribbean countries in their exploration of options for introducing natural gas.

4.24 **Regulatory framework and institutional strengthening**. The public sector of the IDB has focused on institutional strengthening to overcome barriers to renewable energy, construction and rehabilitation of electricity transmission and distribution grids, and hydropower plants. Between 2004 and 2013, 18 percent of the IDB’s climate change and energy grant funds were used to support regulatory and policy changes. This was one of the largest shares of grant fund use. In the same period, 11 operations were approved that supported policies seeking regulatory and institutional changes in seven countries for US$850 million (17 percent of the portfolio). Nine additional loans for US$313 million were approved to provide institutional support for modernization and restructuring of electrical systems. Conditionality in programmatic loans in recent years has led to changes in laws that promote sustainable energy and institutional strengthening. OVE found that Policy-Based Loans (PBL) were used appropriately in Barbados to advance policies and legislation to promote energy

[21] These programs include: Nicaragua (NI-L1040; NI-L1050; NI-L1063); Jamaica (JA-L1025; JA-T1031; JA-T1044); Barbados (BA-L1020; BA-L1025); Brazil (BR-L1111); Regional (RG-X1125; RG-T1025); and MIF: Colombia (CO-M1095).

efficiency and renewable energy.[22] Further work is required in these areas. Improving regulatory frameworks and strengthening institutions will also facilitate the work of the private sector of the IDB.

4.25 Other aspects of the OVE evaluation extend beyond or cut across all of the above-described issues. These are detailed below.

4.26 Integrated watershed management. OVE highlights the IDB's and the countries' limitations with respect to integrated intervention in the sustainable use and development of watersheds. Such interventions are difficult since they are multidisciplinary and require significant coordination, rules of engagement, and definition of priorities for water and land use that raise conflicts among users, government agencies, and other interested actors. OVE found limited multidisciplinary collaboration within the IDB in joint project preparation and execution as well as a lack of technical expertise in electricity production, water supply, flood control, transport facilitation, tourism promotion, fisheries development, ecosystems protection, and agricultural input. Since 1989, the IDB has developed 27 watershed projects for a total of US$1.15 billion and 52 Technical Cooperation (TC) operations totaling US$35 million. All but one were prepared and executed from a single sector perspective, in spite of the adoption of guidelines for an integrated approach to watershed management in 1996, and a strategy in 1998.

4.27 **Knowledge work**. According to OVE, the energy sector accounted for one of the largest amounts approved for knowledge-related TCs. The IDB's work through TCs has contributed to the knowledge base in the LAC region in this area. Knowledge products helped to identify and propose solutions to technological and institutional barriers and to develop new energy technologies. Activities include supporting the UN's SE4All in LAC, institutional development through the Climate Scope (MIF, 2013) and financing studies and pilot projects in new technologies. The IDB's support to hydropower expansion and rehabilitation and renewable energy has helped to build knowledge, catalyze activities, and leverage concessional resources. However, while these interventions in the public sector were innovative, the knowledge was not always transferred to operations.

4.28 **Alignment with government strategies and planned reforms**. OVE found that the IDB has been most effective in the energy sector when its public sector engagement and dialogue and its private investments have been closely aligned with the country's own energy strategy. A good example is the coordination of the two sectors in the support for wind farms in the context of the Uruguayan energy reform.[23]

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[22] There were two programmatic PBL in Barbados in the energy sector totaling US$115 million (US$45 million in 2010 and US$70 million in 2011). These fast-disbursing loans provided much-needed liquidity during the economic crisis (1 percent and 1.6 percent of GDP in FY10 and FY11, respectively), and are expected to generate financial savings by reducing oil imports and energy costs over the medium to long term.

[23] The IDB's financing of the first three large-scale renewable energy projects in Uruguay contributed to the broader environment for private sector investments, and coordination between the public and private sector windows of the IDB contributed to align all actors.

4.29 **Structuring and leading private sector investments**. Between 2004 and 2014, private sector NSG operations represented 45 percent of the climate-change portfolio in energy. OVE suggests that the IDB can increase its relevance for the private sector by further advancing its role in structuring projects and leading syndications. The IDB can maximize its value-added if it takes the arranger role in syndications instead of limiting its participation to obtaining additional B-loans with commercial banks. Increased coordination with the IDB's public sector and the national energy strategy would allow the private sector windows to play a more central role in structuring operations.

4.30 **Public and private sector coordination**. OVE suggests strengthening the alignment and coordination between the IDB's public and private sectors. The IDB group should continue to build on the collaboration already being done.

4.31 **Leveraging of resources:** OVE found that PBLs have been more relevant and effective when they have addressed broad energy policy objectives and integrated a range of instruments, including TC and investment loans (e.g., Barbados, El Salvador, and Nicaragua) rather than addressing pressing fiscal needs (e.g., Panama and Trinidad and Tobago). When PBL were approved quickly to address fiscal problems, OVE found that the need for fast disbursement impaired the selection of robust conditionalities aligned with the objectives of the PBL. Moreover, once the fiscal needs are met, it is likely that the continuation of the reform process will be interrupted.

4.32 Given the externalities of GHGs and the public-good nature associated with the energy sector, OVE recommends greater use of concessional funding for renewable energy and energy efficiency when addressing market failures. Funds such as the Clean Technology Fund (CTF), the Special Climate Change Fund, the Canadian Climate Fund, the Nordic Development Fund, and the GEF Trust Fund have provided LAC countries with concessional resources to compensate for the incremental costs of low-carbon development. In fact, OVE has found that lending is not always the solution for all market failures; in some cases, a market failure could be addressed with soft interventions (demonstration effects).

4.33 **Reduction of carbon emissions**: According to the Climate Change Evaluation, energy (including for use in transportation), along with agriculture (mainly livestock), land-use change, and land use and forestry are responsible for 80 percent of the GHG emissions in the LAC region. The energy sector has played an important role in the IDB's climate change engagement. The most significant results in terms of reduced GHG emissions have come from the IDB's support for hydropower expansion and rehabilitation.[24] OVE found that only 20 percent of the energy projects in the public sector portfolio contain plans to measure GHG emission reductions.

[24] Another remarkable project cited by OVE is the Acre project in Uruguay (approved in 2012 for US$65 million), which developed an improved system for processing dairy products and a biogas plant to capture methane and generate thermal energy, crossing the boundary between energy and agriculture.

4.34 **Climate-change adaptation**: OVE stresses that the IDB should increase its knowledge base on vulnerability and the potential impacts of climate change in the sector.

D. Results from the Development Effectiveness Matrix (DEM)

4.35 A review of the scores listed in the DEM shows significant improvement in sovereign guarantee projects receiving highly evaluable scores and increasing from 13 percent in 2009 to 100 percent in 2013 (see Table 6). In 2014, the IDB revised its classification of evaluability categories and established that only projects above a score of 9 would be catalogued as "highly evaluable". Consequently, the average evaluability score of 8.8 in 2014 results in a classification of "evaluable".

Table 6. Summary of Development Effectiveness Matrixes (DEM) for Sovereign Guarantee Projects

ASSESSMENT	2009		2010		2011		2012		2013		2014	
DIMENSIONS	Energy Se	Bank	Energy Se	Bank	Energy Se	Bank	Energy Se	Bank	Energy Se	Bank	Energy Se	Bank
AVERAGE EVALUABILITY	5.2	5.8	6.9	6.8	8	8.2	9	8.7	9.2	8.7	8.8	8.8
Number of projects approved	8	114	10	135	14	122	10	125	6	108	9	105
% highly evaluable projects	13%	22%	50%	41%	79%	86%	100%	99%	100%	100%	44%	40%
1. Evidence-based Assessment & Solution (Lógica de la Intervención)	5.5	6.7	7.6	7.6	8.2	7.9	9.4	8.3	9.6	8.8	9.4	9.1
2. Monitoring and Evaluation (Monitoreo y Evaluación)	3	5	4.9	5.9	5.9	6.9	6.8	7.5	8.1	7.8	7.2	7.8
3. Ex-ante Economic Analysis (Análisis Económico)	7.1	4	7.5	6	9.4	8.9	10	9.4	10	9.6	9.8	9.5
4. Risks & Mitigation Monitoring Matrix- (Gestión de Riesgos)	6.9	7.3	7.5	7.7	8.8	9.2	9.8	9.8	NA	NA	NA	NA

4.36 The dimension under which operations have performed best in evaluability in recent years is the ex-ante economic analysis. All operations approved since 2012 have included ex ante economic analysis using cost–benefit analysis. Evidence of effectiveness has been challenging to find due to the scarcity of rigorous evaluations, such as impact evaluations of comparable projects. Similarly, there have been challenges in selecting evaluation methods. A large number of projects are for power generation and transmission lines. In these projects it is difficult to measure direct impact on a population given the difficulties in defining the control and treatment groups. For these reasons, the IDB has initiated a process of generating knowledge on evaluation, specifically from interventions with rural electrification components.

4.37 A review of the development effectiveness scores for NSG operations in the energy sector reveals that projects executed by the IDB's Structured and Corporate Financing Department (SCF) between 2011 and 2013 received an average evaluability score of 9.6 (see Table 7). This score is not directly comparable to SG operations. Under its new methodology, NSG operations in 2014 received a score of 8.3; this score is not directly comparable to scores from previous years. The NSG energy operations in 2014 received a Development

Effectiveness Assessment score of 7.3, which measures development outcomes and additionality.[25]

4.38 For unconventional renewable energy projects, the main challenges in measuring development effectiveness are: (i) the small size of the projects compared to overall energy capacity; (ii) the difficulty of estimating and valuing emission reductions; and (iii) the impacts of low and fluctuating energy prices on profitability and economic value.

Table 7. Evaluability and Development Effectiveness Assessments of Projects

ASSESSMENT DIMENSIONS	2011		2012		2013		2014	
	Energy Sector	All NSG projects	Energy Sector	All NSG projects	Energy Sector	All NSG projects	Energy Sector	All NSG projects
Number of projects approved[26]	6	32	5	31	3	38	8	35[27]
EVALUABILITY[28]								
1. Project Logic	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	8.1	8.8
2. Financial and Economic Analysis	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	9.4	7.7
3. Monitoring and Evaluation	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	7.7	8.0
Overall Evaluability Score[29]	**9.4**	**9.1**	**9.7**	**9.2**	**9.7**	**9.1**	**8.3**	**8.2**
DEVELOPMENT EFFECTIVENESS ASSESMENT[30]								
1. Development Outcome[31]	8.0	8.2	8.2	8.1	7.7	8.1	6.7	7.4
2. Additionality[32]	7.7	7.8	8.1	8.0	8.8	7.9	8.9	8.4
3. IDB and Country Priorities Alignment[33]	10.0	9.9	10.0	9.8	10.0	9.8	100% aligned	100% aligned
Overall Project Score	**8.3**	**8.4**	**8.6**	**8.4**	**8.6**	**8.4**	**7.3**	**7.7**

E. Comparative Advantages of the IDB in the Region

4.39 Between 2007 and 2013,[34] the IDB approved 98 loan operations in the sector totaling US$8.718 billion, in contrast to (i) the World Bank, which approved 52

25 Comparable development effectiveness scores from the IIC and MIF are not available.

26 Includes SCF and OMJ projects with a DEM or evaluability assessment at the project level (i.e., no TFFP).

27 If two joint SCF-OMJ operations are counted separately.

28 For operations approved between 2011 and 2014, evaluability for NSG projects was scored based on the Development Effectiveness assessment (as well as the indicators used), and was not comprised of the three subsections of Project Logic, Financial and Economic Analysis and Monitoring and Evaluation.

29 NSG operations introduced evaluability scores in 2011. The methodology was modified in 2014, therefore scores before 2011–13 are not directly comparable to the 2014 scores.

30 The methodology changed in 2014, therefore scores for 2011–13 are not directly comparable to the 2014 scores.

31 Includes the dimensions of Project/Company Business Performance, Contribution to Economic Development, Private Sector Development, and Environmental and Social Performance.

32 Includes financial and non-financial additionality.

33 Scored as 0/10 before 2014, and aligned/not aligned since.

34 This period was taken from the realignment until the last date available for CAF and CABEI. Data for the World Bank was calculated as the fraction devoted to energy and includes IFC investment loans. The IDB data include SG and NSG loans. Information was obtained from the websites of the agencies. CABEI displays information since 2010.

operations for US$3.896 billion; (ii) CAF, which approved 23 operations for US$5.521 billion; and (iii) the Central American Bank for Economic Integration (CABEI), which approved 13 operations for US$1.492 billion between 2010 and 2013. The data show the IDB's greater regional presence in the sector. The IDB also approved 257 TC operations totaling US$162 million from 2007 to 2014.

4.40 IDB operations have focused on transmission, hydropower, rural electrification, regulatory reforms and sector policies, and sustainable energy. In contrast, the World Bank has focused mainly on multisector projects, where a fraction of the project is for energy, and structural reforms. CAF has lent mainly for generation and transmission.

4.41 The IDB's public sector (SG) lending was directed at institutional strengthening and regulatory changes, hydropower plants, and supply-side energy efficiency, while the private sector (NSG) portfolio focused on electricity generation with renewable energy and energy efficiency. The IDB succeeded in channeling concessional resources from other sources of financing. In total, 53 percent of the funds invested in technical cooperation came from external sources that were managed by the IDB. The IDB's demonstrated capacity to mobilize resources from the Global Environmental Facility (GEF), the Clean Development Mechanism (CDM), the CTF, and the Climate Investment Fund (CIF) positions the IDB well in this sector.

4.42 The IDB's level of involvement in investments financed by the private sector varies by country and technology. NSG operations financed 16 percent of new renewable energy generation (total 1,652 MW) for LAC in 2004-2011. Excluding the projects in Brazil, the picture changes dramatically: the IDB's contribution in hydropower rises to 22 percent of newly installed capacity, and 58 percent of investments in renewable energy. Wind power leads the portfolio with 12 projects totaling US$787 million, or roughly 19 percent of the amounts approved, concentrated in Mexico, Uruguay, and the Dominican Republic. Hydropower follows, with six projects and about 18 percent of the approved amounts. Solar power adds another three projects for 3 percent of total approvals, mostly in the Atacama Desert in Chile.

4.43 The public and private sectors of the IDB have distinct comparative advantages. The IDB has provided value to clients and the region by bringing the IDB's social and environmental safeguards to projects, which mitigates risks and provides a trusted confidence level. The technical capacity of the staff has helped to evaluate and structure projects that are technically and economically complex. The IDB has mobilized additional private financing for energy investments. The IDB has also been instrumental in bringing concessional funding to catalyze additional investments in the sector, either from the private sector or from other development and cooperation agencies, in this way leveraging financing resources and increasing the knowledge value. Furthermore, the IDB has fostered innovation and coordination for regional integration, for example, through the Regional Public Goods Program, serving with roles as that of a venture capital investor, regional disseminator of innovation, and an honest broker partner. This and other programs promote innovation, entrepreneurship, and transfer of technology and knowledge. Operations executed by the public and private sectors have financed new technologies and best practice activities

that have acted as demonstration projects. Finally, they have leveraged the Bank's convening power and image as an honest broker to address and resolve complex issues that involve governments, civil society, and the private sector.

4.44 Most of the clients and stakeholders interviewed by OVE highlighted the value of Bank safeguards: (i) to help develop sustainable practices at the firm level; (ii) to ensure that firms comply with internationally recognized environmental and social standards; and (iii) to help insulate firms against complaints of incorrect environmental and social management. The clients also valued the IDB's role in providing technical assistance.

4.45 The possibility of coordinated public–private work and access to concessional funding are regarded as the IDB's most important comparative advantages. Both the public and the private windows of the IDB add value through their access to the government to discuss energy policy and markets. Clients appreciate having a partner in direct dialogue with governments. The IDB has some experience in efficiency and compensation measures through financing one coal-powered thermoelectric plant in Brazil in 2009.[35] The intervention provided a useful learning experience and eligibility requirements for environmentally sensitive projects. Another instance was an IDB operation (with IFC participation) where force majeure events reduced the amount of energy that could be delivered. The government renegotiated the feed-in tariff to ensure the sustainability of the project.

4.46 **Other sources of value-added**. The IDB adds technical value through its public and private sector window operations and policy dialogue. The experience of the IDB in reforming Chile's energy markets in the 1990s and 2000s was a precursor to the large expansion of private investment in recent years. Similarly, Uruguay's strategy to diversify its energy matrix by incorporating wind and solar power and the IDB's support to establish the conditions for bankable projects has expanded private investment. It also adds value by using private sector interventions to support a country's energy policies.

4.47 Alignment of the IDB's private sector portfolio with national policies also serves to mitigate important regulatory and country risks. Many of the risks of these operations have to do with sudden changes in regulatory framework, including tariffs. Insofar as private sector investments fit into a coherent national policy, the likelihood of such changes is lower. For the same reasons, aligning private sector investments to a long-term national strategy also makes the interventions more likely to be sustainable in the long term.

4.48 These advantages are obtained from flexibility and adaptability to the needs and requirements of the clients, embedded in the preparation and execution policies and procedures, including adequate integration of the teams (sector, fiduciary, legal, and safeguard specialists), a strong presence in the field that allows fast responses, multiple financing tools, and the availability of funds to develop knowledge products.

[35] An Approach to Reconciling the Financing of Coal-fired Power Plants with Climate Change Objectives (GN-2532).

4.49 The IDB will work to address the region's main challenges in the sector and will use its comparative advantages, which are based mainly on its experience and knowledge of the strategic areas of development of energy infrastructure in urban and rural areas; energy efficiency and renewable energy; climate change; regional integration of electricity and natural gas infrastructure; strengthening public sector capacities for energy policy, planning, regulation as well as the capacities of energy service providers; and supervision of contracts for high-risk or high-impact projects. Recognizing the IDB's comparative advantages and the challenges concerning the environmental impact associated with certain energy sources, the IDB will not intervene in activities on nuclear energy (as specified in documents DR-791 and GN-2609-2, both of 2011). A priority will be given to cleaner sources of energy, while considering in a case by case basis fossil fuel technologies, when the investments are necessary and make sense from an economic standpoint (taking externalities into account), for example: in the rehabilitation of existing plants, substitution of solid or liquid fossil with cleaner gaseous fossil fuels; or to meet the demand for energy services.

4.50 The IDB has a team of professionals with solid knowledge and experience in transmission and distribution, large hydro, rural electrification, energy efficiency, and renewable energy projects. The availability of professionals both at headquarters and in the field adds to their value. However, projects in technologies such as geothermal, marine energy, waste-to-energy, and smart grids will also require strengthening the knowledge base through training and coordination with other institutions that have experience with these issues to improve the capacity for dialogue with member countries.

4.51 In addition, the IDB in general, and the Infrastructure and Environment Sector (INE) in particular, have teams with extensive experience in each of the infrastructure sectors and in supporting institutions in the region. This is a competitive advantage that, as an institution, could be used to establish the aforementioned "cross-platform". This can be an effective channel to provide better support to countries and to further support the institutional and technical strengthening provided in the region.

V. GOALS, PRINCIPLES, DIMENSIONS OF SUCCESS, AND LINES OF ACTION THAT WILL GUIDE THE IDB'S OPERATIONAL ACTIVITIES AND RESEARCH

A. Bank Goals and Principles in the Energy Sector

5.1 The IDB's goal in the energy sector is to help increase the access of LAC countries to efficient, sustainable, reliable, and affordable energy, in a diversified and secure manner, while reducing poverty, promoting improved quality of life, and fostering competitiveness and economic growth and development.

5.2 Given the heterogeneity and the scale of the challenges of the energy sector in the various countries of the region, the IDB's actions shall meet the particular needs of each. The energy sector technical notes will diagnose and deepen the analysis of the situation of each country. The lines of specific sectoral action will be analyzed together with other sectors of the IDB and will be established in the country strategies.

5.3 Investments and programs will be supported either through public funding, private sector participation, and/or public–private partnerships. Activities shall be governed by the following general principles, since they are crosscutting and apply to all of the activities of IDB irrespective of the particular analysis of each country and intervened sector.

a. **Develop economical and sustainable energy access**. IDB will promote technically, economically, environmentally, and socially sustainable universal access to quality energy services. It will encourage the efficient and cost-effective expansion, electricity generation, and strengthening of electricity networks and power generation systems as well as provide electricity access to off-grid and isolated areas, using appropriate technologies and renewable energy where possible. The IDB will promote efficient stoves and modern technologies for cooking as well as providing the support needed for developing local production and training on use and maintenance. Emphasis will be placed on poverty reduction for the most marginalized and vulnerable populations, incorporating disabled, and indigenous populations as well as reducing gender inequalities.

b. **Promote energy efficiency, renewable energy and cleaner fuels for sustainable energy**. The IDB will promote demand and supply energy efficiency in all sectors (residential, commercial, industrial, and public), as well as renewable energy production and cleaner fossil fuels such as natural gas in the energy mix of LAC countries, reducing greenhouse gas emissions. When possible, the IDB will support the increase in power generation efficiency, for example by upgrading power plants or installing combined cycle generation in open cycle power plants. The IDB will also promote the incorporation of new technologies and concepts such as smart grids in the power sub-sector, in order to strategically manage demand, enhance performance and security, and allow more distributed generation, advanced metering, and monitoring and control of electricity networks.

c. **Stimulate energy security—maintaining and preserving infrastructure and promoting regional integration**. The IDB will support the region to improve and innovate with respect to mechanisms to finance sustainable energy, improved infrastructure and services. Investments will be required to ensure adequate operation and timely preventative maintenance of energy facilities to improve their performance, guarantee and extend their lifetime, and minimize the need for investment in new facilities. The IDB's Public Utilities Policy (GN-2716-6) serves as a reference for guidance on IDB operations having sufficient funds to meet financial commitments, and cover operation and maintenance costs. System protection of energy infrastructure through modern control systems will prevent damage to equipment and appliances due to abnormal currents and voltages. Investments in infrastructure and development of legal/regulatory frameworks for regional integration will also promote energy security. Emphasis will be placed not only on hardware but also on software and systems to enhance efficiency and increase performance. Bank lending to finance energy infrastructure will increase their financial viability by incorporating institutional, technical, environmental, and financial analysis of the operation and maintenance of the works during the lifetime of the project.

Private and public sector financing and partnerships will complement each other and enable investments. Private and public sector financing will be designed to complement each other with the intent to leverage a high ratio of private sector finance to public sector. The IDB will support financing mechanisms and legal/regulatory frameworks that adequately balance risk and encourage private participation in energy markets and in the financing, innovation, development and operation of services in the sector.

d. **Promote good governance, increase financial sustainability, strengthen institutions, and encourage multisector collaboration.** The IDB will provide assistance in diagnosis of the energy sector, industry structure, multisector nexus, and policies, regulatory framework and work to strengthen the sector and government institutions in need of improved planning, decision making, accountability, and regulatory environment. This includes review of subsidies for transparent and targeted allocation when used. It will also promote multisector and multi-institution collaboration to achieve common goals and maximize use of resources.

B. Dimensions of Success and their Lines of Action

5.4 **Dimension 1. The countries approach universal energy access and provide high quality energy services**. The IDB will support countries to improve quality, coverage, reliability, and affordability of the energy infrastructure with affordable prices while minimizing social/environmental impacts. It will contribute to efforts to expand power generation and to extend grids when economically and environmentally viable, or build sustainable isolated systems; reduce energy costs by promoting competition in the energy sector and wholesale electricity markets, reduce energy losses and improve energy efficiency; and increase productivity and competitiveness of economies by supporting reliability of energy services. Through greater energy access, especially in isolated communities, the IDB will contribute to efforts to reduce poverty and increase equity. To achieve these objectives, the following lines of action are proposed:

5.5 **Lines of action** proposed include: (i) promote universal, reliable, and affordable access to energy services, including improvements in energy access in rural and low-income urban areas; (ii) encourage clean, high quality, and modern cooking facilities as appropriate for local conditions, with awareness raising, training, and monitoring on use of new technologies; (iii) include programs to promote productive uses of energy when providing energy services, including in off-grid areas; (iv) rehabilitate/reinforce power generation infrastructure and overloaded distribution networks and associated facilities; (v) upgrade backbone and regional transmission infrastructure capacity when operating over rated capacity and to allow new power generation capacity from variable renewable energy sources; (vi) improve the resilience and adaptability of the infrastructure for natural phenomena and adverse effects of climate change; (vii) increase the reliability of energy systems by adding, strengthening, and sharing (for regional integration initiatives) ancillary services and capacity reserves; (viii) support governments in promoting private sector participation in energy infrastructure development and energy markets; (ix) develop micro-financing opportunities and programs to leverage private sector investments for rural energy access; (x) promote energy efficiency in providing access; and (xi) encourage planning

for universal access at a national level. To pursue these lines of action, the following operational and knowledge activities will be implemented:

a. **Operational activities:** (i) investment programs in generation, transmission and distribution of electricity, including introduction of advanced metering systems, to reduce losses and improve efficiency; (ii) programs for off-grid provision of electricity, fuel substitution and/or efficient technologies for cooking; (iii) investment in transportation, storage, and distribution of natural gas and gas fuels; (iv) investment programs in the rehabilitation (or possible expansion) of energy infrastructure to extend its useful lifetime (and expand capacity); (v) promoting adequate operation and timely maintenance of systems (including support best practices in Program Operating Regulations of projects financed by the IDB) and equipment in order to extend the useful life of infrastructure and reduce losses; (vi) investments in the improvement of energy system reliability; and (vii) ancillary investments in energy markets that support the pricing and use of energy to reduce risks and improve market efficiency.

b. **Knowledge activities:** (i) results assessments of the improvements in energy infrastructure access in off-grid areas, including enhancements in the economic and social conditions of the population; (ii) studies determining causes of high costs and energy losses and how to reduce them; (iii) technology (along with implementation mechanisms) to reduce cost and losses, increase reliability, and reduce environmental and social impacts; (iv) supporting programs to create a culture of electricity payment (especially in countries with significant non-payment and theft); (v) impact assessment studies; (vi) best practices in the sector for institutional arrangements regarding access policies and stimulus, financial, social, and environmental sustainability; and (vii) data for planning and policy design.

5.6 **Dimension 2. Countries have diversified energy portfolios**. Countries in the region combine legacy fossil fuel energy sources [36] with energy efficiency, renewable energy and other cleaner fuels.[37] The IDB also proposes to assist in removing the barriers in the legal and regulatory framework that diminish incentives to utilities, users, and other providers to install nonconventional renewable energy sources, incorporate demand-side management, adopt energy efficiency measures, and lower emission fuels. To achieve these objectives, the following lines of action are proposed:

5.7 **Lines of action** proposed include: (i) assessment of nonconventional renewable energy resources, including solar, wind, smaller hydro, geothermal, and other atlases and preparation of master/action/investment plans; (ii) evaluation of energy conservation and efficiency potential, along with demand-side management; (iii) promotion of efficient and sustainable power generation;

[36] Legacy equipment include all the hardware and software deployed for conventional energy sources, ranging from generation stations and transport configurations, to control systems, protection devices and ancillary services that limit the incorporation of renewable energy.

[37] Specific activities that apply to the energy and other relevant sectors are detailed in the Climate Change SFD.

(iv) analysis of technical and economic viability of substituting conventional generation with renewable sources; (v) analysis of alternatives fuels in transport and higher performance vehicles, and in energy intensive industries/commercial sector; (vi) development of the institutional capacity for the management and coordination of public agencies (including different ministries and government agencies) and private actors involved in investment in renewable energy and energy efficiency, including technical requirements and economic incentives for deployment and support to new energy companies entering monopolized markets; (vii) incorporation of training and capacity building in operations; and (viii) development of markets and the private sector with respect to the provision and installation of distributed generation. To pursue these lines of action, the following operational and knowledge activities will be implemented:

a. **Operational activities:** (i) specific investments in renewable energy power generation; (ii) specific investments in infrastructure to support the transport of utility-scale renewable energy including backbone and/or regional transmission lines; (iii) specific investments in energy efficiency projects in the residential, commercial, industrial, and public sectors; (iv) reforms to legal, policy, and regulatory frameworks for the incorporation and promotion of renewable energy and energy efficiency; (v) programs for institutional strengthening in energy policy, planning and inter-institutional coordination; (vi) programs for training people and developing local capabilities in the design, installation, operation and maintenance of renewable energy options; and (vii) programs to leverage private sector investments and support the private sector through technical cooperation, loans, investments, and guarantees to support the provision of energy services, expansion of public–private partnerships, development of energy efficiency markets, use of energy commodity markets, and promotion of new technologies and sustainable business practices; and (viii) partner with research centers to promote and support innovation initiatives in EE and ER (such as the Clean Energy Solutions Center y Caribbean Centre for Renewable Energy and Energy Efficiency).

b. **Knowledge activities:** (i) formulation of technical specifications for the interconnection of distributed generation to the grid; (ii) formulation of methodologies to determine the economic benefits and incentives for distributed generation based on renewable energy; (iii) national plans for the incorporation of renewable energy; (iv) national plans for energy efficiency measures at the residential, commercial, industrial, and public level; (v) institutional strengthening for the development of legal and regulatory frameworks promoting renewable energy and energy efficiency; (vi) regulatory analysis to encourage effective participation of the private sector in renewable energy through various measures, including public-private partnerships; (vii) diagnosis and proposal of suitable designs to address market failures linked to climate change (externalities, information asymmetries, lack of long-term finance); (viii) renewable energy demonstration projects using innovative financial and risk coverage instruments, technologies, and regulations; (ix) technical, economic, and environmental analysis of scenarios with high penetration of renewable energy; (x) tools for planning, design, and operation of infrastructure resilient

to climate change impacts; and (xi) mechanisms and methodologies for multisector coordination and planning.

5.8 **Dimension 3. Countries reach sufficient level of investment in infrastructure and prioritize the integration of energy networks of countries.** The IDB will support countries in identifying medium and long-term investment needs in the sector. By having clear rules and regulations, private sector investments will have more clarity and certainty in their participation in the sector. The IDB will support the development of programs and projects to connect the countries' electricity and natural gas networks, including small and island nations. The IDB will facilitate the development of hardware and software for greater regional integration. It will promote regional collective action, harmonization of domestic policy reforms and updating regulatory frameworks, national cross-border investment and capture of cross-border externalities, resolution of coordination failures and other barriers in the implementation of regional projects. The value-added to projects of incorporating objectives and components of integration and regional cooperation will be emphasized. To achieve these objectives, the following lines of action are proposed:

5.9 **Lines of action** proposed include: (i) supporting infrastructure planning and assess investment needs for regional integration; (ii) assisting countries in establishing regulations that give clarity to potential investors; (iii) promoting public–private partnerships when there are adequate market conditions; (iv) assessing gas and power interconnection alternatives between member countries; (v) developing physical interconnections between countries; (vi) strengthening participation in initiatives to facilitate the dialogue among countries on regional initiatives, promoting best practices; (vii) promoting greater volumes and number of energy transactions on existing interconnections; and (viii) disseminating the IDB's knowledge on the effective arrangements for promoting greater energy integration. To pursue these lines of action, the following operational and knowledge activities will be implemented:

a. **Operational activities:** (i) financing of planning and infrastructure investments to improve national energy infrastructure that will also enable regional integration (e.g., construction of new energy infrastructure; rehabilitation of generation plants; and reinforcement of national electricity transmission lines and natural gas pipelines, LNG and gas fuel transportation, liquefaction, storage, and regasification facilities as well as subsea electricity transmission cables between Caribbean islands); (ii) promotion of institutional, commercial, and technical agreements and regulatory support to extend the above interventions and ensure sustainability; and (iii) strengthening the IDB's role as a neutral supporter/facilitator between and among countries within the various plans and regional initiatives.

b. **Knowledge activities:** (i) analysis of infrastructure and investment requirements; (ii) sharing and diffusion of regional integration experiences that can provide lessons for LAC countries, including strategic alliances with member countries (e.g., experiences of SIEPAC, Europe, such as NordPool, and the United States); (iii) evaluation of regional impacts and benefits with the provision of energy integration infrastructure; (iv) analysis of mechanisms

for compensating the asymmetric distribution of costs, benefits, and risks in integration projects; (v) development and applications of analytical tools to evaluate integration options and configurations; and (vi) capacity building on public–private partnership schemes.

5.10 **Dimension 4. Countries have institutions capable of developing and implementing energy policy, planning, and supervising/monitoring and regulation of services**. The IDB will support the strengthening of countries' institutions and their governance to improve the management and effectiveness of interventions in the energy sector. The aim is to increase the technical and management capacities to more accurately identify sectorial needs, design policies, as well as their capacity to plan and execute projects effectively. The IDB will encourage the development of institutional arrangements to also ensure institutions and energy companies are financially sustainable and there are human resources for equipment operation and maintenance. Support will include expanding data collection and dissemination for better decision making, analyzing subsidy programs so that they are effective and transparent and support financial sustainability, as per guidance provided in the IDB's Public Utilities Policy (GN-2716-6). Additionally, the IDB will encourage the availability of data and knowledge of the sector to improve the ability to generate policies appropriate to the particular needs of countries and evaluate results. To achieve these objectives, the following lines of action are proposed:

5.11 **Lines of action** proposed include (i) building strategic planning capacity, policy formulation, monitoring, and evaluation; (ii) strengthening capacity to regulate and implement policy and projects; (iii) increasing capacity to manage and supervise concessions and private investments; (iv) ensuring financial sustainability of the sector; (v) reviewing subsidies to ensure that when these are used, the sources and beneficiaries are identified; (vi) expand sources, collect, update and publish significantly greater amounts of data for increased transparency and more efficient management of information for decision making; (vii) building capacity to adopt energy-related international standards; and (viii) gathering and reporting data and statistics to improve the quality and availability of information relevant to the energy sector. The IDB will improve the management and implementation of energy projects with high impacts and/or risks by financing activities of institutional strengthening in countries and generating knowledge of regional application in management and project contracting. To pursue these lines of action, the following operational and knowledge activities will be implemented:

a. **Operational activities:** (i) financing institutional assessments in order to identify areas of improvement; (ii) financing national plans and planning studies; (iii) financing technical, economic, environmental, and policy studies and regulatory changes to promote a more sustainable energy mix and needed regulatory (including subsidy) reform; (iv) training government officials on policy, regulatory, operational, economic, environmental, and related consulting and recruitment of specific support; (v) facilitating adoption of energy-related international standards; and (vi) funding technical and information systems equipment.

b. **Knowledge activities:** (i) providing support at national and regional level to improve the collection, analysis, and dissemination of data in the sector; (ii) developing results assessment tools to identify the effects of interventions in the sector; (iii) sharing best practices on managing and implementing large, high-impact projects; and (iv) implementing strategic planning to understand the water, energy, agriculture nexus.

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