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Energy Security in the Latin American and Caribbean (LAC) Region:

Renewable Energy as a Viable Alternative

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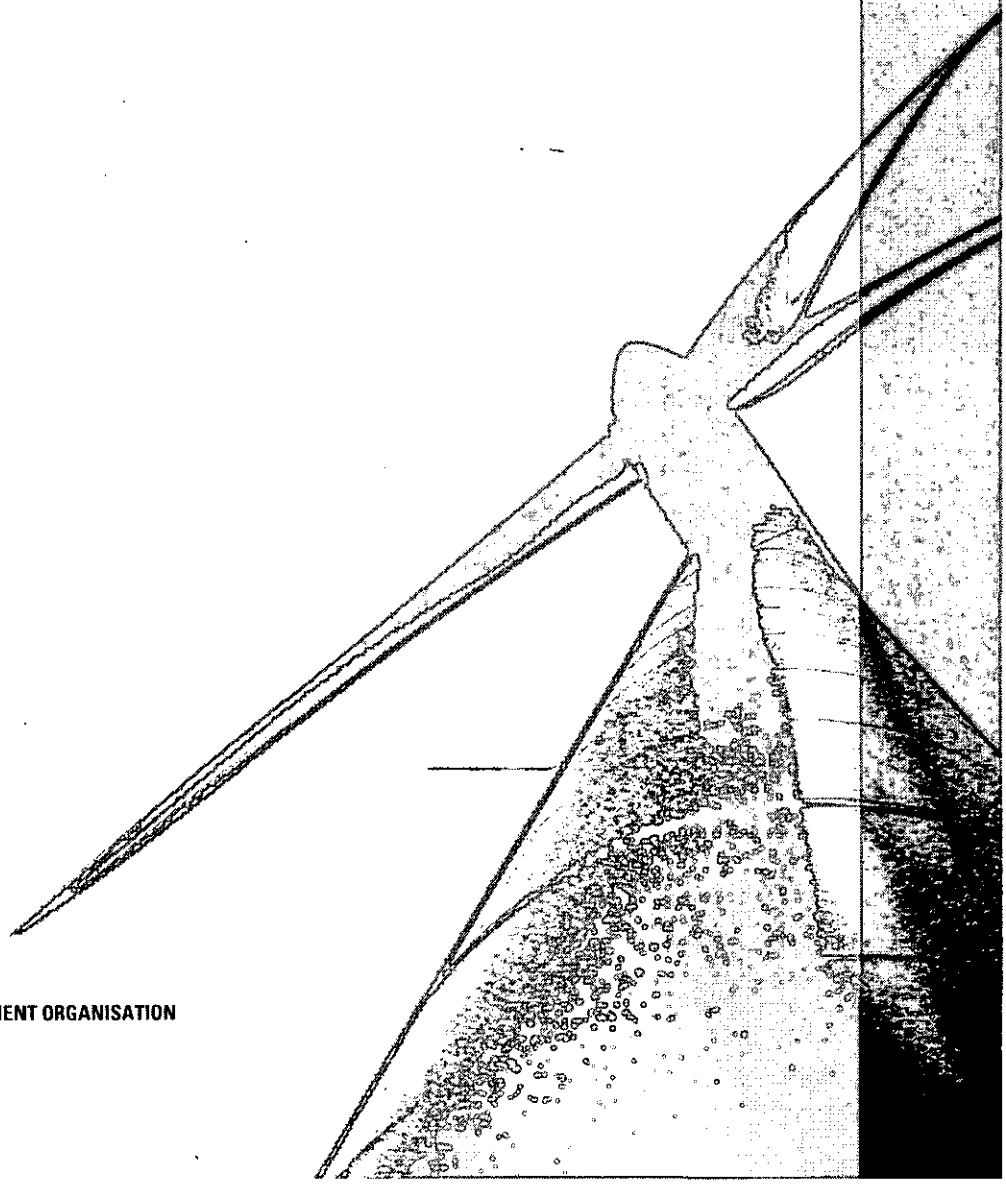

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UNIDO works towards improving the quality of life of the world's poor by helping countries achieve sustainable industrial development. It views industrial development as a means of creating employment and income in order to overcome poverty. UNIDO helps developing countries produce goods they can trade on the global market, and helps provide the tools - training, technology, and investment - to make them competitive. At the same time, it encourages production processes that will neither harm the environment nor place too heavy a burden on a country's limited energy resources.

Over two billion people, mostly in rural areas of the developing world, have no access to commercial sources of energy. One of UNIDO's priorities is to encourage the use of alternative sources of energy - solar, wind, biomass and hydro - and in so doing help those countries and regions to achieve economic growth.

Energy Security in the Latin American and Caribbean (LAC) Region: Renewable Energy as a Viable Alternative

Norbert Wohlgemuth
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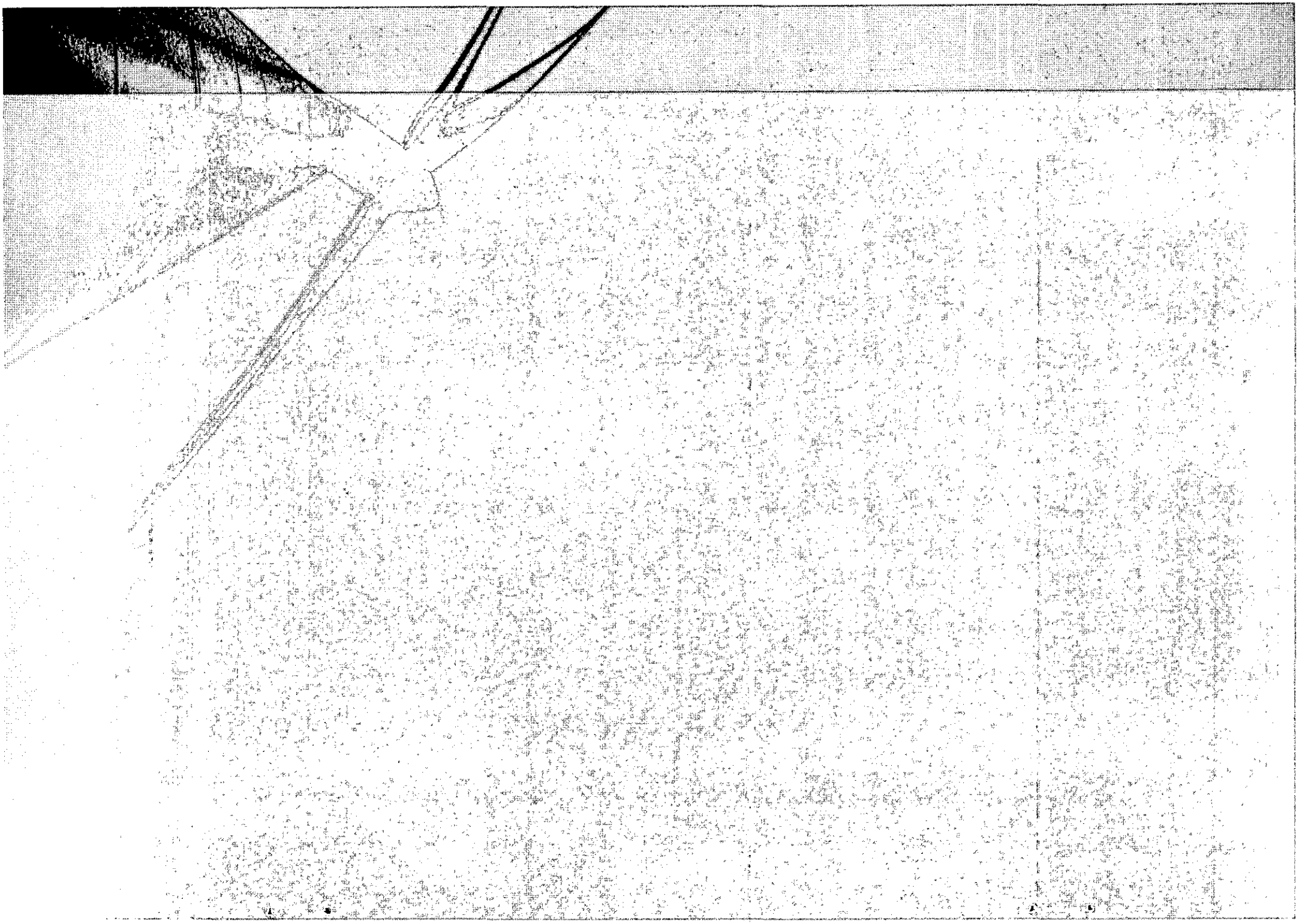
Abstract

High and volatile energy prices have moved global energy security to the top of the political agenda. Energy security has, for example, been one of the subjects of the summit of the G8 leaders in July 2006. Not having access to modern forms of energy is the best example of energy insecurity. In the LAC region 55 million people are without electricity access, many of them in (peri-) urban areas. Access to affordable modern energy services will facilitate the achievement of the Millennium Development Goals. From a developing countries perspective, energy security needs a much broader definition than the availability of a regular supply of energy at an affordable price. Energy security is a complex topic with linkages to other sustainable development objectives.

This paper presents an overview of the potential role renewable energy can play in achieving energy security-related objectives in the LAC region. This part of the world is characterised by a significant endowment with renewable energy resources which – in relation to their potential - have so far only been tapped to a small extent. A greater contribution of (locally produced) renewables to LAC's primary energy supply – along with higher energy efficiency on the supply as well as the demand side – appears in many instances well suited to contribute to all dimensions of sustainable development in this region. Renewable energy can be an attractive option for adding modern energy capacity: it is flexible in scale and it can provide electricity (either on-grid or off-grid), heat and biofuels for transportation.

Issues covered in this background paper include global and regional energy demand and supply trends, (peri-) urban energy poverty, economic effects of high oil prices, the impact of electricity sector restructuring in the region, financing issues of renewables, regional cooperation and energy system integration, as well as the emerging trade globalisation of biofuels, an energy market segment in which the LAC region is one of the global key players.



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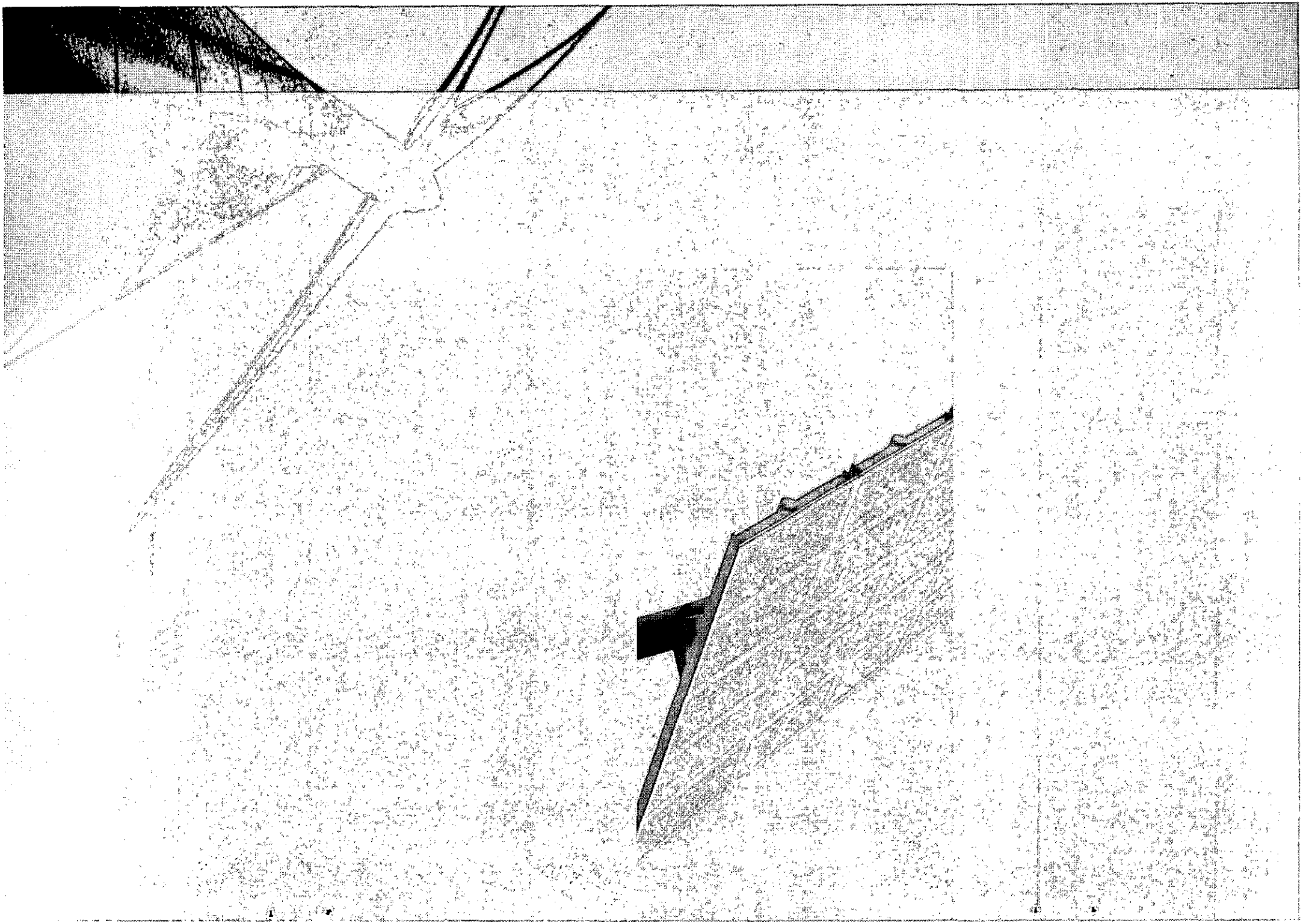


1 BACKGROUND

The current patterns of global energy production and consumption are clearly unsustainable and set to face multiple challenges: global warming and other environmental concerns, geopolitical and military conflicts, significant fuel price rises and depletion of fossil fuel reserves. The social dimension (fight against poverty), the economic dimension (competitively priced energy, security of supply) and the environmental dimension (environmental/climate protection) of sustainable development are in jeopardy. Energy security issues have, again, become an issue of public concern because of high oil and gas prices, the occurrence of power blackouts in the United States and Europe, and recent supply shortfalls of natural gas to Europe.

Energy is essential for every aspect of economic and social development by providing services for cooking and space/water heating, lighting, health, food production and storage, education, mineral extraction, industrial production and transportation. A consistent and reliable supply of energy is therefore one of the major prerequisites to helping developing countries expanding goods production and enhancing productivity and, in the context of a liberalised global economy, becoming competitive on global and domestic markets and, consequently, in promoting a sustainable development. Against this background, developing countries face several important energy sector-related challenges (ESMAP, 2005b): [1]

- the change in global energy demand and supply patterns: on the demand side, the shift from industrialised to developing countries and from the rural to the (peri-) urban areas; on the supply side, the increasing concentration on a few oil and natural gas supply countries;
- the need to increase the use of renewable energy and energy efficient technologies, in order to achieve a transition to a low-carbon economy as well as to achieve the commitments and action plans announced at the International Conference on Renewable Energies and Energy Efficiency in Bonn, 2004;
- increased energy security concerns, for example as measured by high fossil fuel prices and high price volatility, or access rates to modern, i.e., efficient and clean[2], energy services for the poor, and diversification of energy portfolios; [3]

1 The Inter-American Development Bank, in its Energy Sector Strategy (IADB, 2000), sees the following challenges facing the region's sector: "(i) consolidating the structural and economic reforms undertaken in the first half of this decade (economic, financial, environmental, social, and political sustainability); (ii) making new energy options available to all citizens on affordable terms (social sustainability); (iii) developing patterns of production and consumption that are efficient and environmentally friendly (environmental sustainability); (iv) mobilizing foreign and local capital to finance the sector (financial sustainability); and (v) integrating regional energy markets (economic and financial sustainability)." According to the World Bank (2005b) "The energy challenge is to ensure adequate generation capacity for future growth while maintaining the momentum of scaling up access to affordable and clean energy services. The access challenge is to close the gap in availability and quality of infrastructure service provision among the rich and the poor and between urban and rural areas."

2 Clean energy cannot be set equal to small-scale renewable energy technologies, "but with a complete suite of clean and efficient production, supply and end-use technologies" (IMF/World Bank, 2006).

3 Renewables, along with energy efficiency, CO2 capture and storage, and nuclear power are generally considered important elements of a strategic energy portfolio (IEA, 2006c).

- mobilising financing for energy investments in order to provide environmentally sound energy services in developing countries and to contribute to the achievement of the Millennium Development Goals. In the LAC region, for example, the share of people living in poverty has not been reduced during the last two decades.[4] Renewables can be an attractive option for adding modern energy capacity: it is flexible in scale and it can provide electricity (either on-grid or off-grid), heat and biofuels for transportation. Renewable energy-powered applications can, in many cases, offer viable options for improving productive capacities, which could lead, jointly with other variables, to poverty alleviation.[5]

- the environmental challenge in the LAC region is characterised by an increase in CO2 emissions of more than 40 percent from 1990 and 2000. The share of renewable energy in the region's electricity generation mix has fallen over the last decade by 3 percentage points and is likely to decrease further. Urban air pollution is also a major problem in several of the region's major agglomerations.

The current energy situation in the Latin American and Caribbean (LAC) region is characterised by energy production in excess of supply, remote rural areas yet to be connected to grid, continued pronounced dependence on conventional, i.e., fossil, sources of energy, low progress in energy efficiency improvement, small contribution from renewable sources of energy (at least when compared with the potential of renewables) and severe shortage of capital for investment, particularly in the power sector. The fact that - for the region as a whole - energy production exceeds energy demand, however, masks great intraregional variety and a great diversity of the energy situation within individual LAC countries. For example, in Mexico, one of the largest oil producers, there are rural areas that are still unconnected to the grid. Overall rural electrification is 73% of households in Brazil but varies from 90% in the south to 40% in the north. Household electricity access rates range from 34% in Haiti to 99% in Uruguay and Chile (World Bank, 2006). In Guatemala, the share of "traditional" fuels is about 60%, while in countries such as Mexico and Venezuela it is almost negligible (UNDP, 2005). In 2002, 20% of the region's population were relying on traditional biomass for cooking and heating, with highs of around 90% in the rural areas of Haiti, Nicaragua and Peru.

In principle a differentiation between energy demand and energy needs should be made. Energy demand, the manifested demand for energy, is generally lower than energy needs because poor people often cannot afford commercial forms of energy. Considering this difference between energy needs and energy demand, the situation of regional excess energy production appears to be less pronounced than the numbers might suggest.

Given the natural endowment with renewable forms of energy, the LAC region represents a good case study for the assessment of the potential of renewable energy use to meet the above challenges. ESMAP (2005b) identifies "two new areas", energy security and renewable energy, in their 2005-2007 Business Plan:

4 In 2000, the estimated number of people below the poverty line in LAC was 211.4 million, 43.8 % of the total population (GNESD, 2004). 50 million people live on less than a dollar per day (World Bank, 2005).

5 UNCTAD (2006) employs a wide definition of productive capacities: "the productive resources, entrepreneurial capabilities and production linkages which together determine the capacity of a country to produce goods and services and enable it to grow and develop."

"Energy Security: Design sector policies for the poorest countries and for the low income people that take into account factors of vulnerability or instability, such as the dependence on a few fuel resources, fuel price volatility, systems unreliability or income fluctuations; and Renewable Energy: Secure and diversify energy resource portfolios, increase the availability of energy services in un-served areas, in particular where the poorest people live, and accelerate the shift to a low carbon global economy."

These two issues as such are not new but the realisation of the potential renewable energy can play in the contribution to energy security objectives around the world. The issue of energy security is highly topical and of strategic (i.e., long term) importance.[6] Reconciling energy security objectives with sustainable energy development aspects is both an important policy challenge and opportunity. High and volatile energy prices have moved energy security to the top of the political agenda. A greater contribution of (locally produced) renewables to primary energy supply could help reduce dependency on energy imports, reduce carbon emissions and contribute to reducing income inequalities.[7] Global energy security has also been one of the subjects of the summit of the G8 leaders in July 2006. In the St. Petersburg Plan of Action on Global Energy Security[8] the G8 leaders agreed to enhance global energy security through activities in the following areas: increasing transparency, predictability and stability of global energy markets; improving the investment climate in the energy sector; enhancing energy efficiency and energy saving; diversifying the energy mix; ensuring physical security of critical energy infrastructure; reducing energy poverty; and addressing climate change and sustainable development.

This paper presents an overview of the potential role renewable energy can play in achieving energy security objectives in the LAC region.[9] Issues covered include global and regional energy demand and supply trends, (peri-) urban energy poverty, economic effects of high oil prices, the impact of electricity sector restructuring in the region, financing issues of renewables, regional cooperation and energy system integration, as well as the emerging trade globalisation of biofuels, an energy market segment in which the LAC region is one of the global key players.

6 A comprehensive list of energy security definitions can be found in Unido (2006). From these definitions, two broad dimensions of energy security may be distinguished: physical / quantity dimension - risks related to physical supply shortfalls occurring between production and consumption due to infrastructural failure; and economic / price dimension - the risks of price distortions caused by fluctuations in the price of energy products on the world markets. Energy security in developing countries is a complex topic with numerous interlinkages to other sustainable development objectives. Therefore, energy security needs a broad definition, like "a country's ability to expand and optimise its energy resource portfolio and achieve a level of services that will sustain economic growth and poverty reduction" (RIVM, 2004).

7 Sub-Saharan Africa and Latin America are the world's most unequal regions (World Bank, 2005a).

8 Available at http://en.g8russia.ru/docs/11.html. The summit was also referring to "safe and secure" nuclear power.

9 On a fuel basis the focus of this background paper is on renewable sources of energy. Energy efficiency is not covered even though improving energy efficiency is at least as important in achieving energy security objectives. Apart from furthering energy security objectives, improving energy efficiency, at all stages of energy production and consumption, can produce economic benefits in all sectors of an economy; save limited natural resources; reduce urban local air pollution and health impacts; and reduce risks of global climate change. Energy efficiency is politically (even) less contentious than renewable energy. "Energy saved is energy produced and is often a more affordable and environmentally responsible option to meet the growing energy demand" (St. Petersburg Plan of Action on Global Energy Security). Despite some success stories, there had been no overall improvement in energy efficiency in the LAC region, in contrast to the steady improvements in other regions of the world.

2 GLOBAL ENERGY OVERVIEW: DEMAND AND SUPPLY TRENDS

Worldwide demand for energy is likely to increase significantly over the next decades, particularly in developing countries:

- The Intergovernmental Panel on Climate Change (IPCC) projects that the energy demand in developing countries and transition economies could increase by a factor of three to five by 2050. During this time period, all IPCC scenarios suggest that the main sources of primary energy will remain a combination of coal, oil, and gas, providing between 60 and 80% of the energy mix in 2050.

- "By 2050, the approximate distribution of projected demand for primary energy among developing countries and transition economy countries compared to developed countries will be about 80 percent to 20 percent, compared to about 53 percent and 47 percent in 2000. However, the per-capita use of energy will still be highest in developed countries" IMF/World Bank (2006).

- The Energy Information Administration of the US Department of Energy projects an increase of (commercial) world energy demand by 71% from 2003 to 2030 (EIA, 2006). Three-fourths of the projected increase in carbon dioxide emissions results from fossil fuel consumption in non-OECD countries.

- The IEA (2004c) expects an increase of global energy demand of 60% by the year 2030; energy demand in the developing world is likely to more than double over the projection period to 2030. Table 1 shows the projected global energy demand on a fuel basis.

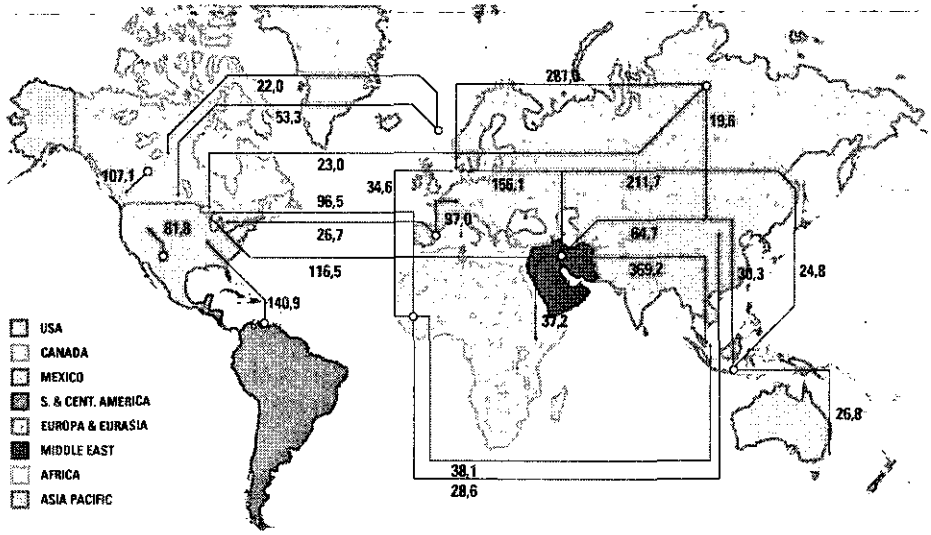
Table 1 World primary energy demand, Mtoe

	1971	2002	2010	2020	2030	2002 -2030 % p.a.
Coal	1 407	2 389	2 763	3 193	3 601	1.5%
Oil	2 413	3 676	4 308	5 074	5 766	1.6%
Of which international marine bunkers	106	146	148	152	162	0.4%
Gas	892	2 190	2 703	3 451	4 130	2.3%
Nuclear	29	692	778	776	764	0.4%
Hydro	104	224	276	321	365	1.8%
Biomass and waste	687	1 119	1 264	1 428	1 605	1.3%
Of which traditional biomass	492	763	828	888	920	0.7%
Other renewables	4	55	101	162	256	5.7%
Total	**5 536**	**10 345**	**12 194**	**14 404**	**16 487**	**1.7%**

Source: IEA (2004c)

Two thirds of the world's oil and one third of global gas reserves are in the Middle East, mostly in the Gulf region. Although these countries currently account for some 27% of global crude oil supplies, they are expected to double their share to 53% by 2010. Figure 1 shows principal world oil trade movements in 2005.

Figure 1 Major oil trade movements, 2005



Source: BP (2006)

Currently, renewable energy technologies supply 13.3% of the world's primary energy supply, but 25% of the developing countries' energy supply, mainly in three forms: traditional biomass[10] for heating and cooking in rural areas, modern biomass combustion and hydropower. The IEA (2004c) projects that the global share of renewables in electricity generation will increase only marginally, from 18% currently to 19% by 2030. "By far the most pervasive form of renewable energy used in the developing world is fuelwood and agriculture residue used for heating and cooking. It accounts for about 10 percent of total primary energy used, or 77 percent of total renewable energy used globally" (IMF/World Bank, 2006). Table 2 presents renewables-based electricity generating capacities by technology and major countries, and Figure 2 shows regional shares of renewables supply in total world renewable energy use by technology.

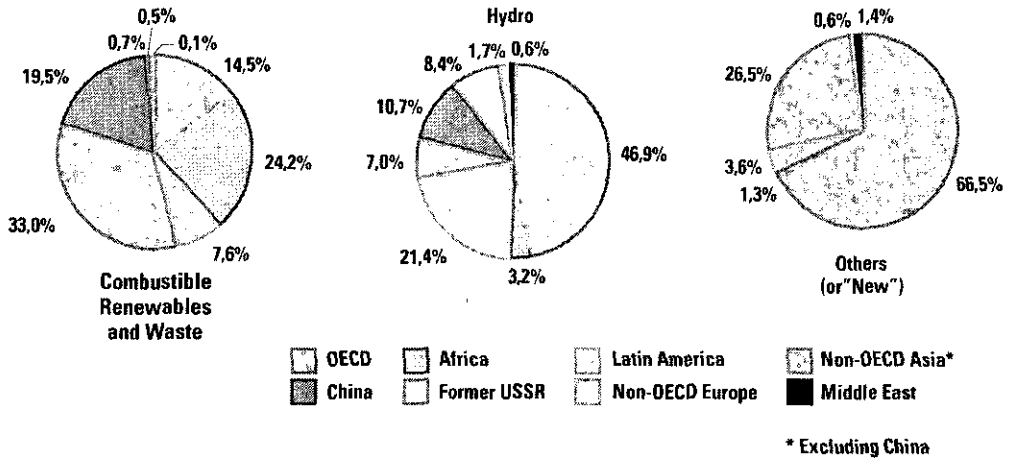
10 Within biomass, a differentiation between three types of biomass use is usually made. Traditional biomass energy use: direct combustion of wood, charcoal, leaves, agricultural residue, and waste for cooking, drying and charcoal production. Improved biomass energy technologies: improved and efficient technologies for direct combustion of biomass, e.g., improved cookstoves. Modern biomass energy use: conversion of biomass energy to advanced fuels such as liquid fuels, gas and electricity.

Table 2 Renewable Electric Power Capacity in 2005, GW

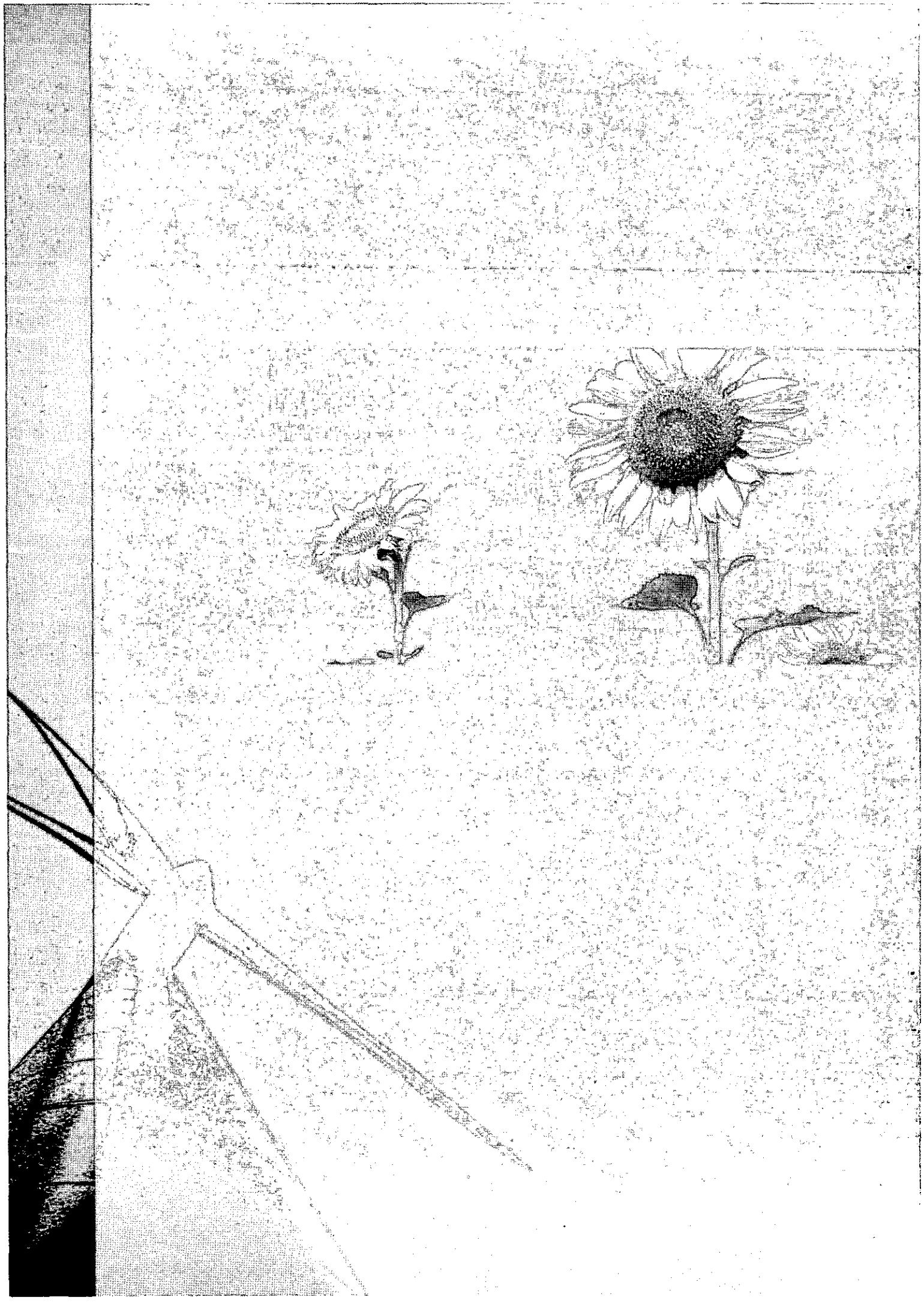
Technology	World total	Developing countries	EU25	China	Germany	U.S.	India
SHP	66	44	12	38.5	1.6	3.0	1.7
Wind power	59	6.3	40.5	1.3	18.4	9.2	4.4
Biomass power	44	24	8	2.0	1.7	7.2	0.9
Geothermal power	9.3	4.7	0.8	~0	0	2.8	0
PV on-grid	3.1	~0	1.7	~0	1.5	0.2	~0
Solar thermal	0.4	0	~0	0	0	0.4	0
Ocean power	0.3	0	0.3	0	0	0	0
Total (excluding LHP)	182	79	63	42	23	23	7
Memo: LHP	750	340	115	80	7	95	n.a.
Memo: Total electric power capacity	**4100**	**1500**	**710**	**510**	**130**	**1060**	**n.a.**

Source: REN21 (2006)

Figure 2 Regional shares of renewables supply, 2003



Source: IEA (undated)



3 THE LAC ENERGY SITUATION: DEMAND AND SUPPLY TRENDS

Table 3 shows basic energy-related indicators by country groupings and individual LAC countries (in descending order of their human development index). As can be seen, most of these indicators for the LAC region as a whole correspond relatively closely to those for the average of all developing countries. As stated above, however, there is a high degree of variation among individual LAC countries. Within the region, Caribbean countries, Barbados and Haiti, have the highest and lowest human development index, respectively.

Table 3 Basic energy indicators, 2002

	Traditional fuel consumption (% of total energy requirements)	Electricity consumption per capita (kWh)	GDP per unit of energy use (2000 PPP US$ per kg of oil equivalent)	Per capita CO2 emissions (metric tons)
All Developing countries	24.5	1,155	4.6	2.0
LAC	19.8	1,927	6.1	2.4
Barbados	6.3	3193	..	4.6
Argentina	3.2	2383	6.9	3.5
Chile	12.5	2918	6	3.6
Uruguay	35.4	2456	10	1.2
Mexico	8	2280	5.6	3.7
Brazil	26.7	2183	6.8	1.8
Colombia	16	1019	9.8	1.3
Venezuela	2.8	3484	2.4	4.3
Peru	20.6	907	10.7	1.0
Ecuador	17.5	943	4.8	2.0
Paraguay	45.7	1129	6.3	0.7
Dominican Republic	7.2	1316	6.8	2.5
El Salvador	32.8	665	7.1	1.0
Nicaragua	47.9	497	5.7	0.7
Bolivia	..	485	4.8	1.2
Honduras	52.8	696	5.0	0.0
Guatemala	58.6	660	6.4	0.9
Haiti*	45.5	73	6.6	0.2
OECD	4.1	8,615	5.1	11.2
World	7.6	2,465	4.6	3.6

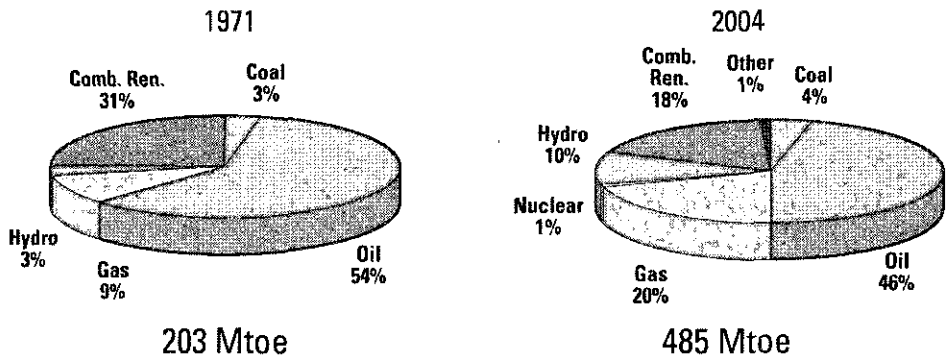
** Haiti is the only Least Developing Country in the LAC region.*

Source: UNDP (2005)

The region's overall primary energy mix is highly oil and gas centred, as can be seen from Figure 3.[11] Only in the Middle East have oil and gas a higher share in energy supply (BP, 2006). The combined share of these two fuels has even increased between 1971 and 2003. Despite the higher utilisation of hydro power, the combined shares of hydropower and combustible renewables has declined, from 34 to 28 percentage points, in the region's energy balance.[12] Coal and nuclear power are only of marginal importance.[13] The Energy Information Administration of the US Department of Energy projects an increase of (commercial) renewable energy demand in the LAC region by 145% from 2003 to 2030, an annual average increase of 3.3% (EIA, 2006). This compares to a projected increase of slightly more than 100%, between 2002 and 2030, by the IEA (2004c).

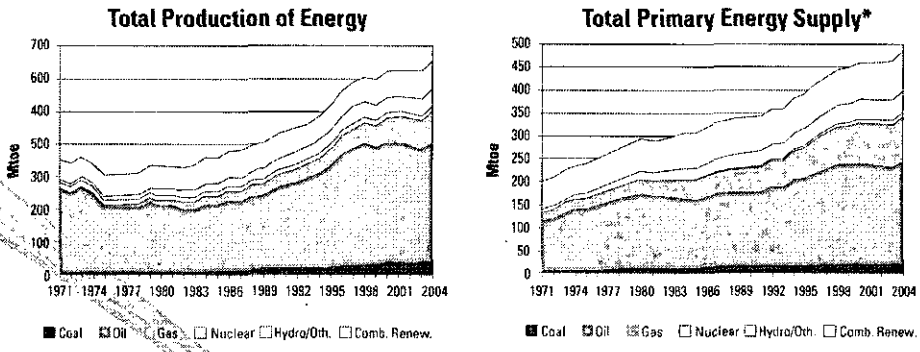
Three countries, Brazil, Argentina and Venezuela, account for two-thirds of the region's energy consumption. Brazil is expected to increase its share in world energy consumption from 1.8 to 2.3% by 2030. Venezuela has the largest oil reserves outside the Middle East. Venezuela also has substantial gas reserves, as do Bolivia, Argentina and Trinidad and Tobago (IEA, 2004c). The average per capita electricity consumption in the LAC region has been rising over the past two decades. However, it remains significantly below the world average.

Figure 3 LAC energy demand, 1971 and 2004



Source: IEA (2006a)

Figure 4 Energy production and supply in LAC, 1971-2004



Source: IEA (2006a)

11. In OECD statistics, IEA and EIA energy outlooks, Mexico is included in OECD North America. OLADE and United Nations institutions (ECLAC, World Bank) assign Mexico to Latin America. This paper follows the convention of the sources quoted.
12. In IEA statistics, combustible renewables & waste comprise solid biomass, liquid biomass, biogas, industrial waste and municipal waste.
13. IEA (2003a) presents energy profiles of several major LAC countries. Further country energy analysis briefs are available at http://www.eia.doe.gov/emeu/cabs/contents.html.

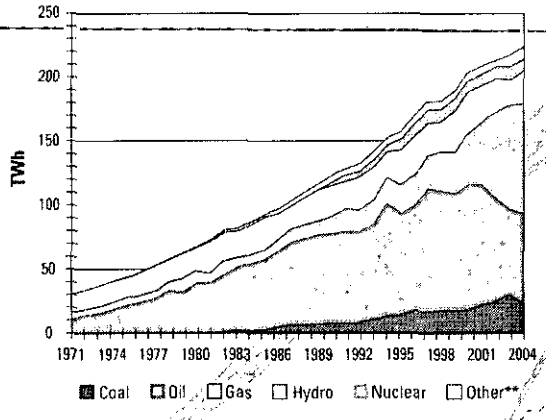
The region as a whole produces more energy than it consumes, see Figure 4. Oil producers in the region have significant potential for increasing output over the next decade. Brazil became a million barrel per day producer of crude oil in 1999, with considerable production potential waiting to be tapped. In both Brazil and Colombia, the oil sector would benefit significantly from the creation of favourable climates for foreign investment. Argentina is expected to increase its production significantly (EIA, 2006).

Oil demand is expected to grow strongly to 2030, chiefly by increased use in the transport sector. Oil production is set to increase even faster, so net exports are likely to increase. Venezuela will remain the largest oil producer in the region, while Brazil will become a net exporter in a few years. Electricity demand is projected to grow strongly, at 3.6% on average per year, driven by increasing income and rural electrification. The region already relies heavily on renewable energy sources, largely hydroelectric power, to meet its electricity needs. In view of their very heavy dependence on hydro, which can be crippled in drought years, many countries in the region are planning to diversify their electric-power fuel mix (IEA, 2004c).

Despite high rates of increase in natural gas consumption, particularly over the past decade, most regional reserves-to-production ratios have remained high. In Central and South America, natural gas production outpaces regional demand. As a result, Trinidad and Tobago continues to export LNG outside the region. Peru, and possibly Venezuela, may also begin to export LNG outside the region over the course of the projection. Ecuador has its first liquefaction terminals under construction, and construction on the second liquefaction terminal in South America is scheduled to begin in 2006 in Peru. Natural gas is the fastest growing fuel source. By 2010, natural gas is likely to overtake oil as the second most prevalent fuel for electricity generation in the region (EIA, 2006).

Renewables (mainly large scale hydropower) will retain their dominant position in the sector over the next decades (EIA, 2006). Hydro power now accounts for two-thirds of electricity generation, but this share may fall to 46% by 2030 (IEA, 2004c).[14] Electricity generation patterns in LAC vary considerably by sub-region. Both South and Central America have traditionally relied heavily on large-scale hydropower for their electricity needs. However, several factors have led to the increased use of fossil fuelled generation over the past twenty years. These include: power sector "liberalisation" with an increased reliance on short term power sales agreements; increased resource availability and reduced costs associated with natural gas fuelled generation; and limited availability of large scale hydro reserves. The Caribbean, in contrast, lacks large hydro reserves and has minimal petroleum production (with the exception of Trinidad and Tobago), has long been dependent almost exclusively on imported fossil fuels for its electricity generation.[15]
Figure 5 shows the Mexican electricity mix, from 1971 to 2004. Mexico is one of three countries (along with Brazil and Argentina) in the region that also relies on nuclear power. As can be seen, natural gas has recently substituted oil in power generation to a significant extent.

Figure 5 Electricity generation in Mexico by fuel, 1971-2004



Source: IEA (2006b)

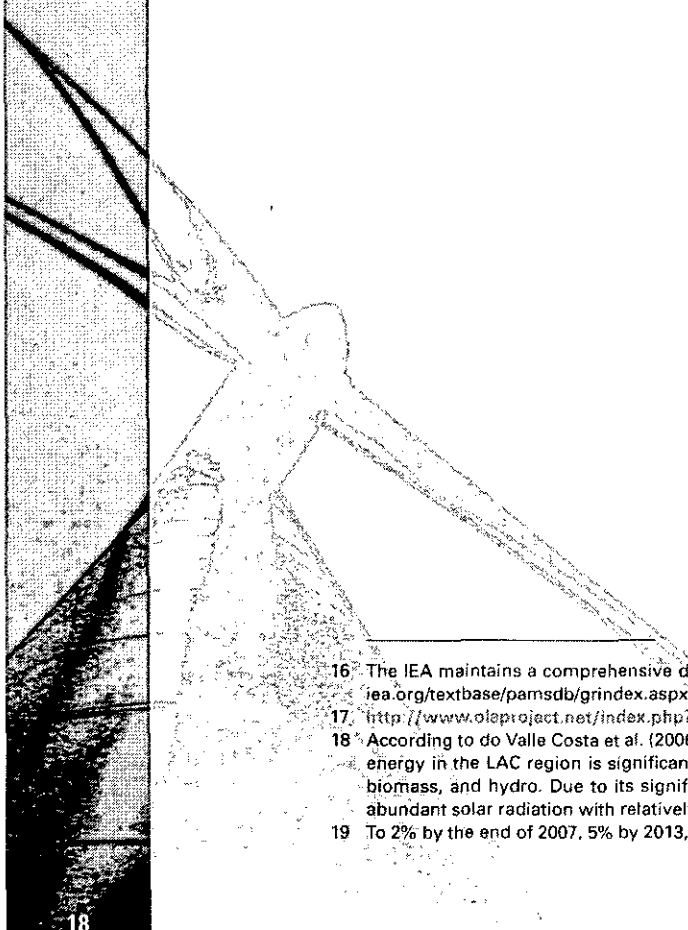
14 Within the renewables grouping, IEA statistics make a differentiation between hydro (includes large [LHP] and small hydro power [SHP]), combustible biomass & waste, and other renewables. Often renewables are separated into large hydro power and so-called "new renewables" because financial instruments to support renewables do typically not apply to LHP. This is because LHP is an established, cost-competitive technology.

15 http://www.reeep.org/index.cfm?articleid=882&ros=1

An overview of the renewable energy situation in the LAC region can, for example, be found in ECLAC (2003), GTZ (2004), REEEP (2003), Altomonte et al. (2003), and Huacuz (2003).[16] As part of the OPET Network project "Promotion of modern clean energy and transport technologies and policies in Latin America and the Caribbean" market analyses for Brazil, Chile, Argentina & Uruguay, Ecuador & Bolivia, the Caribbean and Mexico have been prepared. These reports are available at the project's web site.[17] The following two paragraphs provide a short overview of the renewable energy situation in Brazil and Mexico. These two countries provide interesting examples because they are significant producers of fossil fuels and also very engaged in renewable energy activities.

Approximately 44 percent of Brazil's primary energy supply comes from renewable sources such as hydropower and biomass. Hydroelectricity represents 85 percent of Brazil's power generation; however, Brazil has developed only 41 percent of its hydropower potential[18] with an estimated 260 GW of potential capacity available. Brazil is also the undisputed leader in producing bioethanol and obtained more than 40 percent its liquid fuels for transportation from biofuels, primarily ethanol. In 2004, Brazil made commitments to increase its ethanol and biodiesel production, add 3,300 MW of small hydro, wind and biomass generation capacity,[19] add nearly 3,000 MW of large scale hydropower, and use renewables to achieve 100 percent electrification rate, all before 2010 (IMF/World Bank, 2006). The share of gas in the Brazilian primary energy consumption has more than doubled within a few years, increasing from 4.1% in 1999 to 8.9% in 2004, and this share is expected to rise further to 12% by 2010.

Approximately 10 percent of Mexico's primary energy is from renewable energy, including fuelwood and agriculture residues that account for 53 percent of its renewable energy share. Mexico depends on hydro for a relatively modest percentage of its electricity, and will likely need to expand hydro to diversify its increasingly gas-based power system. Mexico has some of the best wind resources in the world which to date are untapped, but is now embarking on a commercialization strategy beginning with a combination of public and private sector projects (IMF/World Bank, 2006).



16 The IEA maintains a comprehensive database covering global renewable energy policies. It is accessible at http://www.iea.org/textbase/pamsdb/grindex.aspx.

17 http://www.oleproject.net/index.php?id=1&L=1.

18 According to do Valle Costa et al. (2006), only 24% of the potential has so far been exploited. The potential for renewable energy in the LAC region is significant. The region has significant natural resources including solar, wind, geothermal, biomass, and hydro. Due to its significant landmass situated near the equator, the Latin American continent receives abundant solar radiation with relatively little variation (Krauter and Kissel, 2005).

19 To 2% by the end of 2007, 5% by 2013, and a goal of 20% by 2020 (OECD, 2006).

4 RENEWABLE ENERGY POLICIES/INITIATIVES IN THE LAC REGION

4.1 Barriers to the Penetration of Renewable Energy Technologies[20]

Despite the significant potential for renewable energy in the LAC region, several important factors inhibit their wider adoption. Decision-makers receive mixed signals from the investment literature about the issue of when it is appropriate to develop renewable energy technologies as substitutes for fossil fuels. In the case of renewable energy investments, cautious financial institutions often overestimate the risks and decide against extending loans or providing other forms of financial support for otherwise sound projects. In the end, projects that might be good investments and yield a global environmental benefit fail to go forward because of a misperception of the risks involved (UNEP, 2004).

Given the huge potential opportunities in renewables, why are entrepreneurs and financial institutions not rushing to cash on the opportunity? One answer is that renewable energy technologies have to overcome a series of barriers before they can penetrate the market. The barriers have been discussed in detail in the literature on renewables (Reddy and Painuly, 2004; Painuly, 2001). In the initial stages of development, technical barriers predominate. In order for a technology to become cost-effective, market barriers such as inconsistent pricing structures have to be overcome. Then there are institutional, political and legislative barriers which hinder the market penetration of technologies, including problems arising from a lack of awareness of, and experience with new technologies and lack of a suitable institutional and regulatory structure. Finally, there are social and environmental barriers which result mainly from a lack of experience with planning regulations that hinder the public acceptance of a technology. A sound strategy to increase the market penetration of renewables will need to address all these barriers. Table 4 lists the barriers by type.

Table 4 Renewable energy barriers

Barrier type	Example
Institutional	Institutional capacity limitations (R&D, demonstration and implementation)
Market	Small size of the market, limited access to international markets for modern renewable energy technologies, limited involvement of the private sector
Awareness / Information	Lack of awareness / access to information on renewable energy technologies
Financial	Inadequate financing arrangements (local, national, international) for renewable energy technology projects
Economic	Unfavourable costs, taxes (local and import), subsidies and energy prices
Technical	Lack of access to the technology, inadequate maintenance facilities, bad quality of product
Capacity	Lack of skilled manpower and training facilities
Social	Lack of social acceptance and local participation
Environmental	Visual pollution, lack of valuation of social and environmental benefits
Policy	Unfavourable energy sector policies and unwieldy regulatory mechanisms

Source: Painuly (2001)

20 This section is largely taken from Painuly and Wohlgemuth (2006).

There are many causes for imperfections in energy markets which constitute a hindrance for the socially optimal penetration of renewable energy technologies. Financial barriers include:[21]

- The largest barrier to greater renewable energy use is its cost, despite the cost reductions achieved over recent years. But other obstacles, particularly for the increased use of renewable electricity, include subsidies and other support for competing conventional fuels (especially coal and nuclear power). Lack of full cost pricing when determining the cost of competing energy supplies also hinders the development of renewable energy since the cost of environmental impacts are usually not included in energy prices.
- High discount rates and competition on short-term electricity prices, as seen in electricity markets undergoing a change in regulatory framework, may disadvantage projects with high capital costs but low running costs, such as renewable electricity systems - unless governments set up schemes designed to replace and substitute for estimated deficiencies of the market place. In addition to cost-related barriers, non-cost barriers can also inhibit the greater use of renewable energy. This is particularly the case with the imperfect flow of information and the lack of integrated planning procedures and guidelines.
- Financial willingness and feasibility: The user may not have the willingness to pay or the possibility to afford the additional investment on renewable energy equipment. An additional difficulty is that conventional credit does not fit well with the specific conditions for investment in renewable energy technologies. Renewable energy systems are often capital intensive and require larger up-front investments and longer repayment periods than other energy technologies. Investors therefore may prefer to invest in sources with shorter payback periods, thus lowering their long-term risk exposure, even if those sources are more expensive on a long-term life-cycle basis.
- Transaction costs of smaller projects are disproportionately high, compared with conventional projects. Pre-investment costs (including financing, legal and engineering fees, consultants) have a proportionately higher impact on the total costs of renewable energy technology projects. Public agencies can make grants to cover the costs associated with establishing collaborative arrangements which, if successful, can be converted into an equity or royalty stake. The resulting financial return can then be re-deployed as grants for successive projects.
- The free rider or public goods issue: individual consumers might be unwilling to pay for renewable energy technologies because the benefits from reduced emissions are shared equally by everyone, regardless of who pays.
- Energy price distortions: Often energy prices do not reflect the full societal cost of energy. This can be due to subsidies that reduce the market price of energy and a lack of internalisation of external costs[22] caused by pollution or other by-products of energy use.[23]
- Lack of commercial guarantees to enable project financing: Even if long-term contracts are successfully negotiated with developing country public agencies, these agencies are not considered investment-grade without commercial guarantees. In many cases, foreign government agencies are encouraged to privatise and adopt market-based pricing structures at the same time as they are required to provide sovereign guarantees to secure long-term debt from the private sector. As a result, the liability for the project does not shift from the government's balance sheet to private project sponsors. Given the limited amount of exposure any government can credibly assume, renewable energy projects are often unable to compete with other development priorities that receive sovereign guarantees.

21. Painuly (2001) provides an extensive overview of all types of barriers.
22. Altomonte and Rogat (undated) show economic and environmental implications of fuel pricing policies in the LAC region.
23. It is estimated that government subsidies for conventional energy were of the order US$350-400 billion in early 1990s, but decreased to US$250-300 billion per year by mid 1990s. The subsidies are both on production and consumption side.

4.2 Renewable energy policies

Important developments in setting goals and quantitative targets for renewable energy have occurred at the regional level. Examples of significant efforts include (UNDP, 2004):

- With the passing of Directive 2001/77/EC the European Union has adopted the overall target for renewable energy of 12% of gross domestic energy consumption and 21% of electricity consumption of EU25 by the year 2010. This "target bubble" holds for the EU as a whole, while individual Member States have different "indicative targets" (European Parliament, 2001).

- The Latin American and Caribbean Initiative, signed in May 2002 in São Paulo, included a target of 10 percent renewable energy by 2010. As a whole, this region had 24.4 percent of energy use as renewables in 2002, but that includes 15.6 percent in the form of combustible renewables and waste, which in most countries is not renewable. Most of the Caribbean countries and a few in Latin America were below the 10 percent mark in 2002.

Several Latin American countries have launched new rural electrification programs, including Bolivia, Chile, Guatemala, Mexico, Nicaragua, and Peru. Most of these countries have launched efforts to "mainstream" renewable energy as a standard option of new rural electrification efforts.[24] "For example, Chile has recently recognised renewables as a key technology as it enters a second phase of a national rural electrification program. Given this planned scale-up of renewables for rural electrification, regulators and utilities have realised that legal and regulatory frameworks need to be adopted quickly. Indeed, new laws or regulations appeared during 2004 and 2005 in Argentina, Bolivia, Brazil, Chile, Guatemala, and Nicaragua" (REN21, 2005).

In October 2003 a regional conference was held in Brasilia, to follow-up on commitments made at the World Summit *on Sustainable Development in Johannesburg (WSSD)*[25] *in 2002, and to prepare the position of Latin America and* the Caribbean before the International Conference on Renewable Energy to be held in Bonn, in 2004.[26] "At this meeting, the 21 participating countries agreed on a series of guidelines in a document called the 'Brasilia Platform on Renewable Energies', which highlighted one of the commitments: 'To promote the goal of the Latin American and Caribbean Initiative for Sustainable Development of ensuring that by 2010 the Region will use at least 10% renewable energy in its total energy consumption, on the basis of voluntary efforts...'"[27] (OLADE, 2004).

Box 1 describes the PROINFA program that aim at increasing renewable energy use in the LAC region. The PROINFA program attracts interest because of its wide fuel coverage and interesting financing mechanism. The REIA (Box 2) has been initiated in 1992 already and covers the whole LAC region.

24 Altomonte et al. (2003) find that "energy efficiency and renewable energy sources have not been mainstreamed into the energy policies of most Latin American countries."

25 Regarding sustainable consumption and production patterns, governments agreed to increase substantially the global share of renewable energy sources, with the objective of increasing the contribution of renewable energy to total energy supply with a sense of urgency. They recognised the role of national and voluntary regional targets and initiatives, and the need to ensure that energy policies support developing countries' efforts to eradicate poverty.

26 The World Bank, for example, made the commitment to increase its level of lending by 20% a year for the next five years for renewable energy, a goal endorsed by the Bank's Board.

27 The text of the Brasilia Platform on Renewable Energies is available at http://www.renewables2004.de/pdf/platform_declaration.pdf

Box 1 PROINFA - Program to encourage alternative sources of energy in Brazil

PROINFA, Programa de Incentivo às Fontes Alternativas de Energia, aims to increase the share of wind power, biomass energy and small hydropower (SHP), produced by independent power producers (IPPs),[28] in the supply of the Brazilian grid system. The first phase of PROINFA intends to add 3300 MW (equally divided among wind power, biomass energy and SHP) to the interconnected system by 2006. The contracts to be signed between Eletrobras, the major Brazilian power company, and IPPs ensure the purchase of energy for 20 years.

The main features of PROINFA's first phase (PROINFA 1) are: The additional cost of this energy will be equally shared by all households connected to the grid, excluding Low Income Consumers (up to 80kWh/month, plus a second group under special conditions to be defined by ANEEL – up to 220 kWh/month). The Law defines an IPP as a company that is not controlled by any other company involved in generation, transmission or distribution of power. Equipment manufacturers may participate as IPPs. However, a minimum of 60% of the equipment value must be manufactured in Brazil. ANEEL, the National Electric Energy Agency, regulates tariff reductions of at least 50% for access to transmission and distribution systems for plants generating electricity from wind, biomass and qualified co-generation.

PROINFA contracted 144 renewables-based electricity (RES-E) projects. However, up to now, only two wind energy projects (a total of 200MW) and about 300MW from SHP are under construction. This may be because of the initial delays in the bidding process and shows that the entrepreneurs are having difficulties in meeting the requirements established to get access to funding sources. Upon successful completion of PROINFA 1 it should result in a total generation of 11,334 GWh/year (taking into account the capacity factor of 50% for SHP, 50% for biomass, and 25% for wind energy). This amounts to almost 3% of the total country's electricity generation. PROINFA will assure subsidies to producers of electric power from alternative sources until they can supply 10% of the national energy matrix. From that point on it is expected that IPPs will have sufficient know-how and effective market share to compete successfully in an open market.

Sources: do Valle Costa et al. (2006) and Janssen et al. (2004).

Box 2 Renewable Energy in the Americas (REIA) Initiative

The Renewable Energy in the Americas (REIA) Initiative was created in 1992 by a consortium of U.S., LAC interests to advance sustainable solutions - particularly renewable energy and energy efficiency - for meeting the growing energy needs of the Hemisphere. During the 1994 REIA Conference and Exhibition held in Puerto Rico, various governments from the LAC region, joined with the U.S. Export Council for Renewable Energy in setting forth an agenda for formal collaboration in renewable energy and energy efficiency. This consisted of the signing of the REIA Declaration (by 16 countries) and the establishment of the REIA Working Group. The Working Group is composed of a focal point from each of the various participating countries and helps to set the priorities for REIA.

The objectives of the REIA Initiative are fourfold: (1) To identify and promote viable renewable energy and energy efficiency project opportunities in the LAC region; (2) To promote policy measures that will advance the use of renewable energy and energy efficiency technologies; (3) To develop and assist in accessing innovative financing mechanisms suited to the technical characteristics of renewable energy and energy efficiency technologies and appropriate to the social and economic needs of the demographically diverse end-users; and (4) to provide technical assistance and training on matters related to sustainable energy development.

REIA was transferred to the Department of Sustainable Development of the Organization of American States (DSD/OAS) in 1998 in order to provide better service to the countries of the LAC region. The DSD/OAS plays an important role in the follow up to, and preparations for the Summits of the Americas. This summit process, which seeks to encourage sustainable development and environmental protection throughout LAC, offers further expansion of the scope of the REIA Initiative.

Source: http://www.oas.org/dsd/reia/default.htm

28 WADE (2006) provides a global overview of decentralised electricity generation.

Box 3 Global Sustainable Energy Island Initiative

The Global Sustainable Energy Island Initiative (GSEII), a consortium of international NGOs and multi-lateral institutions, including the Organization of American States and UNIDO among others, is currently promoting and supporting Small Island Developing States (SIDS) efforts in transitioning away from energy consumption and supply patterns based on conventional fossil fuels towards more sustainable energy development based on environmentally sound renewable energy technologies and more efficient use of energy. A principal focus of this initiative is to support the consolidation of the efforts of the Caribbean Island States in orienting their national energy policy and development towards renewable energy and energy efficient technologies. In line with their national priorities, the project aims to help these islands to lay the foundations for improved energy security, reduced electricity tariffs and improved allocation of resources. In parallel, the project focuses on expanding sustainable energy planning and implementing activities among SIDS and member nations of the Alliance of Small Island States (AOSIS) and to provide on-going international outreach to demonstrate SIDS commitment and efforts for a more sustainable energy development.
Source: UNIDO

5 FINANCING SUSTAINABLE DEVELOPMENT – THE CASE OF RENEWABLE ENERGY

The financing of sustainable development is a crucial element for the implementation of the commitments reached at the United Nations Conference on Environment and Development (UNCED, 1993) in Rio de Janeiro in 1992 and has, since then, been a major focus of the work and discussion in the United Nations Commission on Sustainable Development (CSD). Finance for sustainable development is the subject of Chapter 33 of Agenda 21.[29] In 2002, the United Nations has convened for the first time a summit-level meeting to address key financial and related issues pertaining to global development. An unprecedented feature of the Finance for Development[30] process is the active participation of the World Bank, the International Monetary Fund (IMF), and the WTO, as well as representatives of civil society and the business sector. Six key areas have been identified: Mobilising economic resources within countries; Increasing the flow and broadening the reach of private international investment; Opening access to markets and ensuring fair and equitable trade regimes; Strengthening official development assistance; Addressing developing country debt difficulties; and improving the coherence of global and regional financial structures and the fair representation of developing countries in international decision-making.

5.1 Energy sector investment requirement

The IEA (2003b) projects energy sector infrastructure investment of $16 trillion over the period 2003 to 2030, see Figure 6. The electricity sector is seen to account for most of this future energy investment. On a geographical basis, developing countries will require almost half of global investment.

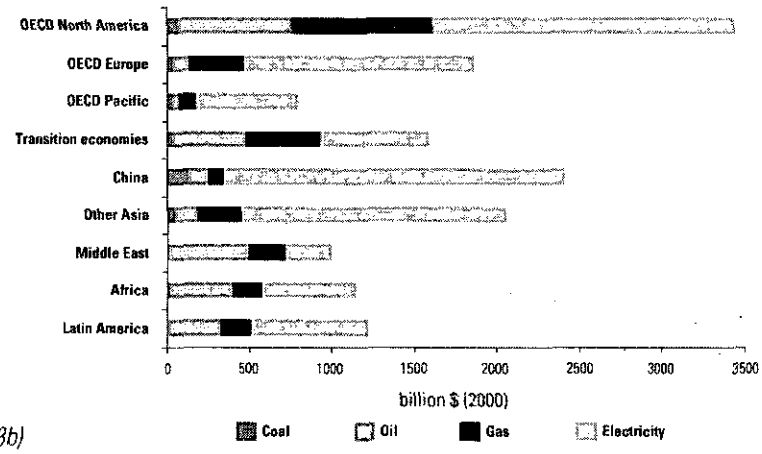
On a global scale there is enough saving; in some regions, however, it is not certain that sufficient capital, from domestic and international sources, will be available. Mobilisation of funds will depend on the energy sector's ability to provide a return high enough to compensate for the risks involved. The absence of clearly defined energy policies and the lack of institutional capacities, human resources, adequate legislative, regulatory and financial frameworks, which are vital for attracting private investment and ensuring the proper functioning of the market, are clear barriers for attracting capital.

29 The General Assembly decided that the UNCED should "identify ways and means of providing new and additional financial resources for environmentally sound development programmes and projects in accordance with national development objectives, priorities and plans and to consider ways of effectively monitoring the provision of such new and additional financial resources so as to enable the international community to take further appropriate action on the basis of accurate and reliable data" and "Consider various funding mechanisms, including voluntary ones, and examine the possibility of a special international fund and other innovative approaches, with a view to ensuring, on a favourable basis, the most effective and expeditious transfer of environmentally sound technologies to developing counties." (Agenda 21).

30 http://www.un.org/esa/ffd/

"Financing for the energy supply sector comes from three sources: internal cash generation, private financing and public funding. The role of each of these sources has varied based on the state of development of the economy and viability of the sectors. Going forward this pattern of financing is expected to continue with private sector playing a progressively greater role in the reforming economies. Currently less than half of the energy supply-side investments for the developing countries and transition economies comes from internal cash generation. The remaining resource comes from public private sources in a rough proportion two to one. However there is wide divergence in these proportions between the low income, lower middle income, and upper middle income countries with the public sector playing a dominant role in low income countries (about 60 percent of the financing) and lower middle income countries (about 30 percent of the financing) and private sector playing an important role in the upper middle income countries (about 40 percent of the financing). The key challenge in the energy sector is the electricity sub-sector where the current levels of investments only fund about 50 percent of the needs of $160 billion, i.e., about $80 billion. With large fiscal constraints in most of the countries requiring the bulk of the investment resources, these investments would come from either internal cash generation or through greater private participation spurred by sector reform and viable tariffs. Any increase in investment levels is expected to be rather unevenly divided over the developing and transition economies and there could be substantial investment shortfalls in a number of countries." (IMF/World Bank, 2006).

Figure 6 Cumulative energy investment, 2003-2030



Source: IEA (2003b)

In the LAC region expected cumulative investment requirement between 2003 and 2030 amounts to more than 1200 billion dollars. More than half of this investment will be needed to maintain the present level of supply. According to the IEA (2003b), the investment required to expand Brazil's energy system from now to 2030 is projected to be nearly $450 billion (in year-2000 dollars). In most LAC countries, the public sector alone will not be able to provide that financing. Private investment will only be forthcoming if the region's regulatory regimes become more transparent and consistent.

"About $50-55 billion was invested in renewable energy worldwide in 2004, including large hydropower, compared to conventional power sector investments of about $110-150 billion. Biomass for industrial and agricultural process heat is used extensively in developing countries and at current oil prices, its use is expanding. Biomass can have a great potential for power generation especially in some of the developing countries where other energy sources are not abundant." (IMF/World Bank, 2006). According to REN21 (2006), an estimated $38 billion was invested in new renewable energy capacity worldwide in 2005.

5.2 Investment in infrastructure projects with private participation

According to UNCTAD statistics, total foreign direct investment (FDI) inflows to the LAC region rose substantially, to US$ 68 billion, after four consecutive years of decline.[31] "Growth in the region remains heavily dependent on the volume of foreign capital flows. Beyond macroeconomic stability and commitment to sound fiscal and monetary policies, the countries of Central and South America will face governance issues and severe economic disparities between the wealthy and the poor in the region's societies" (EIA, 2006).

In energy and transport, investment in infrastructure projects with private participation, global investment flows fell to levels not seen since the early 1990s (Izaguirre, 2005). As in earlier years, the private activity in energy was directed mainly to electricity projects in a few large developing economies. Power plants accounted for 75 percent of investment flows to the sector, followed by stand-alone transmission facilities and distribution companies (each with 9 percent).

During 1995 to 2004 private sector commitments to infrastructure in developing countries totalled $748.4 billion, or $75 billion a year. But this average masks enormous fluctuations. Private commitments rose sharply until 1997, then fell quickly in response to East Asia's financial crisis. In recent years they have hovered around levels like those in the mid-1990s. Most of these investments have gone to energy and telecommunications (in terms of sectors) and to Latin America, East Asia (in terms of regions). Table 5 shows sectoral and regional investment in infrastructure projects with private participation in developing countries.[32] The LAC countries accounted for 40% of total private investments. Approximately, 80 percent of the investments in LAC countries were in divestiture projects (Jamasb, 2006). According to the World Bank (2004), the private sector provides more infrastructure financing than does ODA.

Due to the rapid expansion of private capital flows in the last decade, World Bank assistance to the energy sector has shifted to providing technical and policy assistance, particularly in promoting institutional reforms, see chapter 8.

Concerning the profitability of these investment projects Sirtaine et al. (2005) find that, "contrary to general public perceptions, the financial returns of private infrastructure concessions have been modest and that in fact for a number of concessions the returns have been below the cost of capital. On average telecom and energy concessions have feared better than transport and water."

Table 5 Investment in infrastructure projects with private participation in developing countries, billion dollars

		1995	1998	2000	2002	2004
Sector	Energy	21.7	29.3	27.4	19.2	12.7
	Telecommunications	17.2	51.8	48.9	33.0	45.0
	Transport	8.2	17.5	9.1	3.6	4.5
	Water and sewerage	1.5	2.2	4.8	2.0	1.9
Region	LAC	17.1	71.2	38.7	19.6	17.4
	Europe and Central Asia	8.1	12.1	25.0	16.8	12.5
	East Asia and Pacific	18.8	9.7	14.3	9.7	8.7
	Middle East & North Africa	0.1	3.1	4.1	1.6	10.9
	South Asia	3.8	2.3	4.4	6.0	9.6
	Sub-Saharan Africa	0.8	2.5	3.7	4.2	4.9
	Total	**48.7**	**100.9**	**90.2**	**57.8**	**64.1**

Source: Izaguirre (2005)

31 The resurgence in FDI occurred in 28 of the 42 economies in the region for which data are available. Brazil and Mexico consolidated their positions as the largest recipients of this investment, accounting for 27% and 25% of the total, respectively. The largest FDI increases in Latin America and the Caribbean occurred in MERCOSUR member and associate member countries, especially Argentina (125%), Brazil (79%) and Chile (73%). UNCTAD's World Investment Report attributes the strong growth in investment in Central America and the Caribbean mainly to a 46% rise in inflows to Mexico. In the Andean Community, total inflows remained almost the same as in 2003. Notable exceptions were Colombia and Peru, which had clear upturns of 53% and 37%, respectively, and Venezuela, Ecuador and Bolivia, which saw decreases.

32 From 1980 to 1998, infrastructure spending decreased from 6 to 4 per cent of total government expenditure in Africa, from 12 to 5 per cent in Asia and from 11 to 6 per cent in Latin America (UNCTAD, 2006).

5.3 Renewable energy financing mechanisms [33]

In industrialised countries there is of lot of experience with financial instruments to promote renewable energy for electricity generation. For an overview of the great diversity of mechanisms see for example Menanteau et al. (2003); Mitchell and Connor (2004); Ringel (2006); Sawin and Flavin (2004). In principle, there are several classifications for mechanisms to financially support renewable energy.[34] One classification would be along the development chain of renewable energy technologies. According to this classification, renewable energy technologies can be supported at the R&D, the investment, the production and the consumption stages. Another classification would be whether supply and/or demand or price and/or quantity of renewable energy are supported. Finally, differentiation can be made whether regulatory or voluntary and/or direct or indirect mechanisms are employed.

Table 6 summarises types of support measures for renewable energy, their point of operation and target audience. R&D measures are needed first in order to create new technologies; then measures aiming at commercialisation and market creation follow. For a technology to penetrate the market, the consumer has to adopt it. Therefore, in many cases, information and education campaigns are also necessary.

Table 6 Types of Support for Renewable Energy

Measure	Point of Operation	Target Audience
RD&D support	Basic research to early commercialisation	Researchers, renewable energy technology suppliers
Project-based financial support	Commerciali-sation	Renewable energy generators
Guaranteed markets or buyback rates	Commerciali-sation	Electricity retailers
Green pricing	Market creation	Electricity retailers and consumers
Information and education campaigns	Market "normali-sation"	Consumers

Sonntag-O'Brien and Usher (2004) classify the financing models based on the stage at which financial support is provided. Their categorisation is followed here with some modifications.

- Start-up capital support to meet up-front costs for raising capital, building market awareness, and transaction costs, which are generally high for renewables. Business development grants and seed capital financing fall in this category.

- Operating capital support, which includes lines of credit, credit enhancements for loan provision, and small and medium scale energy enterprises growth capital funds.
  - Lines of credit refers to creation of credit windows in national or local banks, with support from international finance institutions/donors, for lending to renewable energy enterprises.
  - Credit enhancements refer to various subsidies provided by international finance institutions/donors to soften loan financing, either for the lender or the borrower through risk sharing or interest-rate reductions. These assume the forms of (i) partial risk guarantees, which ensure debt-servicing payments to the lender, and (ii) partial credit guarantees, which are used to extend loan repayment periods, improving the project's cash flows in the process. The guarantees can motivate banks to lend for projects they perceive as risky.

33 This section is largely taken from Painuly and Wohlgemuth (2006).

34 Beside the objectives, it is not immediately clear what criteria should be applied to assess the success of a project or program. Possible criteria according to which support mechanisms can be judged include: effectiveness (e.g., total capacity installed or total kWh of electricity generated), cost-effectiveness (kW/ , kWh/), short term economic efficiency (short term cost minimisation), long term economic efficiency (incentives for innovation), equity (fair distribution of costs and benefits), certainty for industry, transparency, transaction costs, and market conformity (especially important in liberalised electricity markets).

Credit enhancement can also be achieved through interest rate subsidies which lower the cost of financing for the borrower. The credit risk in this case remains with the local bank/institution providing the credit, and hence can be applied only if the market potential is big and ripe for development.

Credit enhancement leads to access to business finance to the renewable energy enterprises, one of the major objectives of several World Bank/GEF renewable energy projects. In some cases, they combine credit enhancement with support to the manufacturers and/or dealers to meet a part of their business development costs in initial stages, with a view to develop the supply side of the renewable energy market. In yet other cases, they combine the credit enhancement with subsidies tied to the performance (for each unit sold) to lower the high initial costs of the renewable energy equipments with the view to develop the market, which, in turn, is expected to lead to lower the cost of renewable energy equipment through economies of scale and learning.

- Growth capital funds are similar to seed capital financing but use a mix of commercial capital and donor funds, and reduce the risk of investors by financing the project through equity or debt. Experience with these funds has been mixed.

- End user financing has several variations, including: o The supplier credit model, in which the renewable energy enterprise provides a short term (3-12 month) credit to the end user for purchase of the renewable energy equipment/system. The equipment manufacturer could also extend credit to the renewable energy enterprise for this purpose.
  - The consumer credit (or micro credit) model, in which local finance institutions provide loans to users (households, for example) to buy the renewable energy system. renewable energy enterprise in this case transacts on commercial basis with the users. Credit enhancements, using partial guarantees and interest rate softening, has also been applied with consumer credit.
  - Several World Bank solar home systems projects have used what they refer to as a 'dealer sales model', which uses the consumer credit approach with credit enhancement. In this model, the dealer sells the system to the end user, which can be sometimes on credit. The dealer is provided support through access to business financing. Some additional support (performance based subsidy to dealers) has also been provided to develop the market. A part of the cost in this case were covered by the project, which involved dealer training and dealer business financing.
  - In the fee-for-service model customers pay for the energy service that is provided to them by an energy service company. It makes the energy affordable and minimises the long-term risks for the customers as the ownership and maintenance of the equipment lies with the energy service company. The World Bank used this model in Argentina, Benin, Togo, Dominican Republic, and Cape Verde. In the World Bank energy service company delivery models, financing for energy service companies was provided through either government or multilateral sources, but channelled through commercial financiers in many cases.
  - The lease model is similar to the fee-for-service model as the ownership of the equipment lies with the leasing company, which typically are specialised financial institutions. It has been used for big, mostly on-grid power, generation equipment.

Box 4 LAC Off-Grid Electrification Programs

The Nicaragua Off-grid Rural Electrification Project provides electricity to remote villages and dispersed users in Nicaragua. It finances village mini grids (mostly mini hydro) and solar home systems via output-based aid schemes. The project works primarily with small, local service providers and integrates the delivery of electricity services with business development services and microfinance.

The Bolivia Decentralized Infrastructure for Rural Transformation Project is the most recent project in that country, with an ambitious output-based aid scheme that links subsidies to performance on various levels and out-sources a range of well-specified services to private sector operators. The project aims to electrify over 15,000 users with solar home systems. It also develops synergies with its telecommunications component, which finances the extension of cell phone, radio, and TV services to the same rural areas. In addition, the project provides a complementary fund for the productive use of electricity and telecommunications infrastructure.

Rural electrification programs in several LAC countries are explicitly incorporating large-scale investment in solar home systems for some of the homes to be electrified. Governments are recognising geographic rural areas that are non-viable for grid-extension, and enacting explicit policies and subsidies for renewables in these areas to supplement line-extension electrification programs. For example, Brazil plans to electrify 2.5 million households by 2008 under the Luz para Todos program (about 700,000 have already been electrified), and has targeted 200,000, or about 10 percent of these households for renewable energy.

In Nicaragua, the PERZA rural electrification project focuses on innovative public/private off-grid electricity delivery mechanisms complemented by rural microfinance and business development services to significantly enhance the development impact of rural electrification.

In Argentina, the PERMER program includes a concession approach for rural electrification, based on the country's ample experience with concessions for infrastructure services (e.g., telecommunications, water). Concessions are eligible to re-bid competitively against other eligible firms every 15 years up to a total of 45 years, tariffs are renegotiated every two years, and the financial rate of return is about 14%.

Sources: World Bank (2005b), REN21 (2005), World Bank (2006)

Box 5 Energy Enterprise Development by E+Co

E+Co has been engaged in promoting small and medium scale energy enterprises through seed finance. Working on Rural Energy Enterprise Development (REED) project initiated in 2000 by UNEP, E+Co provided support to 25 energy enterprises in six developing countries in areas such as start-up financing (in the form of debt and equity), enterprise development services such as business planning, management structuring and financial planning, and assistance in securing later-stage financing. The countries include Ghana, Mali, Senegal, Tanzania, Zambia and Brazil with enterprises covering crop drying, charcoal production, biofuels, wind pumps, solar water heating, and efficient cook stoves. E+Co started operations in 1994 and its overall portfolio had reached, by March 2005, about 11 million dollars with 112 investments in Africa, Latin America, and Asia, of which more than 85 per cent is debt. The leverage has been more than 10, with additional investment in these enterprises at US$ 120 million. E+Co experience has been that money is not always the problem, it is the link between money and the good ideas that is often missing in this sector. Their opinion is that the need to promote and strengthen private enterprises is a key element to overcome these issues.

Source: UNEP

Box 6 Revolving Fund for Small Hydro Schemes in Peru

A revolving fund for financing micro hydro power plants was set up in 1994 through an agreement between the Inter-American Development Bank and ITDG-Peru, a NGO. The project is an example of a successful financial model that combines subsidised loans and technical assistance through shared efforts between technical co-operation agencies and government institutions. The project was initiated with the view to provide electricity to remote areas not reachable through conventional grid. The fund has provided loan finance to 15 rural electrification projects of municipalities, 5 projects of the private sector and one project of the co-operative. A loan amount of US$ 700000 was given, which leveraged US$ 2.5 million from government and other agencies to provide electricity to 15000 people. Technical assistance for proposal preparation was provided and regional and local workshops were arranged to create awareness. The project needed social intermediation, forming pre-electrification committees or other ad hoc organisations to operate and maintain the plant (Barnett, 1998), and required technical intermediation in addition to financial intermediation. Repayment levels have been high but considerable time and effort had to be expended to market both the fund and the idea of hydro power. Overall, the project experience implies that micro hydro is not viable without some support, as households had to be provided subsidised power to make it accessible to them.
Source: IDB

Box 7 Generation and Delivery of Renewable Energy in the Isla de la Juventud, Cuba

UNIDO is currently executing a GEF-funded project, Generation and Delivery of Renewable energy in the Isla of Juventud, Cuba, oriented to demonstrate the technical, economical and financial viability of replacing fuel oil based electricity generation, and heat production based on renewable energy resources. The project will address barriers to the development of renewable energy through technical assistance and softening of finance in order to achieve attractive initial conditions for wind power and biomass gasification technology markets. The project will introduce new and innovative financial and institutional structures to encourage private investments, support economically viable, environmentally sustainable markets, and enhance local manufacturing capacity for renewable energy technologies in Cuba. As a result, a robust market and strong institutional and financial capacity at the national level for supporting renewable energy investment projects will emerge that would make Cuba's economy less reliant on imported fossil fuels to meet its growing energy needs, and in the process, also help in reducing overall GHGs emissions through wide-spread use of renewable energy technologies in the country as well as in the Caribbean region. The project aims at installing a large biomass gasifier plant for power generation to the tune of 3.5 MW, four gasifier applications (about 6 MW thermal) to be placed at four industrial sites for heat production and a wind farm (hurricane proof) to produce 1.5 MW of electricity to augment power supply on the Isla de la Juventud.
Source: UNIDO

6 (PERI-) URBAN ENERGY POVERTY

"The 'electricity divide' has not received as much attention as the digital divide" (UNCTAD, 2006).

UNDP (2000) defines energy poverty as "a lack of choice in energy services (in terms of reliability, quality, safety and protection of the environment) under economic conditions that provide support for the economic and social development of families and individuals".[35] Most studies on energy poverty focus on rural energy poverty, typically as measured by access rates to modern forms of energy, and energy affordability. Some LAC countries, however, are highly urbanised. Over 70% of the total LAC population lives in cities (WEC, 2006); in 2002, 82% of the Brazilian population lived in cities (GNESD, 2005). The issues of electricity access are quite different in rural and urban areas. "Rural areas in low-income countries often lack any infrastructure for providing energy services whereas most urban areas have energy providers that already serve better-off populations" (World Bank, 2006).

"The proportion and number of poor people in urban areas in relation to the total showed a significant and steady increase in the 1990s over the 1980s. The number of poor people in urban areas in 1980 was 14 per cent lower than that of the rural poor people in rural areas. In 1999, the number of urban poor was 74 per cent higher than the rural poor. In 1980, the urban poor accounted for 46 per cent of the total poor in the region while, in 1999, that proportion rose to 63.5 per cent" GNESD (2004). Agenda 21, Chapter 7 (promoting sustainable human settlement development), has a distinct program area on "Promoting sustainable energy and transport systems in human settlements".[36]

"Since the 1990s, the phenomenon of urban poverty has become increasingly more important than rural poverty, both in quantitative and qualitative terms, affecting nearly all Latin American countries. While in 1980 the number of people in the region living in poor conditions was 136 million, of which 46% were considered urban population, by 1999 the total number of poor people had increased to 211 million, with more than 63% living in Latin American cities. As a result, urban poverty has doubled in the last two decades, while the number of rural poor has remained stable" (WEC, 2006).

It is generally assumed that urban populations are healthier, more literate and more prosperous than rural populations. UNHABITAT (2006) shows that the urban poor suffer from an urban penalty: "Slum dwellers in developing countries are as badly off if not worse off than their rural relatives." There is evidence showing that poor people urbanise faster than the population as a whole. This implies that anticipating their needs will require a stronger focus on urban issues (World Bank, 2004).

Most of the projections predict that by 2020 more than half of the world's population will live in urban centres, that 70-75% will live in megalopolises of over 1.0 million people, and that 60% of the urban population will be below poverty level (ESMAP, 2005b). About 40 percent of the world's poor already live in peri-urban areas (ESMAP, 2005b). The resulting pressure on the demand for the various forms of energy is not well known.[37]

35 Urban poverty is defined as "the inability to earn an income sufficient to meet the most basic needs, access to energy being a significant element of these needs" (WEC, 2006).

36 http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21chapter7.htm

37 A review of energy consumption patterns in 45 cities reveals that for the poorest income households in the urban areas up to 50% of their energy consumption is from traditional fuels – wood and charcoal (ESMAP, 2005b).

In the 1990's, with the liberalisation of Brazilian energy markets, energy companies found themselves forced to review their pricing policies at the very time when energy costs were going up. The use of cross-subsidies became much more difficult and the inevitable increase in tariffs for vulnerable social groups magnified the energy poverty problem (ESMAP, 2006a). Today, around 11.5 million people in Brazil still have no access to electricity (GNESD, 2005).[38]

The implications for the energy sector are that demand growth will occur mainly in urban and peri-urban centres, and that the emphasis in the access issue is likely to shift to the peri-urban areas. The demographic trends call for revisiting fundamentally urban/peri-urban energy policies. Cleaner energy technologies and renewable energy are important elements in addressing the problems of urban air pollution and climate change in the LAC region.

The following box presents the Brazilian PRONAI program. It is an interesting example of an innovative program that doesn't just provide a safe source of electricity for slum dwellers. It also documents proof of residence, necessary for getting a phone and establishing credit, in addition to other benefits.

Box 8 PRONAI - Program for Normalization of Informal Areas

Rio LIGHT, the electric utility serving most of the population of Rio de Janeiro State, including the metropolitan area of Rio de Janeiro City in Brazil, launched a major campaign in 1997 - 2002, called PRONAI, Programa de Normalização de Áreas Informais. During this program, over 250,000 households were either regularised or connected to electric service for the first time. PRONAI's goal was to provide safe, legal power connections in the city's slums (favelas) and other low-income communities while ensuring customers were billed for electricity consumption. The approach to accomplish this goal was three-pronged: Improving the quality of service and reducing associated safety hazards through upgraded networks and connections Making grid connection and legal purchase of electricity affordable and desirable through subsidies and financing improving the company's image and ability to operate in slum communities.
Source: USAID (2004)

[38] The new orientation of the energy policy focuses on ensuring the access to electricity to all citizens – the "universalization of energy access" (GNESD, 2005).

7 ECONOMIC IMPACT OF HIGH OIL PRICES IN THE LAC REGION

The 1970s oil shocks confronted the world with a new set of energy security issues. Few of the oil importing developing countries had the necessary foreign exchange reserves to absorb price increases. Concerns about macroeconomic management and fiscal balance arose. Energy security was in many cases enhanced through increased reliance on domestic resources, bilateral energy trading relationships with reliable nearby partners, and access to regional markets. However, vulnerability to price fluctuations remains a major energy security concern for exporting countries and net importers of energy products.

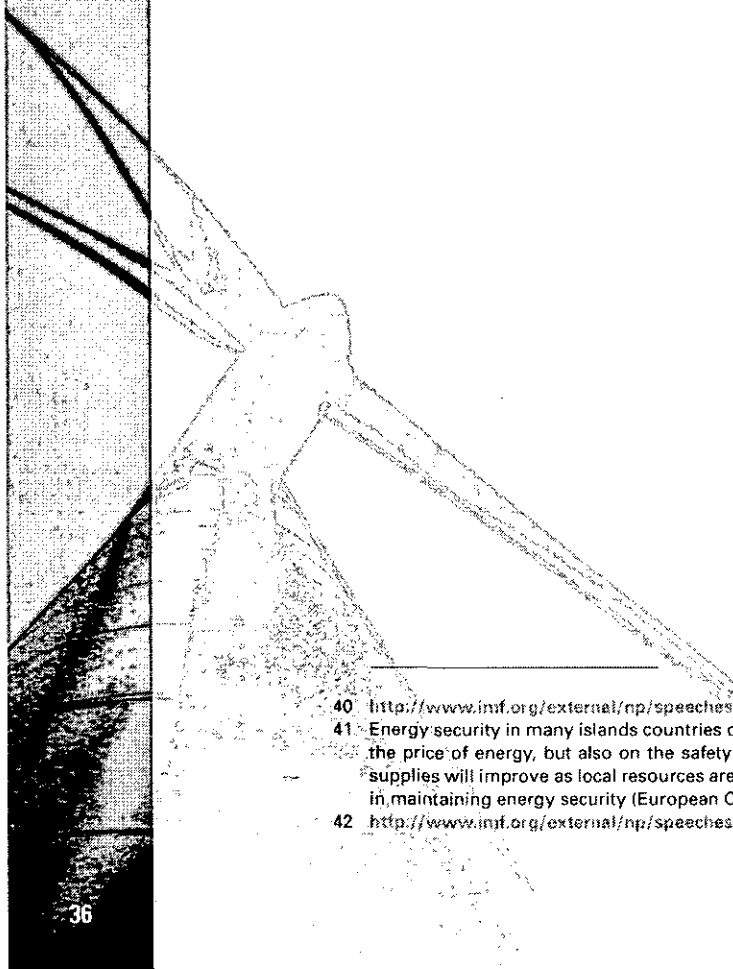
Based on recent estimates by the IMF, a sustained $10 per barrel increase in the oil price would result in a 0.4% fall in the real GDP of non-OECD countries as a whole (including oil-exporting countries) after one year. The economic impact of an oil price increase on the group of developing countries and transition economies as a whole is lower than for the OECD as a whole, because the developing countries grouping includes several oil exporters (IEA, 2004b). LAC would suffer less from an increase in oil prices, reflecting the fact that some of the larger countries in the regions are net exporters or close to a position of balance in their oil exports and imports (Brazil[39]). Economic growth in LAC would be reduced by only 0.2 percentage points.

The challenge for oil exporting countries is to use the extra resources well. Incremental fiscal revenues arising from the higher oil prices need to be spent wisely (UNDP/ESMAP, 2005). To avoid the risks of developing a lopsided economic structure, care must also be taken to avoid a rapid and excessive appreciation of the real exchange rate that would divert resources out of non-oil, traded goods activity (ADB, 2005). "Energy exports themselves may create barriers to that development and diversification. Export rents flowing into a narrow structure of elites may increase social divisions, perpetuate authoritarian regimes, and fund civil or regional military conflicts. The export sector may bring technology, training and markets but may also divert resources from other sectors. Energy exports therefore create risks for the exporting country and investors in it as well as its trading partners" (Mitchell, 2002).
Even when excluding the oil exporting countries of Ecuador and Venezuela, Latin America shows the lowest exposure, as measured by the share of oil imports in GDP, to oil price increases among all developing regions. This has mainly been the result of Brazilian policies aimed at substituting oil with hydropower and alcohol, and at increasing domestic production of hydrocarbons (UNCTAD, 2005c).

39 Production in 2005: 1.98 million barrels per day, consumption in 2005: 2.18 million barrels per day (IEA Oil Market Report).

However, this average numbers for the whole region mask the considerable hardship being faced by net oil importers. Substantial output losses are expected to result for some Caribbean countries and Central America; and, in the latter case, the recent surge in oil prices is expected to cause GDP growth to be over 1 percentage point lower in 2006 than otherwise.[40] Caribbean Small Islands Developing States are particularly vulnerable in the energy field.[41] The further development of their societies depends to a large extent on access to transportation and energy. The high cost of shipping diesel oil to dispersed islands increases electricity production costs substantially. Some islands spend a very significant share of their foreign currency earnings on fuel imports. On the other hand, regional oil exporters have reaped windfall gains from recent fuel price increases.

"The policy response to the sharp increase in petroleum prices has varied across the region. Net oil exporters have tended to avoid letting prices adjust freely, with fuel prices being frozen for years in several cases (Ecuador, Trinidad and Tobago, and Venezuela). The oil windfall has helped finance the budget in Ecuador and led to an expansionary fiscal stance in Trinidad and Tobago and Venezuela. Net oil importers have tended to allow domestic fuel prices to adjust, although there have been exceptions. In most ECCB countries, for example, fuel prices are tightly regulated and pass-through has been limited; in some other countries, taxes on petroleum products have been reduced to cushion price increases (Guyana, Panama, and Peru); and in many cases, higher fuel prices have not shown through to electricity rates (Guatemala, Guyana, and Haiti)."[42]



40 http://www.imf.org/external/np/speeches/2005/101305.htm.

41 Energy security in many islands countries depends not only on the geopolitical factors that govern access to energy and the price of energy, but also on the safety and ecological criteria of the alternative supply options. Security of energy supplies will improve as local resources are developed in a sustainable way. The use of renewables can play a major role in maintaining energy security (European Commission/UNDP, 1999).

42 http://www.imf.org/external/np/speeches/2005/101305.htm.

8 GOVERNANCE AND MARKET EFFICIENCY IN THE LAC ELECTRICITY SECTOR

Regulatory reform can be a powerful contributor to improving (industrial) competitiveness. Countries are increasingly recognising that traditional regulatory structures have been holding back the development of economies, including in those sectors where new technologies have changed the nature of the market.[43] Industrial strategies should emphasise enhanced productivity and competitiveness. "The key to raising productivity to competitive levels lies in improving industrial capabilities" (UNIDO, 2004). The inability of the public budgets of many LAC countries to finance infrastructure also hampers their economy's competitiveness. Generally, industry policy initiatives focus on facilitating trade and promoting investments; ensuring a competitive business environment; and building firm capabilities and competitiveness. The contribution that industrial development makes to poverty reduction is generally acknowledged. Several aspects dominate the debate over regulatory reform and objectives of (de)regulation in energy industries:

- the move from command-and-control to incentive-based regulatory approaches based on the removal of entry barriers in competitive markets;
- the pros and cons of structural measures such as privatisation, and vertical and horizontal separation of formerly integrated monopolies;
- the ways to ensure achievement of important non-economic objectives (such as environmental protection and access to energy for the poor) in a more competitive environment at a minimum cost for society; and
- the design of regulatory mechanisms and institutions.

Energy systems which do not cover their costs in the long term are not sustainable, and long periods of not cost-covering prices may jeopardise future energy availability and, therefore, security. In a perfect market, with externalities fully reflected in energy prices, marginal cost pricing would be the socially optimal way to allocate resources. However, energy markets are far from perfect. There are numerous causes for a deviation from the "textbook model", leading to sub-optimal market results or, in the extreme case, no market-based result at all. Market failures can be broadly classified into the following types: imperfect competition, externalities, public goods and incomplete/asymmetric information. Table 7 presents these generic types of market failure and instances in the electricity industry. Due to these various types of market failures, government intervention in energy markets is sometimes justified to improve overall sector efficiency and, consequently, to achieve the goals of energy accessibility, availability and acceptability.

43 Regulatory reform is also used to promote competition, technological innovation, productivity, structural adjustment, and market contestability.

Table 7 Types of market failure in electricity markets

Market failure	Electricity sector example
External effects which lead to a discrepancy between private and social costs or benefits	Negative external effects: environmental pollution; Positive external effects: improved system reliability[44]
Public goods which are insufficiently or not at all provided for by private firms	In electricity grids technical dispatch, reliability, safety and a continuous flow of energy are often perceived as public goods. Energy security has characteristics of a public good which is not properly valued by the market. It tends to produce a level of energy security that is less than optimal from the society's point of view (Bielecki, 2002).
Barriers to market entry and exit	Natural monopoly of electricity distribution
Imperfect competition - monopolistic and oligopolistic behaviour	(Naturally) monopolistic behaviour of electricity grid operator; oligopolistic behaviour of power generators
Missing futures markets	Increasing scarcity of fossil fuels is not (fully) reflected in current price
Missing market transparency, incomplete and asymmetric information	The regulator does not have all information necessary for efficient regulation

The worldwide process of electricity market reforms started in a LAC country, Chile, followed by Britain, and has since then spread globally.[45] LAC countries have generally been among the first to privatise and restructure their infrastructure (not only energy) industries.[46] The LAC region has been the most progressive region in the developing world in terms of deregulating the electricity industry. The drive towards a market-oriented organisation of the energy industry was concentrated in Latin America — "in part because the debt crisis of the 1980s had forced these nations to be among the first to confront the need for private investment in the power sector" (Victor, 2005). Not surprisingly, there is a lot of literature available on that topic. An overview of the experience with the energy reform process in the LAC region can, for example, be found in OLADE (2000), Estache et al. (2001), Arango et al. (2006), Hall and Lobina (2004), *Williams and Ghanadan (2006), Gabriele (2004), and Bouille and Wamukonya (2003).*

However, it is important to recognise that the fundamental interest of most developing countries in electricity sector reform stems not from any desire to change ownership and/or to introduce competition for its own sake, but from the fact that they have no choice but to attract foreign private investors if their power systems are to grow fast enough to keep pace with demand. The reforms' dependence on attracting foreign capital makes clear the consequent vulnerability to volatile international financial conditions. The burden of price subsidies,[47] low service quality, low collection rates, high network losses, and poor service coverage have meant that many governments are no longer willing or able to support the existing arrangements. In addition, international development agencies have engaged in promotion and implementation of electricity sector reforms ("Washington Consensus") (Jamasb, 2006; Gore, 2000). Williams and Ghanadan (2006) conclude "that improving reform will require emphasizing a broader set of objectives, including service provision, public benefits, effective regulation, and social/political legitimacy."

44 In the LAC region there are on average 10.6 days of electricity outage, representing 2.91% of utilities' sales. Corresponding numbers for the OECD are 1.14 days of outage and 2.25% of utilities' sales (http://rru.worldbank.org/InvestmentClimate/ExploreTopics/Infrastructure.aspx?tab=0&sort=0&direction=asc).

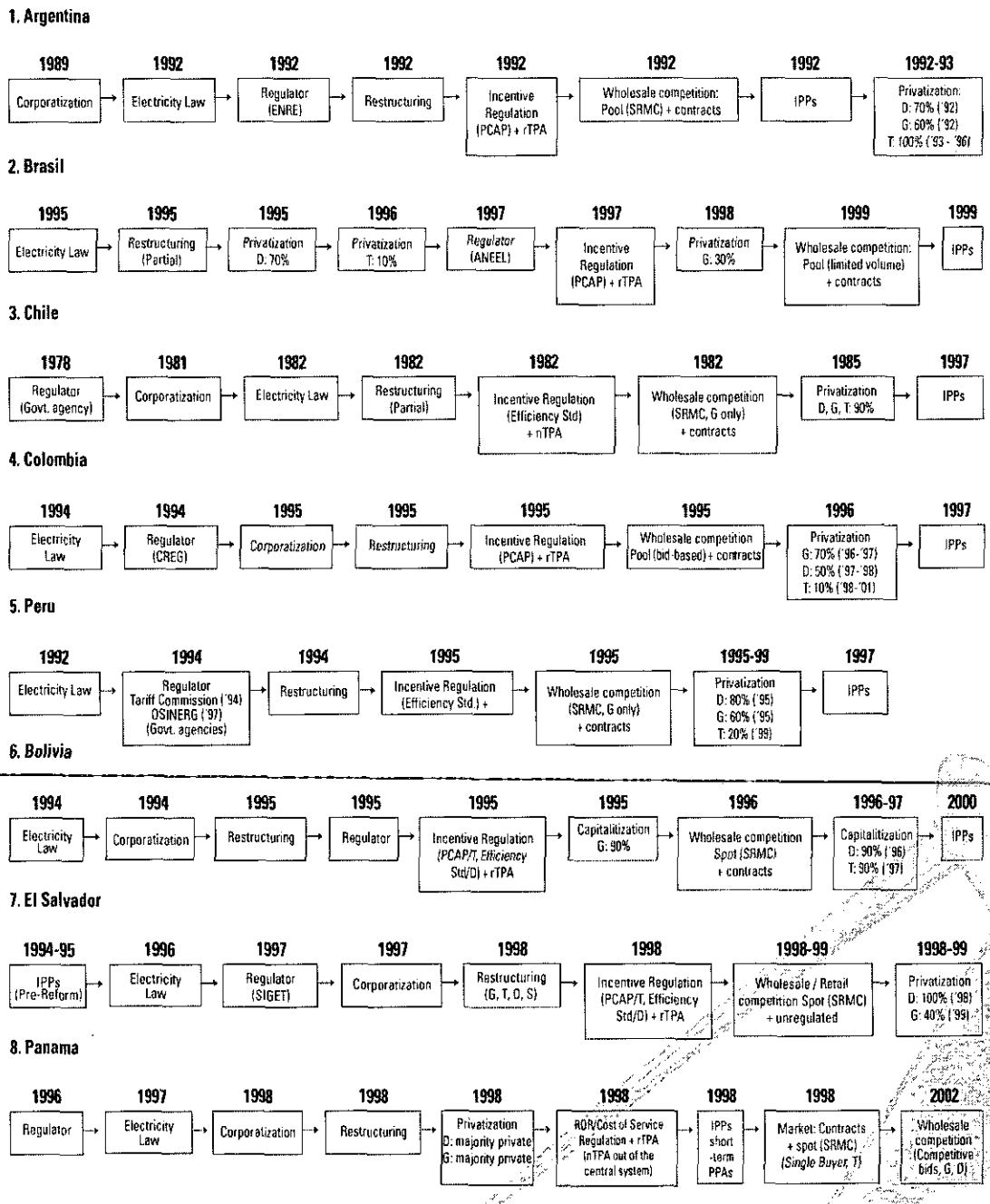
45 A recent overview of the experience with electricity deregulation can, for example, be found in Sioshansi and Pfaffenberger (2006).

46 *Recent decisions to renationalise the oil and gas sector in Venezuela and Bolivia have been a central topic of the latest* EULAC Summit, in Vienna, 2006.

47 OECD (2004) estimates that in Latin America and the Caribbean, where the electricity sector has been reformed, subsidies account for around 9% of total subsidies.

A general feature of the power sector reform process in the LAC region is that the main stages of reforms have been implemented in relatively short matter of time. Figure 7 shows the sequence of electricity sector reform measures in LAC countries. In Brazil, for example, the guiding principles of the New Power Sector Regulations are "to recognize hydropower as the major source for expanding electricity services and integrated management of the water stocks; to pursue diversification taking into account the complementary nature of other sources; and to ensure the supply of electricity to all citizens, connecting all household to the grid or providing decentralized power sources to meet their energy requirements" (do Valle Costa et al., 2006).

Figure 7 Sequence of electricity sector reform measures in LAC



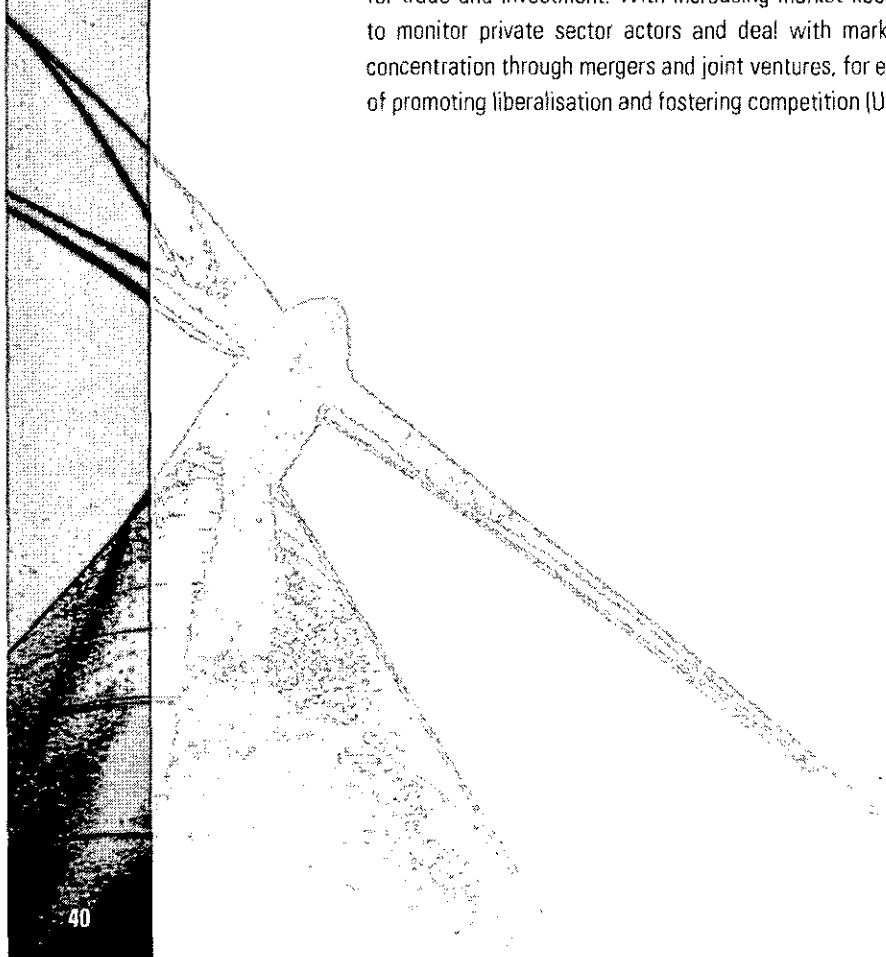
Source: Jamasb (2006)

"Although in the liberalization process of many LAC energy markets, renewable energy did not occupy a prominent place, there now seems to be a new international trend to develop such resources, which will begin to play a more central role, especially in meeting the increasing demands for energy in the process of industrialisation and development" (Zuluaga and Dyner, 2006). The impact of power sector liberalisation on the use of renewable sources of energy is contradictory. Theoretically there is more potential space for using renewables because the industry's generation segment is not longer monopolistically structured; on the other hand, one generally observable phenomenon associated with power sector reform is the increased reliance on short term power sales agreements which constitute a clear barrier for renewables-based electricity generation, mainly because of their capital-intensive nature and, therefore, long pay back times. Innovative support mechanisms, such as Brazil's PROINFA program, allow a cost-effective promotion of renewables for power generation even under conditions of a competitive market.

The final verdict on energy security effects of increased competition is still out, as impacts can go both ways. Possible effects of sector reform on energy security include:

- "The liberalisation of downstream gas and electricity sectors has clearly brought important economic benefits, but it can also have consequences on energy security. In promoting efficiency, increasing the size of the market, and diversifying supply, market reforms will reinforce energy security only if sufficient incentives are built into the design of those reforms. Investors need to be motivated to provide the degree of security demanded by consumers through investments in additional capacity. Exclusive emphasis on cost efficiency could compromise security. With careful market design and the right incentives, for examples capacity markets, liberalised markets can be a powerful tool to attract sufficient investment and bolster security of supply" (IEA, 2005).

- Energy sector regulatory reforms could be compatible with or even enhance energy supply security. Governments, while withdrawing from energy investments themselves, need to create a positive climate for trade and investment. With increasing market liberalisation, there is a growing need for governments to monitor private sector actors and deal with market failures. Certain investors might be looking for concentration through mergers and joint ventures, for example, which might conflict with government policy of promoting liberalisation and fostering competition (UNDP, 2000).



9 ENERGY TRADE AND ENERGY SECURITY

9.1 Intraregional Energy Trade – Regional Cooperation and Integration

Until recently, regional and national political conditions were such that countries tended to rely on their own energy resources. Some cross-border electricity interconnections existed, but they were usually of limited capacity and built to provide backup to remote or isolated border systems, rather than to optimise the use of combined resources. This limited intraregional trade is also due to the large distances involved and to the phenomenal geographical obstacles (IEA, 2003a). The main reason, however, for the historical absence of significant energy exchanges and interconnections is the relatively good energy endowment of individual countries. LAC countries possess abundant and varied energy resources (including oil, natural gas, coal, biomass, and other renewable sources), as well as great hydropower potential, even though these resources are not always evenly distributed. That uneven distribution underscores the potential for large-scale intraregional energy trading. There are very promising prospects for integrating energy markets through natural gas and electricity grids. The integration of gas and electricity markets is taking place mainly in South America, where reforms in the power and oil and gas sectors opened the doors to projects for large-scale international gas pipelines and electricity grids, mostly on private sector initiative. The marketing of natural gas and electricity at the intraregional and regional levels does not only lead to a more optimum use of resources; it also helps to consolidate sector reform in small countries and to increase the availability of cleaner fuels in many of them (IADB, 2000).

"South America's southern cone area is already crisscrossed by gas pipelines linking Bolivia, Brazil, Argentina, Chile, and Uruguay. In addition, a number of new pipelines are under discussion, which would link Peru with Ecuador and Chile, Venezuela with Colombia and Brazil, and Colombia with Panama. The new lines could later be linked with each other and with existing pipelines to create a South American natural gas grid—an idea that is being promoted by Venezuela" (EIA, 2006).

Full regional integration of Central American electricity markets, initiated by the signing of the Central American Market Framework Treaty in Guatemala in December 1996, has to be seen as a longer-term goal. Tomiak and Millan (2002) provide an overview of the efforts to achieve a regional integration of the electricity markets in Central America.

9.2 Interregional Energy Trade – The potential role of biofuels

An important factor that could affect energy security is the extension of world trade liberalisation to energy products and services. Interregional trade is dominated by exports of crude oil and petroleum products. International trade in biofuels is mostly confined to ethanol, which is by far the most widely used of the biofuels (93.5% of total biofuels produced). However, vegetable oils have the largest potential for growth (UNCTAD, 2005b).

Brazil produces some 15 billion liters per year of ethanol from sugarcane, making it the largest ethanol producer in the world.[48] It reached this position by launching a national ethanol program, Proálcool, in 1975 in the wake of the first oil price shock and during a period of depressed world sugar prices. The Proálcool program was effectively eliminated in the 1990s with the liberalization of hydrous alcohol prices. However, the government still provides a measure of support to ethanol production through a combination of market regulation and tax incentives. Ethanol production grew an average of approximately 25% per year from 1976 to 1989. By the mid 1980s, ethanol consumption exceeded gasoline consumption on a volume basis, and more than 90 percent of new cars sold in Brazil used ethanol (ESMAP, 2005a). ESMAP (2005c) documents the experience with biofuels in Brazil.

Brazil is also by far the most cost-effective producer of fuel ethanol – with production costs of about $0.22/litre of ethanol ($0.33/litre of gasoline equivalent) (OECD, 2006). Ethanol from sugarcane grown in the centre-south region of Brazil is by far the cheapest biofuel today.[49] European ethanol is a factor of 2-3 times more expensive than ethanol from Brazil, domestic agricultural policy reforms might influence domestic production levels of ethanol in Europe and removal of trade barrier could encourage production in regions such as Latin America and (in a negative way) Europe (OECD, 2006).

Canada, Colombia, the European Union, India, Malaysia, the Philippines, Thailand, and the United States have all adopted targets for increasing the contribution of biofuels to their transport fuel supplies (UNCTAD, 2005a). OECD (2006) provides an overview of international biofuels policies. In Europe, a Communication from the European Commission (2006) sets out an EU strategy for biofuels with three aims:[50]

- "to further promote biofuels in the EU and developing countries, ensure that their production and use is globally positive for the environment and that they contribute to the objectives of the Lisbon Strategy taking into account competitiveness considerations;
- to prepare for the large-scale use of biofuels by improving their cost-competitiveness through the optimised cultivation of dedicated feedstocks, research into "second generation" biofuels, and support for market penetration by scaling up demonstration projects and removing non-technical barriers;
- to explore the opportunities for developing countries – including those affected by the reform of the EU sugar regime – for the production of biofuel feedstocks and biofuels, and to set out the role the EU could play in supporting the development of sustainable biofuel production."

On the benefit side, increasing the use of biofuels can improve energy security, greatly reduce greenhouse gases[51] and many pollutant emissions, and improve vehicle performance. Their production can also enhance rural economic development.[52] These benefits are difficult to quantify as they are externalities, and not reflected in the market price of biofuels (IEA, 2004a).

International trade is seen to offer opportunities, either with other developing countries or with developed ones. However, there are considerable barriers to international trade: agricultural production subsidies, high tariffs, entry barriers (car manufacturers' recommendations for biofuel blends vary according to countries, with no limit on ethanol content in Brazil, while it is excluded in European countries) (UNCTAD, 2005b).

Biofuels technology is easy to transfer and diffuse because, for vegetable oils in particular, there is no need for the complex industrial processes used in the production of other kinds of renewable energy (wind turbines, photovoltaic panels or solar panels, for instance).

48 The second largest ethanol producer is the United States (REN21, 2006). These two countries account for 90% of worldwide ethanol production. The European Union accounts for more than 90% of global biodiesel production.

49 UNCTAD (2005a) estimate the cost of ethanol production in Brazil to be in the range $0.23-0.29 per litre.

50 European governments intend to increase the share of biofuels in total EU fuel consumption to 5.75% by 2010.

51 Frondel and Peters (2006) investigate the environmental and economic implications of the support of rapeseed-based biodiesel as a substitute for fossil diesel. They find that the energy and greenhouse gas balances of this environmental strategy are clearly positive. Yet, it appears to be unclear whether the overall environmental balance is also positive. Most importantly, though, biodiesel is not a cost-efficient emission abatement strategy.

52 Rural employment may increase significantly, as in the case in Brazil, where ethanol production generated 700,000 direct jobs and 3.5 million indirect jobs, mainly in sugar cane production (UNCTAD, 2005b).

10 CONCLUSIONS

Energy security:

- Energy security is generally defined as the availability of a regular supply of energy at an affordable price. Most definitions of energy security stress two dimensions, a physical / quantity dimension and an economic / price dimension. However, from the perspective of developing countries, energy security needs a much broader definition. Energy security may be defined as a country's ability to expand and optimise its energy resource portfolio and achieve a level of services that will sustain economic growth and poverty reduction" (RIVM, 2004). Energy security in developing countries is a complex topic with numerous interlinkages to other sustainable development objectives. Energy security must, therefore, be integrated into energy policies alongside other policy objectives, such as developmental and environmental goals.

Energy demand and supply trends:

- Global demand for energy is likely to increase significantly over the next decades under almost all scenarios available, particularly in the developing world. This projected growth, together with high fossil fuel prices and an increasing concentration on a few oil and natural gas supply countries, brought energy security concerns to the top of the political agenda.

- Energy production in the LAC region as a whole is greater than its energy demand. This excess supply is also projected to hold over the next decades. However, this does not imply that there are no regional energy security issues because there is a great variety in the sub-regional energy situation: Several countries are net exporters of hydrocarbons; others are significant producers of hydropower; in some LAC countries the contribution of renewables (either in the form of traditional fuels and/or more modern forms of renewables) is substantial; other countries in the regions, mostly in the Caribbean, are almost completely dependent on fossil fuel imports.

- The fact that - for the region as a whole - energy production exceeds energy demand, however, masks great intraregional variety and a great diversity of the energy situation within individual LAC countries. For example, in Mexico, one of the largest oil producers, there are rural areas that are still unconnected to the grid. Overall rural electrification is 73% of households in Brazil but varies from 90% in the south to 40% in the north. Household electricity access rates range from 34% in Haiti to 99% in Uruguay and Chile (World Bank, 2006). In Guatemala, the share of "traditional" fuels is about 60%, while in countries such as Mexico and Venezuela it is almost negligible (UNDP, 2005). In 2002, 20% of the region's population were relying on traditional biomass for cooking and heating, with highs of around 90% in the rural areas of Haiti, Nicaragua and Peru.

- The energy situation in LAC can also be characterised by remote rural areas that yet to be connected to the grid; the continued pronounced dependence fossil sources of energy; the low progress in energy efficiency improvement; and a severe shortage of capital for investment, particularly in the power sector.

Financing sustainable development and renewables:

- Numerous international and regional organisations are active in the LAC region to promote its renewable energy sector: At the regional level, these organisations include the Latin American Energy Organization (OLADE), the United Nations Economic Commission for Latin America and the Caribbean (ECLAC), and the Department of Sustainable Development of the Organization of American States (DSD/OAS). International organisations involved in renewable-energy-sector-activities include-for example the Bretton Woods Institutions and the Inter American Development Bank (IADB). The Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) is also very active in this part of the world.

- LAC is characterised by a significant endowment with renewable energy resources which – in relation to their potential - have so far only been tapped to a small extent. A greater contribution of renewables to LAC's primary energy supply – along with higher energy efficiency on the supply as well as the demand side – appears in many instances well suited to contribute to all dimensions of sustainable development. Renewables can be an attractive option for adding modern energy capacity: it is flexible in scale and it can provide electricity (either on-grid or off-grid), heat and biofuels for transportation.

- Mobilising financing for energy investments is important in order to provide environmentally sound energy services and to achieve the Millenium Development Goals. In the LAC region, for example, the share of people living in poverty has not been reduced during the last two decades. Renewable energy-powered applications can, in many cases, offer viable options for improving productive capacities and, consequently, reduce poverty.

- In the LAC region expected cumulative investment requirement between 2003 and 2030 amounts to more than 1200 billion dollars. More than half of this investment will be needed to maintain the present level of supply. In most LAC countries, the public sector alone will not be able to provide that financing. Sufficient private investment will only be forthcoming if the region's regulatory regimes become more transparent and consistent.

- Despite the significant potential for renewable energy in the LAC region, several important factors inhibit their wider adoption. In the initial stages of development, technical barriers predominate. In order for a technology to become cost-effective, market barriers such as inconsistent pricing structures have to be overcome. Then there are institutional, political and legislative barriers which hinder the market penetration of technologies, including problems arising from a lack of awareness of, and experience with new technologies and lack of a suitable institutional and regulatory structure. Finally, there are social and environmental barriers which result mainly from a lack of experience with planning regulations that hinder the public acceptance of a technology. A sound strategy to increase the market penetration of renewables will need to address all these barriers.

- Direct and indirect investment subsidies, operating incentives through regulatory measures that require higher payment to power generated from renewables and green energy marketing strategies are some of the supply side mechanisms successfully used, mostly in developed countries. The schemes have been carried out through regulatory measures, obviating the need for direct interaction with end users, and thus avoiding high transaction costs. This has worked well in developed countries in introducing renewables for electricity generation. Preferential financing for renewables has also been made available in several countries. Financing mechanisms on the end user side have also evolved; thus revolving funds have been used to provide credit to the end users, renting and leasing schemes have been promoted by utilities or third parties, and hire purchase options have also been explored.

- There is no superior instrument available to support renewables that fits under all circumstances. Much more important than the choice of an economic instrument is the availability of a coherent set of policies to promote renewable energies at all stages along their development chain, such as the regional-specific support program PROINFA.

Urban energy poverty:

- Most of the projections indicate that by 2020 more than half of the world's population will live in urban centres. In the LAC region already more than 70% of the total population lives in cities; in Brazil, for example, this share stands at 82%. In LAC, urban poverty has doubled in the last two decades, while the number of rural poor has remained stable. The urban poor also suffer from an "urban penalty" due to energy poverty, i.e., a lack of choice in energy services under economic conditions that provide support for the economic and social development of families and individuals

- "Although the reduction of poverty is perhaps the most important concern in the developing world, there is significant environmental interest associated with the use of new energy sources which will help to reduce the environmental impacts that have been caused by traditional forms of energy based on the combustion of fossil fuels" (Zuluaga and Dyner, 2006).

- The resulting pressure from an increasing urbanisation on the demand for the various forms of energy is not well known. The implications for the energy sector are that demand growth will occur mainly in urban and peri-urban centres, and that the emphasis in the access issue is likely to shift to the peri-urban areas. The demographic trends call for revisiting fundamentally urban/peri-urban energy policies. Cleaner energy technologies and renewable energy are important elements in addressing the problems of urban air pollution and climate change.

Economic impact of oil price shocks:

- Oil importing developing countries are generally to a greater extent affected by oil price increases, mainly because of their higher energy/oil intensity and general economic fragility. The LAC region as a whole would suffer less from an increase in oil prices, reflecting the fact that some of the larger countries in the regions are net exporters or close to a position of balance in their oil exports and imports. Regional oil exporters have reaped windfall gains from recent fuel price increases.

- Even when excluding the oil exporting countries, Latin America shows the lowest exposure to oil price increases among all developing regions. This has mainly been the result of Brazilian policies aimed at substituting oil with hydropower and alcohol, and at increasing domestic production of hydrocarbons.

- However some net oil importers in the region face considerable hardship. Substantial output losses can be expected for some Caribbean countries and Central America as a result of higher oil prices. Some islands spend a significant share of their foreign currency earnings on fuel imports.

Governance and market efficiency in the LAC electricity sector:

- The worldwide process of electricity market reforms started in a LAC country, Chile, followed by Britain, and has since then spread globally. The LAC region has been the most progressive region in the developing world in terms of deregulating and privatising the electricity industry.

- The impact of power sector liberalisation on the use of renewable sources of energy is contradictory. Theoretically there is more potential space for using the abundant regionally available potential of renewables because the industry's generation segment is not longer monopolistically structured; on the other hand, one generally observable phenomenon associated with power sector reform is the increased reliance on short term power sales agreements which constitute a clear barrier for renewables-based electricity generation, mainly because of their capital-intensive nature and, therefore, long pay back times. As in many other parts

of the world, gas-fired electricity generation has increased substantially in the LAC region. Innovative support mechanisms, such as Brazil's PROINFA program, allow a cost-effective promotion of renewables for power generation even under conditions of a competitive market.

- The final verdict on energy security effects of increased competition is still out, as impacts can go both ways. Exclusive emphasis on cost efficiency could compromise supply security.

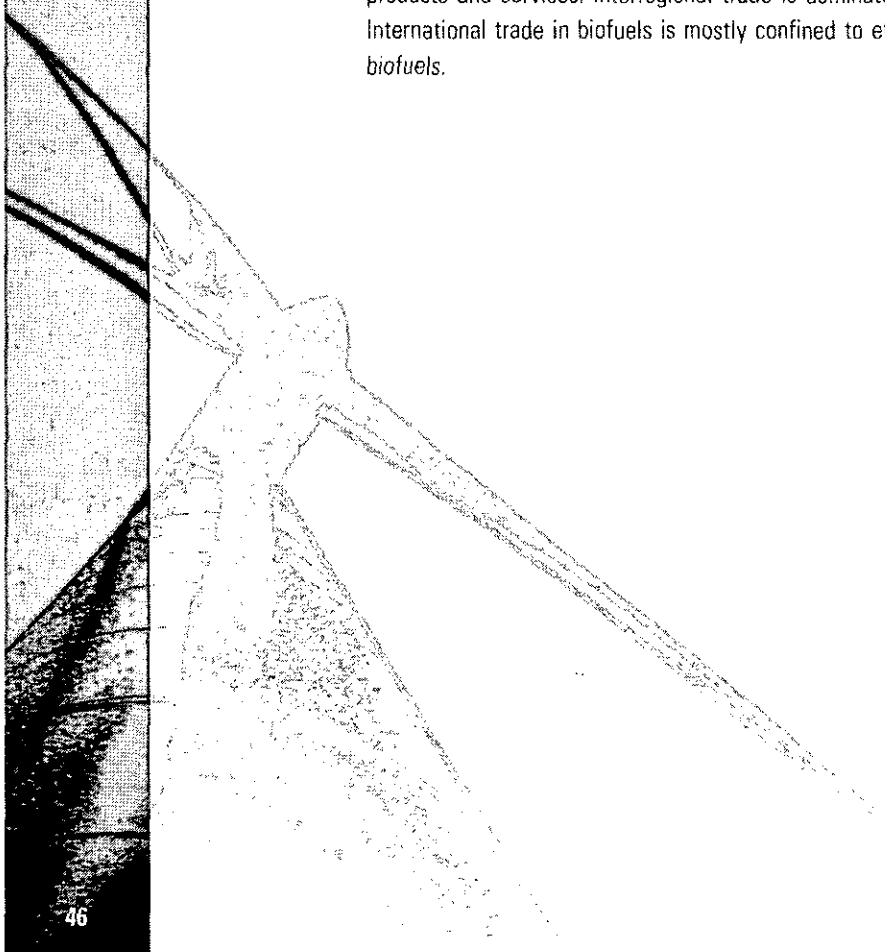
Energy trade and energy security:

- Until recently, LAC countries tended to rely on their own energy resources. Some cross-border electricity interconnections existed, but they were usually of limited capacity and built to provide backup to remote or isolated border systems, rather than to optimise the use of combined resources.

- The main reason for the historical absence of significant intraregional energy exchanges and interconnections is the relatively good energy endowment of individual countries. LAC countries possess abundant and varied energy resources, as well as great hydropower potential, even though these resources are not always evenly distributed. That uneven distribution underscores the potential for large-scale intraregional energy trading. There are very promising prospects for integrating energy markets through natural gas and electricity grids. A higher degree of integration would clearly enhance regional energy diversity and security.

- The marketing of natural gas and electricity at the intraregional and regional levels does not only lead to a more optimum use of resources; it also helps to consolidate sector reform in small countries and to increase the availability of cleaner fuels.

- An important factor that could affect energy security is the extension of world trade liberalisation to energy products and services. Interregional trade is dominated by exports of crude oil and petroleum products. International trade in biofuels is mostly confined to ethanol, which is by far the most widely used of the *biofuels*.



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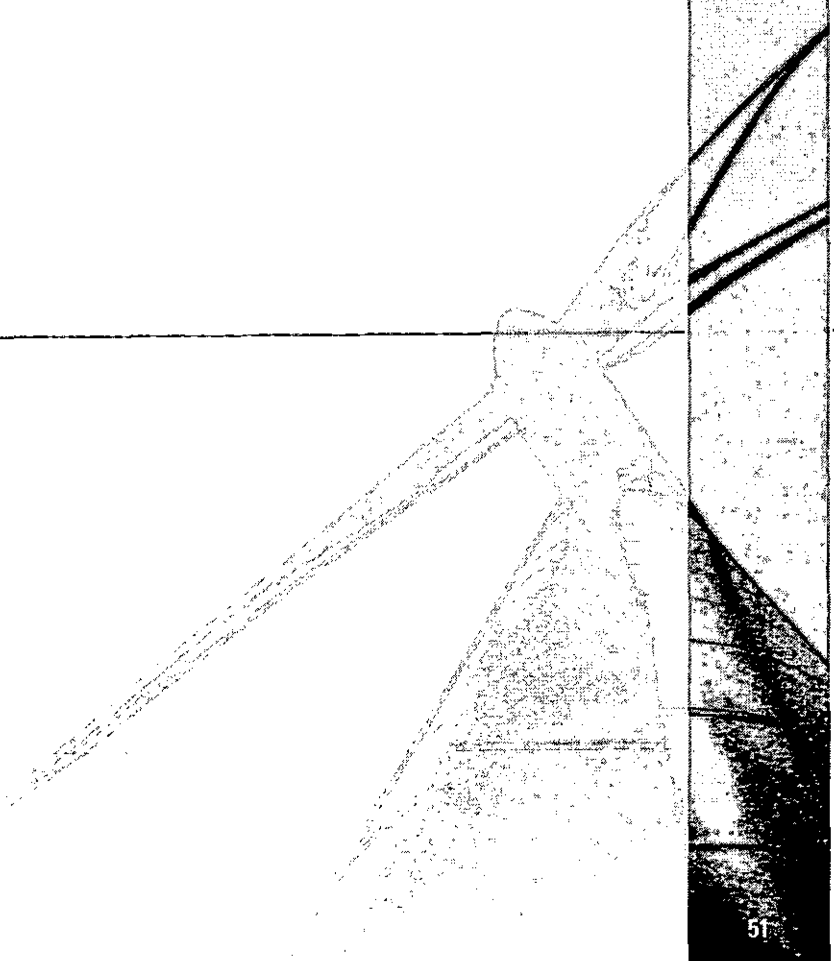

Energy Security in the Latin American and Caribbean (LAC) Region: Renewable Energy as a Viable Alternative

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