Implementing Renewable Energy and Energy Efficiency Measures:

Challenges and Opportunities for Latin America and the Caribbean

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This policy discussion paper is the result of a joint Inter-American Development Bank and World Bank effort to provide background information on issues of particular interest to the Finance Ministers of the Americas and the Caribbean.

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The opinions expressed in this paper are those of the authors and do not necessarily represent the views of the Inter-American Development Bank or of the World Bank.

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EXECUTIVE SUMMARY

Governments throughout the world are increasingly concerned with how to meet growing energy needs while confronting global climate change. While at the same time, less private investment and fluctuating oil prices are providing a more challenging environment for governments to launch projects to fight climate change. In the last few years there has been a boom in the development of many new technologies to harness renewable energy sources. As these technologies develop and become more cost effective, there will be an increasing number of options to meet global energy demand while reducing greenhouse gas emissions, even in existing economic conditions.

Developing countries' governments confront the challenges of meeting growing energy needs as a result of pursuing economic development objectives and raising living standards. Combining climate change policies with economic development goals will ideally result in a shift from this developmental paradigm towards more resilient low-carbon economies. In order to change the existing patterns of development and ensure the shift towards low carbon economies, all sectors of the economy must be included in developing effective policies to confront the new problems and adapt to new realities. These policies entail changes in many areas including patterns of production, usage of alternative sources of energy as well as transportation. Climate change policies become a new prism by which to look at economic development.

At the Latin American and Caribbean Summit on Integration and Development of the Region, in December 2008, there was wide consensus on the urgent need for efforts to ensure regional cooperation, complementation and integration in the energy sector. Given the inter-relationship between energy and climate change, in addition to the recent financial crisis, the importance of conservation and efficient use of energy resources were particularly stressed. At the same time, the investment in and advancement of new technologies for efficient renewable energy production is crucial for economic and social development for the region. There are already many options that are cost effective and commercially viable, even given the recent financial crisis. This paper presents some ideas of how government can use already existing technologies, as well as new financial mechanisms to advance both economic development and climate change agendas across sectors. While the financial crisis has presented new challenges for the region, meeting development goals and combating climate change require immediate

action in order to achieve long-term success. This paper assesses these challenges and provides some suggestions on key areas for action across sectors.

Latin America's Energy Matrix

The combination of fluctuating oil prices (previously high) and awareness of global climate change created an increase in interest and investment in renewable energy worldwide over the last three years. Total primary energy needs in LAC are estimated to increase 63% by 2030 with respect to 2006 and by 2030; LAC's demand for oil will be 30% higher than in 2007, its demand for natural gas about 100% higher and its demand for coal about 150% higher (IEA, 2008). Energy demand includes demand for both electricity and liquid fuel for either electricity or transport. Electricity demand is projected to grow particularly rapidly, in a way that over the next decade generating capacity will need to be increased by about 90 GW -nearly 50% more than current generating capabilities (ESMAP, 2005). Electricity demand will primarily be driven by the residential sector, which is expected to use nearly four times as much electricity in 2030 than in 2003, and industry, which is expected to double its electricity use (EIA 2006).1 Transportation needs in the LAC region are also growing rapidly, and the International Energy Agency forecasts that transportation fuel use will expand 70% by 2030 with respect to 2004.

According to the International Energy Agency, LAC will require a cumulative investment in energy-supply infrastructure of US$ 1.8 Billion between 2007 and 2030 (IEA, 2008). Furthermore, a lack of diversification of energy sources, has left LAC particularly vulnerable to fluctuating oil prices, supply constraints, and changing weather patterns that affect large hydropower projects

Greenhouse Gas Emissions in LAC

According to the IEA, although Latin America comprises only 6% of global emissions, per capita emissions are expected to grow 33% from 2005 to 2030, higher than the world average of 24%. Oil demand alone is projected to increase by almost 2 million barrels per day in the period 2007-2030 (IEA). Transportation will remain the dominant source of CO_2 emissions in LAC, accounting for about one-third of total emissions and increasing over 60% from 2004 to 2030. Carbon dioxide emissions from power generation and heat plants are also projected to grow, and will increase 115% between 2004 and 2030 (IEA 2006). To reduce potential growth in

[1] The current LAC electricity demand profile is industry (47%); residential (27%); commercial and public services (22%); agriculture and forestry (3%); others (1%) (IEA 2004)

greenhouse gas emissions in LAC, immediate measures should be taken. These include increased investment in renewable energy and energy efficiency technologies and processes for both the supply side (e.g., bioenergy) and the demand side (e.g., end-use energy efficiency). Renewable energy technologies to harness wind, solar, geothermal, biogas and other sources are still evolving and continue to become increasingly cost effective and should be included in the energy matrices of countries throughout the region as well.

How Energy Efficiency and Renewable Energy and Deliver Maximum Benefits for Energy Security and Combating Climate Change

There is substantial opportunity for a much improved energy scenario for LAC, with increased sustainable energy businesses in the region, motivated by climate change pressures combined with the abundance of competitive renewable energy sources. First and foremost, energy efficiency measures across sectors will help to reduce demand before addressing the amount of investment required for additional supply. For example, over the next ten years investing $16 billion in LAC in energy efficiency measures could save you approximately $53 billion in avoided fossil fuel power plant investments. In addition, base load systems, such as large fossil-fuel facilities (coal or diesel) can be substituted with clean renewable geothermal power, where locally available. Power facilities used to cover peak demand periods can be substituted by solar photovoltaic and solar thermal power during the day and daily small-hydro reservoirs during the night. Another example from a seasonal point of view, hydro projects without reservoirs (run-off-river) with very high volume and subsequent power production during rainy season, but much less in the dry season, could be backed-up by wind farms and solar facilities during the dry season in many tropical countries in LAC. Other renewable technologies that can be stored and transported, like biofuels, biomass, and biogas, will further diversify and enhance the overall operation of the power grid.

This paper will explore the opportunities offered –but also the challenges facing- the different sustainable energy options in combating climate change while meeting development goals amidst a financial crisis. The paper will first outline the opportunities and challenges for implementing demand side measures in both electricity and liquid fuel; and then outline the opportunities and challenges with implementing supply side measures in both electricity and fuel; with the ultimate goal of implementing these measures to meet climate change and development goals in the region.

Priority Areas of Action

The critical constraint to RE/EE development includes a lack of awareness and experience among investors and financiers, which leads to a higher risk perception for taking on RE/EE projects. This coupled with the absence of robust systems of measuring, monitoring, and verifying energy savings presents a challenge for clean energy projects to prove their merit (World Bank 2006a). In addition, renewable energy and energy efficiency project design and development require specific technical knowledge and training. Because such projects are new, expertise is still limited.

Lastly, there is a lack of up to date, specific information available to identify specific locations where renewable energy and energy efficiency can be harnessed in LAC. The viability of any given renewable energy project tends to be highly site specific. Thus, potential investors need to have quality information on appropriate sites and resource potential. For example, mapping of biofuels suitability areas including agricultural, environmental, and social areas will help decision makers and investors determine where to pursue projects that will help to ensure the sustainability of the industry. For energy efficiency, identifying high priority areas, industries, and sectors will also help policymakers and investors to determine where big savings can be achieved quickly; thereby providing an example for the success of energy efficiency measures and reducing perceived risk.

Despite these constraints to RE/EE development, our analysis of energy demand in LAC suggests a number of opportunities to promote sustainable biofuels, wind, solar, and efficiency as outlined throughout this paper. For example, the transport and electricity sectors are predicted to be the heaviest CO2 emitters in LAC, so efficiency policies should look to expand public transportation projects and promote efficiency measures such as cogeneration in conjunction with biofuels development. To reach these ends, LAC governments need to mainstream renewable energy and efficiency considerations into energy decision-making. With careful planning, renewable energy and efficiency measures can play a significant role in meeting growing energy demand and combating climate change in cost effective ways in the LAC region.

The key proposals and areas for action are:

- *Prioritize institutional capacity building to address energy efficiency and renewable energy in the context of climate change;*
- *Increase investment in technology, research, development and demonstration;*
- *Establish incentives for renewable energy deployment and fuel switching, according to each countries energy matrix;*
- *Harmonize energy efficiency standards and labeling across the region for products and buildings, to facilitate quick adoption and increase user acceptance and awareness;*
- *Establish energy efficiency targets across sectors, with a focus on transport and buildings;*
- *Maximize opportunities for sustainable biofuels production including export or imports tariffs (i.e, eliminating export tax for biofuels production that meets key sustainability criteria);*
- *Increase education and awareness on climate change, energy efficiency and renewable energy to foster implementation and acceptance.*
- *Bundle climate mitigation projects throughout the region to access new financing mechanisms such as the Climate Investment Fund and programmatic Clean Development Mechanism funding*

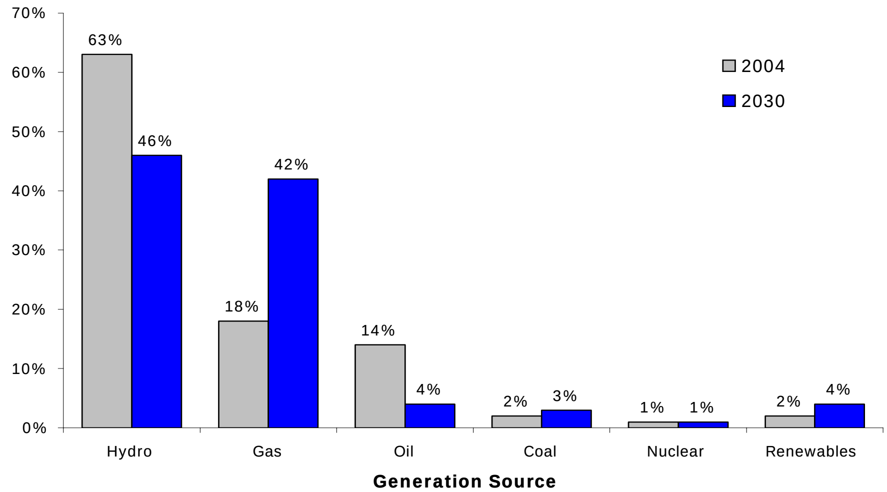
I. Introduction

LAC's Energy Matrix

The combination of fluctuating oil prices (previously high) and awareness of global climate change created an increase in interest and investment in renewable energy worldwide over the last three years. Total primary energy needs in LAC are estimated to increase 63% by 2030 with respect to 2006 and by 2030; LAC's demand for oil will be 30% higher than in 2007, its demand for natural gas about 100% higher and its demand for coal about 150% higher (International Energy Agency - IEA, 2008). Electricity demand is projected to grow particularly rapidly, in a way that over the next decade generating capacity will need to be increased by about 90 GW - nearly 50% more than current generating capabilities (ESMAP, 2005). Electricity demand will primarily be driven by the residential sector, which is expected to use nearly four times as much electricity in 2030 than in 2003, and industry, which is expected to double its electricity use (EIA 2006)[2]. Transportation needs in the LAC region are also growing rapidly, and the IEA forecasts that transportation fuel use will expand 70% by 2030 with respect to 2004. Huge inflows of capital are needed to expand supply capacity to meet the rising demand, as well as to replace existing and future supply facilities that will be retired in the coming years. According to the IEA, LAC will require a cumulative investment in energy-supply infrastructure of US$ 1 832 Billion between 2007 and 2030 (IEA, 2008). Furthermore, as can be seen in Figure 1, a lack of diversification of energy sources, has left LAC particularly vulnerable to fluctuating oil prices, supply constraints and changing weather patterns that affect large hydropower projects. All of these factors act as potential drivers for investment in energy efficiency, as the lowest hanging fruit, and renewable energies that can reduce dependence on petroleum, like bioenergy.

[2] The current LAC electricity demand profile is industry (47%); residential (27%); commercial and public services (22%); agriculture and forestry (3%); others (1%) (IEA 2004)

Figure 1: Electricity Capacity by Source (excl. Mexico) in GW (IEA, 2006)



According to the IEA, although LAC comprises only 6% of global emissions, per capita emissions are expected to grow 33% from 2005 to 2030, higher than the world average of 24%. Oil demand alone is projected to increase by almost 2 million barrels per day in the period 2007-2030 (IEA). Transportation will remain the dominant source of CO_2 emissions in LAC, accounting for about one-third of total emissions and increasing over 60% from 2004 to 2030. Carbon dioxide emissions from power generation and heat plants are also projected to grow, increasing 115% between 2004 and 2030 (IEA 2006). To reduce potential growth in greenhouse gas emissions in LAC, immediate measures should be taken. These include increased investment in renewable energy and energy efficiency technologies and processes for both the supply side (e.g., wind, geothermal, bioenergy) and the demand side (e.g., end-use energy efficiency). Renewable energy technologies to harness solar, waves and tides, biogas and other sources are still evolving and continue to become increasingly cost effective and should be included in the energy matrices of countries throughout the region as well.

Engagement of the IDB in LAC´s Energy Sector

Energy is the main item of the IDB portfolio history: 22 billion dollars until 2007. It represents 14% of the total volume of loans and guarantees approved by the IDB since its creation in 1961 (out of 156 billion dollars approved loans and guarantees leveraging 350 billion dollars in investments). 90% of this 22 billion dollar figure corresponded to loans and

guarantees for the electric power sector (40% to hydro power plants, 25% to rural electrification programs, and the balance due to transmission/distribution projects).

LAC has been one of the cleanest regions in the world, thanks to its huge hydroelectric potential. In terms of electricity, hydropower accounted in 2006 for 68% of total net electricity generation[3], while the world wide figure is just 18%. In terms of total primary energy demand, LAC relied on 30% on renewable energy whereas the world relied only on 13% in 2006. Some countries such as Colombia, Paraguay and Costa Rica rely heavily on large hydro power components in their energy generation matrix, which makes the matrix at first sight relatively "clean" due to low GHG emissions associated with this generation form. Yet, reliance on large hydro makes the electricity sector more vulnerable to climate change impacts, such as reductions in water regulation and higher variability in precipitation rates.

However, the projections for the region, prepared by the IEA at its WEO 2008, indicate in a business as usual scenario not much growth for renewable energy as one might have expected especially given the prevailing oil prices high volatility: by 2030 the share of hydropower in the region's primary energy demand would reduce from today's 11% to 10%, while the share of biomass, waste and other renewables (wind, solar, etc) would just show a mere grow from today's 19% to 20%. In terms of electricity generation, hydropower would reduce from 68% to 56% in 2030, while renewables as a whole would also reduce from 70% to 63%.

Under this situation natural gas - would be responsible for approximately 25% of LAC's total primary energy demand, compared to today's 20%. The balance would be covered by a strong growth in coal utilization (reaching 6% as compared to today's 4%) and oil, which would show a reduction to 38%, compared to today's 45%. This is due to the assumption of a strong increase in the installation of natural gas and coal-fueled electric power plants: the share of these two non-renewable energy sources would go from today's 16% to 32% of the total electricity generation in LAC by 2030. Despite all efforts, wind, solar and geothermal would account for only a mere 4% of the LAC electricity generation by 2030.

Nonetheless, the IDB believe there is plenty of room for a much improved energy scenario for LAC, with increased sustainable energy businesses in the region, motivated by climate change pressures combined with the abundance of competitive renewable energy

[3] International Energy Agency (www.iea.org/Textbase/stats/electricitydata)

sources in LAC. For example, base load systems, such as large fossil-fuel facilities (coal or diesel) can be substituted with clean renewable geothermal power, where locally available. Power facilities used to cover peak demand periods can be substituted by solar photovoltaic and solar thermal power during the day and daily small-hydro reservoirs during the night. Another example from a seasonal point of view, hydro projects without reservoirs (run-off-river) with very high volume and subsequent power production during rainy season, but much less in the dry season, could be backed-up by wind farms and solar facilities during the dry season in many tropical countries in LAC. Other renewable technologies that can be stored and transported, like biofuels, biomass, and biogas, with further diversify and enhance the overall operation of the power grid.

In order to better explore these opportunities, the IDB launched in 2007 its Sustainable Energy and Climate Change Initiative – SECCI, employing its own resources combined with those from select partners, to help catalyze public and private efforts and materialize investments in the field of sustainable energy. SECCI is directing its efforts under 4 pillars:

(i) Renewable energy/energy efficiency;
(ii) Biofuels;
(iii) Carbon finance; and
(iv) Adaptation to climate change.

All supported by 2 funds with US$20 million each employing IDB resources and multi-donor contributions.

This paper will further explore the opportunities offered – but also challenges facing - the different sustainable energy alternatives; but it will start by taking one step back and recalling one of the main drivers for the urgent need in greening the energy matrix.

II. Renewable Energy

Introduction

Renewable energy (RE) offers our society the chance to a more sustainable growth path in terms of energy supply, reduction of carbon emissions, energy security and economic development. Its fantastic development in the last decade has taught us not to merely see renewable energy as an environmentally sound alternative to fossil fuels, but as an integral approach to a sustainable energy policy where society as a whole can benefit from its implementation.

Global Trends

Renewable technologies and industries have been growing at rates of 20 to 60 percent yearly, capturing the interest of the largest global players not only in the power sector but mainstream investors from the most diverse backgrounds. In 2007, more than $ 100 billion was invested in renewable energy assets, manufacturing, research and development. In spite of the current financial crisis the medium and long term trends indicate that these figures will continue to increase.

Recent studies in countries with a high degree of RE penetration show that the costs associated with the implementation of RE technologies, due to financial support from governments (e.g. feed in tariffs) and additional regulatory and transaction costs are less than the savings achieved in the energy sector in terms of reduction of electricity prices[4], avoided costs from externalities (climate change and air pollutants) and avoided costs from fossil fuel imports. This fact demystifies the widely accepted misconception of RE being "not cheap" and a luxury form of generating electricity. While this is certainly true for RE technologies which have not reached market maturity (offshore wind, wave, tidal, grid connected photovoltaic) there are already commercially proven technologies (mainly onshore wind, solar thermal, geothermal, and biomass) which can compete with the traditional "cheap" generation alternatives from fossil fuels like coal and natural gas in specific regions.

In addition, policy incentives favoring renewable energy can help to defray the high upfront costs, and as scale of use increases the costs decline significantly. For example, in the

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[4] Due to the fact that electricity generated from wind or solar plants which is fed into the grid displaces costly backup fossil fuel generation alternatives during peak hours (merit-order effect) wholesale electricity prices experiment a net reduction in the market. (see: *EEG-The Renewable Energy Sources Act. The success story of sustainable policies for Germany*. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. July 2007.; and *Estudio macroeconómico del impacto del sector eólico en España*. Deloitte para la Asociación Empresarial Eólica. Noviembre 2008).

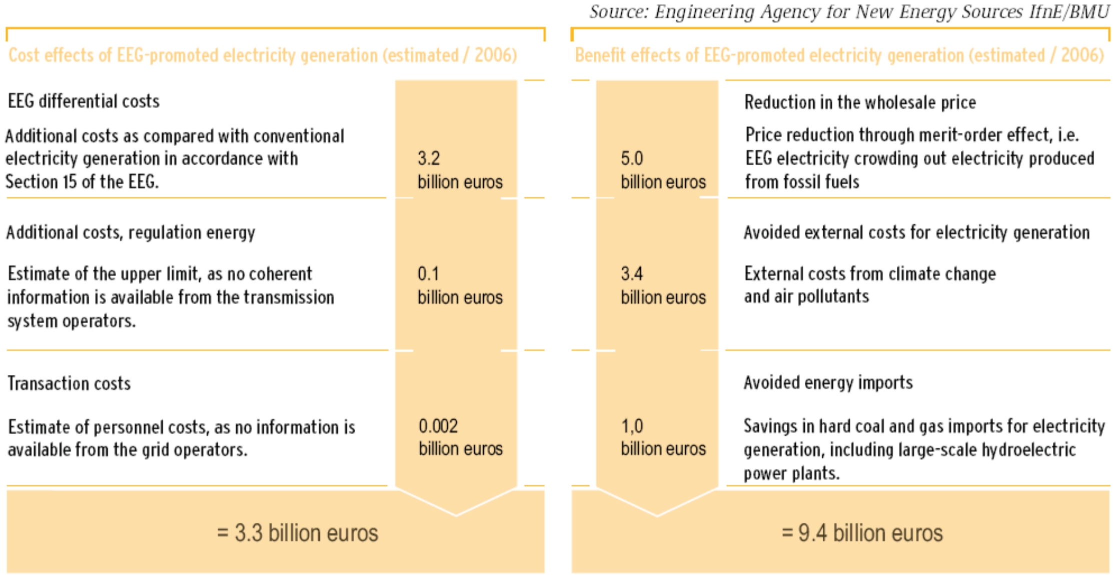
case of solar energy, costs have been reduced from $200 to $3 per installed watt. Private sector investment will also be a key element in reducing costs further. The Millennium Task Force on Poverty estimates that total public funding required to achieve the necessary energy targets will amount to $14.3 billion annually or $20 per capita. [5]

In the case of Germany (Fig. 1) the net benefit for the entire society has been quantified as 5.1 billion € in 2006 thanks to the implementation of the Renewable Energy Law (*Erneuerbare Energie Gesetz - EEG).* A similar effect has been observed in Spain where it was calculated that in 2007 wind energy achieved net savings in the electricity market of 207 million €, even without taking environmental externalities into account. This means that the presence of wind power in the Spanish electricity generation mix did not result in increased power prices, but in contrast helped reduce the electricity price by 6 €/MWh for that period.

In both of these countries renewables have reached a high level of penetration (wind power covering up to 40% of total demand in the case of Spain without any technical problems). The potential of these non-conventional renewable energies like solar, wind, geothermal and marine energy remains untapped, with actual figures showing that less than 2% of electricity generation in LAC comes from these energy sources.

Figure 1. Costs and benefits of the German Renewable Energy Law (EEG)

Source: Engineering Agency for New Energy Sources IfnE/BMU



[5] REN 21,Worldwatch Institute, "*Energy for Development: The Potential Role of Renewable Energy in Meeting the Millennium Development Goals*", http://www.ren21.net/pdf/REN21Report%20RETs%20for%20MDGs.pdf

Renewable Energy as a Solution to the Dual Challenge of Economic Development and Climate Change

Today, climate change has become one of the most salient issues in the global political agenda. Global warming is a recognized problem and an issue that needs immediate policy action. States initially recognized the need to address this issue by signing an international treaty in 1992, the United Nations Framework Convention on Climate Change, in the context of the Earth Summit.[6] Green house gas (GHG) emission levels have risen considerably since then, however.[7] Climate change policies, defined as a twofold action – attempting to mitigate the effects of climate change by reducing greenhouse gas emissions of anthropogenic sources and seeking to adapt to climatic changes, have been an exception more than a rule.

The need to address the impacts of climate change in the developing world is growing more urgent, particularly within the poorest countries given their greater vulnerability. According to the Stern Review (The Economics of Climate Change, 2006), poor countries are the ones that will bear the greatest burden of the impacts of climate change.[8] Poverty alleviation necessitates not only good macroeconomic policies that foster sustained economic growth, but also take into account the interaction between poverty, energy, agriculture, resource availability and climate and environmental issues.[9]

Thus, developing countries' governments confront the challenges of meeting growing energy needs as a result of pursuing economic development objectives and raising living standards. Combining climate change policies with economic development goals will ideally result in a shift from this developmental paradigm towards more resilient low-carbon economies. In order to change the existing patterns of development and ensure the shift towards low carbon economies, all sectors of the economy must be included in developing effective policies to confront the new problems and adapt to new realities. These policies entail changes in many areas including patterns of production, usage of alternative sources of energy as well as transportation. Climate change policies become a new prism by which to look at economic development.

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[6] The Earth Summit in Rio de Janeiro was a singular UN conference, in terms of both its size and the scope of its concerns. Twenty years after the first global environment conference, the UN sought to help Governments rethink economic development and find ways to halt the destruction of natural resources and pollution of the planet.

[7] At a global level, the concentration of GHG has increased to 379 ppm in 2005. According to the Inter-Governmental Panel on Climate Change Fourth Assessment Report, eleven of the twelve years, within the period of 1995 to 2006, rank among the twelve warmest years in the instrumental record of global surface temperature (IPCC, 2007). Moreover, the rate of growth of CO2-eq emissions was much higher during the recent 10-year period of 1995-2004 (0.92 GtCO2-eq per year) than during the previous period of 1970-1994 (0.43 GtCO2-eq per year).

[8] *Stern Review: The Economics of Climate Change*, HM Treasury (2006).

[9] Eugenio Díaz Bonilla, (2008), *Global Macroeconomic Developments and Poverty*, IFPRI Discussion Paper No 00766.

Poverty reduction is the underpinning challenge of the Millennium Declaration and its associated Millennium Development Goals (MDGs) endorsed by 189 nations to halve extreme poverty by 2015. The 2008 Millennium Development Goals Report (MDGR) published by the United Nations describes the progress achieved by countries around the world, even in some of the more challenging regions, in terms of incidence of poverty. According to the Report, it is also expected that, a number of goals[10] will be reached by 2015, as was originally planned. However, in absolute numbers, presently over 1 billion people – two thirds of them women – live in extreme poverty, i.e. with less than US$ 1 a day, nearly 3 billion with less than US$ 2 a day. This means, that in absolute terms, despite international efforts, poverty and inequalities have worsened in many countries over the last decade.

This reality could be made even worse given the current financial crisis. As the literature on poverty alleviation and macroeconomic developments suggests, after financial turmoil there is a documented increase in poverty[11]. Economic disruptions have clear negative effects on poverty in the short term, and tend to crowd out investment on education, health and infrastructure in the long term. The current world economic deceleration raises the question of the impacts of the global economic downturn and resource availability on growth and poverty in developing countries.

In addition to the questions surrounding the possibilities of poverty alleviation in the context of the financial crisis, there are a group of goals[12] and specific targets that will not be achieved unless additional and immediate international support is mobilized. or climate change is taken into account when considering development options.[13] This is of particular relevance if one considers that net development gains from poverty alleviation efforts could be offset by already observed and anticipated impacts of climate change.

Since its constitution, the Intergovernmental Panel on Climate Change (IPCC) has increasingly emphasized that the current and predicted changes in the global climate system are primarily anthropogenic, i.e. caused by human activities. The increases in global mean temperatures worldwide triggers profound changes in the biosphere, such as sea level rise,

[10] Goal 1: Eradicate extreme poverty and hunger; Goal 4 : Reduce child mortality
[11] Díaz Bonilla, 2008.
[12] Goal 5: Improve maternal health, particularly in the Sub-Saharan region and Southern Asia.
[13] Specifically, target 1 under goal 7: Ensure environmental sustainability calls for an immediate international action to contain rising Greenhouse Gas emissions; specifically marine areas and land conservation need greater attention

variations of precipitation patterns, shifts of climatic zones, increase of the frequency and magnitude of extreme weather event such as droughts, floods and storms.

More specifically for Latin America and the Caribbean, the Fourth Assessment Report (FAR) published by the IPCC, indicates that initial estimates of the projected mean warming for LAC could be between 1 and 4 degrees in the best case scenario (B2), and between 2 and 6 degrees in the worst case scenario (A2). In addition, according to IPCC, most general circulation models have predicted large rainfall anomalies in the inter-tropical region and smaller ones in extra-tropical regions, what in turn will seriously affect crop yields and the availability of water for human consumption, energy production and irrigation. These predicted changes in rainfall patterns have been confirmed by observations throughout the region. Moreover, climate models predict that the Caribbean basin will be prone to more intense and frequent extreme events, affecting millions already vulnerable due to other non-climate related stresses directly compromising their adaptive capacity.

Furthermore, new scientific evidence suggests that climate change is happening faster than forecasted a few years ago and that time is running out. While the prediction of these changes, with regard to exact rates and local implications, is subject to uncertainty due to the high complexity of the science behind the models, the one single most important and undisputable fact is that climate change is happening, it is happening fast, and responses are urgent and actions must be committed and concrete.

However, vulnerability to observed and anticipated effects of climate change could be significantly reduced if proper actions are taken during the design process of national sustainable development plans. In summary, climate variability and change threatens to undo all the progress made so far in the achievement of the MDGs and to stagger economic growth in the region in a context where financial resources are limited.

Poverty reduction, as called for in the MDGs, can not occur without affordable and reliable energy services. At the same time, burning fossil fuels for energy only contributes to the damaging effects of climate change on the world´s poor. In order to achieve poverty reduction in the context of climate change a dual approach is required, first to address access and reliability of the energy supply, especially in poor communities; and second, ensuring that the energy supply does not further exacerbate the problems of climate change by increasing emissions. The relationship between climate change and energy is symbiotic in that the impacts of climate change can have serious negative impacts on sustainable development; while at the

same time, implementing renewable energy projects to deal with climate change can improve and support sustainable development.

The energy sector is by far the largest contributor to increasing greenhouse gas emissions, with energy related carbon dioxide emissions accounting for 61% of total GHG emissions. Energy, currently primarily provided by fossil fuel sources, is essential for development and creating jobs, in addition to improving health and education services and other basic needs. Approximately 1.6 billion people worldwide, or about one quarter of the global population, do not have access to electricity, with four out of five of them living in rural areas. he IEA estimates that if the MDG poverty reduction target is to be met, modern energy services will need to be provided to an additional 700 million people by 2015.[14]

Renewable energy can bring many benefits to poor communities including greater access to electricity, lower costs, preservation of local environmental resources, and support local infrastructure development for schools and health care. For example, introducing biogas generators in rural areas to produce methane from local waste or biomass resources, could provide the energy required for cooking and lighting, to reduce or eliminate reliance on costly kerosene, and to preserve neighboring forests that may be stressed from over-logging for fuel. [15] Installing small scale energy generation system, such as wind, solar, and small hydro, can help to bring access to rural areas, since they do not require the large investment of a coal fired or large hydro project and the necessary transmission lines.

Many efforts have been undertaken globally to address poverty reduction by improving access to and reducing the costs of renewable energy but there are still many challenges to scaling up renewable energy projects in the developing world. Although renewable resources, by definition, are abundant in most poor countries, most have not adopted policies to support and expedite the development of renewable energy technologies. Government policies in much of the developing world still largely focus on conventional energy sources such as fossil fuels and large hydro.

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[14] World Energy Outlook 2008, http://www.worldenergyoutlook.org/docs/weo2008/WEO2008_es_english.pdf
[15] *Renewable Energy and Poverty Alleviation*, CGPRT, October 2004, http://www.uncapsa.org/Flash/flash1004.pdf

Combating Poverty with Renewable Energy: Clean Development Mechanism Financing

In addition to the Climate Investment Fund - CIF, discussed in a separate section in this paper, one of the key mechanisms approved under the Kyoto Protocol to attract much needed capital flow to developing countries for investment in renewable energy projects, is the Clean Development Mechanism (CDM). The CDM provides industrialized countries with the possibility to meet their emission reduction commitments by contributing to greenhouse gas reductions in developing countries. The goal of the CDM is to promote investment in renewable energy projects in the developing world.

However, there is some concern about the real development, or poverty alleviation impact of CDM projects. There are higher transaction costs of "pro-poor" projects due to many organizational and administrative factors, including large up-front costs, longer payback periods, and relatively higher risks. The policies and procedures that projects must follow can be a barrier to achieving poverty reduction goals, given that this often impedes the ability of smaller projects to succeed in gaining CDM financing. [16] As currently designed, the CDM will not be effective in helping LAC achieve GHG emissions reductions or development in a cost-effective way.

One example of efforts to address these barriers and make the CDM more effective at improving sustainable development and real GHG reductions is through the Inter-American Development Bank's (IDB) Sustainable Energy and Climate Change Initiative. The IDB is providing grants for technical assistance to assess GHG reduction potential across a range of sectors and projects, and also providing the underlying financing for projects with a high development impact. The objective of the IDB's carbon financing strategy is to reduce the transaction costs and risks for project development in order to increase the number and type of CDM projects in the region, with a focus on high development impact.

Looking forward to the post 2012 climate regime, there are two issues of utmost importance for development and greenhouse gas reduction potential for LAC. One is expanding the scope of CDM beyond project based methodologies, to include programmatic approaches and ideally target increases in energy efficiency measures. A second issue, is

[16] Richards, Micahel, (2003) "*Poverty Reduction, Equity and Climate Change: Global Governance Synergies*", Overseas Development Institute http://www.odi.org.uk/IEDG/publications/climate_change_web.pdf

incorporating forests and reduced emission from deforestation and degradation (REDD) into the post 2012 regime to provide critical biodiversity protection and increased mitigation potential through forestry projects. Addressing both of these issues in the next round of negotiations will also improve the development impacts and poverty reduction potential under an extended CDM framework.

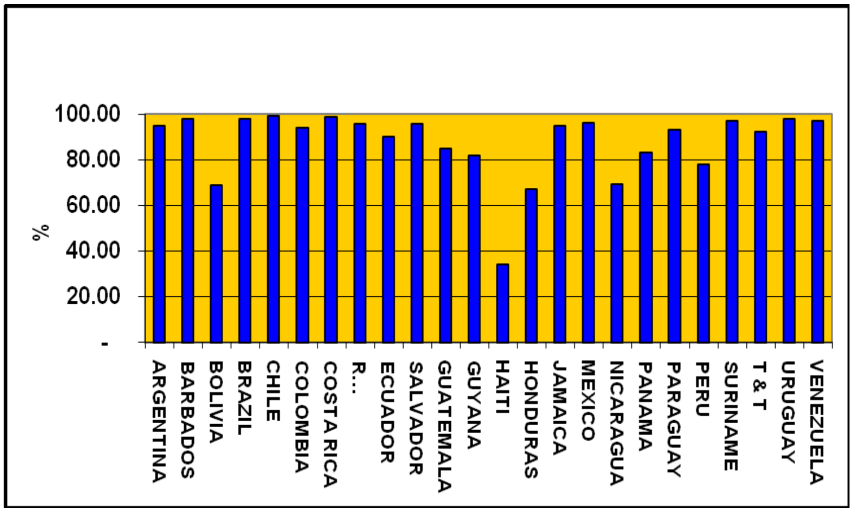
Access to Electricity and Renewable Energy Development

Historically, the LAC region struggled with providing energy access to many more remote communities and rural populations. With respect to the current electricity coverage in LAC, it is estimated that more than 90% of the population of the region now has access to electricity services, especially the urban populations where 98% of the population has coverage. Nevertheless, at least a third of the rural population of LAC still lacks access to electricity services.

Some countries have reached coverage of approximately 99% of the population at the national level, as is the case of Chile, Costa Rica and Venezuela. Nevertheless, the coverage varies greatly among the different countries and several of them remain with very low levels, as is the case of Haiti with 34% coverage and Nicaragua with less than 70% at national levels (see Figure 3). It is estimated that 40 million of the total inhabitants in the LAC region continue without access to electricity services.

Figure 3. Electricity coverage in LAC – 2007[17]

(in percentage of total population)



The IDB, the Energy Sector and Rural Electrification

The IDB has had a prominent role in the development of the electric sector of its borrowing countries along its 50 years of existence, through financing of generation, transmission (including regional integration) and distribution projects, as well as in the design and implementation of reforms in the sector, differentiated among the countries. The energy sector is the main item of the IDB projects portfolio, with US$22 billion, corresponding to 14% of the total volume of resources approved for loans and guarantees since the creation of the IDB (to the year 2007). Of this total of loans to the sector energy, 90% was directed to projects of the electric sector, especially construction of hydroelectric plants and rural electrification, which represent respectively 40% and 25% of the total IDB resources lend to energy.

The recent experience of the IDB in rural electrification in a context of a market with participation of the private sector includes the following loans in execution: GU-L1018 for US$100 million (multiphase) for Guatemala, 1790/OC-PN for US$30 million for Panama and 1475/OC-CH for US$40 million for Chile. All these projects included components to establish projects of renewable energy in remote areas. The loan 1017/SF-NI for Nicaragua, completely

[17] OLADE/SIEE, 2008

disbursed, included a component by US$ 3,5 million for sustainable off-grid solutions with renewable energy[18]. Besides that, the IDB has financed several technical cooperation with non reimbursable resources in support to the rural renewable energy markets development in diverse countries[19], including the construction of pilot projects of sustainable remote systems with the use of renewable energy in preparation for the future execution of loans in the region.

Programs for Sustainable Rural Electrification

The IDB experience in rural electrification in the context of a market with participation from the private sector indicates that one should consider as eligible solutions for rural electrification both: (i) existing electric grid extension systems, and (ii) remote systems employing renewable energy such as small and micro hydroelectric plants, wind power, solar energy and biomass (see Figure 4).

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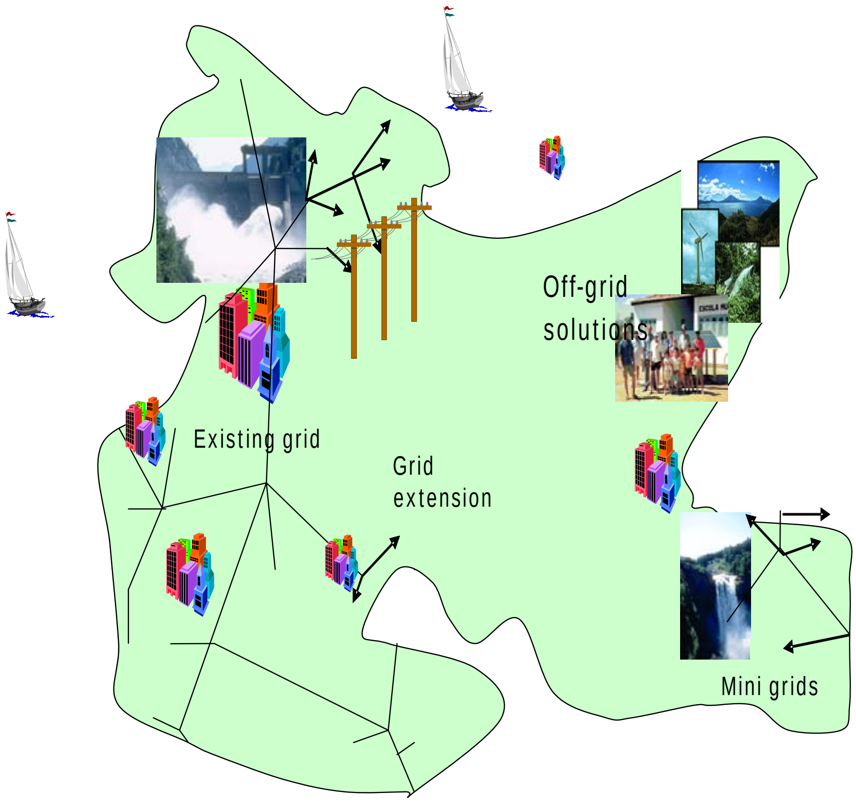
[18] Waspám Project with 1,500 homes with photovoltaic panels under a contract for operation and maintenance signed for 15 years with a private sector operator, executed by the National Energy Commission – CNE of Nicaragua.

[19] Programs in Brazil (ATN/EA-7191-BR, ATN/MT-6697-BR, ATN/JF-6630-BR and ATN/DO-9043-BR), in El Salvador (ATN/JF-7918-ES) and projects for the implementation of micro enterprises for the provision of sustainable rural energy services (ATN/SF-6102-BR in Brazil and ATN/EM-6922-PE and SP/EM-00-03-PE in Peru). See also: http://www.iadb.org/idbamerica/index.cfm?thisid=4070

Figure 4. Rural Electrification Solutions through Grid Extension and off-grid Systems



The State intervention is necessary to assure the coverage expansion if a specific rural electrification project is not profitable for the private sector. This intervention can be done through a legislation that makes mandatory the coverage expansion, or through the provision of an incentive for the investment of the distribution company (or the rural renewable energy service providers). These incentives make possible the coverage expansion while providing benefits to the consumer in terms of allowing for accessible prices for the service. In all cases, the incentives shall be limited to cover part of the initial investment required, so all the costs of operation and maintenance should be covered exclusively by the users through the pricing system defined in order to guarantee the sustainability of the operation of the systems along their useful life (recent IDB projects have considered 10 years as minimum contractual period for operation of renewable energy systems).

The main lessons learned in relation to programs of rural electrification in a context of a market with participation of the private sector have been:

(i) It is preferable to encourage private sector investment instead of financing the State to build the rural electrification systems. This approach simplifies and increases the efficiency of the process of developing the projects while the final designs and construction of the systems remain in charge of the distributors/service providers responsible for operating and to maintain them in the future;

(ii) The importance to incorporate improvements to the procedures and methodologies employed in all the phases of development of the projects, particularly seeking to reduce the State incentives to the minimum required; and,

(iii) Select an adequate plan of administration of the systems to guarantee the sustainability of the remote systems based on renewable energies, for example, by means of micro enterprises as service providers under contracts that define their responsibilities, especially with respect to the operation and maintenance of the systems. The process should include extensive community involvement , seeking their support, while providing accessible costs for the users based on their capacity to pay.

In other words, one should promote projects of rural electrification that:

(i) Could be developed directly by the final beneficiaries of the services, seeking the joint participation of the communities in the provision of the service in such a way that assure its sustainability;

(ii) When incentives are necessary, these are provided only to the investment and not to the operation and maintenance, in a transparent way and in direct benefit to the users.

Examples of renewable energy from the LAC Region

Chile:

A preliminary resource assessment study in the field of marine energy on the Chilean coast has been carried out by the IDB. Marine energy in this instance should be understood as wave and tidal stream energy.

The key objectives of this study are the identification of the most promising zones for wave and tidal energy projects, the quantification of the overall resource and the energy yield associated with a number of demonstration and pre-commercial projects in such zones. A review of similar projects worldwide, engineering expertise required to develop and install such projects and guidelines for the next steps are also provided.

Some key figures are derived for the first time in this study. For example, and with regard to wave energy, the raw potential for the entire Chilean coast exceeds 164 GW, an unrivalled amount. Should only 10% of the raw resource be harnessed, that amount would still largely exceed the total installed capacity in the SIC system (the central electricity network in Chile). The study indicates that the regions south of Valparaiso show the best coupling between attributes and constraints, although it excludes first-stage projects in regions XI and XII as the electrical grid capacity accounts from less than 1% of the national total in such areas. Given the early stage of the technologies and the massive potential, Chile could play a vital role in the field and benefit from an early involvement in the development of the technologies (with worldwide implications).

III. Bioenergy – Global Trends, Challenges and Opportunities

Introduction

By 2030, global transport energy needs are expected to grow 55%, with particularly high growth rates in developing countries, heightening the need for sustainable transport solutions that utilize alternative fuels. Although global biofuel production tripled from 18.2 billion liters in 2000 to about 60.6 billion liters in 2007, it still accounts for less than 3% of the global transportation fuel supply (IEA, 2008). The transport sector remains in a highly vulnerable state of near-total dependence (approximately 98%) on petroleum derivatives. Some regions are almost completely dependent on imported petroleum for all of their energy needs. The Caribbean, for example, imports 93% of its energy in the form of petroleum.[20] In addition, many developing countries subsidize petroleum-based fuels considerably. In this context, even small amounts of domestically-produced biofuels can help diversify fuel options, thereby reducing price risk and supply vulnerability; the IEA forecasts an increase of about 275% in biofuel consumption between 2006 and 2030 (IEA, 2008).

Bioenergy

The IEA estimates that combustible renewables and waste – which includes municipal waste, industrial waste, primary biomass, and biogas – accounted for 10.6% and 10.1% of the world's total primary energy supply in 1973 and 2006, respectively. Of this 10%, approximately 25% of total biomass potential is found in Latin America and the Caribbean, the largest single contribution from any region. Two-thirds of this was residential consumption of primary biomass: woody biomass combusted for heat and cooking. The remaining one-third of combustible renewables and waste that is combusted directly or transformed for thermal and electric power generation, referred herein as "bioenergy". Primary solid biomass accounted for 2.9% of the world's primary energy supply in 2005, with municipal waste, industrial waste, and biogas accounting for a miniscule 0.02%, 0.01%, and 0.01% respectively. In addition to their significance as an actual and potential source of power in themselves, biomass and biogas are frequently used in biofuels projects in order to enhance productivity, lower costs, and improve energy balance and environmental performance (Rothkopf 2008).

Rapid development of the biofuels and bioenergy industries have produced a range of challenges, including increasing commodity and feedstock costs, food security concerns,

[20] Caricom Secretariat Press Release, August 6 2007, http://www.caricom.org/jsp/pressreleases/pres175_07.jsp

adverse environmental impacts, and difficulties expanding supply chains beyond the highly localized level. However new feedstocks, practices, and developing technologies are generating optimism that these issues will be addressed and that biofuels and bioenergy will continue to grow in importance as a renewable energy source for the region.

Biofuels Trends and Opportunities

An increasing number of countries have begun producing biofuels, increasing supply and creating economies of scale for technologies used in production. At the same time, the price of oil skyrocketed, making biofuels not only beneficial for energy security and climate change, but also providing economic benefits from avoided oil expenditures. In late 2008, oil prices subsequently plummeted, making biofuels less competitive from an economic perspective for the near term. Improvements in the efficiency of biofuels production have helped to bring down the costs and will continue to do so as advances are made. Production of ethanol from sugarcane is an especially efficient process when cogeneration from the bagasse is used to fire the facility and provide excess electricity to the grid, discussed in more detail later in this paper. This provides a dual income stream for the producer reducing risk from volatility within the market.

Policy Trends

Biofuels account for ~6% of the energy currently used in LAC's transportation sector. The majority, of this figure is supplied by Brazil, which accounts for 70% of global production. With respect to biodiesel, there are no major producers in LAC, though Brazil opened its first biodiesel plant in March 2005 and many new facilities are under production throughout the region, especially in Argentina, Costa Rica, and Guatemala (IEA 2006). Country-specific plans for biofuel development include those of Costa Rica, Guatemala, Honduras, Colombia, Mexico, and many others which have stated their interest in individual, detailed feasibility studies to outline the potential impact of biofuels development. Costa Rica's government is creating a broad strategy to rapidly expand the use of biofuels by 2020, with a blending mandate beginning in 2009. Colombia passed a law in 2001 requiring a 10% ethanol oxygenation for all gasoline in urban centers of more than 500,000 inhabitants (IEA 2004). Argentina will require B5 (5% biodiesel blend) and E5 (5% ethanol blend) by 2010 and the Dominican Republic will require E15 and B2 by 2015. Mexico has conducted analysis of instituting a blending mandate in a few major cities for replacement of MBTE with ethanol. Over the last year the IDB witnessed an increasing demand from the region to develop Biofuels Action Plans including from Argentina, Peru, El Salvador, Haiti, Dominican Republic, Jamaica, Mexico, Nicaragua, Paraguay, and Venezuela.

As governments throughout the region begin to implement regulatory frameworks for biofuels, some of the most commonly used biofuels support policies are: voluntary or mandatory blending targets; lower taxes; preferential government purchasing; research and development; grants, loans, guarantees and other direct financial supports; and business development incentives. Indirect support is commonly provided through agricultural, forestry, transport and rural development policy (WRI 2008).

The results of these regulatory mechanisms throughout the region, as increased blending mandates and subsidized production, in many countries have yet to be realized, except Brazil. While the initial motivation for Brazil to support biofuels was purely economic and tied to the high cost of imported oil, its biofuel program is now closely tied to efforts to respond to economics, energy security, trade, climate change and to facilitate rural development. Key measures in Brazil included the establishment of a required level of ethanol to be blended into gasoline, and recent initiatives to make flexible-fuel vehicles widely available in order to increase the proportion of ethanol in the fuel mix while maintaining customer freedom of choice between the two fuels. The provision of incentives and support for technologies for ethanol production, setting technical standards have also been important. Brazil's experience indicates that successful uptake of biofuels can hinge upon strong political support for renewable energy.

Environmental policies affect biofuels production, and in some cases – such as with air pollution reduction efforts from cars in several developing countries – environmental policies can be a driver for biofuels development. The risk that biofuel production will cause environmental harm is motivating a number of sustainability assurance efforts, discussed later in this section.

Economic Trends

The economics of biofuels are strongly affected by local factors including local policy, feedstock production efficiency, local infrastructure, climate, conversion process, scale of production, and regional economic conditions, making cost estimates difficult. There is also a lack of accurate data outside the U.S., EU, and Brazil (Rothkopf 2008). Data has not been released yet on the results of this year's economic crisis on biofuels production in the region. That said, Latin America has a comparative advantage in producing biofuels versus other regions given higher yields, abundant biomass, lower labor costs, and proximity for technology and knowledge transfer from the U.S. and Brazil.

On the demand side, fuel markets are heavily fragmented by protectionist trade policies, a patchwork of regional and national biofuels incentives, a lack of standardization, and a lack of international trade logistics and infrastructure. Thus, output prices vary considerably by location. Bioenergy markets are highly diverse and frequently highly localized, with the exception of a few emerging supply chains that are driving a trend toward the commoditization of certain biomass resources. Given this heterogeneity, it is difficult to establish an aggregate figure for total investment and operating costs for bioenergy production. Nevertheless, investment costs associated with some bioenergy technologies are detailed in Table 1 below.

Table 1: Investment Costs for Different Bio-conversion Options (IEA, 2007)

Conversion Option	Investment Cost Ranges ($/kW)
Biomass combustion for heat	300–800/Kwth* for automatic furnaces, 300–700/kWh for larger furnaces
Biomass combustion for electrical power generation	1,600–2,500/kWh
Co-firing of biomass with coal for electric power generation	100–1,000/kWh plus costs of existing power station, depending on biomass fuel and co-firing configuration
Gasification or combined heat and power (CHP) using gas engines	1,000–3,000 kWh, depending on configuration

Note: kilowatt thermal output

Biofuels production costs include costs for feedstocks, non-feedstock operating expenses, and capital expenditures. While production costs vary widely, as described above, feedstock costs have the largest influence for first-generation technologies. Among current technologies, sugarcane based ethanol is by far the cheapest, at $0.20 - $0.30 per liter, a little less than half that of corn ethanol[21]. Biodiesel from waste oil is the only competitive biodiesel, at $0.40-$0.55 per liter, compared to vegetable oil costs of $0.70-$1.00 per liter. Next generation biofuel costs will come with lower feedstock costs and higher capital and operating costs.

Global biofuels markets are fragmented, with international trade currently accounting for only about 10% of the world's biofuel consumption. The immaturity of the international market is due to a range of factors including a lack of harmonization in standards, protective tariffs in major U.S. and EU markets, and the relatively low level of global demand for biofuels

[21] U.S. corn ethanol production cost $0.35 - $0.50

compared to petroleum products. These factors have impeded necessary investments in logistics and infrastructure networks. In the absence of liquid and deep international markets, biofuel prices are determined by fossil fuel prices, the local economics of production, and national and local subsidies for producers, distributors, and consumers (Rothkopf 2008).

Trends in Global Biofuels Trade

Historically, biofuel trade flows have been limited as most of the production has been for domestic consumption. However, in 2008 and increasingly going forward, international trade in biofuels is projected to rise as the upsurge in consumption and accelerating production responds to continued fluctuating fossil fuel prices, nations need to diversify their energy supply matrices, and as policy mandates in Europe and the US take effect.

In 2006, the volume of global ethanol trade increased to around 7.8 billion liters, compared with 5.9 billion the year before and 3.2 billion in 2002. The surge was attributed mainly to the significant increase in exports from Brazil (primarily to the U.S. and the EU), which exceeded 3.5 billion liters in 2007, up only slightly from 2006 numbers, but representing a nearly five fold increase over 2002 figures. With record levels of shipments from Brazil, the share of world ethanol trade that North and South America represent has remained a consistent 60%. Brazil has been cultivating many other export opportunities including several Asian countries, and in early 2008 was negotiating a deal with Germany. Despite consistently strong performance, analysts estimate that US ethanol import demand did not remain as strong in 2007 as it was in 2006 due to changing market conditions. However, the new U.S. Renewable Fuels Standard – RFS passed at the end of 2007 is expected to increase demand for both domestically produced and imported biofuels.

In addition to the WTO, several regional and bilateral trade agreements, mostly involving the U.S. and the EU, currently regulate biofuels trade. The U.S.-Caribbean Basin Initiative (CBI) allows member nations to export ethanol duty-free to the U.S., produced in a non-member country as long as 30% of the value is generated in the Caribbean. In the case of ethanol, this is generally done by dehydrating hydrous ethanol to produce anhydrous ethanol that can be blended with gasoline. This export is duty free up to 7% of total US domestic ethanol consumption beyond which, up to 265 million liters can be imported into the U.S. duty free as long as 30-50% of the ethanol is produced using Caribbean feedstock. For 2006-2007, additional dehydration capacity being developed in the CBI signatory nations is likely to contribute heavily towards the U.S.'s duty-free import quota. CBI countries are poised to be allowed to ship 1.3 billion liters of duty free alcohol to the U.S. compared with 1.015 billion in

2006 (F.O. Licht, 2007[22]). In 2006, total imports from CBI countries amassed to 780 million liters or 77% of the total tariff rate quota which was a dramatic increase from 43% in 2005 and 37% in 2004.[23]

In addition to the CBI, there are a few other regional trade agreements that will most likely impact future biofuel trade between member countries. The Southern Common market (MERCOSUR) was formed in 1991 to allow free trade between member countries with the eventual goal of economic integration of all of South America, as the world's fourth largest trading bloc after the EU, NAFTA, and ASEAN. Current members of MERCOSUR include Argentina, Brazil, Paraguay, Uruguay and Venezuela with Chile, Bolivia, Colombia, Ecuador and Peru as associate members[24]. Even though ethanol is integrated according to the rules of MERCOSUR, very little trade has happened due to: technical fuel specifications being different in each country (limiting export from Brazil to other member countries); very limited production in the member countries besides Brazil[25].

CAFTA-DR is the second largest free-trade zone in LAC for U.S. exports that was created by the CBI countries. It has eliminated 80% of export tariffs since its creation in 2004, with the remaining tariffs being scheduled to be phased out over the next 10 years.[26] Even though a huge opportunity has been opened to CAFTA member countries to export biofuels to the US, little investments are being made for domestic biofuel production in most member countries.[27]

Domestic and regional policies also affect trade flows. For example, as mentioned previously, the EU has passed several biofuels support policies over the past few years including a biofuels directive in 2007, building upon former legislation EC 2003/30, which requires a 10% renewable energy penetration level in the transport sectors of all EU countries by 2020 effectively guaranteeing a market. It is widely acknowledged that most EU countries will have to import some fuel to achieve this target thus the policy will stimulate trade.

[22] F.O. Licht, July 23, 2007, World Ethanol and Biofuels Report, Vol. 5, No. 22.
[23] Op. Cit.
[24] European Commission, European Union in the World-External Relations. The EU's Relations with Mercosur. Updated, November 2005,; Marcos Sawaya Jank, Geraldine Kutas, Antonio Josino Meirelles Neto, Andre Meloni Nassar, Joaquim Henrique da Cunha Filho, EU-Mercosur Negotiations on Agriculture: Challenges and Perspectives, Institute for International Trade Negotiations (ICONE), ,September 10, 2004, Sao Paulo.

[26] US Department of State, International Information Programs, "Central America Free Trade Agreement – Dominican Republic" . Last updated March 2007. http://usinfo.state.gov/wh/americas/regional_trade/drcafta.html
[27] Datagro. Plinio Nastari. Email to Suzanne Hunt May 2008.

Trends in Production

There have been many improvements in the cultivation and processing of first generation biofuels over the last couple years. Per acre yields have increased dramatically through the use of genetically modified strains that are resistant to insects and diseases, and more tolerant of herbicides and drought. Other factors increasing yields is the use of advanced technologies in farm management (including the use of global positioning systems - GPS), the adoption of reduced till and no-till farming practices, slow-release fertilizer, and improved irrigation systems. Specific to sugarcane production, mechanical harvesting has become more widespread, instead of traditional field burning which decreases emissions, and increases overall biomass yield, providing greater total energy yields. Brazil has mandated that all sugarcane producers in Sao Paulo must adopt mechanical harvesting in the next fifteen years.

There have also been significant gains in the commercialization of second generation or next generation biofuels, given the blending mandate requirements set forth by the U.S. and the EU. This has led to a surge in second generation biofuels technology investment ranging from hydrolysis to gasification of feedstocks such as municipal solid waste, pineapple waste, and elephant grass. At the writing of this paper, there are still no commercial scale second generation biofuels plants in Latin America, but a significant amount of proposed projects in the pipeline. The main barriers to commercialization are high enzyme and capital costs. Production costs today are roughly \$0.79 per liter – about double the cost of U.S. corn based ethanol[28] – although DOE believes that costs will drop to \$0.34 per liter by 2012 (Rothkopf 2008).

Challenges

Harmonized Fuel Quality Specifications

To achieve successful global trade in biofuels, there is a need for the development of consistent, harmonized international fuel quality specifications. This is necessary for engine manufacturers and for consumers. As relatively new fuel alternatives or additives in most markets, bioethanol and biodiesel are accompanied by more uncertainties regarding their performance than conventional gasoline and diesel.

Although regional standards are in place, they have not yet been harmonized and applied globally. Some have been loosely adapted by foreign nations, given the absence of

[28] U.S. corn ethanol at approximately \$0.35 per liter. Daniel Budny and Paulo Sotero, editor (2007-04). "Brazil Institute Special Report: The Global Dynamics of Biofuels". Brazil Institute of the Woodrow Wilson Center

global criteria. For example, the American Society for Testing and Materials (ASTM) initiated the development of biodiesel standards in 1994 which later became incorporated into the national specifications of Brazil, countries of the EU, Japan, Philippines, South Korea, Australia and South Africa.[29] As the demand for non-fossil biofuels increases in the future, nations are likely to espouse, refine and build upon existing biofuel quality standards in order to support the parallel modernization of transportation infrastructure and facilitate, along with the development of strong international trade policies, the globalization of biofuels as a standard commodity.

Efforts are underway to move towards global specifications. The U.S., Brazil and the EU are collaborating on the harmonization of technical standards and codes for biofuels. The tripartite task force released a White Paper on Internationally Compatible Biofuel Standards in early 2008. Reference materials creation is the current priority and in 2009 the focus will shift to implementing the recommendations generated by the group. This work is being done in collaboration with the industry and standards organizations of the U.S. (the U.S. National Institute of Standards and Technology (NIST)), Brazil (the National Institute of Metrology, Standards and Industrial Quality of Brazil (INMETRO)), and EU (The European Committee for Standardization (CEN)) under the International Biofuels Forum (IBF). IBF members include Brazil, the U.S., the European Commission, China, India, and South Africa.[30]

Infrastructure Development

Another critical factor necessary for bioenergy market development is the infrastructure capable of distributing and using this energy, either as electricity, heat, or liquid fuels. Indeed one of the important advantages of liquid biofuels is that they are generally compatible with our current global transport fuel infrastructure, as opposed to transitioning to a gaseous fuel for example. However, while much attention is currently focused on production infrastructure investments, a significant amount of investment will also be needed in the distribution (ports, pipelines, pumps) infrastructure, and end use infrastructure (biofuel compatible engines).

[29] Worldwatch Institute, *Biofuels for Transport: Global Potential and Implications for Energy and Agriculture* (London: Earthscan, 2007), chapter 9, p150-153.

[30] White House. Office of the Spokesman. Washington DC. Media Note. "Memorandum of Understanding Between the United States and Brazil to Advance Cooperation on Biofuels". March 9, 2007.

Technology Transfer, Information Management, and Capacity Building

Focused research and development will be vital to develop sustainable bioenergy technologies, crops and products. Every growing industry needs a solid information base, effective information development and sharing tools, and trained professional. Universities need to develop curricula and research initiatives appropriate to train biofuels professionals and advance the public information base. In addition to conferences, list serves, and other standard information sharing methods, new tools appropriate in today's information age need to be developed. Capacity building in country will be vital ranging from farmer/producer training to institutional and policy framework development. Along with intellectually capital, equipment and technology will need to developed in-country or imported. Technology transfer will be critical to third market development.

Food vs. Fuel

There is a very real risk that increasing global biofuel consumption will result in more arable land being used for fuel production, which could in turn lead to declining food production in some areas and possible increase in food prices worldwide. Such impacts could have worrying implications for food security, particularly for poor people, and the achievement of the first Millennium Development Goal to reduce global poverty and hunger. On the other hand, increased demand for biofuels could boost the economy of regional agricultural sectors with positive effects on rural development and poverty reduction (Rothkopf 2007). There is an urgent need to better understand the extent to which the production of some types of biofuel feedstocks could adversely affect the production of food crops. Studies to understand tradeoffs between fuel feedstock production and food production must also consider the impacts of subsidies to the agricultural and energy sectors in order to properly reflect the benefits and costs involved (WRI 2008).

Sustainability Standards

Biofuels can provide dramatic environmental gains but, like all energy types have downsides, and have the potential to cause great harm if not produced, stored, distributed and used in appropriate and sustainable ways. The potential social, environmental and economic benefits of biofuels are, for the most part, not yet realized or guaranteed. Looking ahead, the future of biofuels as one of the sustainable alternatives to fossil fuels will largely depend on market development and the successful management of risks associated with this fast growing new energy sector.

With the mounting negative environmental impacts of fossil fuel use, rapid bioenergy growth brings its own set of environmental and social risks. It is becoming clear that rapid and effective measures must be taken so that the solution does not become the new problem. The leading strategy at the international level, and in many cases the national level, is to create sustainability standards that can then be applied by various actors (government, industry, independent organization, etc.) using some form of certification scheme. There is currently no international set of sustainability standards or sustainability assurance mechanisms for bioenergy. There are, however, several international efforts underway, as well as national and sub-national initiatives at different stages of development.

One of the key barriers today to the development of sustainability standards for biofuels is the concern that they will create an additional barrier to trade and will be used by some countries to protect their domestic industries.

Key international initiatives include:

- The Roundtable on Sustainable Biofuels (RSB), http://cgse.epfl.ch
- The Global Bioenergy Partnership (GBEP), http://www.globalbioenergy.org/.
- IEA Task 40, www.bioenergytrade.org
- IDB Biofuels Sustainability Scorecard, www.iadb.org/scorecard:

  In 2008, IDB's Sustainable Energy and Climate Change Initiative created the first-of-its-kind Biofuels Sustainability Scorecard, the primary objective of which is to encourage higher levels of sustainability in biofuels projects. The Scorecard is a tool for IDB's clients to think through the range of complex issues associated with biofuels addressing both environmental and social criteria.

Examples of Sustainable Biofuels in the LAC Region

Companhia Nacional de Açúcar e Álcool (CNAA) projects:

The financing of biofuels projects that meet key sustainability criteria will help to increase the supply of biofuels that comply with import standards being developed by the EU and other markets. Development banks can play an important role in building this supply by targeting their investments in this direction. One example is the IDB approval for the financing of greenfield ethanol projects in South Central Brazil in July 2008. The IDB will lend up to $269 million and help raise a maximum additional $379 million for the projects, in the largest biofuel investment ever made by a development bank.

In addition to being the largest biofuels investment, these projects also exhibit sustainable biofuels production criteria that the IDB has recently included in a Biofuels Sustainability Scorecard, based on the principles and criteria of the RSB. The new plants are being built in the states of Minas Gerais and Goiás, far from the Amazon or any protected areas. Instead of purchasing land outright, CNAA will lease it from owners of medium to small-sized plots who decide they can earn a better return from sugar cane than they can from low-intensity pasture—the area's predominant land use at present. The new plants will use mechanized harvesters for more than 90% of their acreage, and they will provide some 4500 high-quality permanent jobs. They will recycle all their stillage (wastewater) as fertilizer on the cane fields. The plants will produce up to 420 million liters of ethanol for the domestic market each year, and will generate their own electricity by burning bagasse (plant waste). In fact, the cogeneration technology they will employ is so efficient that the plants will produce enough surplus electricity to power 400,000 medium-sized Brazilian homes, reducing the need for fossil fuel power generation.

Examples of Sustainable Biofuels in the LAC Region

Biofuels "Blueprints" and Technical Assistance:
Increasingly, importing countries, such as the Members of the EU, will require biofuels to meet strict sustainability standards. LAC has the potential to be consolidated as a leader in supplying sustainable biofuels that are climate-friendly, socially responsible and energy efficient, and comply with international standards. Technical assistance and cooperation throughout the region, and from other parts of the world, to advance knowledge, technology transfer, and harmonize sustainability standards will help LAC to keep its leadership in biofuels.

The U.S. and Brazil signed an MOU in 2007 to advance biofuels throughout the Central American and the Caribbean region. The IDB has been supporting this partnership by financing biofuels "blueprints" in Haiti and complementing its efforts in the Dominican Republic and El Salvador to determine the suitability for domestic biofuels production; mapping of areas for feedstock development; key locations for production facilities, etc. The IDB is also supporting Biofuels Action Plans throughout the region including in Guatemala, Honduras, and Mexico. The Action Plans help to determine regulatory issues and legislation; fiscal impact analysis; technical feasibility studies; and environmental and social assessments. Many countries in the region, such as Colombia and Costa Rica have already begun biofuels programs and in these nations, the IDB is providing technical assistance on a range of issues including sustainability standards, Clean Development Mechanism credits; new technology utilization, among others.

IV. Energy Efficiency: Global Trends, Opportunities and Challenges

Introduction

As mentioned earlier, according to the International Energy Agency, Latin America will need 63% more energy by 2030 than it needed in 2006 (IEA, 2008), if current growth trends continue. Electricity production will have to expand by an estimated 50% within the next 10 years. The region's transportation fuel use will soar 70% by 2030. In many countries, investment in new sources of energy is struggling to keep pace with demand. Opposition to new hydroelectric complexes (which have historically provided the bulk of the region's electricity) is forcing governments to build expensive gas, diesel and coal-powered plants. This in turn is feeding the global rise in fossil fuel prices, while increasing emissions linked to global warming.

New research by the IDB indicates that Latin America and the Caribbean as a whole could reduce energy consumption by 10% over the next decade by investing in widely available technology and equipment. It would cost approximately US$16 billion[31] to reach that target, which would reduce total energy consumption by some 143,000 GWh in 2018. The IEA estimates that energy efficiency accounts for more than half of the global energy related GHG emission abatement potential achievable within the next 20-40 years[32]. And contrary to popular perception, such efficiency measures would not compromise people's comfort or compromise the region's economic competitiveness.

One of the definitions for energy efficiency is the reduction in the energy used for a given energy service or level of activity with the same quality. It is the cleanest, readily available, stable, and cost effective component of any energy matrix, while also providing greenhouse gas reductions and economic benefits. Energy efficiency improvements can be on the supply side (efficiency in generation, transmission and distribution), or work to reduce energy in demand side through specific end-use devices and systems.

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[31] This estimate is based on the following three assumptions:
1) That the country's energy demand will grow at an average of 3.5% for the next 10 years for the "business as usual" scenario.
2) That the displaced (avoided) power plants in the more efficient scenario are 250 MW open cycle gas turbine units operating at 20% capacity factor with an estimated construction cost of US$650/kW (these costs include building the plant and transmitting and distributing electricity). Note that this is an extremely conservative cost assumption; the actual cost could be much higher for plants using different generation technologies.
3) The energy efficiency scenario assumes a substantial increase in the load factor of electricity generating plants, which would make it possible to significantly reduce the installed electricity generation capacity.

[32] World Energy Outlook 2006

The IEA recently reported that between 1990 and 2005, a group of 16 industrialized countries met *around half* of their increased energy demand through improved efficiency. Indeed, worldwide energy consumption would be 58% higher today without energy efficiency measures implemented since 1973. Since 1990 about half of the increased demand in energy services has been met through higher energy generation and the other half through gains in energy efficiency. Efficiency improvements have resulted in energy and CO2 savings of 15% and 14% respectively in 2005.[33] The World Energy Council (2006) estimates existing efficiency technologies can produce additional global energy savings of as much as 25% by 2020 and over 40% by 2050, making energy efficiency the most relevant energy source in the world. Energy efficiency and conservation are usually not considered a "source" of energy, of course. But from a cost standpoint, they most certainly are. The IEA estimates that in 2005 these countries saved at least US$180 billion in fuel and electricity costs. That figure is not an abstraction: it is the amount these countries would have had to spend on new power plants if they hadn't improved efficiency.

And what if the region does not improve its energy efficiency? In that case, Latin America and the Caribbean will need to spend around US$53 billion to build the equivalent of 328 gas-powered open cycle generators (250 MW each) necessary to produce the same 143,000 GWh of power. In other words, there are two ways for Latin America to generate 143,000 GWh of electricity in 2018. One costs around US$16 billion; the other, US$53 billion.

Latin America's Choice

The good news, for Latin America, is that the region has rich energy efficiency "reserves," and it has barely begun to exploit them. Though some countries -notably Mexico and Brazil- are already reaping substantial savings from energy efficiency programs begun in the 1980s and 1990s, most of their neighbors have yet to look seriously at conservation. Of course, many factors, such as climate, structure of sectoral energy consumption and the technology used by predominant industries, can influence an economy's overall energy intensity[34] and the latter varies significantly between the different countries of the region (Figure 2).

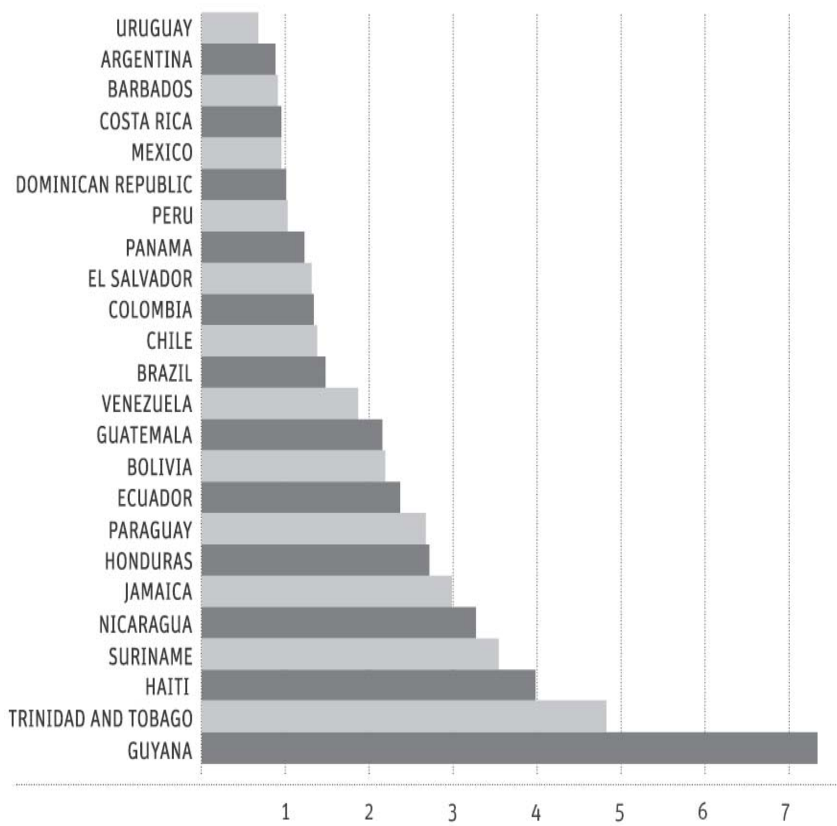
Nonetheless, the opportunities are everywhere, because Latin America's energy productivity is uniformly low. The region is still overwhelmingly reliant on incandescent light

[33] "Worldwide Trends in Energy Use and Efficiency: Key Insights from the IEA Indicator Analysis", IEA 2008

[34] Energy intensity is a measure of the energy efficiency of a nation's economy. It is calculated as units of energy per unit of GDP. High energy intensity indicates that a country needs more energy consumption to generate one dolar of GDP, and low energy intensity indicates that the country needs less energy consumption to generate one dolar of GDP.

bulbs, for example, even though these consume 70% more power than newer "compact fluorescent" or LED alternatives. The region's factories and water systems use millions of old, energy-wasting electric motors and pumps. In many countries the transportation infrastructure -which consumes more than 30% of the region's energy- is grossly inefficient. Commercial and residential buildings are full of outdated air conditioning systems, refrigerators, washing machines and water heaters.

Figure 2: Energy Intensity (OLADE, 2006)



Opportunities by Sector

Increasing energy efficiency requires the implementation of sound demand-side management strategies and a shift from solely supply-driven policies. Energy Efficiency offers still largely unexploited potential in many sectors:

- ***Transportation.*** Integrated transport planning, urban mass transport systems, more efficient engines, incentives for hybrid-electric vehicles or lightweight/efficient cars

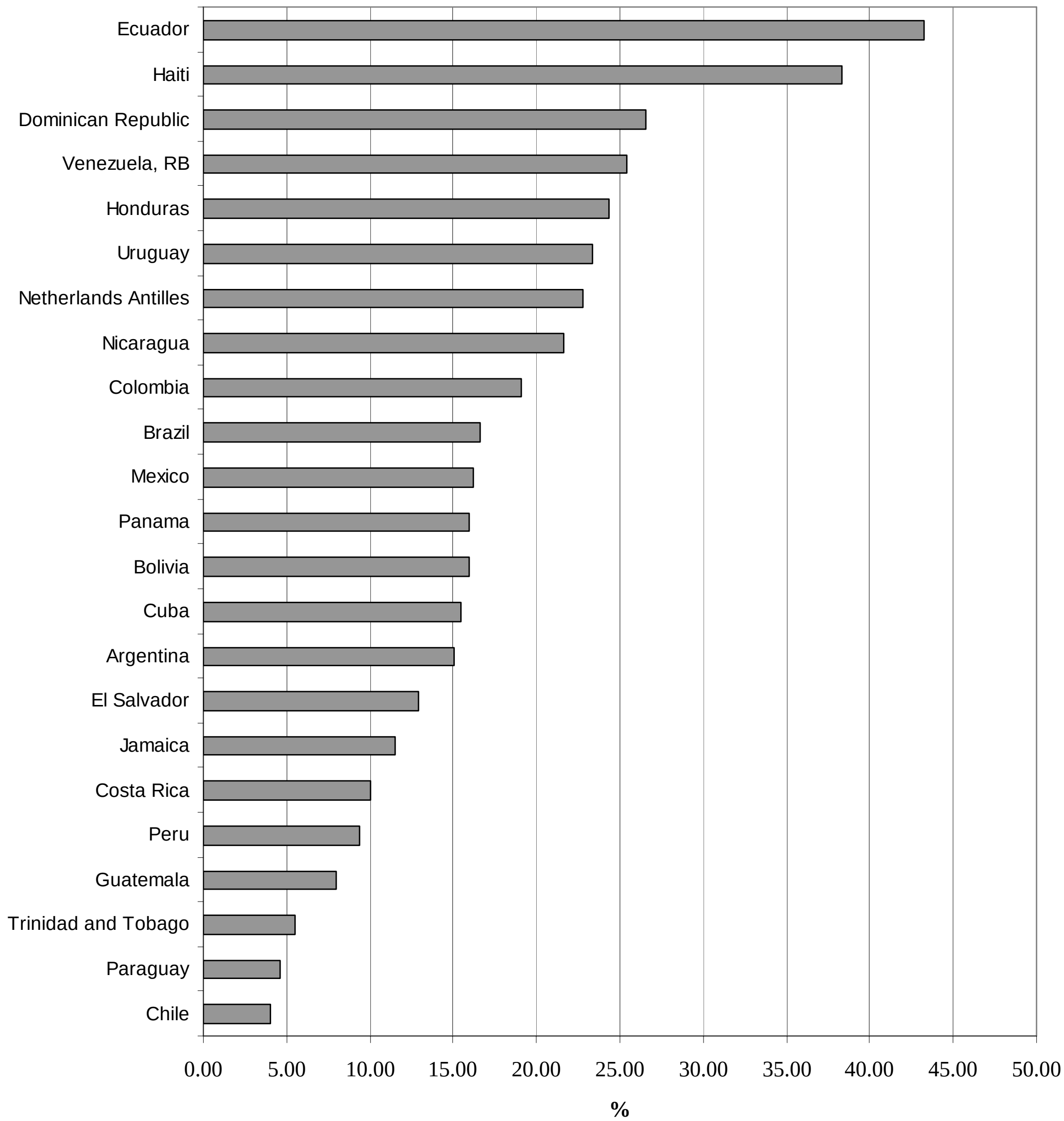
- ***Buildings.*** Integrated building design, better insulation, advanced windows, energy-efficient lighting, more efficient HVAC (heating, ventilation, air conditioning) systems, water heating, and refrigeration technologies, reducing standby losses in appliances and equipment, energy management systems
- ***Industry.*** Cogeneration, waste heat recovery, pre-heating, efficient drives (motor, pump, compressors), Corporate Energy Management

- ***Municipalities.*** Combined heat and power, efficient street lighting, efficient water supply- pumping and sewage removal systems

- ***Agricultural.*** Efficient irrigation pumping and efficient water use, such as drip irrigation

- ***Power Supply***:
  - *New thermal power plants:* Combined cycle, supercritical boilers, IGCC, etc.
  - *Existing generation facilities:* Refurbishment and re-powering (including hydro), improved operation and maintenance practices, and better resource utilization (higher plant load factors and availability)
  - *Reduced transmission and distribution losses:* High voltage lines, better insulated conductors, capacitors, efficient and low-loss transformers and improved metering systems and instrumentation as well as Smart Grids. Figure 3 shows the transmission and distribution losses per country.

Figure 3: Electric Power Transmission and Distribution Losses, % of Output (WRI, 2006)



Cogeneration

Cogeneration, which is also called combined heat and power (CHP), is an application of various technologies that allow a single fuel to simultaneously produce electricity and useful heat. Cogeneration technologies have efficiencies in the 70–90% range, as compared to 55–60% for the most efficient conventional combined cycle natural gas power plants (USHCPA n.d.). Cogeneration technologies can be suitable for use in industrial, agricultural, commercial, and some small-scale residential buildings. Other advantages of cogeneration include that small-scale units tend to have relatively short development times, and because cogeneration systems are located at or near the point of consumption, they tend to increase the stability of energy

supply and reduce the necessity of additional investment in transmission and distribution infrastructure. In addition to contributing to efficient electricity production, cogeneration options also offer substantial greenhouse gas mitigation potential. In Mexico, for example, the OECD estimates that 35.4 $mtCO_2e$ could be avoided through more widespread use of cogeneration technologies (OECD, 2003).

There are measures in place to take advantage of cogeneration opportunities throughout LAC. In Brazil, sugar cane factories often use waste bagasse[35] to generate electricity. Current installed capacity of cogeneration in Central American nations exceeds 310 MW (Table 2.5), and this supplies 774 GWh—or 2.6%—of total electricity production to grid systems. Particularly, Guatemala and Nicaragua relied on sugarcane bagasse cogeneration for respectively 12% and 10% of its national power generation in 2007. In 2005, 316 MW of combined heat and power energy was installed in Mexico (WADE 2006). There is a need for further research to identify country-level opportunities in LAC for cogeneration technologies to be utilized through new installations or refurbishment of old facilities.

Costs of cogeneration will vary widely depending on the type of fuel being used and the size of system. In Brazil, cogeneration costs have been estimated to be US$35 to US$105 per MWh (Amous, 2004). The CDM Executive Board has now approved six methodologies for cogeneration projects, including two that apply to small-scale projects.

While each country will differ in its industrial cogeneration potential, in Argentina alone it is estimated there is 1,300 MW of cogeneration electricity potential from the industrial sector. Utilizing these sources in Argentina would require conversions that would cost approximately US$800 million with a projected return of up to 20% (REEEP, 2003).

Near- and long-term cogeneration options are also applicable for a number of commercial operations and some public building complexes (Box 2.11). Again in Argentina, the gains that could be made by utilizing cogeneration in the commercial and public sectors are estimated at about 250 MW, requiring investments of up to US$300 million, with returns of up to 25% (REEEP, 2003).

Opportunities for the application of cogeneration technologies range from roughly 1 GW in Chile to as much as 15.6 GW in Mexico (ECEE, 1999c; CONAE, 2006). Given current

[35] Bagasse is the residue remaining after the extraction of juice from the crushed stalks of sugar cane.

demand for electricity in these countries, this suggests that cogeneration options could satisfy as much as 31% of electricity demand. If similar possibilities exist throughout the LAC region, cogeneration could make a very substantial contribution to the more efficient use of the region's energy resources.

Transportation

The transportation sector is responsible for approximately 31% of LAC's GHG emissions and this number is growing rapidly (WRI, 2006). In developing countries, transportation emissions are expected to double by 2025 due to the significant growth in number of vehicles on the road and vehicle kilometers travelled (VKT). With an average of around 90 vehicles per 1,000 people, the motorization rate in the LAC Region exceeds those of Africa, Asia, and the Middle East.[36] In addition to this already elevated average, vehicle ownership is expected to increase at an annual rate of 5 percent from a fleet of 24 million in 2008 to 70 million vehicles in 2030. [37]

This section briefly outlines the possible contributions of increasing efficient transport in order to lower or at least control GHG emissions in this sector. Use of alternative fuels also is also an important part of developing sustainable transport networks in LAC.

Bus Rapid Transit (BRT)

Bus Rapid Transit (BRT)[38] uses a combination of infrastructure, equipment, and operations to elevate bus system service to a quality that rivals modern rail transport (WRI, 2006). BRT can be implemented regionally or on an individual corridor basis, and it provides a flexible alternative to personal vehicle use. Potential benefits of BRT include:

- Lower passenger kilometers travelled when compared to traditional bus systems and automobiles;
- Lower economic costs than automobile and rail infrastructure facilities;
- Relatively fast implementation (within one administration term);
- Enhanced system flexibility, where implementation can be incremental with additional corridors and stops added on once a project gets off the ground;
- Decreased travel time and increased reliability when compared to traditional bus systems;

[36] World Bank, "Low Carbon, High Growth: Latin American Response to Climate Change", 2009
[37] World Bank, 2009
[38] BRT can be broadly defined as "[a] permanent system of facilities, services and amenities that collectively improve the speed, reliability and identity of bus transit" (Levinson *et al*. 2002).

- Easy integration into transit and pedestrian-oriented developments.

No one specific technology defines BRT, but the majority of successful systems have the following attributes: dedicated or preferential lanes for public transport, rapid boarding and exiting through multiple, elevated doors, prepayment mechanisms, tariff integration, high-capacity modern vehicles with clean technologies, high-quality signage and user information, distinctive imaging, and excellent marketing and customer service (WRI, 2006).

A number of BRT projects have been implemented within the LAC region or are in various stages of planning. In 2006, 22 Latin American cities had BRT projects in development, seven of which were in the construction phase. A further 53 Latin American cities are applying for Global Environment Facility Program (GEF) grants to develop sustainable transport projects and of these, most were BRT projects (Joint Implementation Quarterly 2006). Some of the most cited case studies for BRT in the world include three in Latin America: Curitiba, Brazil; Bogotá, Colombia; and Mexico City, Mexico.

Along with its emissions benefits, BRT corridors are significantly less expensive and involve less construction time compared to light rail transit (LRT) or metro lines. BRT is estimated to cost US$1–US$10 million/km versus US$20–US$220 million/km for metro or rail. In addition, the planning and construction time is typically 12–18 months versus 3–30 years for metro networks (Fjellstrom, 2003). Actual realized savings for BRT systems depends on both the locale in which the system is instituted and the share of ridership achieved.

A recent study commissioned by the World Bank looked critically at a number of BRT systems in Latin America, and found lack of funds to be a serious challenge to implementing bus rapid transit systems (Hidalgo *et al.*, 2007).[1] High interest rates, not enough financing, and deficient information about financing are all hurdles that lie in the path of developing BRT systems. At present there are no standardized institutional mechanisms to help these projects become more attractive to financers (CTS, 2006). To be successful, BRT systems also need to set a fare level that covers operating costs, is affordable for users, and is competitive with other forms of transport (WRI, 2006). Experience has shown that fares that cover system costs are higher than previous public transportation costs and at times have raised the overall cost of transport. To remain low, fares must often be subsidized by the government, which undermines system sustainability (Hidalgo *et al.*, 2007).

Research has also shown city governments that designated an independent authority with technical independence to plan and implement its BRT system were more successful than those who utilized existing channels of government. However, with dispersed institutional structures and poor technical capabilities, many Latin American cities may find creating and staffing a competent authority somewhat difficult, and they must rely heavily on outside consultants for expertise. It is also important that development teams are staffed with a variety of experts, and engineering planning does not overshadow financial, legal, and environmental aspects of planning (Hidalgo *et al*., 2007).

Fuel-efficient and alternative fuel vehicles. While integrated transport planning and efficient public transportation systems are the key to sustainable transport development, individual vehicles can also advance towards being more fuel-efficient or using less carbon-intensive alternative fuels. Hybrid-electric vehicles and buses, and small, efficient cars such as "smart cars" are increasingly common in industrialized countries and offer near-term solutions to increasing fuel efficiency. Brazil has also had tremendous success in developing flexible-fuel vehicles that run on ethanol, gasoline, or a blend of both. Personal vehicle fleets in LAC are growing, and it is important that governments address this growth by establishing fuel efficiency standards and incentives for purchasing efficient vehicles.

Commercial and Residential Buildings

Existing buildings account for 42% of all electricity consumption[39] and represent 15.3% of world CO_2 emissions (WRI, 2005). The many energy efficiency opportunities available to commercial and residential buildings can save money and resources, are often relatively easy to implement. They also can help reduce peak load capacity and pressure on electricity generators to expand capacity. For new construction, improved building codes should include energy saving options such as the use of more or better insulation materials, advanced building methods, improved wiring and lighting systems, whole systems design, and, where feasible, cogeneration options. Retrofits of existing buildings are also possible in many cases through upgrading HVAC, lighting and office equipment, installing modern electronic temperature control systems, and replacing older windows and doors with those that provide better insulation during both heating and cooling seasons. Payback periods on these measures are as short as one season.

[39] 23% from residential, and 19% from commercial and public.

Improving the efficiency of energy consumption within the housing sector can result in positive returns to households in the form of reduced expenditures on energy bills and/or improved comfort. Housing efficiency measures span from new construction that uses whole system design and passive solar design, to installing better insulation, using energy-efficient windows, updating appliances to those that use less energy, and changing incandescent light bulbs over to compact florescent light bulbs or LED lighting technology. Several countries in the LAC region have implemented energy-efficient lighting programs for homes—of these Mexico's ILUMEX is the best known. More efficient light, however, is only one of an array of efficiency options that are available to the housing sector.

Estimates show that energy-efficient technologies can increase the efficiency of new buildings in many countries by more than 70% over existing structures, or improve the efficiency of motors, pumps, boilers, and heating systems by 10 to 30%, depending on the industry and technology. The UNDP estimates savings from various residential efficiency technologies to range from 20–40% for different types of electrical appliances, to as much as 35–50% for refrigeration units, and up to 30–80% for some types of lighting (Table 2).

Table 2: Potential Residential Energy Efficiency Savings (UNDP, 2000)

Technology	Low	High
Appliances [a]	20%	40%
Food preparation [b]	0%	24%
Lighting [c]	30%	80%
Refrigeration [d]	35%	50%
[a]Mexico and Brazil; [b]LAC wide; [c]Brazil and Argentina; [d]Brazil, Argentina, and Mexico		

Research by Coelba, an electricity generator in Brazil, found that it is difficult for low-income families to reduce their consumption of energy. Reasons include high ownership of electric appliances relative to income levels, use of inefficient light bulbs, poor electricity installations—including the lack of on/off switches, use of inefficient refrigerators, and poor construction of residential units—including lack of natural lighting and poor ventilation. The company found that improved wiring in low-income housing resulted in energy savings of more than 10%, and when this was coupled with replacement of low-efficiency light bulbs the

savings increased to nearly 25% (Pinhel 2005a). There are approximately 222 million people in the LAC region that are categorized as poor by the United Nations Population Fund (UNPFA 2006). If simple improvements in energy efficiency such as new wiring and energy-efficient light bulbs can save 10 to 25% of electricity use, savings for these poor could reach millions of kWh per month.

The greenhouse gas emissions reductions resulting from energy efficiency projects in the LAC region—and therefore the ability to generate CERs—will depend upon the type of fuel offset as a result of these activities. CDM methodologies have been created for a number of EE technologies, including two approved small-scale CDM methodologies cover a number of energy efficiency technologies.[40]

Sanitation and Water

Globally, electricity use by the water and wastewater sectors is expected to grow by roughly 33% over the next 20 years, with higher than average rates of growth among countries in the developing world. Energy costs represent a significant portion of LAC water utilities' operating budgets, and energy savings could be an important factor in improving the financial performance of this sector (Table 3) (Alliance to Save Energy [ASE] 2005, Watergy 2006a).

[40] Small-scale methodology AMS-II.C applies to "programs that encourage the adoption of energy-efficient equipment, lamps, ballasts, refrigerators, motors, fans, air conditioners, appliances, etc. at many sites." Small-scale methodology AMS-II.E applies to: "any energy efficiency and fuel switching measure implemented at a single building, such as a commercial, institutional or residential building, or group of similar buildings, such as a school district or university." The aggregate energy savings by a single project for either methodology may not exceed the equivalent of 15 GWh per year.

Table 3: Water supply Energy Cost and Potential Savings

(aASE 2005; b Watergy 2006a)

	Low	High
Energy costs relative to gross revenues [a]	32%	40%
Potential energy savings from energy efficiency improvements [a]	10%	40%
Annual cost of water losses [b]	US$1 billion	US$1.5 billion
Source:		

As with water supply systems, the sewage treatment is energy intensive. Energy used for wastewater treatment can account for 25–50% of a treatment plant's operating budget. Some processes such as sludge treatment account for 30–80% of a facility's energy consumption, while other factors, such as the infiltration of ground- and rainwater can increase the load in treatment plants resulting in heavier work loads for pumps and other equipment (Watergy 2006b).

Sewage treatment involves primary and secondary treatment stages as well as post-treatment processing of removed solids and a disinfection process. Energy consumption during the primary treatment stage is relatively low.[41] Secondary wastewater treatment, which includes water purification, is the more energy-intensive process involved in sewage treatment. Depending on the equipment already in place, retrofitting aeration systems with monitoring and automatic controls can lower energy consumption in this stage of wastewater treatment by as much as 30% (Pakenas 1994).[42]

To further reduce expenditures on energy, wastewater treatment facilities that are well suited for generating and capturing biogas from extracted solids could benefit from the application of cogeneration technologies. Estimates indicate that the cost of electricity generated from onsite cogeneration ranges from about US$0.02–0.09 per kWh depending mainly on how much biogas is available. The methane used would then potentially displace other fossil fuel energy sources, creating carbon reduction benefits. In general, the carbon

[41] However, some opportunities to improve energy efficiency at this stage are available. For example, using screens to remove debris, rather than grinding it, reduces the energy needed to remove the material in the more energy-intensive secondary stage (Watergy 2006b).

[42] However, there are some trade-offs that might be required for decreased energy consumption and higher maintenance requirements for equipment such as the agitators that are used to aerate wastewater.

benefits of reducing energy demand by the sewage treatment sector depends largely on the type of fuel used to generate electricity consumed in water treatment operations.

Costs of installing efficient technology at water and wastewater treatment plants will vary according to the size of the plant and the extent of the retrofits. Cost savings, however, are easier to quantify, and according to the Northwest Energy Efficiency Alliance, energy savings at many treatment plants could range from 15–75% with short payback periods (Northwest Energy Efficiency Alliance n.d; California Energy Commission 2006). Some estimates say that water facilities could save 5–15% of electricity consumption through installing variable frequency drives and high efficiency motors and drives, and wastewater facilities could also save 10–20% through equipment modifications (Carns 2004). An approved CDM methodology for improving water-pumping efficiency exists, as well as another for small-scale demand-side efficiency improvements.

Challenges to Implementing Efficiency Measures

Of course, the success of Energy Efficiency programs largely depends on whether governments provide the right incentives. These can take many forms, from tax rebates and subsidies to regulations requiring specific efficiency standards for vehicles and appliances. Seen from another perspective, it is interesting to note that Latin America's governments are spending billions of dollars to subsidize fuel prices. The Financial Times recently reported that Latin America and the Caribbean has spent around US$50 billion in subsidies for transportation fuel during 2008. This is about five times what the IDB lent to the region during 2008 for all sectors. These subsidies have the laudable goal of protecting consumers from high fuel prices and keeping inflation in check. But they also tend to discourage investments in efficiency. The reason for raising this argument is to underline how prices for fuels and electricity play a crucial role in either encouraging or discouraging energy efficiency. These prices vary widely across Latin America and the Caribbean, because governments apply different price policies, subsidies and/or taxes (Figures 3 & 4). Generally speaking, consumers and companies in countries with higher than average fuel and electricity prices are more likely to invest in efficiency, while those in countries with lower than average prices will have little incentive to conserve. And the main question to be asked is: what if even part of that US$50 billion were spent on incentives for consumers or companies that purchase energy-efficient lighting or machinery?

Figure 4: Electricity Prices (OLADE, 2006)

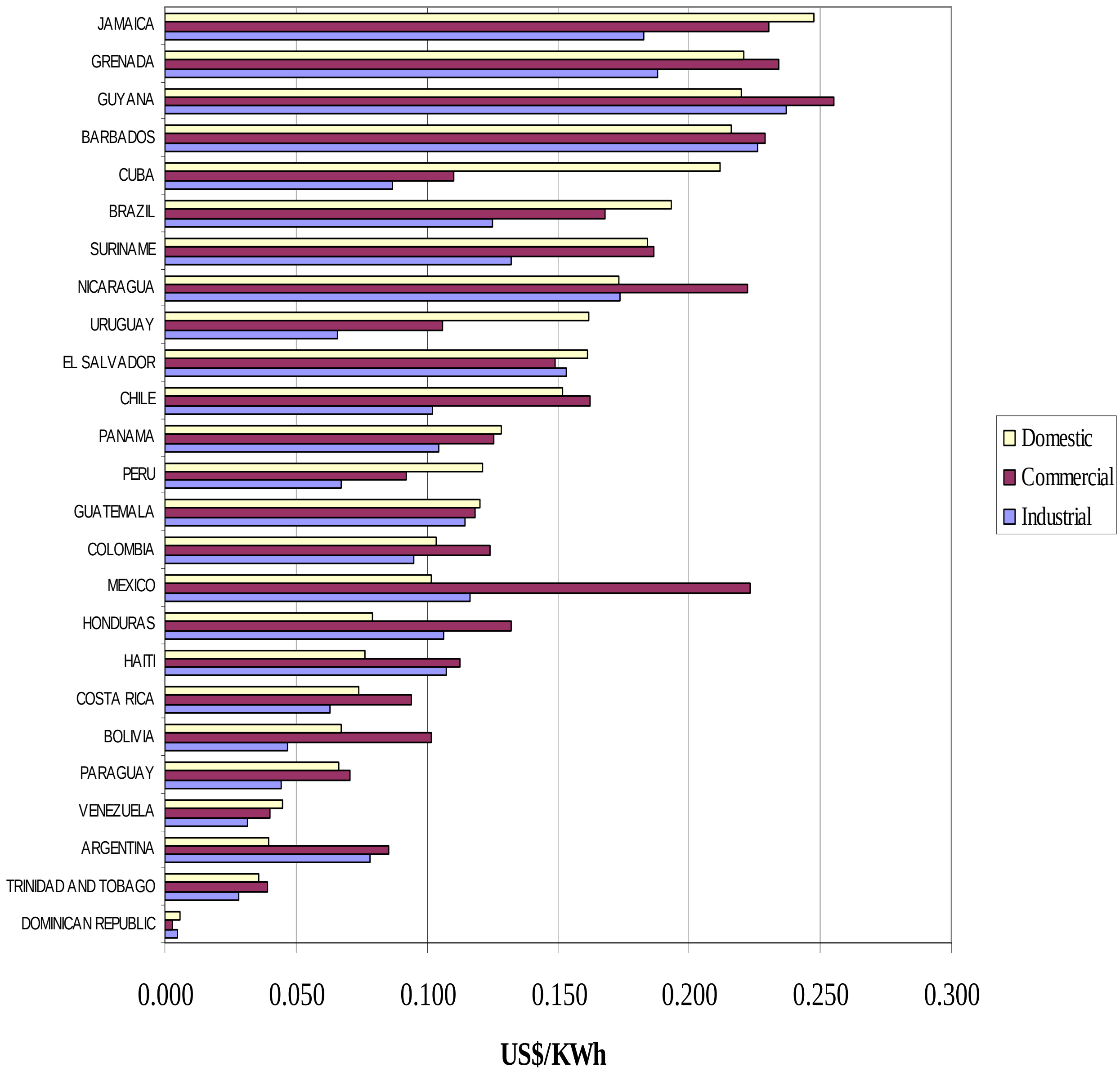
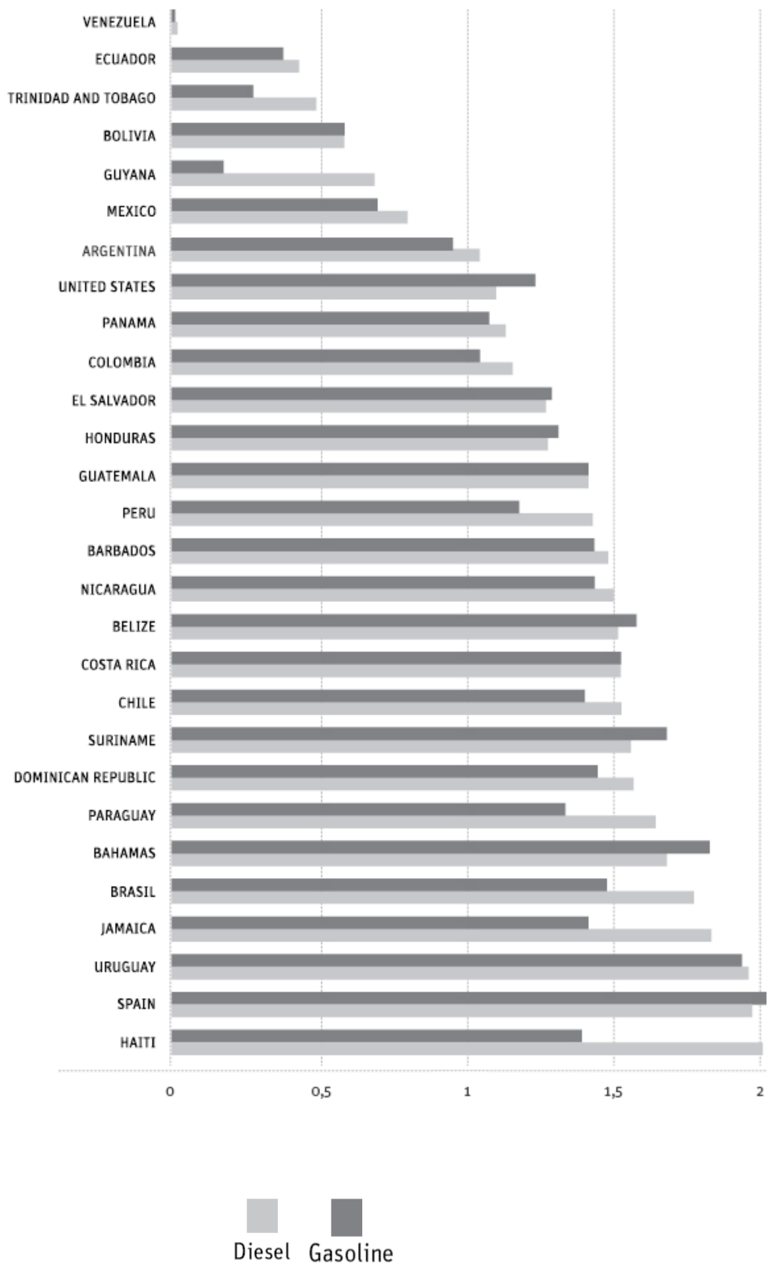


Figure 5: Gasoline and Diesel Prices (IDB, 2008)



Note: Prices expressed in US$/liter, retail prices in capital cities on August 20, 2008

All these elements are part of the reason why even with all of these opportunities, energy efficiency programs, policies, and financing have continued to face many barriers both in LAC, and throughout the world. Although sufficient success stories exist, there continues to be a lack of confidence that the level of projected energy savings will actually occur.

Additionally efficiency is often associated with giving something up, which has made it a tough sell politically. In order to maximize the benefits of energy efficiency in the LAC region these barriers will need to be addressed comprehensively.

Informational Issues

One of the principle and most widespread barriers is a simple lack of information on the part of consumers, vendors, manufacturers and policy makers. This lack of information is heightened when the measure/policy/technology is new and there is conflicting information circulated. An example of this is the public perception of compact florescent light bulbs. Many consumers do not realize that there are new types of bulbs and many of the issues with flickering, etc. have been addressed.

Financial barriers

One significant barrier to energy efficiency adoption is the lack of capital to invest in new energy efficient equipment or technologies. This is exacerbated by the difficulty of accessing capital to make these investments. Even though the payback period of most energy efficient technologies is very quick, the up front cost continues to deter investment. Many smaller, regional banks are not accustomed to financing measures in energy efficiency and are risk averse. For example, although the payback period on a new energy efficient refrigerator may only be 2-5 years, the high up front cost has deterred investment.

Electricity rate structures

Electricity throughout much of Latin America is subsidized and rates do not reflect the marginal costs of producing electricity or the rising cost of fossil fuel powered generation. In addition, the concept of decoupling and conservation tariffs has not taken on in LAC yet, and traditional rate-making structures reward utilities for more energy sold, which further discourages efficiency measures.

How can Energy Efficiency "Fill the Energy Gap"?

Addressing the barriers to achieving energy efficiency savings will be most successful using a multi-pronged approach by targeting specific sectors with specific solutions.

Set Energy Savings Targets

The first step to addressing barriers is making energy efficiency a priority and setting energy savings targets. By defining a goal, and subsequent roadmap for how to achieve these savings through a variety of measures, it will be much easier to track actual savings and troubleshoot where necessary.

Standards and Labeling

Creating standards and clear, educational labeling for products that meet efficiency targets will help consumers make informed decisions and help raise awareness and understanding about the potential for energy, and economic, savings with different products. This includes all consumer products, including vehicles, but can also be extended to building codes.

Industry

Increasing technical assistance for industrial actors will help foster greater understanding of new technologies and potential for energy efficiency measures that will increase productivity and increase economic returns. One example of this is combined heat and power systems, or cogeneration, which have efficiencies in the 70–90% range, as compared to 55–60% for the most efficient conventional combined cycle natural gas power plants (USHCPA n.d.). Cogeneration technologies can be suitable for use in industrial, agricultural, commercial, and some small-scale residential buildings.

Research, Development, and Demonstration

Continued research into new technologies and practices for energy savings is a necessary component in order to continue achieving energy efficiency gains. Demonstration of new and existing technologies will help to increase awareness and understanding and further implementation.

Examples of Energy Savings with Efficiency from the LAC Region

FIDE:

In Mexico electricity demand will expand at an estimated 5.6% per year between now and 2013 significantly faster than predicted economic growth (IDB 2008[1]). The IDB estimates that merely to keep up with that demand, Mexico will need to invest US$5.5 billion per year in new energy production capacity. If energy efficiency and conservation measures were adopted in Mexico, the country could save more than US$2 billion per year in new capacity expenditures. In 1990, Mexico established a Trust Fund to Support Energy Efficiency in the Electricity Sector (FIDE) to carry out concrete programs in specific sectors such as lighting and industrial machinery.

In 1997 the IDB approved a US $23 million loan to help FIDE carry out a ground-breaking program to improve energy efficiency in the industrial and commercial sectors. The program used a rebate system to encourage retailers of electrical motors, compressors and lighting to market efficient models, and it financed a variety of regulatory measures such as the development of efficiency standards and product labels for such equipment. Though it was essentially a pilot project, the program yielded impressive results: during its first six years of operation, it saved an estimated 5,274 gigawatt hours of electricity—enough to supply more than 2 million households with electricity for a year. The project also avoided the emission of around 4 million tons of CO2 during the same period.

Examples of energy savings with efficiency from the LAC Region

Brazil:
In 2001 Brazil experienced severe droughts that limited the hydroelectric facilities that were supplying 87% of its electricity. Faced with the prospect of mass blackouts, the government implemented an innovative energy efficiency plan that offered financial incentives to consumers who decreased electricity consumption—and expensive penalties to those who didn't. This measure resulted in energy savings of over 20% in just one month. Although the program was designed for reaching only short-term energy savings, it provided long-lasting results. It took approximately four years for Brazil's electricity consumption to grow back to its pre-2000 levels, since people adopted several of the energy efficiency measures and became accustomed to using electricity more efficiently.

Mexico—Veracruz Metropolitan Water System:
The Alliance to Save Energy (ASE) worked with the Metropolitan System of Water and Sanitation in Veracruz, Mexico under its Watergy™ project to help address its two biggest problems: energy costs were the second largest component of its operating costs, and there were severe interruptions in service to the utility's 628,000 customers in the municipalities of Veracruz, Boca del Río, and Medellín. Results from a pilot project in the Volcanes sector of the Veracruz system (which services 25,000 individuals) included: energy savings of 24 million kWh/year, cost savings of US$394,000/year, improved reliability and the reduction of service complaints, and substantial reduction of water losses. These savings were made through a number of improvements, including optimization of electromechanical energy, installation of high efficiency pumping equipment, leak detection and water conservation, determining optimal pressure and flow range through hydraulic modelling, and installation of automatic control mechanisms including variable frequency drives (ASE 2005). The technologies and methods utilized in this project have been valuable in addressing similar energy-related issues in water systems worldwide, especially those systems that were designed prior to the 1990s.

V. New Financial Resources for RE/EE Investment: Climate Investment Funds

As mentioned previously, climate change presents an urgent challenge to all countries and particularly to the poorest countries and communities which are likely to suffer earliest and hardest due to geographical location, low incomes, and low institutional capacity, as well greater reliance on climate-sensitive sectors such as agriculture. Moreover, in order to ensure economic growth, developing countries will face growing demand for energy in the power, transport, building and industrial sectors. Investment decisions being made now will typically be locked in for the next 40 to 50 years, thereby having a far-reaching impact on the global climate. Therefore, the next 10-15 years provides a finite window of opportunity to demonstrate transformational investments that provide energy and other infrastructure services, while reducing GHG emissions to prevent irreversible climate change.

At the same time, even if efforts to reduce GHGs are successful, some degree of climate change impacts will continue to occur in the next decades. An effective response to climate change must therefore combine both mitigation – to avoid the unmanageable - and adaptation – to manage the unavoidable.

Lower historical contribution to existing concentrations of GHGs underpins developing countries expectations for international support for financing their transition to low-carbon growth, as well as for building resilience to climate change. Future financing arrangements of a long-term post-2012 climate change agreement are central to the current UNFCCC negotiations as reflected in the Bali Action Plan. Yet the urgency of the climate change and development challenges requires immediate action – to accelerate and scale-up low carbon investments, particularly to reduce the trend of emissions growth in those developing countries with already large emission profiles, as well as to build climate resilience, notably for the poorest and most vulnerable developing countries.

As a response to the climate and development challenges, the Multilateral Development Banks, in consultation with interested countries, UN agencies, civil society and the private sector have developed the Climate Investment Funds (CIF). The overall objective of the CIF is to support country investments that deliver poverty reduction and development goals through transition to a low carbon and climate resilient development path.

The CIF aims to promote and support poverty reduction and development in a way that is consistent with the challenges posed by climate change, through:

- being country-led and undertaken in the broad context of sustainable development and poverty reduction;
- piloting innovative approaches and ideas for integrating climate change within poverty reduction and development planning and assistance
- providing incentives for transformational public and private sector financing to encourage early action (both mitigation and adaptation) in developing countries over the next five years, and until the future carbon market and other international funding arrangements become effective;
- enabling a learning-by-doing that can inform and support a successful long-term (post-2012) agreement under the UNFCCC; and
- utilizing the skills and capabilities of the Multilateral Development Banks to raise and deliver concessional climate financing at a significant scale to achieve meaningful reductions of carbon emissions and support climate resilient growth in eligible middle and low-income countries.
- providing a more coherent international locus to encourage support from a range of bilateral donors, private sector and civil society contributors and to catalyze innovative forms of global financing towards the climate and development challenges.

This new financing dedicated to climate change objectives therefore provides a major opportunity for the IDB to scale-up its operations in support of LAC countries climate change agendas. The IDB, along with five other MDBs,[43] is an implementing agency of the funds. The IDB has taken an active role, working with the World Bank as Trustee of the Funds and host to the CIF Administrative Unit of the CIF, in the ongoing design of CIF programs and investment guidelines and criteria. Focus now is for working with LAC countries that are seeking to access the funds and, by utilizing existing IDB procedures, to assist Governments in identifying, preparing, executing, monitoring, and evaluating CIF related projects and programs.[44]

The CIF provides grant and concessional loans to be blended with IDB ordinary capital through a variety of sovereign and non-sovereign guarantee financing instruments, including Specific Investment Loans, Policy Based Loans, Conditional Credit Lines for Investment Programs, Financial Intermediary Loans, and risk mitigations instruments, such as Partial Off-take of Risk and Guarantees. It is expected that the CIF will provide a menu of blending

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[43] The other MDB implementing agencies are the African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, International Finance Corporation and the World Bank.

[44] According to the CIF Guidelines for Investment Plans "the first step in country programming is for the multilateral development banks (MDBs) to conduct a joint mission, involving other relevant development partners, to discuss with an interested government, private industry and other stakeholders.

options to accommodate different needs of client's countries and Program interventions. The Trust Fund Committee will endorse programs and projects to be financed by CIF at the concept and pre-appraisal stages, following which projects should follow internal IDB procedures and will require Board approval.

The Climate Investment Funds comprise of two new funds dedicated to supporting climate change related investments, notably: the Clean Technology Fund (CTF) and the Strategic Climate Fund (SCF). In September 2008, potential donors pledged $6.2 billion for the two funds, around $5.0 billion for the CTF and the remaining for the SCF. The CIF aims to complement and reinforce the UN negotiations on climate change, without seeking to prejudice the on-going UNFCCC deliberations regarding the future of the climate change regime.

Clean Technology Fund (CTF): aims to provide scaled-up financing for public and private sector projects that contribute to the demonstration, deployment, and transfer of low-carbon technologies with a significant potential for long-term greenhouse gas emissions savings. At the request of the Mexican Government, the IDB is working with the International Bank for Reconstruction and Development (IBRD) and the International Finance Corporation (IFC) to develop an Investment Plan for Mexico, which is will potentially attract around US$500m of CTF concessional finance. As the CTF finance seeks to leverage MDB financing (and expertise), along with other public and private sector investment, this should result in around $8 billion of investment in support of Mexico's low-carbon objectives identified in the 2007-2012 National Development Plan, its National Climate Change Strategy and Special Climate Change Program.

Strategic Climate Fund (SCF): has a broad scope for integrating climate change within development planning and assistance and support related strategic poverty reduction and climate change priorities. Programs designed under the SCF are likely to prioritise Low Income Countries where poverty reduction challenges are greatest. So far three programs are under design, with each likely to total around $500m of concessional finance that will be available for piloting new and innovative investment approaches in a small number of low income countries.

The first program is the Pilot Program for Climate Resilience (PPCR) which aims to integrate resilience to climate change within developing countries national development and planning processes. The focus is on less developed and most vulnerable countries, the Small Island Developing States amongst them.

Consultations are underway on a new Forest Investment Program to mobilize significantly increased funds to reduce deforestations and forest degradation and to promote improved sustainable forest management, leading to emission reductions and the protection of carbon reservoirs.

A Program for Scaling-up Renewable Energy in Low Income Countries is also being considered to support investments in low income countries for energy efficiency, renewable energy and access to modern sustainable energy.

VI. Concluding Points and Next Steps

While bioenergy, renewable energy and energy efficiency (RE/EE) opportunities in LAC are vast, financial institutions, governments, and non-governmental organizations must help build capacity to capitalize on these opportunities. Achieving the economic and technical potential of bioenergy, renewable energy and energy efficiency in LAC will require strategies that address the financial, technical, regulatory, and policy constraints affecting the dissemination of these technologies.

The critical constraint to RE/EE development includes a lack of awareness and experience among investors and financiers, which leads to a higher risk perception for taking on RE/EE projects. This coupled with the absence of robust systems of measuring, monitoring, and verifying energy savings presents a challenge for clean energy projects to prove their merit (World Bank 2006a). In addition, RE/EE project design and development require specific technical knowledge and training. Because such projects are new, expertise is still limited.

Lastly, there is a lack of up to date, specific information available to identify specific locations where RE/EE can be harnessed in LAC. The viability of any given renewable energy project tends to be highly site specific. Thus, potential investors need to have quality information on appropriate sites and resource potential. For example, mapping of biofuels and renewable energy suitability areas including agricultural, environmental, and social areas will help decision makers and investors determine where to pursue projects that will help to ensure the sustainability of the industry. For energy efficiency, identifying high priority areas, industries, and sectors will also help policymakers and investors to determine where big savings can be achieved quickly; thereby providing an example for the success of energy efficiency measures and reducing perceived risk.

Despite these constraints to RE/EE development, our analysis of energy demand in LAC suggests a number of opportunities to promote sustainable biofuels, wind, solar, and efficiency as outlined throughout this paper. For example, the transport and electricity sectors are predicted to be the heaviest CO_2 emitters in LAC, so efficiency policies should look to expand public transportation projects and promote efficiency measures such as cogeneration in conjunction with biofuels development. To reach these ends, LAC governments need to mainstream renewable energy and efficiency considerations into energy decision-making. With careful planning, sustainable biofuels and renewable energy and efficiency measures can play a significant role in meeting growing energy demand in the LAC region.

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