CUBA'S POWER SECTOR: 1998–2008

Manuel Cereijo

The last decade has been one of mixed results for the Cuban electrical power system. From 1998 to approximately 2004, some progress was made. However, the reliance on domestic oil as fuel and the age of several units produced breakdowns in some of the major plants and an overall crisis in the system. The Cuban government has attempted to address the problems of the industry by purchasing and installing a network of small diesel and fuel oil generating plants.

This paper, which is extracted from a larger study prepared by the author, deals with selected issues related to the Cuban power sector.[1] The first part analyzes Cuba's largest thermoelectric power plants. The second part describes the system of small diesel and fuel oil plants that has been created in the last few years, while the third part does the same with respect to other power generation facilities. The fourth part describes the electricity distribution system and the fifth the structure of electricity tariffs.

MAIN POWER PLANTS

Unión Eléctrica (UE), Cuba's national power utility, encompasses 17 plants of 33, 50, 64, 100, 125, 158, 250, and 330 megawatts (MW) generating capacity. It also brings together other companies such as provincial distribution companies, maintenance and construction companies, and consulting firms. The present installed capacity of the system, in round numbers, is 3,000 MW. Generation capacity is distributed as follows: thermoelectric plants, 84%; combined cycle plants, 12%; gas, 0.5%; diesel, 1.5%, others, 2%. The UE's main thermoelectric plants, i.e., those with capacity over 50 MW, are analyzed below.

Antonio Maceo (formerly Renté)

The Antonio Maceo plant is located in the Renté Peninsula, west of Santiago de Cuba, by the bay. It is of Soviet technology. Installed capacity is 450 MW, in 3 units of 100 MW and 1 of 150 MW. Before 1998, it had a capacity of 300 MW, with 2 units of 50 MW, and 2 units of 100 MW, of the STG type. The plant employs approximately 240 workers. Three of the units were modernized in 2001 because of technical deficiencies and high consumption of fuel oil. The fourth unit was modernized in 2005. The plant has faced problems with water supply. Several water wells have been drilled in the last few years, but water problems persist.

The original Renté power plant (Units 1 and 2) was built in 1966 with Soviet equipment. In 1978–79, Units 3 and 4 were added, followed by Units 5 and 6 in 1983–84, all of Soviet technology. These units have had a history of breakdowns and by 1989, only 4 of the units were in working condition. In spite of enormous efforts, presently only 5 of the 6 units are working. The main vapor lines (MVL) in the 100 MW units have had mechanical fractures, and the power plant is working presently at 65% of installed capacity. The main vapor lines have an average length of 70 meters and even though should work for 100,000 hours with no breakages, fissures have developed.

1. Manuel Cereijo, *Republic of Cuba: Power Sector Infrastructure Assessment* (August 2008). The full study contains extensive statistical data on Unión Eléctrica. It is available at http://www.a-i-c.org/.

The use of the domestic fuel oil has contributed to the breakdown of some of the units. Some other factors have been:

- Low caloric power of domestic fuel oil in comparison with imported fuel oil (e.g., Russian fuel oil).
- Increase in the ashes on the low temperature zones, which requires a larger effort by the fans, less heat transfer, and an increase in the zone temperature.
- Corrosion of the boilers.
- Poor mixing with other fuels.
- Increment of sulphur and oxidants in the system.
- Higher water percentage, increasing the humidity of the combustion gases.

In the last 6 years, there has been an investment of 80 million Euros in the modernization and maintenance of the Antonio Maceo Plant.

Antonio Guiteras

The Antonio Guiteras plant, located in Matanzas, has 4 units, two of Japanese technology and the other two of Czech technology, for a total of 330 MW. It operates presently as a one unit block. It was the most efficient of all Cuba's power plants with regard to consumption of fuel to produce electricity and the one with the lowest operating costs. It has the advantage that it receives fuel oil from an oil duct only 4 Kilometers long. The units were finished in March 1988; however, due to testing, calibration, and warranty tests, the plant did not start operation until January 1989. The cost to build the plant was $450 million dollars. It employs approximately 100 workers.

The Antonio Guiteras power plant was modernized in 2002 to allow the use of domestic fuel. This retrofitting work was expected to last only two months, but it took seven months to complete. Since that time, the plant has operated very unstably and only up to 65% of total capacity.

In May 2004, the plant was shut down for maintenance, and many difficulties arose, among them, problems with pressure and temperature. The turbines were damaged. (The axis had a 1.9 mm bent, which did not allow the turbine to operate.) For many years, the plant has worked at an average generating capacity of 65% (of its installed capacity of 330 MW), which makes the real cost of the plant very high.

From 2004 to 2008, the plant operated very inefficiently, with several shut downs due to damage to equipment, problems with maintenance operation, and start-up instability. It continues to operate at an average of 60% of installed capacity. Every time that the Antonio Guiteras plant is down, it produces a total unbalance on Cuba's electric energy system due to the poor interconnection of the grid and control equipment.

Lidio Ramón Pérez

This power plant is located in Felton, near Holguín, approximately 800 Kms from La Habana. It is the largest in the system. It has two units of 250 MW each, for a total installed capacity of 500 MW. It was built between 1996 and 2000, with the first unit starting service in 1996 and the second unit in 2000. The Lidio Ramón Pérez plant is very efficient, using 255 grams of fuel to produce one Kilowatt-Hour (KWH). Recently, the plant has gone through changes and modifications to be able to use domestic fuel. It employs approximately 140 workers.

As it is common with Cuba's power generation units, the Lidio Ramón Pérez plant has incurred damages during its period of operation. Unit 1 underwent a major modification in 2007 to improve earlier repairs done to convert it to the use of domestic fuel. Originally programmed to take 60 days, the repairs were still ongoing during the summer of 2008. The plan was to repair the air heaters and replace part of the MVLs. However, damages were detected on the coils of the generating units, which meant a major repair job. It was also necessary to provide maintenance to the rotor and the sealed hydrogen system. They are also improving the control system of the plant. There are some 700 workers assigned to this job, from several units of the Empresa de Mantenimiento de Centrales Eléctricas from Santiago de Cuba, Camagüey, and La Habana. They are working 24 hours/day, in 12–hour shifts. This is the most complex job ever performed at a power plant in Cuba. The complete job is not supposed to end until at least August 2008.

Meanwhile, Unit 2 continues to generate electricity, however at a capacity of 65%. It also needs to undergo maintenance and repair, which will have to wait until Unit 1 is on line. Therefore, although the plant has

500 MW installed capacity, it is generating only approximately 150 MW.

Máximo Gómez

Construction on this thermoelectric plant, located in Mariel, started in the mid-1960s. It was designed for an installed capacity of 600 MW. Presently, it has an installed capacity of 450 MW, with 4 units of 100 MW each and 1 of 50 MW. All the units are of Soviet technology, steam turbo generators. Some of the plant's original 8 units have been retired. At present, it has a generating capacity of 320MW. It employs approximately 320 workers.

The Máximo Gómez plant is very inefficient. Each of its 100 MW units consumes approximately 200,000 tons of fuel oil per year (about 320 grams per KWH). Unit 6 was the first one to modified to be able to use domestic oil. The results were not effective.

In 2005 a huge investment was made at this power plant, modernizing Units 5, 7, and 8, improving their control system, and reconstructing their MVLs. In 2006, Unit 6 was also modernized. A large portion of the modernization work has been the installation of very expensive on-line systems for the monitoring and analysis of the vibrations in the generating equipment. For example, the installation of a monitored on-line vibrocontrol 1100, which uses a software module Vibroexpert CM-400. In some units, they have installed eddy current transducers, as well as seismic transducers.

Other improvements have been in proximity and accelerometer sensors to measure phase. A multi-channel system, ADRE, for the diagnostic of rotors, with 8 channels has also been installed. In spite of the work done, since 2005 to present, with an investment around $50 million dollars, the plant is working at 57% capacity.

As will be discussed below, as part of the new approach (Grupos Electrógenos) of installing small generating units along key points in the country, the government has installed 11 small fuel oil units at the site of the Máximo Gómez plant, for a total of 147 MW. Each of the units weighs approximately 300 tons. The total investment for the units on this site has been $125 million.

10 de Octubre

The 10 de Octubre plant, located in Nuevitas, has technology from the former Czechoslovakia. Completed in 1969, it has four units: 1 unit of 64 MW and 3 units of 125MW each. Installed capacity is 503 MW. Generating capacity is 400 MW. The boilers malfunctioned from the beginning. The four units were modernized between 1998 and 2006, at a cost of $80 million dollars. The plant employs approximately 250 workers.

Units 4 and 5 have a long history of breakdowns due to damages in the air heaters, as well as in the pumps. All problems have been due to technical deficiencies of the equipment. The plant has also problems with the MVLs, which have an average length of 80 meters. The plant lacks of a good control and instrumentation system. Presently, the plant's condition is poor, operating at 65% of capacity.

Carlos Manuel de Céspedes

Located in Cienfuegos, the equipment of this power plant is of Japanese technology, later modified with French technology. It was built in the early 1980s. It has four units, 2 units of 33MW and 2 of 158 MW, with an installed capacity of 382 MW. The present generating capacity is 215 MW or 57% of installed capacity. It is supposed to provide 13% of the total energy for the country. It employs approximately 300 workers.

The plant has undergone several modifications in the last 4 years, including changes to make possible to use domestic fuel, for a total investment of $60 million dollars. Consumption is around 260 grams of fuel per KWH.

The plant's control system has been recently modernized (it had been modernized years before with French technology) and includes a digitized distributed control system. The plant has used 1 million tons of crude oil in the last 3 years, of which 65% was domestic oil. Presently, Unit 4 is undergoing maintenance and repairs, including the exchange of 23 coils in the boiler, the assembly of a new monitoring system in the turbine and huge repairs in ancillary equipment. The turbine, ventilators, the MVLs, and other equipment and attachments are also under rehabilitation. The work is being performed by power plant repair brigades from

La Habana, Matanzas, Santiago de Cuba, Camagüey, and Cienfuegos from the Empresa de Mantenimiento a Centrales Termoeléctricas (EMCE) as well as other workers from the Ministry of Construction. There are a total of 450 workers involved. The work being done so far has lasted 240 days. Once the work in this unit is finished, there are plans to start maintenance of Unit 2, which has a generating capacity of 33 MW.

Este de La Habana

Located in Santa Cruz del Norte, the Este de la Habana power plant is the most recent of the large power plants, built in 1989–1995. It uses Soviet/Russian technology. The plant has 3 units of 100 MW each, for a total installed capacity of 300 MW. At the time of preparing this report (Summer 2008), generating capacity was 170 MW, that is, 57% of installed capacity. The plant employs approximately 150 workers.

Two of the units were modified in 2005 to make them able to use domestic fuel oil, as well as natural gas. These changes made it possible to save 70,000 tons of imported oil per year. In Unit 1, eight burners were replaced to allow the use of domestic fuel and gas. Investments from 2005 to 2008 have been the highest for a power plant in Cuba. Only 2 of the units have been modernized to date. A third unit is presently not generating power. The plant has had problems with heat exchangers, boilers, and pressure vessels.

DISTRIBUTED GENERATION (GRUPOS ELECTRÓGENOS)

Since 2005, the Cuban government has purchased several thousand small generators, of 2MW or higher generating capacity, from South Korea (Hyundai), Germany (Daimler Benz), and Spain (Guascor). The investment through 2008 has been approximately $1,200 million dollars. These small generators are referred to as Grupos Electrógenos. They have been located in 116 of the 169 municipalities of the island.

Chronic blackouts and decaying energy infrastructure led Fidel Castro to declare an "energy revolution" on January 17, 2006. Through a combination of stringent conservation, increased efficiency, price hikes on electricity to household consumers, new generating plants, and recent oil and gas discoveries, Cuba is seeking to improve its energy situation. At the direction of the government, many households are replacing old, inefficient appliances with energy-saving fans, rice cookers, and refrigerators. Smaller electric generating plants are also gradually being built throughout Cuba, supplanting large old power plants that have suffered chronic breakdowns due to years of operation on heavy Cuban oil.

The small generators initially purchased used diesel as fuel, but lately the equipment uses fuel oil. They are installed in groups, depending on the desired output, and the groups are referred to as "batteries." The objective is to provide power to locations close to the "battery" to minimize transmission losses. The units within a "battery" have start and stop control systems, according to the load demands, to increase efficiency. There are numerous locations for these groups across the nation. A few examples are:

- The Moa group, with an installed capacity of 174.6 MW, located in Punta Gorda, Moa. It has 20 units, each of 8.73 MW. It uses fuel oil. Total investment: $60 million.
- The Manatí group, near La Calera, Las Tunas. It uses diesel fuel.
- The Camagüey group, located north of the city of Camagüey. It uses fuel oil. The main loads for this group are the provincial hospital, the historic center of Camagüey, and the northern part of the city, where several industries are located.
- The Güines group, which uses fuel oil, with an installed capacity of 28 MW.
- The Cayo Largo del Sur group, in Cayo Largo del Sur, with an area of 37.5 square Kms, 177 kms from La Habana, and 135 kms from Nueva Gerona. Due to its special location, workers from different parts of the country were involved in the installation of the group. It consists of 4 units, each of 395 Kilowatts (KW), for a total of 5,600 KW. It uses fuel oil.
- The Mariel group, installed at the site of the Máximo Gómez power plant. It uses fuel oil, and has an installed capacity of 147.2 MW. The battery consists of 11 units. Total investment was $125 million. Its consumption is 250 grams per KWH.
- The Ciudad de La Habana group, 56 units, located in 14 different sites, uses diesel fuel. Total installed capacity of 85.6 MW.

- The Ciego de Avila group, with 24 units, uses fuel oil; it is rated at 40 MW installed capacity.

Investment in the diesel power generators (for 1,311 MW) is practically completed. They will supply all the needed electricity in the hours of highest demand. The 425 units using diesel fuel were the first to be installed. Presently, they are used in the groups using fuel oil, some only for the peak hours of operation. The total installed capacity for the Grupo Electrógeno is 1,500 MW. It is an expensive, not efficient, method to provide electricity in Cuba.

OTHER POWER GENERATION FACILITIES

Isla de la Juventud (Isla de Pinos)

Isla de la Juventud stands apart, because it is not connected to the main Cuban power grid. Isla de la Juventud's power generation in 2004 was as follows:

- Three units of 3.6 MW, MAN generators, using light fuel oil. Consumption of 220 g/KWH. They provide about 85% of the power generated.
- Five units of 400–500 KW, for a total of 2.2 MW, powered by Czech diesel generators, with over 200,000 hours of operation. Consumption is about 300g/KWH. They are presently used to cover peak demand. They generate about 5% of the total electricity generated. The diesel costs are approximately $360 dollars/ton.
- Eight 3.2 MW Russian diesel generators, with over 40,000 hours of use. Specific fuel consumption is 300g/KWH.

The older units have been retired or left as reserve units. Presently (2008) the power generation units, besides the units mentioned above, are:

- A 3.6 MW biomass gasifier plant to produce power on the island. Started in 2005, this was the first diesel-biomass hybrid installation in Cuba. It is an ongoing project with GEF and UNEP.
- A wind farm (1.5 MW) located on the North coast of the island, on Playa de la Bibijagua, where optimal wind conditions were found for producing electricity to be fed into Isla de la Juventud's main grid.
- Additional units (MAN generators) with gross power generation of 115 GWh.

A total investment of $50 million dollars was made from 2005 to 2008, including the biomass project, to increase the installed capacity of Isla de la Juventud. Maximum demand is around 20 MW, as follows: industrial, 17%; commercial, 22%; residential, 13%; agriculture, 13%; energy losses and public lighting, 11%.

Energas

Energas, S.A., is a joint venture between the Cuban state-owned companies Cupet and UE and Canadian corporation Sherritt International, established to promote the use of technologies capable of cleaning and processing natural gas. The Energas facilities are a small-scale showcase of the Cuban energy sector, exemplifying ecologically-friendly processes for the production of electricity to the national grid in partnership with a foreign firm that has been successful in creatively utilizing the existing oil reserves in a manner that promotes efficiency and, by all indications, has provided a sound return on investment for the joint venture.

At the time of this writing, Energas has an installed capacity of 395 MW in two projects, one at Varadero and the other at Boca de Jaruco. At the Varadero site, there is a 12 Km, 12–inch diameter gas pipeline, and a gas cleaning unit. These facilities allow the daily production of 60 tons of sulfur as well as 50 cubic meters of condensation. At Boca de Jaruco, the plant produces 45 million cubic meters per year.

Varadero Project: In 1997, Energas launched an ambitious project to convert flared gas from the Matanzas-Varadero oil fields into fuel through a combined cycle process. The project allowed Cuba to make use of the associated gas for power generation facilities in Varadero, for a total capacity of 173 MW.

The project was financed by an initial public offering (IPO) in Canada by Sherritt, and construction was completed in 2004. The process entails the removal of sulfur from the heavy crude of the region, utilizing the associated gas to fuel turbines. Environmentally, this process is much cleaner and allows the Cubans to capture emissions and particulates that were previously being discharged into the environment. This is especially critical as the Matanzas-Varadero oil fields are contiguous to Cuba's major tourist destination, the beaches of Varadero, located some 90 miles east of La

Habana. There are no tell-tale signs of oil production in this region to the tourist crowds owing to two factors: first, most of the offshore fields are accessed by slant and horizontal drilling techniques, behind and out of sight of the Varadero peninsula; and second, the thermo-electric generation stations are relatively distant from the tourist zone.

The Varadero Project involved retrofitting the three gas turbines (GTs) at the Energas Varadero electrical generating plant with a heat recovery steam generator (HRSG). The HRSG uses the heat in the exhaust from the gas turbines to produce high pressure steam that is used to power a steam turbine. If desirable the heat from the GTs can be enhanced by burning surplus gas in the HRSG boilers, increasing the heat available. The electric generator driven by the steam turbine produces about 75 MW of electric power.

Operational responsibility for the project activity is under the authority of the Varadero Plant Manager, who reports to Energas senior management. Sherritt International has been authorized by the shareholders of Energas S.A. to make the CDM application in respect of the Varadero project on behalf of Energas. Energas employees for the project activity and for other operations have benefited from training in the operation and maintenance of the facilities. Training is in areas of technology that are not generally available in Cuba and accreditation is earned to Canadian standards.

The Energas Varadero power plant has all required environmental licenses and permits in place. A baseline environmental study is carried out annually by Energas and from the verification of these reports it was confirmed that there no negative impacts are caused due to the implementation of the project. It was verified by international agencies that Energas has all the environmental control and monitoring equipment in place and maintain an environmental operating standards document for the management of the environmental procedures.

Boca de Jaruco Project: In Boca de Jaruco, 30 miles east of La Habana, Energas, S.A. has built a plant with a total capacity of 80MW, as an expansion to one of 33 MW, for a total of 113 MW. This plant is very close to the Este de La Habana thermoelectric plant, and only 30 miles east of La Habana. In June 2007, Energas, S.A. started the construction of a new combined cycle gas turbine, of 125MW at this facility, which is not finished yet. As mentioned before, the total investment that is planned by Sherritt, in oil, natural gas, nickel, and Energas, is $1.25 billion dollars.

TRANSMISSION AND DISTRIBUTION SYSTEM

Transmission and Distribution Lines

The National Electricity System is interconnected throughout the island by a transmission grid operating at 220/110 kV, with 2,833 kms of 220 kV and 4,188 kms of 110 kV. The distribution grid covers 95% of the island. Also used are lines of 33 kV, 13.8 kV, and 4.16 kV. There are 9,300 Kms of sub-transmission at 33 kV, 27,382 Kms of secondary distribution at 4.16 kV, and 34,540 kms of primary distribution at 13.8 kV. Transmission conductors are mostly ACSR 150 mm. The 33 kV lines are mounted in type H poles of 35' and 40' made of reinforced concrete (*hormigón*), or wood (mostly *eucalipto*). One of the causes for large losses is the poor technology used in the support used to mount the conductors.

In the 1970s and 1980s, the national line system was built, with a 220 kV line along the island and 110 kV in certain regions, like Pinar del Río. From La Habana to Santiago de Cuba, the system was connected with a 220 kV line. A serious mistake was made in the design of this system. The conductors were covered with heavy, dense grease, similar to vaseline. Cuba's hot weather crystallized this grease and penetrated the conductors, creating a corona effect, and producing large losses due also to reactive power.

The economic crisis did not allow for proper maintenance of transmission and distribution (T&D) lines. Half of them have been operating for over 25 years. Inadequate placement of power plants (i.e., long distances from consumption centers) required long power transfers, with resultant losses. Illegal connections to the electricity grid increased during the economic crisis, generating additional electricity losses (i.e., distribution losses).

There are over 6,000 metal towers for the 220 kV lines, distributed along 3,200 Kms. The 110 kV use Benetti-type towers, of which there are 2,210. A

chronic problem has been the theft of metal and parts—such as angular pieces, screws, nuts, bars—from the transmission line towers, with over 2,500 incidents in 2007. The theft includes the conductors; 40,500 meters were stolen in 2007.

The distribution network (primary and secondary lines) is 63, 500 kilometers long. Until 2006, the maintenance and replacement of these lines was very poor, with only preventive-type maintenance carried out. Since 2006, the government has replaced 121,546 poles, and 21,293 kms of transmission and distribution lines. So far, in 2008, they have replaced 960 kms of lines, and 5,700 poles. The distribution of lines is as follows: 85% for distribution, 5% for 220 kV, 7% for 110 kV, and 2% underground.

Transformers

Since 2006, the plant Latino, located in La Habana, has produced 21,000 transformers. This is the only plant in Cuba that produces these units. The plant has 225 workers. In terms of kVA, they have produced 432,103 kVA. They mainly produce for distribution voltages.

The plant is undergoing modifications, with an investment of $25 million. So far, in 2008, 1,500 new transformers and 180,000 breakers have been installed. In spite of this, the need just in La Habana is for four 220 kV substations and 325,000 more breakers.

Transformers made in the United States dating from the 1940s and 1950s are still being used. Unión Eléctrica has several plants to repair transformers. Transformers are imported from Skoda, Czech Republic; EFACE, Portugal; Hitachi and Toshiba, Japan; Russia; and most recently from China and from Inekom, Czech Republic.

The number of installed transformers nationwide is as follows: Sub 220 kV—50; Sub 110 kV—224; Sub 33 kV—3,059; Other sub—103; Distribution lines—106,818. The number of substations is as follows: 220 kV—22; 110 kV—109; 33 kV—2,258; and Others—79. Over 410 new trucks have been purchased from China's Great Wall brand for Unión Eléctrica to provide maintenance and carry out new installations through the electrical grid.

Investment in the transmission line sector, including the new trucks, has been $55 million in the last 2 years. In spite of these investments, the loss from the plants to the loads (in the range of 17% and higher) due to transmission line losses is much higher than it should be for a given generator power output. Also, the total time of interruption in the lines is still very high, around 700,000 hours per year. An approximate estimate of future cost investment to build transmission lines, based in 2012 costs, follows: 60,000 pesos/km for 13.8 kV voltages; 85,000 pesos/km for 110 kV; 105,000 pesos/km for 220 kV; 63,000 pesos/km for 33 kV; 11,000 pesos/km for 4.16 kV. These costs assume, among others, the following conditions: urban areas, construction in a 140 mph wind zone, accessible areas, transmission structures, no fiber optics, no environmental concerns, minimal site restoration, no sidewalk repairs.

Immediately after a transition period, the following investment will be needed: (a) 150 kms of 110 kV lines; (b) 200 kms of 220 kV lines; (c) 500 kms of 33 kV lines; (d) 750 kms of 13.8 kV lines; (e) 1,200 kms of 4.16 kV lines; and (f) 900 kms of lines for homes/industries.

STRUCTURE OF ELECTRICITY TARIFFS

Cuba's electricity tariffs vary with respect to the customers being served. Cuban homes, the public sector, agricultural businesses, and the sector of industry not producing for the dollar markets pay their power bills in Cuban pesos. The energy billed to consumers is around 17,490 GWh per year. It is estimated that 75% of the electricity generation costs are in hard currency, which far exceeds the prices the population pays for this service. Foreign companies, diplomats, and joint venture companies (*empresas mixtas*) are billed in convertible pesos or dollars for their power consumption.

Homes

In 2007, monthly household consumption increased to an average of 148 KWH per household, compared to 140 in 2006. Also, in 2007, around 31% of households consumed 100 KWH electricity or less; nearly half, or 47.7%, between 101 and 200 KWH, 17.6% consumed between 201 and 300 KWH, and almost 4% consumed above 300 KWH.

The tariff for residential consumers is based on a sliding price related to level of consumption. The tariff was revised in January 2006. The current tariff is:

- The first 100 KWH consumed per month are priced at 0.09 pesos per kWh;
- For monthly consumption above 100KWH and up to 150, the price rises to 0.30 pesos per KWH;
- For consumption between 150 KWH and 200, the price increases to 0.40 pesos;
- For consumption between 200 KWH and 250, the price increases to 0.60 pesos;
- For consumption between 250 KWH and 300, the price increases to 0.80 pesos;
- For consumption exceeding 300 KWH, the price increases to 1.30 pesos per additional KWH.

Industry

Cuban industry is charged a combined power price tariff that varies by time of the day. The three time zones are: the peak load time, from 6PM to 10PM; the medium load time, from 6AM to 6PM; and the low load time, from 10PM to 6AM. The power price is a contractual purchase agreement. For example, the so-called tariff 32 applies to an industrial customer with two production shifts and a purchase commitment of between 1,000 KWH and 2,999 KWH.

At the time of this writing, the contracted KW price is 4 pesos/KW per month. If the ordered amount is exceeded during peak times, the difference between the actual load and the ordered load costs 13 pesos per KW per month. Businesses running three shifts are charged a low load tariff during the night shift of 0.02 pesos/KWH. Electricity prices for industrial businesses with a purchase commitment below 1,000 KW are around 15% lower. Prices for businesses with a purchase commitment exceeding 3,000 KW are higher. The power prices for industrial customers paying in dollars are $0.20 during peak loads, $0.15 during medium loads, and $0.13 during low loads. The author estimates the total revenue of UE in 2008 to be around 2,500 million pesos.