The Nicaraguan Energy Sector:

Characteristics and Policy Recommendations

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Picture 1: Cover Photo: East German IFA trucks burn a lot of diesel

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I. Reference Material

A. Acronyms and Abbreviations

- CNE: Comisión Nacional de Energía (National Commission for Energy)
- CNG: Compressed natural gas
- DGE: Dirección General de Electricidad (The General Directorate of Electricity, a sub-branch of the INE)
- DGH: Dirección General de Hidrocarburos (The General Directorate of Hydrocarbons, a sub-branch of the INE)
- DISNORTE: “Distribuidora del Norte”, the state agency that distributes and charges for energy use in the north of the country.
- DISSUR: (“Distribuidora del Sur”), the state agency that distributes and charges for energy use in the south of the country.
- EIA: Energy Information Administration (a U.S. Government agency)
- ENEL: Empresa Nicaragüense de Electricidad (The Nicaraguan Ministry in charge of electricity. A sub-department of ENEL is Hidrogesa).
- ENTRESA: Empresa Nacional de Transmisión Eléctrica (the Nicaraguan state agency that owns and maintains the nation’s transmission lines and international interconnectors)
- GDP: Gross domestic product.
- GECSA: Nicaraguan company in charge of producing geothermal power. Still a state-owned institution.
- IDB: Interamerican Development Bank
- INE: Instituto Nacional de Energía (The National Institute of Energy), a regulatory oversight agency for the energy sector.
- Hidrogesa: Generadora Hidroelectrica, the government ministry in charge of producing hydropower at three dam sites in Jinotega and Matagalpa.
- INTA: Instituto de Tecnología Agraria (National ministry for agrarian technology). Functions like an agricultural extension program as well as a 4-H program.
- LPG: Liquid petroleum gas.
- PLC: Partido Liberal Constitucionál, the conservative political party of Anastasio Somoza and Arnoldo Alemán.

- S.I.N. “Sistema Interconectado Nacional,” the Central American electrical grid that unites several countries’ energy distribution systems.
- S.K.M. Sinclair Knight Merz. World’s foremost geothermal consulting firm.
- TOE: tons of oil equivalent. One TOE is 1*107 kilocalories, 41.868 gigajoules, or 11,628 GWh and approximates the energy-producing characteristics of one ton of crude oil (World Resources Institute, 2003 page 3)
- URE: Unidad para la Restructuración de ENEL (Unit for the Restructuring of ENEL, the agency responsible for dismantling and coordinating the privatization of the energy sector institutions)

B. Spanish Glossary

- bagazo de caña: bagasse (spoils) from sugar cane processing
- cascarilla de arroz: rice hulls
- caudillo: a Latin American “strong man” leader who governs on the strength of his charisma and patron-client relationships. Perón (Argentina), Trujillo (Dominican Republic), and Somoza (Nicaragua) are all well-known examples.
- chatarra: junk metal
- maquila: free trade manufacturing zone, often referring specifically to clothing assembly plants that piece together clothing from pieces sewn elsewhere, then exported.
- pulpería: small convenience-store type shop, usually operated out of the home, and selling small consumer goods.

C. Map

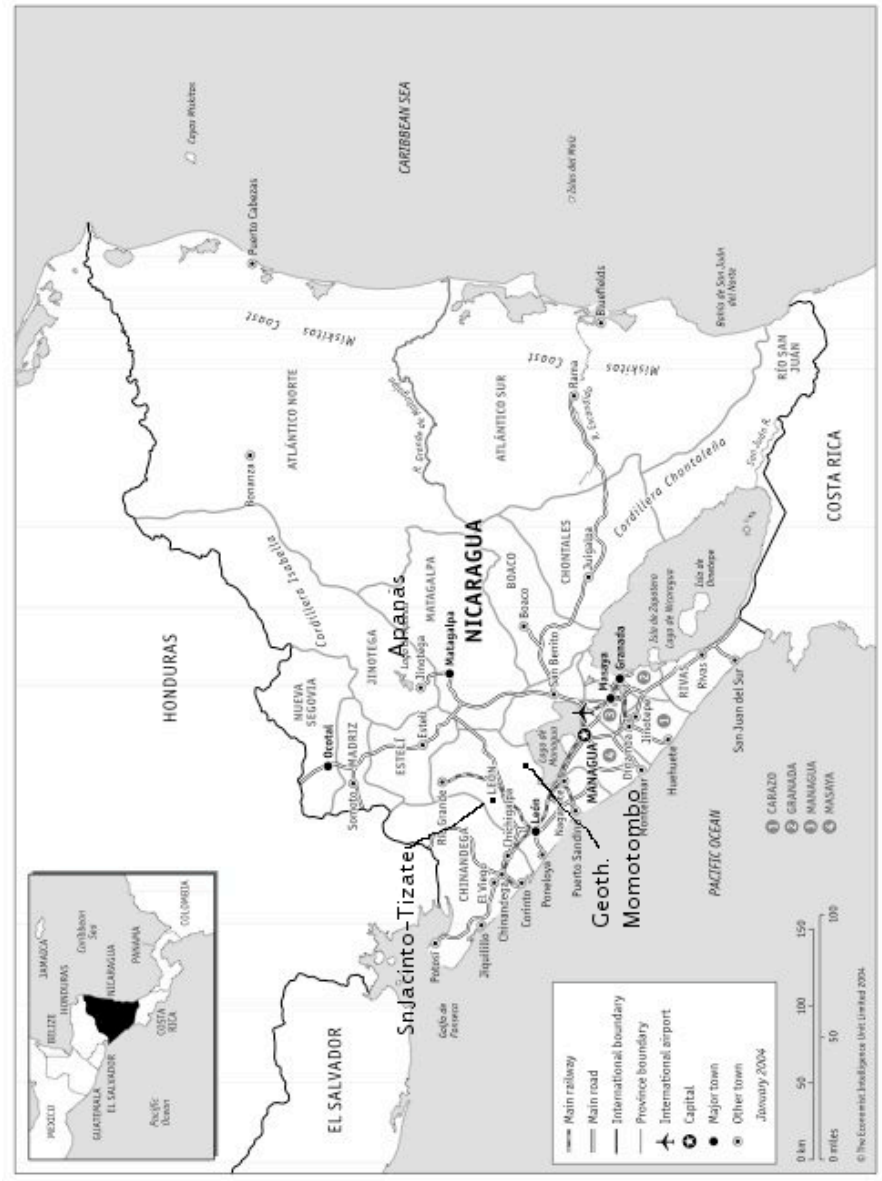

Figure 1: Map of Nicaragua

Map of Nicaragua courtesy of (The Economist Intelligence Unit, 2004)

II. Country Overview

A. Geography and Climate

The largest and lowest-lying nation of Central America, Nicaragua is also the second poorest nation in the western hemisphere. A highlands ridge of volcanic mountains runs down the western third of the country, dividing the territory into a Pacific plain and a much broader and less steeply-sloped Caribbean plain. About 27% of the national territory is classified as forested and another 46% as pastureland; the portion facing the Caribbean tends towards low lying savanna and scrub pine (West, 2003 page 628).

At 15° North latitude (Wood and Berman, 2001 page 11), Nicaragua enjoys a tropical climate through much of its territory. The highlands are cooler, but not by much: the highest point in all of Nicaragua is Pico Mogotón on the Honduran border at 2438 meters, and much of Nicaragua is barely above sea level (West, 2003 page 628). Nicaraguans' nickname for their country – "the land of lakes and volcanoes" – aptly characterizes the physical landscape (Wood and Berman, 2001 page 3). At its center, Nicaragua is dominated by two immense fresh water lakes: Lake Nicaragua (8157 sq kilometers, one of the largest fresh water lakes in the world) and the smaller Lake Managua (West, 2003 page 628). But no fewer than 40 volcanoes form Nicaragua's landscape, 6 of which are active members of the "Ring of Fire" that extends from the Aleutian islands through Indonesia and Chile (Wood and Berman, 2001 page 4). And periodic seismic and volcanic events have punctuated Nicaragua's history from the first days of human settlement. The first volcanic event in North America's recorded history was the eruption of Volcán Masaya in the early 1500s, and in 1609 the Spanish were forced to abandon their early colonial settlement at León when nearby Volcán Momotombo erupted, burying León in

volcanic ash (Wood and Berman, 2001 page 4).

Volcanoes are no less important to the Nicaraguan landscape today than they ever were: the volcanoes San Cristóbal, Telica, and Momotombo remain active and threaten nearby communities with impending destruction from time to time. Volcán Telica erupts approximately every five years and the gas vents at this volcano's base produce boiling mud and sulfur Nearby Cerro Negro has erupted at several intervals since it first emerged through a farmer's field in the 1850s; in 1992 it erupted, burying the modern city of León (the original León remains abandoned) under 15 centimeters of ash and dust and choking the air with poisonous gases (Wood and Berman, 2001 page 5). This intense seismic activity is the source of abundant supplies of geothermal power that remain as yet untapped.

B. The Nicaraguan Economy

In 2005, Nicaragua retains its position as the second-poorest nation in the Western hemisphere, with a GDP per capita of only $495: only Haiti has a lower GDP per capita. Nicaragua entered into a period of profound economic collapse beginning in 1972 with the earthquake that destroyed the capital city, Managua. Not long after 1979, when the popular Sandinista movement overthrew the Somoza dictatorship that had oppressed the country but provided economic growth for over four decades, an opposition movement formed to oppose them. The ensuing civil war that consumed the Sandinistas and all of Nicaragua throughout the 1980s, on top of the American economic embargo that attempted to strangle the Sandinistas, not to mention gross economic mismanagement by the Sandinista government itself, left the Nicaraguan economy in tatters and most of the nation's infrastructure in ruins. By 1994, three years after the Sandinistas were defeated at the polls and had stepped down from power, the GDP per capita was less than a third of its level fifteen years previous; the nation's economic

output was 60% of what it had been before the Sandinista revolution (Wearne, 2003 pg. 635).

Even by Central American standards, Nicaragua is poor. In 2001 Nicaragua's GDP per capita was less than a quarter of neighboring El Salvador (Wearne, 2003 pg. 635). Three fourths of the nation lives on less than $2 per day, and the national government is highly dependent on foreign aid: one in four dollars spent in the national economy is provided by international funding (Wood and Berman, 2001 pg. 44). But considering how much worse the economy was under the Sandinistas, when hyperinflation and rampant mismanagement necessitated stamping extra zeros on existing currency to deal with runaway prices, there is reason to be hopeful. Unfortunately, Nicaragua's primary export, coffee, is experiencing a permanent worldwide downturn in prices, and the cash-strapped Bolaños administration is unable to spend as much as it would like on social programs because of the fiscal limitations of IMF-sponsored macroeconomic restructuring, which has led to social tension and even protests (Wood and Berman, 2001 pg. 44).

The current administration faces the limitations of IMF-imposed fiscal accountability that reduces their ability to maneuver. But at the same time valuable tax resources go uncollected because of the Nicaraguan government's inability to collect them. Current tax code is convoluted and vague. Businesses that should legitimately pay taxes are able to avoid doing so because the penalty for not doing so is difficult to impose, and because enforcement of the tax code is half-hearted at best. When disputes arise, the current system involves costly mechanisms for resolving them, including a judicial, not administrative procedure for resolving conflicts. Tax officials are furthermore currently able to forgive tax obligations to individuals as desired, which has led to rampant political abuse of the system (The International Monetary Fund, 2004pg. 17). This greatly weakens the government's financial situation and exacerbates

its inability to deal with other issues like social programs.

C. Politics

In the aftermath of the failed 1979 Sandinista revolution, Nicaragua remains a polarized society whose diverse interests and selfish *caudillo* politicians often preclude good policy-making. This is an important factor that will radically affect the ability to enact sound energy policies for Nicaragua. Daniel Ortega, the de facto president during the Sandinista administration of the 1980s, was defeated in uncontested elections in 1990 and handed power over to Violeta Chamorro, whose administration began addressing the economic and infrastructural damage caused by the civil war. One of the most important acts attributable to her administration was negotiating the pardon of a large portion of the nation's debt (in 1990, Nicaragua had the highest debt-per-capita ratio of any country in the world). The Chamorro administration ceded power to Arnoldo Alemán, the wily former mayor of Managua, whose PLC party ("Partido Liberal Constitucionál") launched a crusade to eliminate the Sandinistas from the political sphere. Alemán turned out to be a phenomenally corrupt politician whose avarice exceeded even that of the much-hated dictator Somoza. Alemán's personal fortune leapt from $20K to $250M in the 1990s, through an aggressive scheme of kickbacks, back-room business, and the siphoning of public accounts (Wood and Berman, 2001 pgs. 35-40).

Alemán was unable to eliminate the Sandinistas, so he instead began bargaining with Daniel Ortega to ensure together they would retain political control over the country after Alemán's political term ended. In the much-criticized Pact of 2000 Alemán and Ortega granted themselves political immunity and divided up the National Assembly (essentially, the Congress) between them, in addition to politicizing the remaining institutions of government. The Pact gave both parties near-total control over the offices that investigate corruption. This political

context of politicized government offices, Ortega, and Alemán sets the stage for Nicaragua's current crisis. Enrique Bolaños, vice president under Arnoldo Alemán, ran for president in 2001 and won on a platform of eliminating corruption. He proceeded to begin rooting out corruption from the national government, which personally threatened both supporters of Arnoldo Alemán and supporters of Daniel Ortega. Alemán himself was indicted on charges of corruption and sentenced to house arrest. But Alemán retained control over the PLC and used it to turn Congress away from Bolaños, who by 2004 was unable to enact meaningful reform at any level (The Economist Intelligence Unit, 2004 pgs. 8-9).

A series of constitutional amendments in 2004 initiated by Congress has weakened the constitutional authority of the democratically-elected Bolaños and strengthened Daniel Ortega, who is clearly seeking reelection in November 2006. While Ortega has lost presidential elections by overwhelming majorities in 1990, 1996, and 2001, he is for the first time in a position to regain the presidency (The Economist Intelligence Unit, 2005). This affects energy policy in a dramatic way. The Sandinista platform has traditionally been a populist one whose outright Marxist doctrine has been muted over the past 15 years into a rallying cry for "people's rights" that precludes privatization of any sort and encourages an enhanced and unsustainable welfare state. Ortega and supporters led rallies in 2002 against the privatization of Hidrogesa, the state agency in charge of hydropower, rallies in 2004 against the reduction of gasoline subsidies for bus cooperatives, and rallies in April 2005 against increased bus fares to offset the increased price of diesel fuel (Ortega Campos and Núñez Salmerón, 2005). It is widely believed Ortega's rallies of 2005, which were ostensibly about high energy prices, were nothing more than a pretext to try to weaken an already embattled Bolaños.

This decreased popular enthusiasm for privatization is a trend visible through much of

Latin America. A poll run by Latinobarometro in 2002 indicated that Latin Americans are frustrated with an increase in crime and civil violence, and are less in favor than before with privatization of state resources. Fewer Latinos now believe that the state should leave the economy completely in the hands of the private sector, as a result of specific complaints about the way privatization and other neo-liberal reforms have been undertaken (The Economist, 2002). Financially weak governments frequently have no other alternative to encouraging private investment, however. Ortega has successfully used this trend to his advantage, and it can be expected that no privatization will occur if Ortega regains the executive branch.

III. Energy Data

A. Energy Use by Fuel Type and Estimated Growth

Energy use *per capita* has actually decreased over the first decade post civil war due to an expanding population that has grown faster than the nation's ability to produce or procure energy. The drop from 554 kg of oil equivalent in 1990 to 536 in 2001 (The World Bank, 2004 page 141) reflects the increased population over the same time period, during which energy production essentially stagnated. In this regard, an overall negative percentage growth in energy usage per capita is not Nicaragua's prerogative alone: Nigeria, Honduras, Hungary, Kazakhstan, and Moldova all experienced a similar decrease in per capita energy consumption. In fact, Nicaragua's -0.2% growth rate is less serious than that of the Kyrgyz Republic (-7.5%) or Moldova (-8.1%) (The World Bank, 2004 page 141). But it is nevertheless an indication that Nicaragua's quality of life has not improved over all in terms of energy consumption over the past decade when Nicaragua should have been enjoying the so called "peace dividend" of increased economic growth and prosperity.

According to the same data, 45% of energy consumed in Nicaragua is the result of the combustion of fossil fuels. The remaining 55% is generated from renewable energy sources, 94% of which come from firewood. In the rural areas, firewood is the main fuel source for cooking (heating is not necessary in this tropical country). Geothermal energy provides a mere 6% of the renewable energy consumed and only 3% of the total energy consumed, in spite of its great potential. So-called “green” energy sources, including solar, wind, and wave power, remain un-utilized as energy sources (The World Bank, 2004).

The World Resources Institute shows the following pattern for consumption of energy resources as of 1997 (World Resources Institute, 2003 page 1):

Fuel Category	Quantity (1000 metric tons of oil equivalent)
Total Fossil Fuels	1,176
Coal and coal products	0
Crude oil and nat. gas liquids	828
Natural gas	0
Nuclear	0
Hydroelectric	34
Renewables, excluding hydroelectric	1,449
Primary solid biomass (incl. firewood)	1,361
Biogas and liquid biomass	0
Geothermal	87.7
Solar	0
Wind	0
Tide, wave, and ocean	0

Table 1: Energy Consumption Patterns by Fuel Source (1997)

According to the World Bank’s 2004 World Development Indicators, energy consumption has grown by 30% over the past decade from 2,118,000 metric tons of oil equivalent in 1990 to 2,792,000 metric tons of oil equivalent in 2001. This trend can be expected to continue into the

future. Of that energy consumed, 48.2% of the energy resources consumed in the production of energy is considered combustible renewables and waste.(The World Bank, 2004 page 141) Population growth and the reactivation of the Nicaraguan economy have led to increased demand for energy. While the energy sector had 312,013 clients in 1991, that number increased by 62.98% to 526,476 by June 2004 (INEa pg. 22). This energy demand has been met with increased consumption of petroleum resources (INEa pg. 20-21).

The following chart shows the trend in energy consumption by fuel source, which gives us an idea of what the demand for fossil fuels and other renewable energy sources (geothermal, hydropower, and biomass) will be in the near future (World Resources Institute, 2003 page 1).

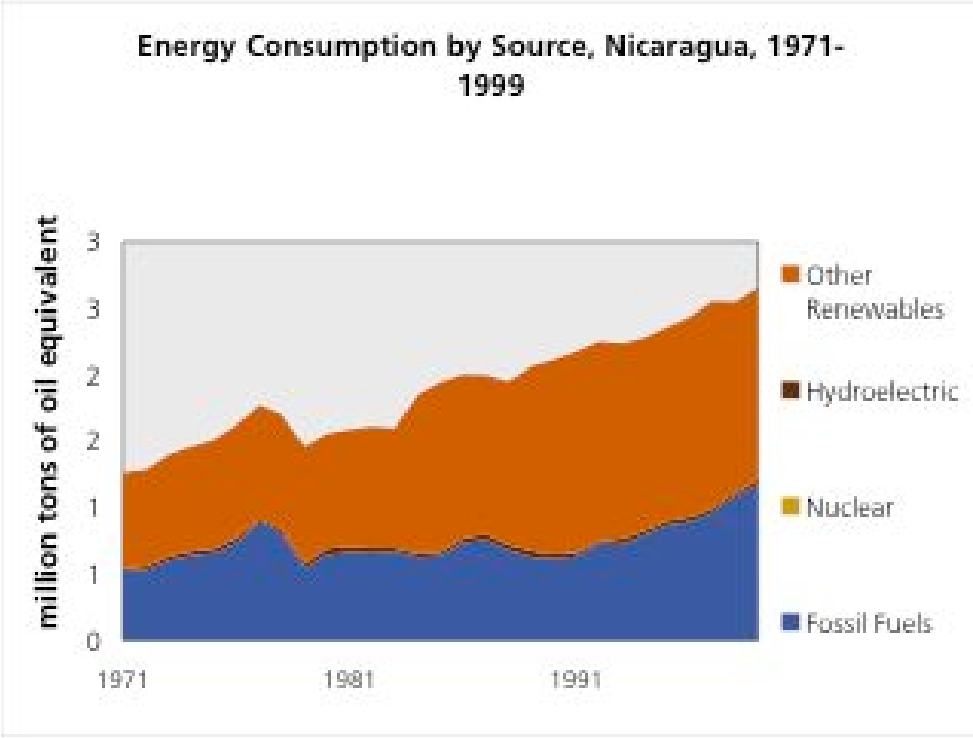

Chart 1: Energy Consumption by Source

B. Energy Use by Economic Sector and Estimated Growth

The World Resources Institute provides the following consumption data organized by end-user sector (World Resources Institute, 2003):

Sector	Quantity (1000 metric tons of oil equivalent)
Industry	373
Transportation	489
Agriculture	18
Commercial and public services	91
Residential	1,150
Non-energy uses and other consumption	36
Total	2,156

Table 2: Energy Consumption Patterns by Sector (1997)

The data makes clear that Nicaragua, like most poor countries, expends a great deal of its energy resources to meet the needs of ordinary households, not for industrial or agricultural purposes. As shown above, 53% of energy consumption is at the residential level (the world average is 27%), while industry consumes only 17% (world average is 32%). Agriculture, a resource glutton in other nations where agricultural production is capital intensive, consumes a mere 1% of all energy utilized in Nicaragua (the world average is 2%), where the majority of agriculture is subsistence and requires oxen and a strong back, not capital. Transportation is the second most energy-intensive industry, responsible for 23% of energy consumed (the world average is 26%). This is not surprising, considering the transportation system, which consists of used American school buses in varying degrees of disrepair.

In 2003, the end use consumption of energy as registered by INE, the national energy regulator, was as follows: commercial use (490.64 GWh, 28.09%), industry (354.73 GWh, 20.31%), residential (514.78 GWh, 29.47%), irrigation (64.09 GWh, 3.67%), public lighting

(54.05 GWh, 3.09%), pump stations (157.55 GWh, 9.02%), and large consumers (110.95 GWh, 6.35%). Large consumers are those who require greater than 13.8 kilovolts and at least 2000 kilowatts of energy annually (INEa pg. 14).

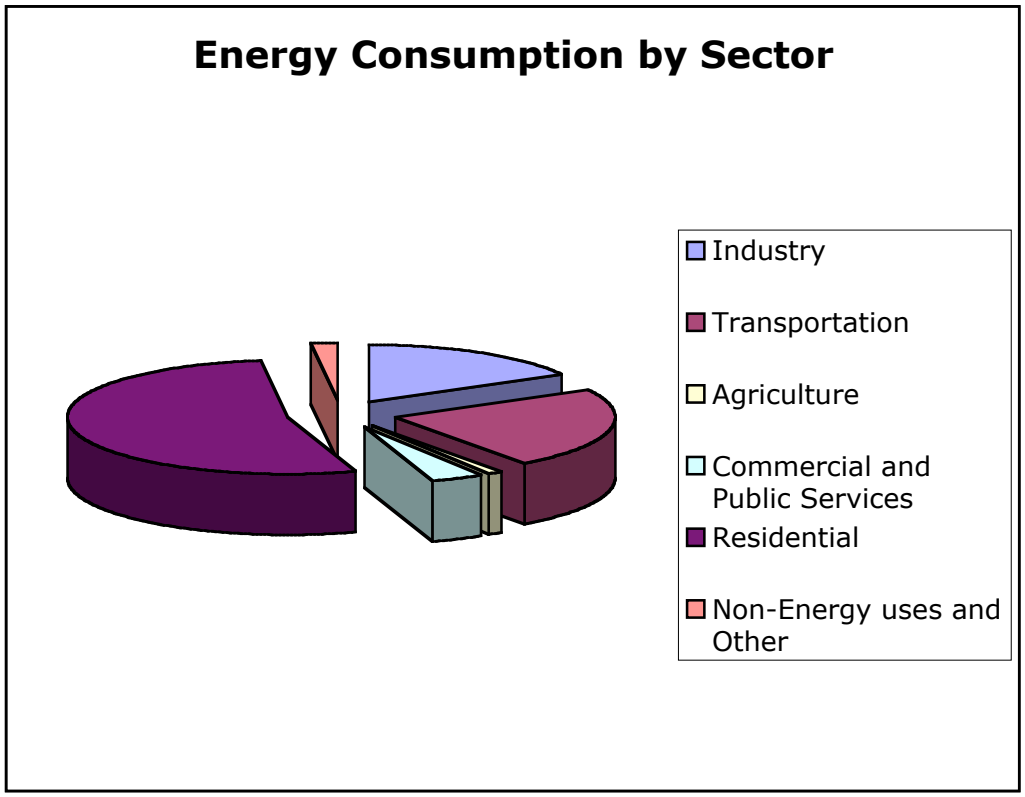

Chart 2: Energy Consumption by Sector

Nicaragua's current population of 5.1 million is growing at 2.7%, one of the highest rates of population growth in Central America. And its fertility rate is double the Latin American average, at 3.9 children per woman. High fertility combined with a young average birth age (over 10% of births are to adolescents, a third of which are in rural areas) means that population pressure alone will generate a significant increased demand for energy consumption (UNFPA). And although the total fertility rate has fallen from 4.6 children per woman to 3.9 children per woman over the second half of the 1990s, the still higher-than-average rate of population growth

means that Nicaragua will have to find ways to meet the demand of a greater population.

While the industrial sector grows over the next decade its increased demand for energy will grow in parallel. But Nicaragua's industrial sector is marginal at present. Light manufacturing may contribute additional demand for energy, but this too represents a relatively small fraction of total energy consumption. More growth in demand can be expected for petroleum for the transport sector, due to the combination of Nicaragua's explosive population growth and the concurrent rapid growth in motorized transport. Agricultural energy use in the subsistence sector is currently close to zero as subsistence farmers don't make use of irrigation or motorized farm vehicles. Increased demand for energy in this sector will be dependent on economic growth that enables those farmers to switch to more intensive crops, export crops, and off-season crops that require irrigation. Existing commercial plantations can be expected to increase their demand for energy slightly, but if they improve their efficiency as they grow – a policy goal – their increased energy demand will be slight.

C. Energy End-Use Within Sector

Manufacturing and Industry

Manufacturing declined in Nicaragua through the war years and grew afterwards only sporadically. However, in spite of the relaunching of the economy in the aftermath of the civil war, drastically-reduced national consumption was a severe constraint on the market. The manufacturing sector consists primarily of processing of beverages, processed foods, and tobacco and textile products. While the building materials sector experienced a brief surge in production in the aftermath of Hurricane Mitch (which caused widespread damage in September 1998), this was an anomoly in an otherwise flat trend (Wearne, 2003 pg. 637). The building

materials industry – particularly concrete – took advantage of high demand post-Hurricane Mitch, during which time the sector expanded by nearly 60%. From 1998-2000 cement production nearly doubled and asphalt production increased by 42%. By 2000 output of both products dropped precipitously (Wearne, 2003 pg. 637).

The biggest growth in the manufacturing sector has been in the *maquilas*, or free trade zones. The Las Mercedes free trade zone and successors generate nearly $308M in export earnings annually; this sector is expected to grow dramatically in the future as additional companies from the USA, Hong Kong, and Taiwan take advantage of low-cost labor and good access to the American market. Although the principal export from these *maquilas* is assembled clothing, the plants also produce footwear, aluminum glasses frames and jewelry, and other simple, manufactured goods (Wearne, 2003 pg. 637). As of 2004, the free trade zones are comprised of 65 separate enterprises that employ over 58,000 workers and export approximately $150M (US Embassy in Nicaragua).

The DGH reports the following quantities of petroleum imports for this sector (DGH):

Fuel Type	Quantity Imported (barrels)
Fuel Oil	3,616,279
Asphalt Products	113,150

Table 3: Petroleum Imports Consumption in Manufacturing Sector

The garment industry uses a lot of energy relative to other manufacturing sectors, for the use of myriad types of sewing machines, as well as for lighting and ventilation in the large, newly-constructed facilities. The facilities outside of Managua suffer from tremendous heat problems and are forced to use enormous building fans to circulate air through the building in lieu of air conditioning. The free trade zones rely on electricity for their equipment needs, though most manufacturing zones employ diesel generators as backups for the now-infrequent

but not unheard-of power outages in Managua and Tipitapa. The sugar refineries outside Managua and in the vicinity of León rely to a large degree on the combustion of organic materials like cane bagasse ("bagazo de caña") that has been dried in the sun. They even co-generate some electricity and take advantage of the liberalized market to sell the electricity onto the grid.

The concrete and asphalt industries use high amounts of energy as part of their production processes. Nicaragua does not produce its own fertilizer; neither does it produce any steel. The slow pace of economic development and infrastructure improvement means demand for these products will grow steadily but at a slow pace over the next decade. Nicaragua will more likely see a rapid growth in export-oriented manufacturing firms. If government policies or the world economy facilitate value-added manufacturing in the foodstuffs industry, additional electricity and perhaps process heat will be required to meet the demand. Possible areas for growth in this field include value-added food products like bread and corn meal, livestock feeds, corn oil, high fructose corn syrup, and ketchup. All of these manufacturing industries would require additional electricity to run the processing equipment, heat for cooking the food products, and in some cases, refrigeration.

Transportation

Nicaragua has a reduced system of major roads that serve the more densely-populated western third of the country. International highway CA-1 links Honduras to Costa Rica via Managua; CA-3 links Managua to El Salvador via the Nicaraguan cities of León and Chinandega. One improved, asphalt-surfaced road runs from Managua east to the river port city of El Rama, and a smaller improved highway is paved from Sébaco through Matagalpa to Jinotega. The rest of the nation's road infrastructure consists of unimproved dirt roads of

varying quality, from bumpy-but serviceable (Estelí to San Rafael del Norte) to impassable in the wet season (Juigalpa to San Carlos). The Atlantic Coast port city of Puerto Cabezas is essentially an island because of the poor quality road that becomes unusable during four months of the year.

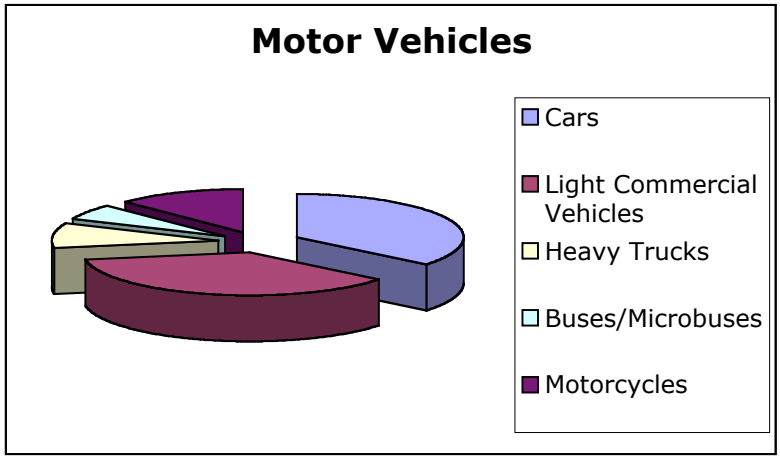

Chart 3: Distribution of Motor Vehicles in Use

256,000 vehicles made use of that road system in 2002, a marked increase from 201,000 two years previous. Passenger cars and light commercial vehicles (LCVs) represent 83,168 and 84,310 vehicles respectively; 21,805 heavy trucks, 13,488 buses and microbuses, and 28,973 motorcycles also shared the roadways in 2002 (The Economist Intelligence Unit, 2004 pg. 18).

Nicaragua abandoned and later sold for scrap its rail system in 1994. The international airport in Managua receives all international flights, while a half dozen regional airports provide communication with the capital's fleet of 10-seater small aircraft offering about 1 flight per day. Traffic to the Managua international airport has increased by 50% over the period from 1997 to 2002 in response to the expansion and modernization of the airport facility there (The Economist Intelligence Unit, 2004 pg. 18).

These vehicles, with the exception of aircraft and motorcycles, overwhelmingly run on diesel. The motorcycles run on gasoline, and the aircraft use high test aviation fuel. DGH ("Direccion General de Hidrocarburos") statistics for the period from 1990-2001 show the following fuel consumption profile: (DGH)

Fuel Type	Average Consumption (barrels)
Aviation Fuel	2,141
Diesel	2,863,725
High-test Gasoline	684,849
Regular Gasoline	717,946

Table 4: Petroleum Consumption in Transportation Sector

Diesel imports are nearly double all gasoline imports and aviation fuel imports combined. This is because of its relatively lower price. Consumers in Nicaragua are less likely to buy vehicles with gasoline engines because of their lower fuel economy, even taking into account how gasoline engine cars are "peppier" at low speeds.

The large fleet of passenger buses that provide transportation between major cities and even outlying villages are of two types. Refurbished and lavishly decorated yellow school buses carry the bulk of the nation's passengers between cities. These vehicles are cast-offs from the American school system, sold used at a discount and pressed into service on some of the worst roads in the nation. They are habitually overloaded with up to 150% of the stated passenger count, and buried under stacks of cargo that is loaded onto steel-frame roof racks custom fitted to the buses' curved roofs. These buses run entirely on diesel fuel. Smaller and more nimble, 20 passenger minibuses of Asian manufacture are sold new or used to the Nicaraguan market; these vehicles provide transport between major cities on major routes like Managua-Granada, Managua-León, or Estelí-Ocotal. Their weaker suspension systems preclude their being used for extensive hauling of cargo, and instead charge higher passenger fares for "express" service.

They too consume diesel fuel.

Agriculture

Agriculture is the mainstay of the Nicaraguan export economy, employing 38.3% of the economically active population and generating 31.6% of GDP. Throughout the civil war of the 1980s, agricultural production had to contend with not only the traditional threats to production – crop disease, inconsistent weather patterns, and fluctuating commodity prices – but armed conflict as well. As a result, production declined precipitously and the government was obligated to import basic foodstuffs. Production since the 1990s has risen again, but not to the pre-1979 level. Coffee is Nicaragua's principal cash crop, but it has suffered dramatically in the world's worst price drop as a result of a world market glut in coffee beans in the late 1990s. The cotton industry, prevalent in the 1960s and 1970s, disappeared during the civil war. By the time the war ended, market conditions had changed unfavorably for the crop's reestablishment. Other significant export crops include sugar, bananas, and sesame seeds. Large rice fields in the Sébaco valley are cultivated at high expense as a result of high subsidies for inputs. New export-oriented crops marketed to the United States in the winter include cantaloupe, peanuts, okra, soy beans, asparagus and vidalia-type onions, and currently generate $103M in export earnings. Likewise, high quality tobacco is grown throughout the Estelí area and processed into several tobacco products for export. Coffee is grown in the mountainous highlands of Matagalpa and Jinotega where rainfall is still abundant. As a result, the coffee industry does not rely on irrigation. With the exception of the depulping machinery, which is run from diesel generators, the coffee industry on the whole is not a major consumer of energy. Most of the drying of coffee beans, for example, is done using solar energy on broad concrete platforms, and the actual coffee roasting is performed in the countries that import the beans.

An increasingly significant part of the Nicaraguan export economy is cattle production, which has grown since 1998 and now nearly rivals coffee in export earnings. Before the revolution of 1979 beef exports were a major source of revenue for the nation. In 2003, beef exports to El Salvador, Mexico, and Honduras reached $84 million. This sector is expected to continue growing as production efficiency improves.

The majority of Nicaragua's 3 million farmers are subsistence farmers who grow white corn and red beans on family plots. They plow using oxen and rely on rainfall to water their crops. These farmers are extremely adversely affected by drought and are entirely dependent on manual labor or beasts of burden to accomplish their days' chores. Energy demand is higher in the non-traditional export sector, where irrigation of crops necessitates the use of small gasoline generators or large diesel engines to pump water from wells. Tobacco is a particularly thirsty crop, and is irrigated incessantly, even at the expense of local aquifers. The rice fields of Sébaco are another exception. The engines that run these irrigation wells are typically diesel engines extracted from old trucks, or are left over from the Soviet era. They generate large amounts of atmospheric pollution (and noise) when running, as the equipment is old and worn, allowing oil to sink into the combustion cylinders, and so on.

Pesticides are usually applied manually using backpack sprayers, or not at all. The use of tractors is unheard of with the exception of the larger cane or corn fields in the León-Chinandega area, where land tends to be held in larger estates, and subsistence farming forms a smaller part of the regional economy. The sugar cane fields around Chichigalpa are a notable exception. Part of the extensive land-holdings of the Pellas family, the wealthiest family in the nation, better-quality equipment is in use, including relatively modern tractors and new irrigation pumps that are kept in good repair. The Pellas family harvest the sugar and ferment it to

produce *Flor de Caña*, an export-quality rum.

Commercial/Public Services

Residential

Residential energy use is limited to illumination and electro-domestic appliances, particularly refrigerators. However, this category also encompasses some business usage, because as much as 40% of the economy is thought to be in the informal sector, where it goes unreported. Examples of such small businesses are:

- homes that operate *pulperías* (convenience store-type shops, specializing in soaps, detergents, cookies, candy, gum, cigarettes, and other small consumer goods),
- families that run industrial freezers to facilitate the sale of small quantities of meat,
- families that rent or buy industrial refrigerators from soft drink distributors like Coca Cola or Pepsi and sell soft drinks.
- families that operate leatherworks and produce boots or saddles, small tailor or seamstress operations, or auto repair shops.

Outside of small, unreported businesses, however, even in larger cities like León or Granada, the consumption of energy within the home is limited to illumination and the use of electro-domestic appliances like refrigerators, toasters, blenders, and televisions or radios. Lighting within the home tends to be fluorescent light-bulbs or small incandescent bulbs. Whether in the city or the countryside, as a family acquires the means to do so, the first electric piece of equipment they purchase is a small fan, which alleviates the tropical heat (even in the highlands). These can be found in the local markets for $5, of Chinese manufacture. Televisions are the next major purchase. Even poor families like to watch 1-2 hours of

television in the evening if they have the means. Those who don't have televisions usually congregate in the homes of those who do.

Residential cooking needs are almost never serviced by use of electricity. In the rural areas and even in parts of most towns, cooking is entirely done using fire wood, the collection of which is leading to severe deforestation throughout the country. In larger cities and among the wealthier sector of the population, cooking is done with bottled LPG gas. Electrical cooking apparatus is unheard of, as gas is relatively less expensive compared to electricity. The DGH reports for the period 1990-2001 an average import rate of 113,150 barrels of LPG per year for residential consumption (DGH).

IV. Energy Sector Overview

According to the World Bank's 2004 World Development Indicators, total energy production in Nicaragua has grown only slightly over the past decade. In 1990, immediately following the peace accords that ended a decade of civil war, the nation produced 1,495 thousand metric tons of oil equivalent; in 2001 that figure had grown to 1,540 thousand metric tons of oil equivalent (The World Bank, 2004 page 141). INE records its data in GWh, which makes comparison with the World Bank data cumbersome, but records the following for the year 2003:

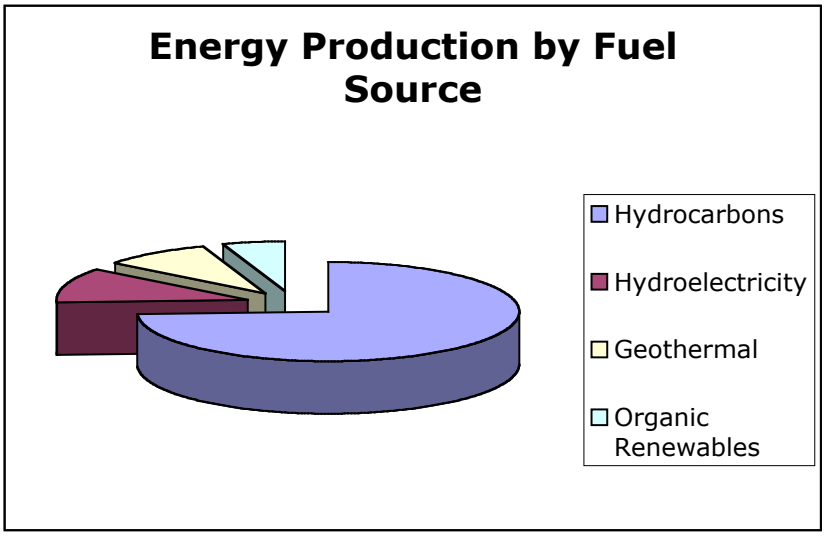

Chart 4: Energy Production by Fuel Source

Total, gross energy generation in 2003 was just over 2,771.96 GWh, representing an increase of 5.8% over the previous year. The majority of that energy – 98.88% of the total – was generated by facilities connected to the grid known as the S.I.N. ("Sistema Interconectado Nacional"); the remainder was produced locally for local consumption by isolated systems that do not take part in the grid. Of the gross amount of energy produced, 180.52 GWh (6.51%) is consumed by the electric plants themselves, leaving 2,591.44 GWh (93.49%) for national consumption (INEa pg. 4).

A. Hydrocarbons

Of the 2,591.44 GWh of energy produced in 2003, the majority – 74.20% was generated by "thermal plants" that produce electricity through the combustion of hydrocarbons (INEa pg. 5). The principal fuels are bunker (fuel oil) and diesel (INEa pg. 7), both of which are imported. In 2003, fuel oil consumption increased moderately by 0.74% relative to 2002, reaching 129,747,050 gallons; diesel consumption increased far more drastically, registering an increase

of 21.83% relative to 2002. Of this consumption, GEOSA (Planta Nicaragua), Planta Energética de Corinto, Tipitapa Power, CENSA, and GECSA were the primary consumers. The Planta Nicaragua (GEOSA) alone consumed 30.44% of the fuel oil. Of the diesel consumed, GECSA (Planta Las Brisas) was responsible for over half (51.78%), with various isolated producers, GEOSA (Planta Chinandega), and others accounting for the rest (INEa pg. 7).

With the exception of several small hydropower facilities, the nation has met its need for additional energy production through the construction of thermal plants that combust imported hydrocarbon fuel sources. Installed capacity of these plants was 195MW in 1990, but climbed to 497.80MW by 2003 (INEa pg. 19). While these operate at a greater expense and at the whim of the prices of the world petroleum market, they have several advantages: they require relatively low initial investment in capital, and can be put in operation relatively quickly, which means they can begin to recuperate their costs in the immediate short-term. Hydroelectric and geothermal plants often require extensive site assessments and require longer time to construct, which means that even though they can operate at much lower expense, they take longer to generate the income that compensates for their construction (INEa pg. 20). The following chart shows thermal plants, the date they went on line, and their capacity (INEa pg. 19):

Plant name	Date on-line	Capacity
CENSA	1997	36 MW
CENSA, additional capacity	2001	16.2 MW
Energética de Corinto	1999	74 MW
Tipitapa Power	1999	52 MW
Nicaragua Sugar Estate	1998	15.8 MW
Nicaragua Sugar, add'l cap.	2003	23.5 MW
Ingenio Monte Rosa	2003	26 MW
Turbina a Gas de las Brisas	1998	65 MW

Table 5: Thermal Plants and their Installed Capacity

To date, no known petroleum reserves are found on Nicaraguan territory. Exploration for petroleum began in 1930 and continued through 1979. International petroleum companies undertook the exploration of 74,000 square miles in two principal regions, the Miskito basin in the Atlantic Coast and the Sandino basin off the Pacific Coast. The Pacific Coast's Sanindo basin is better known, as research and exploration was more intense in that area. Geologists collected over 10,931 km of seismic data on the basin and built 6 exploration wells (INEb). It is known that both basins are over 10,000 meters thick, indicating the possibility of – but not confirming – commercially-exploitable deposits (INEb). To stimulate continued exploration of petroleum resources, the Nicaraguan government under Arnoldo Alemán's administration passed Law no. 286, "Special Law for Exploration and Exploitation of Hydrocarbons" to permit exploration of oil reserves, and "Decree 43-98" under which the exploration would be regulated. The laws permit concessions, production sharing with cost recovery, and other production schemes generally recognized and used by the international petroleum industry, in an effort to attract foreign investment capital to the region (INEb).

President Enrique Bolaños continued the trend by signing legislation in early 2002 that would permit foreign investors to explore for oil in several key areas of Nicaraguan territory, including sections of the Caribbean continental shelf near the Miskito and Pearl cays, marshland along the Pacific coast, jungle along the border with Costa Rica, and some inland territories around Managua (Lorenzetti, 2002). While Nicaragua still has no proven oil reserves, the US Energy Information Administration (EIA) considers Nicaragua one of the last remaining Central American territories worth exploring for possible petroleum reserves. Nicaraguan government officials predict the oil concessions under consideration in 2002 could yield up to 50,000 barrels per day and 2 MMcfd of gas over the life of the proposed extraction fields. At the same time, the Nicaraguan government would be able to collect an estimated $300 million in tax revenues from the 50,000 square miles currently open for development (Lorenzetti, 2002).

B. Hydropower

Of the 2,591.44 GWh produced in 2003, 11.27% was generated by hydroelectric plants associated with turbines and dam facilities in the north and center of the country (INEa pg. 5). But in comparison with 2002, Hidrogesa, the state agency that runs the dam facilities, passed 1.3% less water over the turbines at its facilities, and therefore likely produced less electricity: in 2002 the hydroelectric plants consumed 545,842,230 gallons of water, and in 2003, they consumed 545,842,230 gallons (INEa pg. 7). The first hydropower plant – Centroamerica – was put online in 1965 with the construction of the artificial reservoir Lago de Apanás; it produces 50MW of electricity. The second hydroelectric plant–Carlos Fonseca, also known as Santa Barbara – was installed in 1965, and produces 54.4MW. Two small plants were added online in 1972 and 1990: the Wawule and Las Canoas plants. They produce a relatively miniscule proportion of the hydroelectric power, at 1.62MW and 1.79MW respectively, and were taken off-

line in 2002 (INEa pg. 19).

According to the International Journal on Hydropower and Dams, the Nicaraguan government is planning two additional hydropower projects of 20MW and 25MW capacity, respectively (quoted in Webster et al., 2001 pg. 8). These would add valuable capacity to the Nicaraguan energy sector and alleviate the risk currently associated with both the Centroamerica and Santa Barbara hydropower plants, both of which suffered extreme damage during Hurricane Mitch in 1998 (Webster et al., 2001 pg. 8). But little information exists on these two planned facilities, making them unlikely sources of increased energy production in the next 10 years.

C. Geothermal Electricity

Of the 2,591.44 GWh produced in 2003, 9.35% was generated by geothermal plants (INEa pg. 5). The production process in the geothermal plants was recently made more efficient, which resulted in a lower use of water vapor but a corresponding increase in electricity production: consumption of water vapor was reduced from 1,945,040 tons of vapor in 2002 to 1,740,610 tons of vapor in 2003 (INEa pg. 7).

The first geothermal plant – Momotombo – was installed in September 1983 and produces 35MW. The second plant went on line in the same place in April 1989, producing an additional 35MW, and in 2002 a third plant went on line, producing 7.5MW (INEa pg. 19). But by 1999, production at Momotombo had declined to almost zero due to lack of maintenance of the geothermal wells which led to mineral incrustation and reduced capacity. In 1999, the Israeli company Ormat Industries signed a 15-year operating contract with ENEL, for the right to run and operate the Momotombo geothermal plant on the north side of Lake Managua. The contract required Ormat to invest an initial $15 million upon takeover and an additional $30M

subsequently, as well as to increase capacity from 13MW to 70MW. (Wearne, 2003 pgs. 636-637).

D. Organic Renewables

A meager 5.17% (131.10 GWh) of the nation's energy was produced via the combustion of renewable energy sources of an agricultural nature; these resources include spoils from sugar cane harvesting ("bagazo de caña"), firewood, and rice hulls ("cascarilla de arroz") (INEa pg. 6). Over the period 2002–2003 the composition of this fuel source changed, as rice hulls and sugar cane bagasse comprised a larger percentage of total organics combusted. This energy production meets some of the nation's demand for energy in the cane producing facilities and sugar mills (INEapg 7). The combustion of wood resources for cooking is the most important source of energy consumption in the countryside, where alternatives do not exist.

E. National Distribution

In 1999, ENEL, the state monopoly that had previously encompassed both production and distribution of power, was divided into three production companies and two distribution companies so that they could be privatized. In November 2000, a controlling share in the distribution company was purchased by Unión Fenosa, a Spanish company.

The distribution network is still prone to enormous losses due to physical infrastructure problems, theft of services, and similar problems. As measured by billing records for 2003, an estimated 29.58% of the energy produced in 2003 was lost and can not be accounted for. While that figure is an improvement from 31.32% the previous year, it reveals nonetheless a significant amount of consumption for which the energy distribution industry is not reimbursed (INEa pg. 13). INE data reveals that losses due to the transmission system were only 1.65% in

2003 through all of the 1999.46 kilometers of transmission lines (INEa pg. 10), indicating that systemic losses other than those during transmission account for the majority of energy loss between production and consumption.

Sale of energy to the end user takes place through several regional government agencies organized geographically: DISNORTE, DISSUR, and Bluefields, corresponding to the north and south of the country, and the Atlantic Coast, respectively. In addition, the 32 isolated systems provide electricity in small regions of local production (INEa pg. 13). DISNORTE provides service to 52.38% of the national clients, DISSUR to 46.32%, and Bluefields to 1.30% (INEa pg. 15).

In early 2005, the INE approved a proposal that permitted Unión Fenosa the right to receive a one-time subsidy of US $5.6m for the year of 2005, in lieu of charging a 10.8% tariff increase. Unión Fenosa requested the right to charge the price increase in November 2004 as a result of the higher prices Nicaraguan energy producers are charging to compensate for higher operating expenses. INE approved the subsidy in an effort to prevent higher electricity prices from driving consumer prices higher in 2005, given the attention the Nicaraguan government is giving to keeping inflation below 10% (The Economist Intelligence Unit, 2005 page 21).

One of the distribution system's primary shortcomings is a system of cross-subsidies that taxes higher usage customers at a higher rate and provides energy to rural inhabitants at a subsidized rate. This cross-subsidization has made prohibitively expensive the idea of increasing the number of rural or agricultural electrical connections, and encourages theft or fraud by the larger customers not to mention inefficient consumption by smaller customers, which leads to economic losses for Unión Fenosa. The cross-subsidies cut through customer

categories (larger and smaller customers) and across categories (residential, commercial, and industry-specific groups). A preliminary analysis of a rural electrification subsidy program performed by the IDB indicated that it would have to pay more than 100% of the interconnection cost to compensate Union Fenosa for connecting the customers (Bohn, 2005).

F. The Interconnected National System (S.I.N.)

Several private companies are connected to the Sistema Interconectado Nacional, a network of transmission systems that provide connectivity throughout most of Central America. These companies produce electricity and sell it to the system. These include the Empresa Energética de Corinto (505.96 GWh, 19.52%), GEOSA (487.83 GWh, 18.82%), Tipitapa Power Company (407.89 GWh, 15.74%), CENSA (289.17 GWh, 11.16%), ORMAT (242.40 GWh, 9.35%), Nicaragua Sugar Estates Ltd. (97.36 GWh, 3.76%), and Monte Rosa (36.74 GWh, 1.42%) (INEa pg. 6). The three companies that produce electricity but are not connected to the grid are in all cases isolated geographically. They are Ometepe (4.59 GWh, 0.18%) and Corn Island (2.15 GWh, 0.08%), both of which are islands, and Puerto Cabezas Power (17.33 GWh, 0.67%) and Aprodelbo (0.34 GWh, 0.01%). Puerto Cabezas, while located on the mainland, is essentially cut off from the rest of the nation and even the rest of the Atlantic Coast, by lack of infrastructure, particularly good, year-round transitable roads (INEa pg. 6).

Being positioned on the grid provides additional flexibility in times of energy surplus or shortage, and over the course of 2003 Nicaragua actually exported more energy than it produced, generating some revenue. Costa Rica, Panama, Guatemala, El Salvador, and Honduras are the principal trading partners in this exchange of energy, Honduras being the biggest importer of Nicaraguan energy (99.82% in 2003) (INEa pg 9). The months of greatest exportation of energy are September through December (INEa pg. 9), which represent the

heaviest part of the rainy season (Wood and Berman, 2001 pg. 10-11). The months of greatest importation of energy are January, February, and August; this energy was imported from Costa Rica (78.57%), Panama (18.18%), Guatemala (1.35%), and less than a percent each from El Salvador and Honduras (INEa pg. 9).

G. Regulation and Oversight

In 1998 the Nicaraguan government enacted the Electricity Industry Act ("Ley de la Industria Eléctrica") which separated the generation, distribution, and transmission assets from the state agency ENEL. To this day, ENEL retains the Bluefields distribution company, but the rest of the distribution system was privatized. The transmission company ENTRESA (Empresa Nacional de Transmisión Eléctrica) remained state-owned (US Embassy in Nicaragua), and INE was formed to provide regulatory oversight for the industry.

But in 2005 the sector as a whole suffered an institutional setback when for political reasons, the National Assembly (the Congress) decided to reduce the influence of the Executive branch over this sector (and others). The National Assembly enacted legislation that disbanded INE as well as the agencies that provided oversight to the water and telecommunications industries, and transfered the regulatory function to superintendents appointed by the National Assembly. This unnecessary politicization has unequivocably undermined the decision making process in the energy sector, and allows the National Assembly to make energy decisions based on political whims rather than sound market signals and commercial principles.

V. Summary of Key Energy-Related Institutions

At present the key energy-related institutions in Nicaragua are undergoing change. Unión Fenosa remains in charge of distribution of energy to consumers. The state agency

ENEL is in charge of production of energy in its several thermal plants which burn petroleum for the generation of electricity. Geothermal activity at Momotombo is in the hands of the private sector operator Ormat Industries, which sells its power to Unión Fenosa. Hydropower facilities at the Planta Centroamérica and the Planta Santa Bárbara remain in the hands of the state-run agency Hidrogesa. Attempts to privatize Hidrogesa have failed repeatedly due to "irregularities" and political pressure spearheaded by populist presidential candidate Daniel Ortega.

VI. Energy Policy Priorities of Current Government

A. Reduce Petroleum Dependence

Reliance on imported fossil fuels has been a problem for Nicaragua's economy for decades. The Sandinistas relied on cheap or bartered petroleum from Mexico or the former USSR. But when Nicaragua grew unable to pay for petroleum under even the lenient terms established by Mexico, it found its fuel source cut off (Wearne, 2003 pg. 637). As Nicaragua's population has grown, successive governments have met increased demand for energy with additional imported fuel. While in 1990 29% of demand for energy was met with imported resources, that figure rose to 45% in 2001 (The World Bank, 2004 page 145).

The rising cost of petroleum products led to a dramatically increased financial burden for the Nicaraguan government: while the government spent $133.3 million on petroleum imports in 1998, it was forced to spend $269.8 million in 2001 (Wearne, 2003 pg. 636). Raúl Solórzano, head of the Comisión Nacional de Energía revealed in early February 2005 that while Nicaragua is presently able to produce enough energy to meet its immediate needs, the rising costs of petroleum would significantly reduce Nicaragua's ability to meet rising energy needs at prices acceptable to consumers. At present, Nicaragua generates electricity at the price of US$0.06

per kilowatt-hour, but continued price increases could force the price of electricity in Nicaragua to climb to US$0.11 per kilowatt hour within five years (Martínez, 2005).

At the same time, reliance on hydrocarbons as a fuel source has led to atmospheric pollution. Carbon dioxide emissions have increased by 42% over the past decade from 2.6 million metric tons in 1990 to 3.7 million metric tons in 2000 (The World Bank, 2004 page 145). Statistically, population growth has kept pace with the greater carbon dioxide production, causing the per capita rate of emission of carbon dioxide to remain steady at 0.7 metric tons (The World Bank, 2004 page 145).

The Government of Nicaragua has identified the expansion of energy production using renewable resources as a primary goal of energy policy in the near future, and submitted to the World Bank a request for feasibility study funding for the development of geothermal resources in the departments of Chinandega and León (Bohn, 2005). Because high energy prices led to street protests (semi-politically inspired), it's clear that dependence on a high priced fuel source is posing enormous financial constraints on this developing nation, and it's appropriate to look at alternative sources of energy to reduce the fiscal burden of both generating electricity based on petroleum, and using inefficient, old vehicles that burn gasoline or diesel. Cost savings in this area would lead to increased financial resources with which the Bolaños administration or its successors could invest in other development criteria (like schools, for example).

B. Reduce Losses in Production and Transmission

Raúl Solórzano also indicated in February 2005 that the primary threat to the ability of Nicaraguan energy facilities to meet future energy demand is the current lack of adequate backup sources to cover the needs of consumers and industry in the case of equipment failure at one of its facilities (Martínez, 2005). In 1997, the existing physical infrastructure for

production and distribution of energy was mostly twenty years old and unmaintained since before the revolution of 1979 (American Embassy, 1997). In addition, large losses due to inefficient production, transmission, and theft of energy all contribute to a problem of great inefficiency in the energy sector. Reducing the nation's reliance on old or inefficient sources of energy, reducing losses in transmission, and preventing theft of services are critical to free up much-needed resources for other initiatives as well as to reduce the nation's dependence on petroleum imports. Making this sector more efficient will complement other existing policy goals of the Nicaraguan government and make the burden of rising petroleum costs less onerous.

C. Reduce Dependence on Biomass Fuels

Lastly, the overwhelmingly rural Nicaraguan populace depends on wood for cooking, which over the course of several decades has left Nicaragua's forests severely depleted and its hillsides bare. Exposed hillsides has led to increased erosion and loss of soil fertility, both of which pose severe constraints on the future development of a nation whose primary exports are all agricultural. Stopping the rapid deforestation is an important policy goal that will prevent the rural poor from slipping further into poverty.

VII. Policy Recommendations

Reducing Nicaragua's dependence on petroleum will rely on a multi-pronged strategy that targets the sectors that most rely on petroleum as a fuel source: the electricity sector and the transportation sector. Policies to encourage the switch from petroleum to alternative fuel sources have to simultaneously provide an alternative fuel source while discouraging continued use of petroleum.

A. Open Geothermal Exploration to Concessionary Development

In this regard, Nicaragua has a tremendous advantage: an alternative fuel source. Geothermal energy should play a key role in the Nicaraguan government's strategy for reducing its dependence on petroleum. Studies have repeatedly shown that the seismic nature of Nicaragua's western third provide numerous opportunities for the development of geothermal energy facilities, and that in many cases the energy is available in commercializable quantities. Expanding production of geothermal energy production will be an important part of Nicaragua's strategy to reduce dependence on imported hydrocarbons. But Nicaragua lacks both the financial and human capital necessary to develop these resources, and as a result must depend on foreign investment as a mechanism to develop this energy source. Cash-strapped Nicaragua's best hope for developing this resource is thus to open up the opportunity under a concessionary framework to the private sector and encourage the development of projects by foreign companies with the financial wherewithal to do so.

Nicaragua should open up the geothermal market for concession as it has for the San Jacinto-Tizate concession. Geothermal consulting firm Sinclair Knight Merz Ltd. (SKM) has indicated a 90% probability that the resource capacity at San Jacinto-Tizate will exceed 75 MW and a 50% probability it will be greater than 115 MW. Additional resources in the area have been identified but not yet measured. The San Jacinto-Tizate project in its current form proposes the development of a 66MW plant in phases I and II, with additional phases to be completed afterwards as necessary. Polaris Geothermal is the company with a 67.6% controlling interest in the project. Other firms involved in the venture include Debis Industrial GmbH, a wholly-owned subsidiary of Daimler Chrysler. Polaris is publicly traded company that

raised $7M for the exploration of the concession and development of the plans by selling 7 million units of stock at $1 each. The project enjoys an additional advantage: a 138kV single circuit overhead transmission line is located near the property, enabling Polaris to divert the main grid via a double pole circuit line to the power station to be built on the project site. This arrangement provides two separate connections to the national power grid at a distance of 13 kilometers (Fraser Mackenzie, 2004).

Nicaragua should facilitate investment of this sort by ensuring the country remains an attractive country in which to invest financial resources. That means adhering to the rule of law, ensuring policies are confiscatory to foreign nationals, and respecting the court system. The Bolaños administration has shown itself to be extremely willing to provide this kind of investment climate, but Ortega's Sandinista roots provide grounds for suspicion. One of the Sandinista government's earliest acts was to confiscate foreign-owned businesses and properties, some of which are still being contested today. Ortega himself lives in a house in Managua that was confiscated from an American in 1979. His rhetoric about eliminating privatization of national resources does not bode well for the investment climate in Nicaragua on the whole.

An important part of development projects of this nature is the financing of such large-scale endeavors. In the case of San Jacinto-Tizate, the project is backed by a 20 year take-or-pay power purchase agreement (PPA) at US$0.0595/kWh. The contract is subject to minor rate increases on the basis of US inflation. This kind of agreement is essential to the further development of geothermal resources by foreign companies, and the Nicaraguan government must be prepared to extend other PPAs to companies that consider investing in this resource.

Research performed by Management Science Associates (MSA) indicates that the policy structure for commercialization of renewable energy – and geothermal energy in

particular – in its current form is not amenable to significant private investment in geothermal resources for three reasons. First, current energy policy requires energy distributors to solicit competitive bids from potential new suppliers. This process requires bilateral negotiation under the regulatory supervision of INE, which is an inappropriate policy when trying to encourage the development of specific resources. Second, the primary purchaser of energy in Nicaragua is Unión Fenosa, which has little capital available with which to provide credit. These financial and political constraints lead to the third issue: any developer of the geothermal resources will also be forced to provide the interconnection from the facility to the grid, which represents a substantial increased investment of capital in order to commercialize the new energy sources (Saiger, 2005).

Encouraging further growth in the geothermal sector therefore requires some sort of mechanism for assuring developers the energy will be purchased. Under traditional PPAs, the risks inherent in operating a power plant belong to the operator, the project lender (typically an external bank), as well as involved insurance agencies. But Union Fenosa's financial weakness precludes it from being able to offer this sort of guarantee. The Nicaraguan government would have to be the institution to provide a guarantee – to support the financial performance of Unión Fenosa and assure fair treatment of the project under normal government regulation. For the Nicaraguan government to take on the burden of that risk may make additional private sector development feasible. However, Nicaragua's ability to assume additional debt burden is limited by existing agreements with the IMF and the Poverty Reduction and Growth Plan (PRGP) that has placed restrictions on the Nicaraguan government's fiscal accounts. The first step then is to renegotiate an arrangement with the IMF to permit such a financial arrangement, and then proceed to guarantee Unión Fenosa's financial performance in order to encourage the

development of additional geothermal facilities. That done, the government should establish solicit bids and award concessions to private sector companies willing to develop geothermal power plants.

The concessions should establish several things: a minimum time period during which the entity will provide geothermal power, a fixed rate for purchase of the power, and a minimum level of infrastructure development the investing company will be required to provide. In exchange for the financial support of Unión Fenosa, the concessions should also require Unión Fenosa to provide the infrastructure necessary for the geothermal power companies to transmit their power to the national grid. In the case that the distance requires an investment that surpasses an established limit, Unión Fenosa and the geothermal concession company should be required to split the expenses between them, as established by the terms of the concession.

It is clear however that domestic consensus for reforms and the continued implementation of sound policies could be weakened by further politicization of government institutions and the strife expected as a result of the November 2005 presidential elections. The Bolaños administration is embattled and continues to be challenged by high debt, a weak banking sector, and growing popular opposition to privatization as a result of the populist rhetoric of Daniel Ortega.

The Bolaños administration should make an unequivocal effort to reach out to the people to bolster popular support for private investment in Nicaragua's energy infrastructure. Recent protests in April 2005 make this an excellent time to draw attention to the nation's energy needs and press for more foreign investment. Bolaños has at his disposal a bevy of public speaking opportunities, as well as a weekly radio address in which he addresses the people directly. Bolaños should take immediate advantage of these opportunities to raise the profile of the

current energy problems Nicaragua is facing, and explain what private investment means to a country that has limited financial resources of its own. Ortega's message resonates among the disadvantaged sector of Nicaragua because it is simple and sounds good to a mostly undeducated and increasingly nationalistic populace. Bolaños and his staff should repeat these messages at every opportunity possible to clarify the possible damage Ortega's easily-quoted but poorly-rationalized "no privatization" rhetoric would mean to the country. As weakening popular support for Ortega is amenable to Bolaños' existing political strategy, it would be in his interest to do so. By improving the people's support for foreign investment, the Bolaños administration facilitates the real possibility of alleviating existing sources of social tension, including rising oil prices, rising transportation fares, and rising utility bills for consumer households.

B. Strengthen Government Fiscal Accounts

Provided private enterprise is prevented from investing in energy projects due to political developments, the Nicaraguan government will be forced to look at financing such endeavors itself. And if the government is going to offer financial guarantees to potential investors it will need additional sources of revenue. But strengthening Nicaragua's other financial institutions will be an important element of energy policy anyway, as additional financial resources will enable the Nicaraguan government to provide tax breaks elsewhere to encourage adoption of other technologies. So a big step in providing additional financial resources for the energy sector is to provide tax revenue. Nicaragua must modernize its tax code in order to promote compliance by tax-payers and strengthen the government's institutional ability to determine and collect tax liabilities. The improved tax code should outline an effective regime for imposing penalties and sanctions for failure to pay taxes, establish administrative procedures for tax

collection, and identify clearly what actions lead to a tax liability. The absence of these activities at present has led to a greatly reduced source of revenue for the government, and high costs involved in obtaining that revenue (The International Monetary Fund, 2004 pg. 17).

C. Promote Rural Electrification and Alternative Fuels

To reduce dependence on biomass fuel sources in the countryside and thereby reduce the risk of deforestation and its associated environmental impacts, it is necessary to promote increased rural electrification while simultaneously providing alternative fuel sources for those who are willing and able to use them. Rural electrification is presently inhibited by political concerns, not technical ones.

One cause for limited penetration of the electricity grid into Nicaragua's rural interior is the weak financial situation of Unión Fenosa, which has been limited by a rate structure that includes various cross subsidies within categories (from bigger customers to smaller) and across categories (residential, commercial, and industry specific groups) which has resulted in inefficient consumption by consumers that use less electricity and provides less revenue to the distributor. The first step then is to rework the tariff structure despite the political cost of doing so in order to provide Unión Fenosa Nicaragua with the financial resources necessary to encourage expansion of the grid. Where it is desirable to implement a rural electrification program that reaches poor rural customers, it is more appropriate for the Nicaraguan government to introduce a direct subsidy rather than an inefficient, indirect subsidy through the tariff structure that distorts economic behavior. If the regulatory body – the superintendent appointed by the National Assembly, if that issue hasn't been dealt with, or INE otherwise – rearchitects the tariff structure, Unión Fenosa will be more able to actively look for rural consumers. The Nicaraguan government should also pass a law mandating meters for all

energy consumers big and small and provide penalties for those consumers that damage or disconnect meters or are found guilty in a court of having misreported their energy usage. While Unión Fenosa already meters energy usage, strong penalties and mandatory meter usage reinforces the distributor's ability to collect for services rendered.

In the meantime, it is important to both stem the rapid deforestation and provide alternatives to wood for fuel sources in the countryside. The Nicaraguan government in association with various international NGOs has already made a good start at encouraging reforestation programs, but more work can be done here. The hardwood species Neem (*Azadirachta indica/ Melia azadirachta*) was introduced in the mid-1990s from India, and has shown itself to be appropriate for large- and small-scale reforestation projects. It grows extraordinarily quickly, uses less water than some native species, and can be propagated at little- to no-cost by cutting smaller branches and inserting the lower end into a bag of soil, causing the branch to grow roots and develop into a new plant. The berries have medicinal value as antibiotics, and the extract can be used as a form of natural pest control. Neem provides lots of shade and only sheds its leaves under extreme heat duress, and seems to thrive in the Nicaraguan climate. Several NGOs have helped promote the planting of this tree on denuded hillsides in the north and east, along stream banks to protect watersheds, and more. But for the purposes of the energy sector, its principal contribution is the rapid production of lots of firewood.

To continue encouraging the planting of this valuable wood species the Nicaraguan government should provide an economic incentive to rural farmers, but because the national government already provides very little to farmers in the way of subsidies or services, this is not easy. One way of reaching out to the rural areas is through the children, who receive classes in

state-run schools, even in the most rural areas. The Nicaraguan government can easily leverage its network of elementary school and high school teachers to promote the development of wood lots, simply by requiring every student to plant 100 saplings on his own property before being permitted to advance to the next level. This policy will dovetail nicely with existing environmental education programs, some of which are co-sponsored by USAID and other international donors. Because the trees can be reproduced at little cost, this will not present a financial burden on the poor families, and because each student plants the trees on his family's own property – or a property chosen by the family – an additional incentive exists for the student to do the work well. The government has little leverage over the adults, most of whom are already burdened with the difficulties of subsistence farming or household chores and livestock, which makes targeting the school kids a more effective strategy. Lastly, graduating high school seniors are obliged to perform 60 hours of community service. The national government can declare that in lieu of 60 hours the student can plant 600 saplings instead. The burgeoning student population will ensure that leads to the provision of more abundant wood resources.

Encouraging the use of alternative fuels in rural Nicaragua is a tremendous challenge. Most families lack the financial resources to purchase bottled fuels, and transportation rules prevent them from carrying bottled gas containers on the bus anyway. A more effective strategy is to encourage the use of bio-digesters, which consist of covered pits in which organic residues – especially manure – are fermented to produce methane gas, which can be easily piped into kitchens for cooking. The amount of capital investment in a biodigester is no more than the cost of a couple yards of black plastic and a length of plastic tubing; the rest consists of digging the hole and sealing the edges effectively. While the growing scarcity of wood as a fuel source should provide an additional incentive, the Nicaraguan government can provide small

farm or food subsidies in exchange for the construction and use of these bio-digesters. For example, the government can provide PL-480 (food for work) commodities such as flour and soybeans to families that participate in the bio-digester program. Existing PL-480 programs provide similar incentives, and USAID could easily be persuaded by the Minister of external assistance to request PL-480 funds for this initiative. As existing USAID programs aim to mitigate the risk of deforestation they would not require much convincing to support the program. The nation's national INTA program (Instituto de Tecnología Agraria) is the right institution to promote this policy in rural areas. INTA technicians work from day to day with rural farmers providing training in integrated pest management, soil conservation, and crop rotation, among other topics. A policy that integrates these technicians into the food-for-biodigester program would be a low-cost and effective way to promote the use of this technology. And because once implemented the technology serves as an example to families that have not participated in the program, the combined impact of less work (fuel gathering takes an inordinate amount of time for rural farmers) and easier fuel should serve as a good stimulus for non-believers to join the program, whether there's free PL-480 food involved or not.

Finally, INTA has already promoted the use of more efficient wood burning stoves that consist of baked clay receptacles into which the fire wood is inserted along one side, and holes on the top surface on which the pots are set. This arrangement concentrates the heat and retards the burning of the fire wood, which leads to improved efficiency of fire wood use. The stoves require nothing more than clay which can be acquired locally, and the expertise to construct them. If Nicaragua decides to press the use of these ovens it should make use of its INTA staff, perhaps implementing an incentive system with rewards for those technicians and extensionists that help the most families convert to the use of these new stoves. This is a low

cost-high impact project that is easily implemented.

D. Improve Efficiency of the Transportation Sector

The transportation sector is critical to Nicaragua's being able to reduce its dependence on imported hydrocarbons because such a high proportion of fuel imports are used in this sector. Fortunately, modernizing the transportation sector is the policy goal the Nicaraguan goal has shown itself most capable of accomplishing. And because the transport sector is so highly dependent on petroleum, the cost of which is rising steadily, modernizing this sector is crucial to meet the nation's goal of reducing national dependence on petroleum. In doing so, the government could alleviate some of the social tension caused by a populace addicted to petroleum but unwilling to endure high prices to purchase it.

Over a period of two weeks, the celebrated "Plan Chatarra" (chatarra means "junk metal") cracked down on the dilapidated, out of repair vehicles operated on Managua streets. During the crack down, the national police stopped and ticketed the owners of vehicles that appeared not to meet minimum safety requirements, were missing lights, had bald tires, or similar. The plan was hailed as wildly successful at forcing vehicle owners to invest in the repair of their vehicles, and earned money for the police force as well. Although it was an operation conducted by the national police, the effort was concentrated mainly in the capital, where the incidence of dilapidated vehicles is the highest, and where potential revenues were the highest as well.

Ideally, the government could make changes to the transport sector in a two stage process in which first, existing vehicles were forced to meet efficiency standards and import restrictions were placed on new or used vehicles entering the market. In the second stage – 10 years from now, for example – the nation could make the change to a cleaner fuel like CNG or

methanol.

The first step is forcing old, inefficient vehicles off the road. Fortunately little policy is needed for this to happen; rising diesel and gasoline prices alone will help to accomplish that. But to ensure those old vehicles are replaced with something more efficient, the national government should enact vehicle registration and inspection laws that require every vehicle newer than 10 years to be inspected annually and meet minimum performance criteria to be permitted to continue circulating. The same regulations should prohibit the import of any vehicle that does not currently meet the same criteria. Families from overseas repatriating their vehicles to Nicaragua should not be exempt from this requirement.

Buses are currently operated through cooperatives, who purchase the right to a route concession. Free-lance buses are not permitted. The government should leverage this situation to ensure buses meet efficiency criteria as well: for a concession to be renewed, all buses in the cooperative that will operate on the streets must meet fuel efficiency criteria. To avoid the loss in efficiency due to overloaded vehicles, city police who are currently stationed at bus terminals should be employed to monitor the cargo limit of incoming and outgoing buses, and fine bus operators as appropriate for overloaded vehicles. While a more efficient measure would be the installation of scales at all terminals, simply using existing police presence is a stop-gap measure that requires no investment.

Managua, the capital, suffers more from vehicular congestion than any other part of the nation. Roads are gridlocked twice a day, and the constraints of the street layout and the way the city developed (organically) preclude easy solutions to the traffic problem. City buses are dangerous, overloaded, slow, and uncomfortable. Robbery and pick-pocketing on board is common. Managuans use taxis whenever possible for safety reasons. Because Managua is

home to over half of the vehicles in the country, this one city is important to a national strategy to reduce dependence on petroleum even though the policies must be put in place at the city level. One mechanism to encourage the governor of Managua to implement policies of this nature is to provide federal funding for city projects. Managua desperately needs money for improvements to its three principal open air markets, for example. The Bolaños administration could offer to help fund capital improvements in that area (funding it through the sale of government bonds, or by negotiating with an international lender) in exchange for support towards a plan to reduce the incidence of vehicles in Managua. Dionisis Marenco, the mayor of Managua (barring political sparring; he is from the opposition Sandinista party, and may have reason to resist national policy directives in an effort to weaken Bolaños) should then proceed with the following:

With four months of lead time, Marenco should open new concessions for city bus routes. There are more bus owners than concessions, so demand for the concessions is high. As an incentive to draw in the working class, 10% of the concessions should be for luxury "middle class" buses which will consist of luxury microbuses with air conditioning etc. and the right to charge a higher fare. Provided the higher fare is cheaper than the average Managua commuter's taxi fare, demand for this kind of route will be high.

The existing bus concessions will strike in response to a reduction in their oligopoly power, as they always do. Marenco can force the strike to a conclusion by both threatening to revoke concessions of strikers (as he's already soliciting new concessions, it won't be hard to solicit a couple more) or by forcing all strikers' vehicles in for immediate safety check-ups – this threat should be clear enough to strike home. With additional buses on the road, Marenco should implement a plan that prohibits certain vehicles on the road during certain times. A

similar plan is already in place for taxis, so this is merely the extension of an existing policy to a broader sector of vehicular traffic. A prohibition could be “if the calendar date is even, only even-plated vehicles can circulate between 5-11 AM and 5-7PM; similar for odd calendar dates”). During those hours, the right lane of all Managua thoroughfares should be devoted soley to bus traffic. The combination of increased bus availability and vehicular prohibitions should decrease the amount of vehicular traffic and therefore the demand for petroleum. The most affected will be the politically-powerful wealthy class, which means real political strength will be necessary to bring this plan to completion.

At a nationwide level, the Bolaños government should implement a vehicle ownership tax in the form of an annual registration, to supplement fees earned from inspections, and tickets to buses that travel overloaded or operate without the proper inspection sticker, and vehicles that circulate on days their even/odd numbered plates do not permit them to. The sum of all these mechanisms should provide a decent source of revenue for the Bolaños government and the city of Managua with which they can finance some or all of phase II.

Phase II, to be implemented over ten years, will require several simultaneous elements: the introduction of improved fuels like CNG (compressed natural gas), the development of filling stations that can provide it, and the introduction of vehicles equipped to use it. All can be achieved through tax and tariff incentives, and market forces will do the rest. The modification of existing gasoline pumping stations so that they can distribute CNG and the import of CNG into the country should happen close to simultaneously. Texaco, Exxon, Shell, and BP (British Petroleum) all operate pumping franchises in Nicaragua, so these are the companies that should be targeted.

The Bolaños administration should announce publicly that all government vehicles – the

fleet numbers around 400 vehicles – will be retrofitted to run CNG within 18 months. It should simultaneously offer both a tax break and a government purchasing-agreement to the distribution company that is able to retrofit its existing filling stations with CNG pumps for the lowest price. That company will win as an incentive, the exclusive contract for fueling all government vehicles for the next two years, plus a one-time tax exemption on imported materials to facilitate the construction of the additional tanks and installation of the new pumps. The CNG can be acquired from Venezuela or Mexico, both of whom are trading partners of Nicaragua. The government should negotiate a blanket purchase agreement with the nation that provides the lower price for a 5 year purchase agreement. That will ensure the fuel is made available to the Nicaraguan market, and the government vehicle retrofits will ensure there is demand for the fuel.

Once the framework described above is put in place, the Nicaraguan government should establish a tariff structure that gradually but steadily increases the price of traditional diesel and gasoline while exempting CNG from the tariff. The government should simultaneously offer a tax incentive for taxis and buses that want to retrofit their vehicles to run on CNG: the national government will provide three year loans at 1% interest to any vehicle owner that uses the money to retrofit an existing vehicle. The funds for the retrofit-loans can come from the fines earned from the activities mentioned above in this section. After a one year period, the program will be open to any vehicle owner that wants to take advantage of the relatively cheaper CNG available on the market.

The retrofitting requires specialized mechanics, of whom Bolivia and Italy both have a number available. The Nicaraguan government can develop a training program for Nicaraguan mechanics with World Bank or bilateral funding from a donor like USAID. Donor agencies are

especially fond of programs of this nature. If the Nicaraguan government sponsors a month of workshops, it can successfully train the mechanics, some of whom can be hired by the government to service the fleet of government vehicles. The training can utilize government vehicles for practice, as these Nicaraguan mechanics will need to practice to gain experience before they open up their own shops or offer the retrofit service to the public.

A similar tariff structure should be imposed on imported vehicles. Any vehicle imported into the country will be assessed a higher import duty if it has a gasoline or diesel engine, and a lower – or zero – duty if it runs on CNG. At the end of approximately 6 years, Nicaragua will have trained mechanics, CNG available on the market, an incentive for distributors to sell it, and incentives for vehicle owners to choose it for their vehicles.

This program would be vastly improved if Nicaragua could work with its neighboring countries to implement such policies in a coordinated, regional manner. The most appropriate policies for this approach would be the blanket purchase agreement for CNG from Mexico/ Venezuela, the import tariffs, and the fuel tariffs. The last item requires special regional coordination to prevent entrepreneurs from black marketing diesel fuel or gasoline over national borders in response to the differential in price. While Central American nations have traditionally been unwilling or unable to coordinate policy with much effectiveness, the revenues from diesel and gasoline tariffs might be an incentive for them to work together. Furthermore, all Central American nations suffer from similar challenges in the transportation sector, so the policy solutions should be applicable to Costa Rica, Honduras, and El Salvador equally.

E. Increase Efficiency of Production and Distribution

The dilapidated condition of much of Nicaragua's energy-provision infrastructure, and the high losses that occur between production and consumption of energy resources is the last

link in reducing Nicaragua's financial burden due to increasing petroleum costs.

Unión Fenosa recommends reducing national use of the Managua and Nicaragua thermal plants, whose capital equipment is nearly 20 years old and is the least efficient but most intensely-used equipment in the nation (Unión Fenosa, 2005). Providing a tax break for expanded production capacity at the Empresa Energética Corinto and Monterosa power plants, while not contributing to the expansion of alternative fuel sources (they are both hydrocarbon burners), would at least provide for a more efficient production of electricity in the short term while geothermal alternatives are developed. Strengthening Unión Fenosa financially using the mechanisms outlined above would provide the distributor more capital to invest in improving existing equipment. Passing a law that privatizes ENTRESA would provide a similar stimulus for the transmission network. Politically this would be very difficult to achieve. But assuming the political challenge can be overcome, privatizing the transmission network should be done in the context of a contract that forces the purchasing company to reduce line losses along the transmission network by a fixed percentage, and provide a short-term (5 year) tax break to incentivate capital improvements throughout the system. Similar clauses have been inserted in the contract with Ormat for the existing geothermal plant at Momotombo, indicating this is a feasible policy choice.

This is an appropriate point in which to encourage further co-generation by providing additional tax breaks for the nation's few industries that have the capacity to generate electricity while engaging in their traditional activity: rice growers burning bagasse and organic debris could easily build bio-digesters at a larger scale than the casual rural farmer, and the Pellas family in Chichigalpa could be encouraged to generate more energy than they already do. The electricity market has already been deregulated to the point where Unión Fenosa can purchase

power from independent producers like these. A targeted conference to which major industry participants were invited to hear more about the possibility for revenue generation by selling electricity to the grid would be necessary to effectively reach out to these groups.

In regards to the S.I.N., it's just political will that has prevented a more extensive linkage of the energy production networks of the Central American neighbors. But participating in the S.I.N. is clearly an effective way to improve the efficiency of the system. Should the Nicaraguan government pass a law mandating full connection to the S.I.N. by a certain date it would make available additional energy resources at market prices to the entire nation. This can help provide additional energy when Nicaragua's ability to produce is low, but also introduces much-needed competition into the national system. In a de-regulated market, if the Costa Ricans can provide energy at a lower price due to a more efficient production process, Unión Fenosa will have the ability to purchase it in lieu of the more expensive and less-efficient Nicaraguan producers. This should spur the existing producers to improve their facilities in order to remain competitive in the market. While 10 years of civil war reduced prevented wide-scale investment in energy-production equipment, in the 15 years since, lack of competition in the market has allowed inefficient producers to continue without upgrading their facilities. Promoting better connections through the regional network would be a big step forward in pressing for more efficient production of energy.

This is far from a comprehensive list of ways to make Nicaragua more energy efficient and reduce the national dependence on costly imported petroleum, but it addresses some of the main areas in which significant change can be made. Every single issue requires strong poltiical will however, which may be absent in the current political context and less so as a result of the November presidential elections. But a clear vision for the nation's future and the political

clout to see that those goals are met will go a long way to improving the lives of 5 million very needy people.

Appendices

A. Photo Documentation

Picture 2: Most agriculture is not capital intensive and uses few energy resources

Picture 3: Nicaragua's transportation system relies on old buses

Picture 4: Firewood is the main fuel source in the countryside

Picture 5: Free Trade Zones employ 58,000 in light manufacturing

Picture 6: Methane bio-digesters are an excellent alternative to wood

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