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Capstone Project:

Electric Energy-Saving Education Guidelines
for Senior High School Students in Honduras

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INDEX

1.0.0	Executive Summary	2
Part I: Electricity sector		
2.0.0	Definition of the issue to be researched	3
2.1.0	Global issues	3
2.2.0	Regional issues: Globalization and markets of energy	3
2.3.0	Introduction to the electricity issue in Honduras	5
2.4.0	Trends and demographics of the electricity sector	6
3.0.0	Sectors involved in the issue	9
4.0.0	Probability of technological (or other) breakthroughs	10
Part II: Education sector		
5.0.0	Definition of the global issue to be researched	11
5.1.0	Global approaches to electric energy education	11
5.2.0	How has new knowledge been tried to be implemented in Latin America's education?	12
6.0.0	Introduction to the education issue in Honduras	13
6.1.0	Any concerns about the academic performance of the Honduran schools of education	14
6.2.0	How the education about electric energy savings has been implemented in Honduras?	15
Part III: An approach to Electric Energy Savings Education in Honduras		
7.0.0	Introduction, development and follow-up of the guidelines into the Honduran Education System	17
7.1.0	Institutions	17
7.2.0	Antecedents of how the energy-savings education material is given through the campaign:	17
7.3.0	Development of the E. Energy Savings Education Guidelines into the Education System	18
7.4.0	Conceptual framework of the Energy-Savings education guidelines	19
8.0.0	Samples of energy-saving education guidelines	23
8.1.0	Considerations of the education standards used for the lesson plans	24
8.2.0	Evaluation of the energy-saving education guidelines	25
8.3.0	Example of lesson plans	26
9.0.0	Conclusions	51
10.0.0	Recommendations	52
10.1.0	Recommendations for the educational aspects	52
10.2.0	Recommendations for the energy-savings guidelines and the electricity sector	53
	Acknowledgements	56

1.0.0 EXECUTIVE SUMMARY

Latin America is going under political changes because of the influence of Globalization, particularly in the electricity sector. The electric utility of every country is undergoing changes in their structure because the supply of electricity does not meet growing demand. A consequence of this incapacity of satisfying the demand is the growing dependency on fossil fuels to generate electricity.

Regions around the world are using a strategy alternative to fight against this dependency: energy-savings education. For example, the US and the European Union have labels and user guides on their products to tell the consumer how much electricity consumption each appliance requires. Other countries like India have taken a broader approach through tests verifying the student population's knowledge.

Since 1994, Honduras has started energy-savings education through the help of Argentina and the European Union. This education was given through a voluntary effort from schools, the National Electric Energy Utility (ENEE) and some other governmental institutions. There have been some achievements through all these years, but the results could have been better if all the Honduran high schools were aware of this educational material. In addition, there are no education guidelines for the high school level, causing the schools not to have parameters or indicators of the quality of education given, especially concerning to the environment and energy.

For these reasons mentioned, this project proposes education guidelines, which will introduce electric energy savings as a transversal axis. A transversal axis means that a concept will be supported and discussed through other topics, for example electricity can be discussed within a Physics or in a Chemistry class. The idea is that in the future there could be more people aware of the electricity situation, they would change their behavior towards the environment, increase the participation of the people in the solutions on the electricity problems and decrease the rising dependency on fossil fuels to generate electricity. Because it is not possible to introduce energy-savings as a separate course due to the lack of faculty prepared on the matter and budget, then introducing it as an axis will not require hiring a teacher or extending the schedule of classes in schools. Nine courses in the high school level are proposed as a model to introduce the guidelines, an example of a lesson plan for each course, a framework of how it is recommended to guide the education and indicators to evaluate the success of the education. At the end, there are some conclusions and recommendations, which consider other additional factors that might help certify the success of the education.

Part I Electricity sector

2.0.0 Definition of the issue to be researched

2.1.0 Global issues

Promotion of the sustainable development of natural resources as sources for electricity is very important for the world, because many countries depend too much in fossil fuels. The United Nations Environmental Program (UNEP) has calculated that in 1993 about 50% of the energy produced in Central America is generated by hydropower. The problem is that now Latin American electric utilities are going under deregulation and privatization, and usually private investments in Latin America prefer to use fossil fuel power to hydroelectric plants because capital costs are lower and the return on the investment is faster even though energy costs are higher ¹. If there is a higher dependency on fossil fuels to generate electricity, then there are more carbon dioxide emissions. GREENPEACE forecasts how big the problems can be if there is an increase of Global Warming throughout the world, especially when there is a high dependency on fossil fuels to generate electricity. Although Honduras is not a great direct contributor for this problem, it is directly harmed by what the countries that emit Green House Gases. The following table shows what could happen to Central America (which includes Honduras):

Table 1: GREENPEACE: Central America's future in the presence of Global Warming, years 2030-2050

Temperature	Hydrographic basins	Agriculture
Increase in a 1.5-4.5 °C	Excess of hillside erosion by 5-30%	Great losses in crops
Increase in sea level		Population
Possibly caused by severe floods, but there is also scarcity of water in mainland, lost of ecosystems and damage to infrastructure		Big catastrophes, hunger, energy rationing, scarcity of water, increase of external debt and unemployment and migration to urban areas

Source: Nicaraguan sustainable network: www.sdnnc.org.ni/documentos/calentamiento_global

International institutions, like the Inter-American Development Bank (IADB), notes that Latin America has reached its highest growth since the last twenty years. This bank believes that the prospects for investment will continue to improve in the following years.² One of the reasons causing the Latin American economies to grow is Globalization, where developed countries have increased their investments in these countries. The International Monetary Fund (FMI) warns that although this may be favorable, Honduras has to face the changes in employment, especially from the public sector because international funding institutions recommend the decentralization of the utilities and decrease of governmental staff³. Economic growth through time brings new technology and changes in lifestyles, causing more demand for electricity. Increasing the electricity demand could also possible imply more use of fossil fuels and thus increasing the carbon dioxide emissions. This would support GREENPEACE's statement of Global Warming.

(1) Global Environmental Look 2000. "Atmosphere". UNEP. www.unep.org/GEO2000/english/0090.htm

(2) Newspaper "La Tribuna". Public debt over crosses GDP" Pg 114. 4/11/05

(3) Newspaper "la Tribuna" The Honduran economy is still vulnerable. Pg 13. 4/14/05

2.2.0 Regional issues: Globalization and the electricity sector

During the 1990s, the effects of Globalization started to be felt in Central America, where collectively each country had to adjust its economic and development strategy when new markets were introduced. Some tariffs and taxes of goods have dropped or decreased in commerce and people now are free to cross between countries. Because of the damage caused by hurricane Mitch, information is being shared more than before in order to fortify cooperation. With respect to electricity, Central America is now interconnected and it is hoped that consistent quantity and quality standards will become official in the near future.

Not all the information regarding Globalization and electricity is well known or distributed in Honduras. To make it worse, some information is not well supplied or used. For example, the Honduran National Electric Energy Utility, ENEE, like the rest of the utilities of other countries where the central government still controls the electricity sector (generation, transmission and distribution of electricity), the use of information and money to extend the electric grid cause conflicts, especially by political intervention. Political intervention means that the information is possibly modified or falsified, and the money destined to supply electricity to regions with a priority problem is not always used for that purpose. Money is usually redirected to other projects or no one at the end of the governmental period knows how that money was spent. To avoid this bad use of money, some international funding organizations suggest that electricity generation should be privatized and the communities affected by any electrification project should participate in all the phases of implementation⁴. In addition, within the country, many Hondurans do not believe in their local or national authorities claims about how money is being spent. Because of the different perspectives mentioned above about the use of money, some citizens from different sectors have voluntarily made teams to give ideas to the central government that could help decrease the impacts of the purchase of fossil fuels. These teams include members from ecclesiastic authorities, which most Hondurans trust more than any other sector to guarantee that the money available is better used to solve the problems caused by the electricity generation and its distribution.⁵

Some problems of electricity generation and distribution are beginning to be solved by the private sector. By 1998, 30% of all the electricity generation was produced by the private sector. There were more people ready to invest in the private sector, but there were legal and administrative obstacles, such as delays in providing environmental permits to initiate an electrification project.⁶ In 1999, in order to avoid obstacles in the investment, a framework had to be designed to help introduce renewable sources into electricity generation.

Other frameworks about electricity could be needed when trade agreements such as the Central American Free Trade Agreement (CAFTA) come into operation. CAFTA will tear down barriers to trade and investment between the USA, Central America and Dominican Republic. The introduction of new markets in Central America will require in each country to supply more electricity to the new industrial and commercial demand.

(4) Hugh Rudnick. Second Generation Electricity Reforms in Latin America and the California Paradigm” 2002

(5) Newspaper La Prensa. “Maduro will analyze the proposal to reduce the price of fossil fuels”.8/13/04

(6) ESA Consultants. Honduras for the 21st century: An battle against competitiveness. 1999

The new demands for electricity cause in developing countries problems that seem endless, such as the continuous dependency on hydrocarbons. Some people in the US, who are against this dependency, say, “Globalization is a fact of life in the energy business..., and the energy trade is accelerating”. This statement means that now major oil companies do not have as much access to big fields as they once did because oil-rich countries like Venezuela, are taking more control over their domestic energy resources to avoid having problems in their own supply.⁷

Honduras’ and Costa Rica’ electricity utilities are still owned by the government and sometimes their hydroelectricity sources are not enough to cover their respective demand during the summer, when the water levels significantly decrease. No direct indicators are available that could show how much contamination comes from electricity generation in Central America, but the following chart shows how much carbon dioxide emissions (in million metric tons) result from the fossil fuels used per each country:

Table 2: Percent of each country’s energy that is derived from fossil fuels and carbon emissions in Central America, year 2000 (includes transportation)

Country	Fossil Fuels	Emissions	Country	Fossil Fuels	Emissions
Belize	83%	0.1	Honduras	70%	1.4
Costa Rica	47%	1.3	Nicaragua	88%	1.0
El Salvador	67%	1.4	Panama	75%	2.4
Guatemala	81%	2.5			

Source: EIA 2002 (Units: million metric tons)

From table 2, Honduras has an intermediate generation of CO₂ emissions and dependency of fossil fuels compared to the rest of the Central American countries, but the tendency is to depend more on fossil fuels. An alternative to the possible increasing dependency is to save electricity. The economical efforts to save 1 megawatt (MW) of electricity could start by no investment up to big investments, but to generate 1 MW through hydroelectricity costs US\$950 or through from fossil fuels costs US\$10,000 (prices value from 1997)⁸. There are several routes to make people save electric energy: By governmental legislation and administrative rules, by rewards and punishment and by voluntarism⁹. Some efforts of governmental legislation are still in early stages, for example, the design of an hour-tariff schedule for the electricity usage, but there are no rewards or punishments yet for its consumers¹⁰. Voluntarism has taken some steps, like substituting conventional light bulbs by efficient bulbs, but most of the Hondurans are not aware of the ways to save electricity because there is no formal education through media and education. If people are educated and informed about the current electricity situation and benefits of electric energy savings, then it will be easier for them to obey and volunteer in the efforts made by the central government. In addition, when they become part of the commercial and industrial sector, they will probably become more responsible for their electricity consumption and their environment. This possible behavior from the Hondurans and consequences are the reason for this document.

(7) Robert Bryce. “The gushing truth”. www.salon.com 5/04/05

(8) Madrid Calix, Oscar. Former National Co-Director of the GAUREE 1 project (1996-1999)

(9) Rodney, Allen. “Energy Education: Goals and Practices”. Phi Delta Kappa Educational Foundation., Indiana. 1980 Pgs 6-8.

(10) Hernández Maradiaga, Carlos Leonel. Energy efficiency coordinator. GAUREE 2 Project. ENEE. cleonel2001@yahoo.com2004

2.3.0 Introduction to the electricity issue in Honduras

During the decades of the 1950's to the 1970's, when the population was less than 2.5 million people, Honduras's electricity was based on small hydroelectric plants of 50-60 kW.¹¹ During the 1960's, the National Electric Energy Utility (ENEE), began making studies of electricity supply that would cover the future demand for the country for the next thirty years. It was not until 1982 that the biggest Honduran hydroelectric dam "El Cajon" was built to satisfy the demand projected since the '60s.¹² During this year, Honduras depended on 75% hydroelectricity and almost 25% on hydrocarbons.

In 1994, due to the atmospheric phenomenon of La Niña, the reservoir of the dam "El Cajon" decreased from 280 to 226 meters above sea level, near the minimum limit to generate electricity. Because of this shortage of water, ENEE began rationing electricity at the national level. At first, rations were two hours per day, but as the water supply got worse, the interruptions were enlarged, causing drastic impacts on all the economic sectors until 1996. Since then, ENEE was forced to greatly depend on fossil fuels. In 1997, the Central American Electrical Interconnection System (SIEPAC: Honduras, Nicaragua, Costa Rica and Panama) was created to start up the electric power market, develop the first regional grid and help each member to cover shortages of electricity during the peak hours.¹³

In 2004, Honduras was depending on a 63.4% of electricity generated by hydrocarbons (871.8 MW), 34.5% by water (474.9 MW) and 2.1% by solar energy and biomass (28.8 MW). Since the water levels of the hydroelectric dams are not stable, energy contracts based on fossil fuels must be made in emergencies to supply the demand for electricity in Honduras, especially during the daily hours of greatest consumption of energy.¹⁴

2.4.0 Trends and demographics of the Honduran electricity sector

2.4.1 What is known about the demographics of the supply and demand for electricity?

Honduras's population has grown 442% over the past 50 years. In 1974, the urban population was 33.36% while the rural was 68.64%¹⁵. The agriculture sector, especially the banana commercialization in that time was the main economic activity until the beginning of the 1980s.

By the early 1980s, the electricity supplied exceeded the demand for that moment. By the end of this decade, rural populations decided to move toward the urban areas in search for better standards of life because there was a greater population and the time of dictatorships ended, allowing the people more freedom and economic opportunities. These new residents usually have relatives abroad that send them consignments and modern electrical appliances, which it would not be possible for them to buy. For example, it is possible to find big and brand new refrigerators and stoves in a house where the monthly earnings are around US\$130. This means that there is big electricity consumption in the urban areas in poverty. La Niña phenomenon and the new demand of electricity caused by immigration to the urban areas caused the electricity supply to decrease rapidly.

(11) Hernández Maradiaga, Carlos Leonel. Energy efficiency coordinator. GAUREE 2 Project. ENEE. cleonel2001@yahoo.com 2004

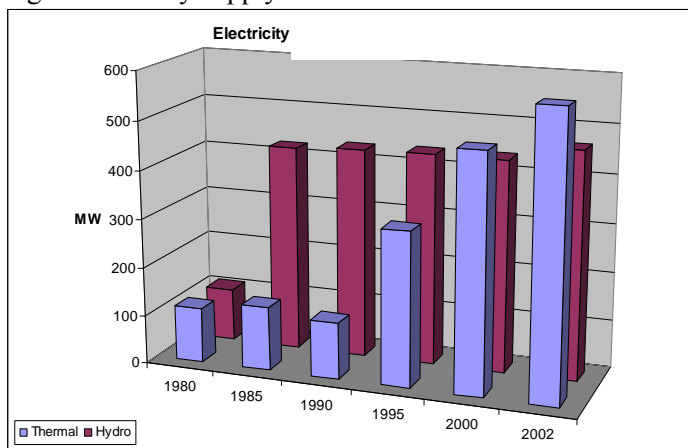
(12) Empresa Nacional de Energía Eléctrica (ENEE): Interconnection System. www.enee.hn 2004

(13) Inter American Developing Bank (IDB) www.iadb.org/exr/doc98/apr/rg1368E.pdf. 1998

(14) Newspaper "La Tribuna". ENEE says that the El Cajon is causing the problem" 4/4/04 . ENEE's website: www.enee.hn

(15) Newspaper "El Tiempo". "Honduras's population near the 7 million people" Pg. 3 8/7/04

Fig 1. Electricity supply from 1980 to 2002



Note: These numbers include imports of electricity Source: ENEE 2005

In the early 1990's, the government made big economic reforms that helped the introduction of new industries. These industries brought progress, development, and changes in living, consequently causing more electricity to be needed. The electricity production in 2001 per Honduras was 553.66 kWh (being the 113rd of 167 registered countries). Iceland is in the first position in the world (26,853.44 kWh).¹⁶

By 1999, the urban sector grew to 47.7%¹⁷, causing at the same time more demand for electricity because of their new lifestyles. When the population was 6 million in 2002, these people lodged in 1,155,124 dwellings (each house had an average of five persons)¹⁸. By August of 2004, Honduras already reached 7,000,011 inhabitants¹⁹. The population has been grown from 2000 to 2003 at 2.5% and there was a population density of 61 persons/km² (20). The problem in the places where there is a small population density is that there are more non-technical and technical problems than in higher populated areas because there is little supervision from ENEE, causing economic and energy losses.

2.4.2 What is known technically about the underlying demand for electricity?

Technical losses are the electricity losses during the transmission and distribution of electricity to the populated areas. The maintenance and quality of cables used to carry the electricity and the distance to travel are the factors that increase the electricity losses. The losses mean that there is less electricity being reached to the populated areas. When the technical losses increase, then more sources to generate electricity are needed in order to have the same previously supplied. In Honduras, the technical losses are 17-20%.

Non-technical losses happen when clients do not fully pay their bills and others steal electricity directly from the main distribution cable. Other people even try to alterate the power meter of their houses. The technical and non-technical losses of energy increase the money spent to generate each MW of electricity²¹. In 1997, before Hurricane Mitch damaged the electricity infrastructure, the Per Capita Electricity Consumption (PCEC) in Honduras was 350 kWh/person/year²². In 1999, after the hurricane, the Honduran economy was still recovering slowly, but the reconstruction demanded more electricity and the population was still growing.

(16) Central America and the Caribbean: Energy. www.nationmaster.com. 6/02/05

(17) Pan American Health Organization-WHO, "Chronicles of Natural Disasters". 2003

(18) Newspaper "El Tiempo". "Honduras's population near the 7 million people" Pg. 3 8/7/04

(19) Pan American Organization of Health (OPS): Sectarian Water Analysis, 2003

(20) CEPAL. Boletín demográfico no. 63. <http://www.eclac.cl/Celade/publica/bol63/BD6311.html>

(21) Newspaper La Tribuna. "ENEE consumes an energetic fraud". Pg. 8, 9/28/05.

(22) BUN-CA. "An overview of sugar cane cogeneration in six Central American countries". 1997.

<http://www.bun-ca.org/publicaciones/Sugar%20Cane.pdf>

Table 3 shows the power consumed from 1997 to 2003, where during the new century the economic activity was reactivated after the devastation caused by hurricane Mitch in October of 1998. These losses are not charged to the public, causing to the government to have more unplanned expenses.

Table 3: Energy consumption (GWh)

1997	2000	2003
3,100	3,189.00	3,775.20

Source: ENEE's website

By 2004, the PCEC was 572.96 kWh/person/year. An average of 45.13 kWh/person is needed in electricity imports to satisfy the demand (44th from 170 registered countries).²³

2.4.3 What is known economically about the demand and supply for electricity?

Besides having a dependency on fossil fuels, there is a loss of US\$900,000/month by theft of electricity (5% of the total generated). Each kWh is being sold at US\$0.82 to the clients that consume less than 300 kWh/month, instead of US\$0.12 (price being paid to the private thermal electric utilities). This price has been maintained since 2004 in spite of the changes in the market. To pay for these costs, the Honduran government asks for loans to international funding institutions, such as the International Monetary Fund (IMF). When better alternatives exist, such as the setting of a new hydroelectric dam or generation through renewable energy, permits usually take 2 to three years to be released.²⁴

2.5.0 What is known environmentally about the demand and supply for electricity?

2.5.1 Present environmental conditions

Renewable energy is an alternative to substitute fossil fuels, but many of the projects have to be big enough in order to be economically feasible. For example, only three solar energy projects exist, because their dimensions were done to supply three small communities (these projects are not connected to ENEE's electricity grid). In addition, only two biomass projects of 28.1 MW based in sugar cane operate in Honduras because there are not enough incentives from the government to sponsor them, and these two they are connected to the grid. The use of hydroelectricity could again increase in the next years if there is collaboration from the local communities to help maintain the water and have the appropriate management. The total demand for water in Honduras is about 1,820 million m³/year. If there are 1000m³/year available to every Honduran citizen, then 15.8% of that water is used for hydroelectric generation. The lack of water increases the costs of electricity provision; it is cheaper to generate one MW through water (US\$950) than one with fossil fuels (US\$10,000).²⁵

2.5.2 Description of the future environmental conditions

From 2002 to 2015, Honduras plans to have a power supply of 1.519 GW installed, 705 MW from fossil fuels and 814 from renewable resources (577 MW are from four new and medium size hydroelectric projects)²⁶. ENEE has projected a possible growth in electricity consumption of a 107.5% from 2002 to 2015 (4590 to 8530 GWh).

(23) Central America and the Caribbean: Energy. www.nationmaster.com. 6/02/05

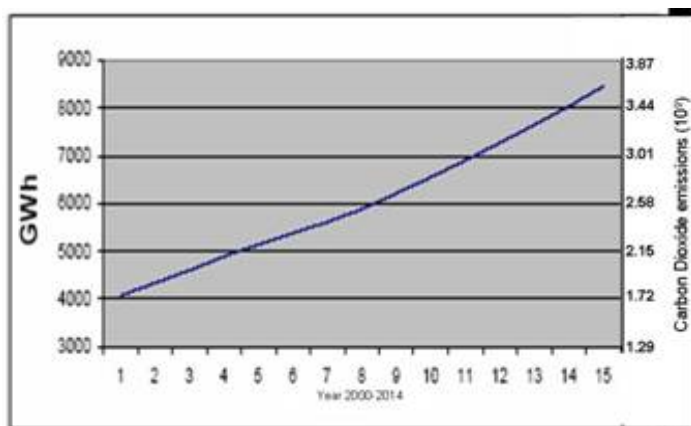
(24) Gilberto Ramos, ENEE's Sub Manager.

(25) Carlos Leonel Hernández Maradiaga. Energy efficiency coordinator. GAUREE 2 Project. ENEE. 2004

(26) Guide to develop electric energy projects. www.bun-ca.org/publicaciones/Honduras.pdf. 2002

About 66.5% of the energy (6,337 GWh) will be provided by renewable resources and the rest 33.5% (3,190 GWh) from fossil fuel thermal energy. For the year 2010, Honduras is projected to have electricity coverage of 79.67% and 100% coverage by 2015.

Fig.2: Electricity demand from years 2000 to 2014



Source: CRI Center of Natural Disasters. www.ns.rds.org.hn. 2005

For this to occur, ENEE is investing in the urban marginal areas and rural areas. An investment of US\$ 704,452,163 between the years 2002 to 2015 is planned to result in 100% electricity coverage. Figure 2 shows the electric demand calculated from the year 2000 to 2015, (which does not include energy efficiency measures and mitigation effects of CO₂ emissions), which will remain the same even if no measures are included.

To counteract the possible effects of the future demand for electricity, an Extension Plan for the National Electrical Interconnection System for 2000-2015 has been created and is based on a thermal Scenario (only using more hydrocarbons) and a Medium Scenario (intentions to increase hydroelectricity and generation through renewable resources).²⁷⁾

3.0.0 Sectors involved in the electricity issue

In 2004, the Honduran central government declared that the country is capable of satisfying the present and future demand for electricity if through the native resources could be generated 5 GW. This potential energy is even enough to meet the demands of globalization, but the problem is that there is no even national interest, money and incentives to explore them.²⁸⁾ The equivalent to this amount of supply are 17 hydroelectric dams to be built as big as the dam “El Cajon” (300 MW installed)²⁹⁾. Some money is obtained through international donations, but the problem is that Honduras is considered within the countries with the highest level of corruption: In 2004, from 145 countries, Honduras is in the 114th least corrupted position. Corruption decreases the interest for national and international investors in electricity generation to invest in Honduras.³⁰⁾

ENEE reported in 2004 that the national coverage index of households with electricity was 65.9%.³¹⁾ The Residential Sector is the biggest consumer of electricity and the population in the urban area has grown from 1990-2003 at a rate of 3.7% per year.³²⁾ Since the Residential sector is causing the biggest impact on the electricity demand, and from here, the people derives to control the other demanding sectors, electric energy savings education must be specially taught and practiced here.

(27) Natural Disasters Regional Information Center (GRI). www.ns.rds.org. 2005

(28) Newspaper “La Tribuna”. “Maduro will make four hydroelectric projects to proceed” 8/3/04

(29) Newspaper “El Libertador”. “El Cajon is about 8mts away to be closed” 10/04

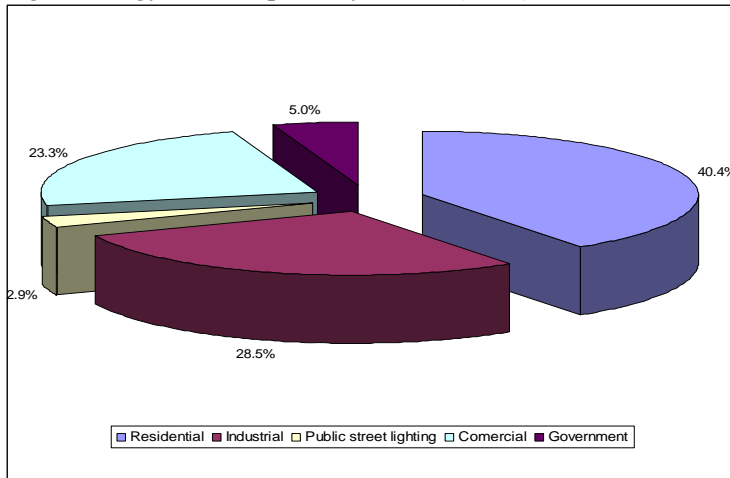
(30) Newspaper “La Tribuna”. “They study thermal waters in Choluteca” 4/14/05

(31) CEPAL. “Central America: Electricity subsector statistics. 2005. www.eclac.org/id.asp?id=9507

(32) UNICEF website 2005: Honduras at Glance, statistics (March 2005)

In 2003, 46% of the Honduran population was urban, but around 57% was made up of poor families.³³ People immigrating from the rural to urban area settle in areas which are green (along a river) and reas owned by the government. After some time adapting to the urban environment, some are able to buy new electronic equipment to satisfy their needs and consequently use more electricity. Additionally, most of the Hondurans are tending to have a family lifestyle similar to that US families...every person in a house wants to have his/her own electrical equipment and car. All of the mentioned factors increase the demand for electricity by the resident sector. The next figure shows how the electricity was consumed by sectors last year in Honduras.

Fig. 3 Energy Consumption by Sector (2004)



Source: ENEE (2005)

The industrial and commercial sectors still keep using very old equipment, which is less electrically efficient than any later model. In the governmental offices, some of the problems rely on leaving electrical appliances as well as lights turn on even after finishing the daily operations. Finally, the bulbs used for public lightning in the urban areas have been changed with a better efficient technology, thus saving electricity³⁴.

4.0.0 Probability of technological (or other) breakthroughs

Honduras's former president, Ricardo Maduro-Joest (2002-06), set up the framework to expand the electric network in the country. The current coverage is 63%, but he proposed to leave the procedures so that by 2013 it can be raised to 96%, if the population growth is 2.35% per year (it now is 2.5%).³⁵ To make this possible, new hydroelectric dams and renewable energy projects have to begin as early as possible. Thermal energy through geysers has been under study in southern part of the country³⁶. European countries, had come to Honduras to study the potential energy stored in fruits (ie Finland and the African palm tree).³⁷ In addition to the introduction of CAFTA in Honduras, the International Monetary Fund (IMF) is satisfied with the Gross Product that Honduras had in 2004 (US\$6,842). In spite of this success, about 3 million Hondurans still live under conditions earning US\$1/day. The Honduran economy grew in a 4.3%, because of successful macroeconomic goals, but the external debt grew in a 7.7%.³⁸ If the government wants to save money to invest in development projects, have fewer environmental contamination and have more electricity coverage, then E. Energy Savings education is part of the solutions because it is possible to save money without investing first.

(33) UNICEF website 2005: Honduras at Glance, statistics (March 2005)

(34) Madrid Calix, Oscar. Former National Co-Director of the GAUREE 1 project (1996-1999)

(35) Newspaper "La Tribuna". "Maduro will leave his office with the table served". 9/03/04

(36) Newspaper "La Tribuna". "They study thermal waters in Choluteca" 4/14/05

(37) Newspaper "La Prensa" "Finland begins to teach to generate clean energy in Villanueva". 5/28/05

(38) Newspaper "El Libertador". "The first solar Honduran community has been forgotten" 03/05

Part II Education sector

5.0.0 Definition of the global issue to be researched

5.1.0 Global approaches to electric energy education

Regions in the world are also practicing electric energy savings education throughout schools. Some countries, like the Philippines, are under the same process Honduras is taking of decentralizing the electricity utility. With the purpose of awaking competition of electricity generation and control the growing electricity demand, the Philippine Congress has mandated under Republic Act 9136 to educate and protect end users about the appearance of new providers of electricity, liberalization of the prices of energy and save electricity in order to have a better control of the national demand. No energy-savings education through schools has been specifically discussed yet, but the Congress wants to people to understand the reasons of restructuring the electric sector. In this way the government will be able to promote competition among electricity providers and give people empowerment so that the widest participation of people, whether directly or indirectly, is insured.³⁹

Other countries have had experiences with electric energy savings education in schools. In April 2001, the Energy Conservation Center from Japan (ECCJ) started an Education Program at model schools selected from the existing nation-wide primary and junior high schools to promote energy conservation activities in their communities⁴⁰. The activities include teachers and students examining how their lifestyles have changed through the years by having electricity available, examination of the environmental problems locally and nationally, and they evaluate themselves how good they able to manage and save electricity in their houses. For example, they decide if it is worthy to watch television when they do not have something in specific to see, or think about all the food they serve themselves to eat...are they going to eat all?⁴¹. Some schools have set a goal to save 6% in the annual electricity consumption in the families of each student by the year 2010. For this to happen, school officers, parents and local government officers of some cities have met together in meetings in order to fulfill electric energy savings goals⁴².

The European Union, through the Council Directive 93/76/EEC of 1993⁴³, has had the experience of conducting electric energy savings campaigns in some schools around Europe. One of the motives to educate people through schools is because Europe has not been able to annually save in electricity more than 0.5%, when in the 1990s the annual savings were 1.4%. A factor that has influenced to have this stationary rate is the increasing use of standby mode for electrical appliances, which is boosting European household bills by up to 10%⁴⁴. To help analyze other factors affecting the electricity savings, European schools collect energy consumption data and exchanging this information with the partner schools in order to elaborate through a scientific methodology conclusions and recommendations.

(39) Congress of the Philippines. "Republic Act No. 9136." Pg 56-57 2002. Contact: Lina Mortega (lina_mortega@yahoo.com)

(40) Energy Conservation Center, Japan. "Energy Conservation education". 2006. <http://www.eccj.or.jp/eng/e3405education.html>

(41) Energy Conservation Center, Japan. "Energy saving model schools". 2006. http://www.eccj.or.jp/ambassador/eng/36/03/3_1.html

(42) ECCJ. "Activity reports of model schools to promote and teaching energy saving", 2006.

http://www.eccj.or.jp/.../eng/33/03/3_1.html

(43) MANAGENERGY. "Legislation" European Commission". 2006. <http://www.managenergy.net/products/R532.htm>

(44).MANAGENERGY. "Education on energy". EU. 2006. <http://www.managenergy.net/download/education2005/05-0001-EN.pdf>

For the moment, the collection of energy consumption data and exchange of information have helped obtaining a 10% in electricity savings. However, the goal is set between 20-25% and the schools have learned that in order to have better results, it is necessary to set up teamwork among teachers, students and parents, and that energy saving education has to be introduced in the curricula of the different courses ⁴⁵.

5.2.0 How has new knowledge been tried to be implemented in Latin America's education?

Using renewable energy in a country will help decrease carbon dioxide emissions, decrease the use of fossil fuels and increase electrification coverage in the rural areas. The United Nations Organization Educational, Scientific and Cultural Organization (UNESCO), because of the World Summit on Sustainable Development (WSSD) in Johannesburg which is promoting the sustainable and renewable energies high on the international agenda, has established the Global Renewable Energy Education and Training Program (GREET). Latin American Authorities have actively expressed their support to the conception of Sustainable Development and meeting the Millennium Development Goals (paragraph 19 of WSSD), increasing the use of renewable energy to a 10% as a share by 2010. Since 2004, discussions continue with stakeholders of each country ⁴⁶.

The Honduran Department of Education tries to innovate in the educative system through the enrichment of the curriculum of the formal courses given at schools. Some topics are not usually discussed in formal courses (ie stewardship), but are discussed as a transversal axis in the different courses of the Honduran educational school system. A transversal axis means that some topics are taught through some official courses as a complement of the given ideas. In this way, students are able to learn about new concepts that are national concerns, and be involved in ways that could help improve solve the problems, thus bringing a new scientific, humanistic and ethical perspective to their lives. Some Latin American countries have individually implemented in the school academic instruction related to the environment and electricity:

Table 5: Example of transversal axes related to the environment in Latin America

Country	Axis	Country	Axis
Dominican Republic	Science and Technology	Bolivia	Environmental Education
Nicaragua	Environmental culture	Guatemala	Environmental Education

Source: González Valdez, Ernesto. "Posibles ejes transversales para el Currículo de Honduras" Department of Education. 2006

There is still no country in Latin America that through their Department of Education has official transversal axes regarding electric energy savings education in their schools, but through their electric utility. The countries that have done electric energy savings education through their schools are Mexico, Honduras, Guatemala, Brazil and Argentina ⁴⁷.

(45) MANAGERENERGY. "Energy Savings activities in school". 2004. www.managenergy.net/products/R1031.htm

(46) ForschungsVebund Sonnenenergie. "UNESCO's Global Renewable Energy Education and Training Program in a Latin American View": 2004. http://www.fv-sonnenenergie.de/publikationen/05_e_UNESCO_01.pdf

(47) Hernández Maradiaga, Carlos Leonel. Energy efficiency coordinator. GAUREE 2 Project. ENEE. 2004

For example, Mexico has trained 69,000 elementary school teachers, which have at their disposition 2.3 million students and has permanent expositions in 30 museums nationwide about electric energy savings⁴⁸. In the case of Brazil, the program began in 1990 by training 100,000 students. By 2005, 2 million students have been trained and it is estimated that each student collaborates by saving 84 kWh/year⁴⁹. The topics developed in a transversal axis in Honduras are a response to satisfy the demand and reality of the Honduran society: National Identity, Work, and Democratic Participation⁵⁰.

However, there is a proposal to introduce Environmental Education as a transversal axis in Honduras, and some booklets are already been designed⁵¹. The problem with this proposal is that it does not have a specific topic about electricity. However, there are some related topics to electricity such as the Kyoto Protocol (chapter 5), Green House Gases (Chapter 6) and Use of Clean Technologies (Chapter 16).

6.0.0 Introduction to the education issue in Honduras

The birth rate in Latin America is 2.8 children/woman, while in Honduras is average 4.9 children/woman, one of the highest in the region. Big families are usually found in the rural areas. About 47% of the Honduran population lives in urban areas (around 3.3 million) and 20% of this percentage lives in the two biggest cities, Tegucigalpa MDC and San Pedro Sula⁵². The biggest sector of the Honduran population is made of children. For example, in the year 2000, when the population was 6.4 million people, the young population from 5-14 years of age was approximately 1.7 million (27%) and from 15-17 years of age (the ideal age to attend high school) was around 760,000 (12%). International institutions have concluded that the trend of the young population will start to decrease by the year 2025⁵³. This is beginning to be seen especially in the middle and upper class families, where they try to place their children in good private schools.

Most of the young population can only afford to attend public schools managed by the central government. The big young population has caused the central government to have economic difficulties in sustaining public schools because there are not always enough funds to provide the necessary academic staff and academic material to the students, especially to Elementary Schools. The table in the next page show how the Honduran educational system is divided by education and age, which is similar to how the American system divides its educational system at schools. Depending on the educational institution, the high school years are 2 to 3 years long, but most of the schools request two years to graduate.

The standard high school education offers 2 degrees, the Bachelor Degree in Science and Letters (gradually changing the name to Scientific Humanist Bachelorate or Professional Technical Bachelorate degrees, depending on the institution), and the High School diploma if the institution is bilingual.

(48) FIDE. "Educación para el ahorro y uso racional de la energía eléctrica". 2006. <http://www.fide.org.mx/resultados/index.html>

(49) PROCEL. "PROCEL nas Escolas de Educação Básica". 2006. <http://www.eletobras.com.br>

(50) Dirección General de Currículum. "Currículo Nacional Básico. 2003" Department of Education. 2003

(51) Cerrato, Armando. Engineering System Coordinator. Department of Education, 2006. armandocerrato@yahoo.com

(52) Dirección General de Currículum. "Currículo Nacional Básico. 2003" Department of Education. 2003

(53) US Census Bureau. "Population Pyramid Summary for Honduras" 2000. <http://www.census.gov>

Table 4: Honduran educational system

Source: CNB 2003

Levels	Division 1	Duration	Division 2	Duration
Pre-basic Education*	Kindergarden	1-2 years	Elementary school	6 years
Secondary school *	Middle School	2-3 years	High School	2-3 years
Basic school	(For rural areas)	9 years (totally free and a duty for kids 6-15 years)		
Higher Education	University	4-7 years (Social sciences and Humanities: 4 years average)		

* Undergoing changing names since 2003: Grades 1-9 will belong to the group called “Basic Education” and grades 10-12 will belong to the group called “Médium Education”

If the high school center has technical orientation, then the degree has concentrations in agriculture, industry, management, environmental education, and civil construction. The industrial concentrations include electricity, electronics, air conditioning, wood and metal labor. The environmental concentrations include ecology and environment, health and nutrition⁵⁴. In order to evaluate the performance of the educational process in the technical orientations previously mentioned, the Department of Education is supposed to check out:

- a) The internal and external learning process of the students, which is verified through reviewing the given programmed course work and evaluation of each center
- b) The performance and personality of teachers with their students
- c) The objective of the academic plans and budget of each educational center

The State and Local Departments of Education will use the above criteria to determine the failure of the given Honduran education per year⁵⁵. However, the results are usually not so good because there are usually financial problems from the government when they have to pay salaries, causing the teachers not to want to work and consequently the educative plans are not well carried out and the students are not well-trained academically⁵⁶.

6.1.0 Concerns about the academic performance of the Honduran schools

Many of the results of the evaluations in schools show that the teenagers graduating from Honduran high schools are not well prepared to face the challenges of today’s requirements in technology, computing, labor, and higher studies. Other reviews show that the national high school curriculum does not reflect the needs of what the Honduran society needs today or to help the sustainable development of the country. The basic reasons for these conclusions are that many of the teachers are not academically well qualified for their jobs and most of the high schools do not offer academic program (ie agriculture) to students oriented to help improve the Gross Product⁵⁷. Only few of the public and rural high schools offer these academic programs because international institutions have granted the equipment and lab to run them. Most of these high schools are overpopulated with students and do not have an adequate number of teachers.

(55) Dirección General de Currículum. “Currículum Nacional Básico. 2003” Department of Education. 2003

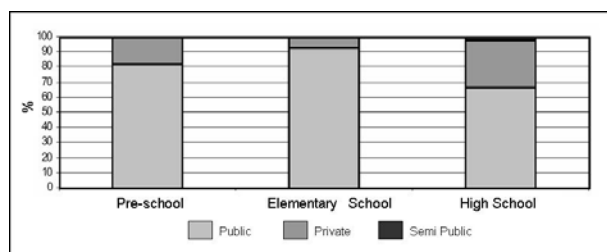
(56) Newspaper “La Tribuna”. “Maestros no aflojan jornadas de protestas” 4/17/05 www.latribuna.hn

(57) Currículum Nacional Básico. “Marco Contextual”. Department of Education. Pg 9. 2003

Generally, there are better results when a small teacher-student ratio is small than a big one. In Honduras, there are an average of 22 students per teacher in high school, while 34 students per teacher in elementary level (in the US, an average of students of 16 are attended per teacher).

The high school level shows the biggest gap between what the Honduran society expects from the educational process and what is really taught. Most of the poor families see high school as the access to a better economic and social condition, but the education given does not provide this reality, causing teenagers to be not adequately prepared for university level and real life. Girls register more times than boys to attend high school (23% more) because boys decide to work to sustain their families or learn to live individually.

Figure 4: Distribution of students by schools (year 2000)



The central government is financially funding the majority of the schools attended by the student population (Fig 4). However, the government cannot longer sustain their operations because it has began to also subsidize some private institutions in financial crisis (1.6%).⁵⁸

Source: Cesar Castillo, UNDP 2003

6.1.1 Problems posed by high dropouts rates, teacher shortages and unqualified staff

Besides the problems coming from the central government that affect the Honduran education system, other problems come from the students. The Honduran Department of Education calculated in 2003 that only 22.7% of the total student population that was ready to go to high school did finish secondary school.⁵⁹ The average level of education of the Hondurans is low (4.7 years of study). Dropouts rates are high and represent a fiscal burden (26% of social expenditures of the Department of Education are absorbed by repeaters and dropouts). As a consequence, the Honduran government with the help from foreign countries and international banks, has designed strategies to fight this dropout rate, which include the redesign the national curricula, upgrade of material to one-teacher schools, and increase bilingual education.⁶⁰ Some reasons for the dropouts by students are the need to help sustain their nuclear family and/or gain independency, and the lack of motivation to continue studying. There are similar problems in the rest of Latin America. On average, Latin-Americans need to attend at least ten to twelve years of school education if they want to have a possibility of 90% of not turning to or continue in poverty.⁶¹

6.2.0 How the education about electric energy savings has been implemented in Honduras?

An Energy Efficiency program began in 1994 with the joint-cooperation of the Argentinean Horizontal Fund and ENEE, done through the educative system. In 1996, the European Commission and ENEE built up the

(58) Castillo, Cesar. "La equidad en el sistema educativo en Honduras". UNDP. Pg. 16 2003

(59) Educación por departamento. "Cuadro 1: Taza de analfabetismo y años de estudio promedio por estrato. 2003. www.se.gov.hn

(60) World Bank. "Honduras CAS: Country Program Matrix (FY03-06)." Annex B1

(61) Castillo, Cesar. "La equidad en el sistema educativo en Honduras". UNDP. Pg. 13 2003

GAUREE 1 project, a cooperation treaty with the objective to promote energy efficiency in the residential sector through a national educative campaign and perform energy audits in the industrial sector.

The Energy Efficiency program that began in 1994 has taken a similar approach to the one the US' has used since in the 1970s: through infusing the academic curriculum of High schools with information on energy⁽⁶²⁾. Other options to attempt to formalize electric energy savings education are not possible at this time in Honduras, because adding a new course to the school curriculum will require expanding the academic schedule, possibly designing specific books for this topic and hiring new professors. Placing electric energy savings education as an elective course would only be possible to be done through the richest schools where there are options for electives; most schools do not practice having options for their students.

After more than ten years of the National Electric Energy Utility (ENEE) has been implementing electric energy savings education through schools (residential sector), commercial and industrial sectors (through energy audits and seminars), many people are now aware that electric energy savings education is helpful because they realize the program teaches them how to save money. Ever since Honduras has been more dependent in fossil fuels to generate electricity than through water and now with the coming of new technology and change of lifestyles that the free-market trade CAFTA, it is more important than ever before for the Hondurans to learn about the benefits of electric energy savings to save money.

Some of the benefits of an electric energy savings education are that it helps the people save money in their houses and businesses, the government will spend less money investing in the purchase of fossil fuels and there is going to be less pollution. In addition, it will help prepare the people to act better with the possible new electricity scenarios resulting from increased dependency on fossil fuels. By 2002, GAUREE 2, the second stage of the project, makes more coverage in these sectors through modules that decrease the transmission losses in the rural sector and that promote renewable energy. In 2004, the electric energy savings obtained because of the educative campaign were the equivalent consumption of having 200 houses that used 800 kWh/month⁶³. Some of the consequences derived from the awareness of electricity savings is that encourages people to influence in the political decision-making of the country⁽⁶⁴⁾.

GAUREE 2 is finishing its functions by September 2006. ENEE will need to make another agreement with the European Commission or look for international cooperation to continue sponsoring the energy audits and the electric energy savings campaign. Hopefully, many schools will continue the campaign within their academic plans, but by introducing energy saving guidelines to high schools, electric energy savings education will be given in a better systematic way.

(62, 64) Rodney, Allen. "Energy Education: Goals and Practices". Phi Delta Kappa Educational Foundation., Indiana. 1980 Pgs 6-8.

(63) Jose Jorge Canales Martinez. Technical Cooperation Engineer. 2004 Report. GAUREE 2. 2004.

Part III: An approach to Electric Energy Savings Education in Honduras

7.0.0 Introduction, development and follow-up of the guidelines into the Honduran Education System

7.1.0 Institutions

7.1.1 Institutions already involved in the topic of electric energy savings education

The following institutions have already participated in the development of the electric energy savings campaign, which again could participate in the introduction and development of the energy-education guidelines: Congress, Department of Natural Resources and Environment (SERNA), Department of Education (SEP), National Institute of Statistics (INE) and the National Electric Energy Utility (ENEE). All of these governmental offices have given information and lent staff for the design of the campaign. There was only one period (2000-2001) where the private sector helped economically to provide some funds for the printing of the booklets designed by ENEE and the European Commission.

7.1.2 Institutions recommended to be involved in the development of the electric energy savings guidelines:

The Presidency and the Department of International Technical Cooperation (SETCO) are recommended to participate in the stage of introduction and development of the guidelines. The Presidency needs to be aware of the objectives and efforts followed in this campaign and help through SETCO the sponsorship of the new books to be designed as a follow up of this thesis and through the Department of Education the formalization of electric energy savings as a transversal axis through all the Honduran Education System.

7.2.0 Antecedents of how the energy-savings education material is given through the campaign:

During ENEE's campaign, the training of the schoolteachers and students have been made through seminars in the most important cities in Honduras. ENEE has made the training in two days every two years with the cooperation of governmental presenters from SERNA, SEP and Congress.

The material given to the schoolteachers from each institution involved are fliers and booklets, but some few ideas were repeated in each material. The material that ENEE still provides to the schools divides into two small booklets: The first one contains information explaining why electric energy savings are a worldwide concern, historical and current electricity situation in Honduras and benefits of renewable energy over fossil fuels. The second booklet describes how to save electricity in a house, how to read the electricity meter and shows the electricity consumption of some common electrical appliances. None of them describes how the concepts should be taught to the students, causing the schoolteachers to guess how and when to teach appropriately the contents. Updates for the statistics in the material are given by INE and ENEE every time there is a new design for the material (until the existence of material finishes). After the GAUREE 2 project finishes in Fall of 2006, ENEE will need to look for financial help from the embassies and NGOs through SETCO and private sector because the economical support from the European Commission would have finished.

7.3.0 Development of the Electric Energy Savings Education Guidelines into the Education System

Since all the schools only officially follow the transversal axes of Identity, Work, and Democratic Participation (section 5.2.0), the Electric Energy Savings Education Guidelines also need support from the Minister of Education. After the Minister of Education has pointed out his concerns, approved of the Energy Saving Education Guidelines, and become a new transversal axis, then it is necessary to show the guidelines to each governmental education sector, inform the Presidency of the benefits of the guidelines, and obtain support for international financial cooperation. The Department of Education will then start by notifying of the activity to all the States Directors of Education and some school-representative Principals from the 18 Honduran states. This stage will become the official presentation of the guidelines by ENEE and the Department of Education to the states. The next stage needed is the training of the teachers of each school from the Honduran states.

7.3.1 Training of the schoolteachers about the electric energy saving guidelines

In each state, through the cooperation of each State Director of Education, request to the most populated schools in each state-capital to send a school teacher in the area of natural sciences to attend a seminar where schoolteachers are going to be shown the importance and use of the energy-savings education guidelines. Each seminar will be given every two years and to different high schools. The seminars are recommended to be done in the State Department of Education in order to save costs of renting. Within the building, it is advised to allow 2-3 private providers of food so that the guests are able to have a greater variety of choices. Each seminar is recommendable to be done if possible before the academic year begins. Consequently, this means there is going to be a seminar by separate between the bilingual and non-bilingual schools due to their different academic year.

After the seminar, these professors (called School Facilitator SF)) will be in charge of introducing the guidelines through their schools and will receive from ENEE educational materials to promote the concepts in classes. The teachers will introduce the topics to their school Principals and let them know that the energy-savings education will be given in a transversal axis in the different existing courses. The axis means that through many courses the concepts of the guidelines could be applied into what the professors have planned in their academic year. For example, the Computer schoolteacher could assign the students to design charts that show how their families use their electricity each day and examine which activities are the most economically influencing the electricity bill. No school will have to pay additional working hours to these professors because the activities to support the campaign are going to be made supplementing the academic material under process and extracurricular activities related to electric energy savings be made during specific festivities such as Earth Day, National Tree Day, and Mother's Day.

The School-facilitator will need to seek the collaboration through the school Principal of the other high-school teachers in the same school to introduce the electric energy savings guidelines. When the SF plans to move away from the institution, he/she must prepare another high school teacher to help monitor the guidelines in the following year. In order to learn in anticipation of this event to happen, the professors must provide a report to their school Principal about the activities accomplished at the end of the school year and their decision to continue in the school. In case the current professor is moving away, the school Principal will then have to

request the departing professor to train a new professor to monitor the development of the energy education guidelines.

7.3.2 Outreach plans within and outside the schools with a School-facilitator

Depending on the activities proposed by the school teachers involved in the use of the energy guidelines, the SF and the rest of the schoolteachers could design activities that will introduce the topic of electric energy savings throughout the school. For example, during Mother's day, design some posters containing energy-savings messages; selected high school students could also use the same posters to make a presentation in one day in one hour to elementary school students.

Since there are going to be a limited number of SF's every 2 years, every SF needs also to extend the message of the electric energy savings guidelines to other high schools within the same city/town until all the schools work independently with the guidelines. In order for the High School Students to graduate, they need to perform a Social Educative Work (TES) in their community during the entire academic year⁶⁵ The TES involves designing a macro or micro project that will help the students to integrate and participate in the solutions of social concerns of their community. Therefore, through the TES, the SF can extend the training of energy saving guidelines to other high schools that do not have yet a SF.

7.4.0 Conceptual framework of the Energy-Savings education guidelines

The following courses from the High School level to be discussed in this section are the courses that are suggested to be used to follow up the Energy education guidelines. The Computer, Physics, Chemistry and Biology classes are usually given throughout the two High School levels. High schools usually divide a specific textbook into two stages for 10th and 11th grades. The textbook used in bilingual schools are usually from the brands Prentice Hall and Scott Foresman; non-bilingual schools usually follow either a translation from a US textbook, Mexico or Honduras.

Some courses are not given in both High school grades or the content is different in each grade. The Social Studies course given at 10th grade (Honduras's History) is given in Spanish at bilingual schools. At 11th grade, the Social Studies course becomes oriented with sustainable development approach, causing its name to be changed to "Social Economic Development"; also given in Spanish. The History of Cultures course includes changes in Honduran traditions (ie cooking) and the Social Educative Work (TES) involves the interaction of students with the local community. Depending on the high school, a course is usually given with a miscellaneous topic, which includes Arts, Agriculture or Music. In this case, the Arts topic is proposed to help the purpose of this document.

The academic year is different between bilingual and non-bilingual schools. Bilingual schools follow in a similar way the US academic year (190 days in average), whereas non-bilingual schools start classes in February and end by November (200 days in average) The following suggested curriculum of courses will show how the contents from some of US textbooks help pursue the objectives of the energy-savings guidelines.

(65) UNESCO. "Desarrollo de la Educación". 1996. <http://www.ibe.unesco.org/countries/countryDossier/natrep96/honduras96.pdf>

Figure 5: Proposal of high school courses that would help give the message of the electricity energy-savings education guidelines

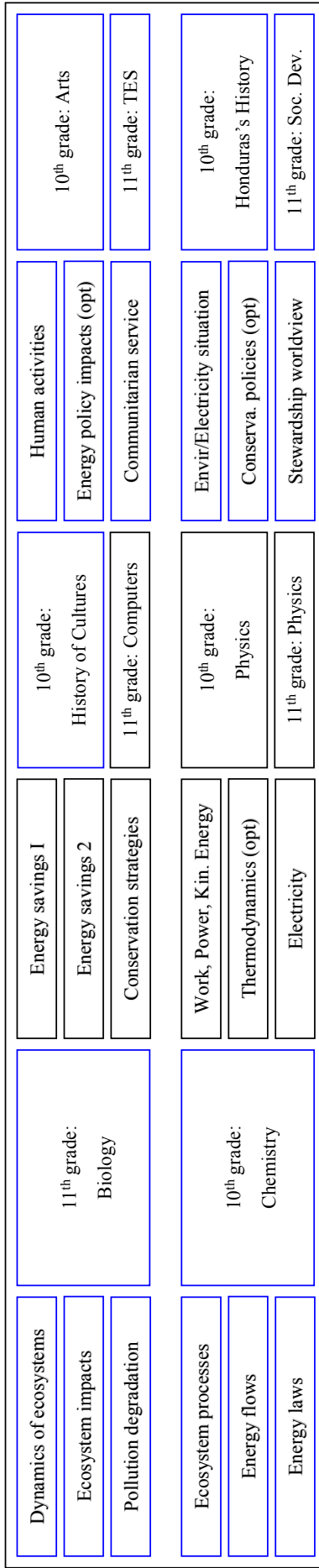


Chart 5: Diagrams that shows how the content of the energy-saving guidelines are recommended to be given during 10th and 11th grades

Course	10 th grade			
	1 st Trimester	2 nd Trimester	3 rd Trimester	4 th Trimester
Physics	Work, power, kin. energy			
Chemistry	Ecosystem processes	Energy flows, energy laws		
History of Cultures				
Honduras's History				
Arts				

Course	11 th grade			
	1 st Trimester	2 nd Trimester	3 rd Trimester	4 th Trimester
Physics			Electricity (includes circuits)	
Biology	Ecosystem: pollution			
Computers				Conservation strategies
Social Econ. Devel.	Stewardship overview			
TES	Communitarian service	Communitarian service	Communitarian service	Communitarian service

For the High School level, there are no specific guidelines that specify which is the content of every trimester for each course. Schoolteachers usually follow order of the lessons of the textbooks used, or they skip lessons in between of them⁶⁶. Figure 5 shows a summary of the contents reviewed in certain courses that help orientate the student and teacher in the topic of electric energy savings. The division of most of the topics comes from a model given by Havemen & Connell, where they suggest that the left column involves natural systems concepts, while the right column human systems; the interaction of both systems is shown in the center column. The model also suggest that the concepts learned in the last row are concepts to be understood and the first row involves topics where the concepts learned operate⁶⁷; the selection of the courses and high school level were not included in their document. Chart 5 shows the ideal lineup of the contents of some textbooks that could be studied per trimester. In the case of Physics, the set up of the contents are helpful in both 10th and 11th grades, but not for Chemistry and Biology. In the case of Honduras's History, History of Cultures and Social Economical Development, they use a different textbook each one, so within their content it is shown what is useful in their curriculum to the energy-savings axis. The Arts and Computer courses, their content is more flexible, so the topic of energy efficiency was placed where it is ideal for the development of the axis. The TES course involves a project where the energy-savings knowledge could be applied anytime depending on the programmed activities.

(66) Martinez Alonzo, Daisy. Engineering organizer, section school-construction. Department of Education. 2006. daisiesdonottell@yahoo.es

(67) Havemen, Jaekeline. O'Connell, Kathryn. "Energy Conservation curriculum model (Orientation guide). Far West Lab. 1979

7.4.1. Concepts to be given during the 10th grade

a) Arts

This course could help spread the message of electric energy savings through what they do in their assignments each trimester. For example, a trimester where topics about marketing, poster design or/and elaboration of booklets are done, students can elaborate posters and informative booklets/handouts related to electric energy savings, which can be afterwards given during special celebrations at their school or to other students from the Middle and Elementary levels. Other idea is to design material that could help the student's parents how to read the electricity meter, which is helpful to understand why the electricity bill is different every month.

b) Chemistry

Using the Chemistry book written by Peter Atkins and Loretta Jones, "Chemistry: Molecules, matter and change", 2000 edition, from the W.H. Freeman Press, we have the following lessons useful to support the energy education guidelines:

Topic1: Chemical reactions (Lesson 3)⁶⁸: Learn the concepts of: chemical reaction, potential energy, kinetic energy, Law of Conservation of Energy, hydrocarbons, exothermic and endothermic reactions and combustion

Topic 2: Thermo-chemistry: The fire within (Lesson 6)⁶⁹: Learn the concepts of enthalpy, calorimetry, work, heat and the forms of energy and their interconversion.

By using the material from lesson 3, there is a reference how an ecosystem is not static because its pressure factors (land use, fragmentation and climate changes) change over time by environmental factors (intensity of agriculture, dams and precipitation respectively)⁷⁰. The driver pressures affect the sources of electricity (ie water). The final product of lesson 6 is to understand how electricity changes into other types of energy (ie Heat), useful to indicate the efficiency losses when distributing the electricity supply in a house.

c) Physics

Following the contents of the Prentice Hall 1999 edition⁷¹, the topics that are useful for the 10th grade student, which are linked with the energy saving guidelines are:

Topic1: Energy (Lesson 8)⁷²: Learn the definition and mathematics of work, calculating the amount of work done by forces, potential and kinetic energy, mechanical energy and power

Topic 2: Thermodynamics (Lesson 24) (Optional: also possibly to be reviewed in the Chemistry course)⁷³

- Temperature and heat; 1st, 2nd, and 3rd Laws of thermodynamics

By defining what is power and energy, the student will be able to understand how energy could be generated from the environment (ie water) and how humans use potential sources of electricity (ie waterfall).

(68) Hope Benson. "Chemistry curriculum guide" <http://www.angelfire.com/nj3/benchemistry/>

(69) Washington University. "Thermo-chemistry Energy, flow and chemical change"

http://depts.washington.edu/chemcrs/bulkdisk/chem142U_aut01/notes_For_November_13_2001.pdf

(70) GLOBIO. "Conceptual framework GBM". 2001 www.globio.info/download.cfm?File=methodology/gbm.pdf

(71) Pearson & Prentice Hall. "Scott Foresman Addison Wesley Conceptual Physics". 2004. <http://phcatalog.pearson.com>

(72) Glenbrook. "The Physics classroom". 2004. <http://www.glenbrook.k12.il.us/gbssci/phys/Class/energy/energto.html>

(73) Wikibooks. "High school physics". 2006. http://en.wikibooks.org/wiki/High_school_physics

In Thermodynamics, machines and modern devices change heat into work (such as an automobile engine) or turn work into heat (or cooling, as in a refrigerator), reason why is necessary to know how much mechanical energy can be equivalent to heat energy and to electricity ⁷⁴.

d) History of Cultures

The contents of this course are a comparison of the modern times and post-modern times. The relations between culture and society are related to the advances in technology and mass media. Because how to save electricity is innovative in the Honduran education system, the purpose is then that through the History of Cultures course help introduce the student to this practice of saving electricity. Hondurans now demand more electricity because there is new technology available and many of them like to be updated in regard to worldwide lifestyles (for example, use of the internet to learn which electrical appliances offer the same service but with less use of electricity). The teacher in this course might need the cooperation of the Physics or Math courses because of some technical concepts that might need review.. From this practice, the students can extend their reasoning to save water and other resources, not only in their households, but also in their future jobs or enterprises.

e) Honduras's History

The book usually used for this course is called "Historia de Honduras", written by Guillermo Varela Osorio (1994) ⁷⁵. In the last part of the book, there is an explanation of how the electricity sector is linked with some other governmental problems during the late 20th century. The chapters include the Honduran Liberal Reforms, Economy and Society and the Centro American political crisis (years 1982-1990). The information in these chapters could help the student relate how the changes in the environment and in the Honduran society have contributed to changes in the electricity service. In addition, there could be a discussion of how general governmental policies relate to the trends of Globalization and consequently increases the demand of electricity.

7.4.2 Concepts to be given during the 11th grade

a) Biology

Following the Biology book written by Dr. George Johnson, Dr. Jonathan Losos (both from Washington University) and Dr. Susan Singer (Carleton College), in its sixth edition, the lessons to consider helping the energy guidelines are ⁷⁶:

Topic 1: Dynamics of ecosystems (Lesson 28): How species richness influences community stability

Topic 2: The Biosphere (Lesson 29): Evolutionary responses to environmental variation

Topic 3: The future of the biosphere (Lesson 30)

The purpose of these topics is to understand how the end use electricity generated from fossil fuels (pollution) can cause harm to the stability of a community, causing environmental degradation.

(74) School for champions. "Thermodynamics". 2006. <http://www.school-for-champions.com/science/thermodyn.htm>

(75) Nacional Autonomous University of Honduras (UNAH). "Curso de Historia de Honduras" 2006. <http://www.cra.unah.edu.hn/sued/Cronograma%20Historia%20de%20Honduras.htm>

(76) McGraw-Hill. Online Learning Center: Biology. 2002.

http://highered.mcgraw-hill.com/sites/0073031208/information_center_view0/list_of_changes.html

b) Computers

The Computer Course is not available through all High Schools because many public schools and few private schools do not have computers, but Congress has officially declared in February 2006 to be given in all schools from 4th to the end of High School (including English) ⁷⁷. Because of this order, the Department of Foreign Affairs will look for foreign donations to bring some computers for the public schools. Depending in the software program that the course is practicing, the students could elaborate, for example, an excel chart showing how the electricity is being used in a household. The files to be made through this course will help the student give an insight of how the family budget can be organized in a systematic and computerized way.

c) Physics

Using the same book from 10th grade, the following topic is suggested:

Topic 1: Electricity (Lesson 34): Voltage, current, Ohms Law and electric circuits

The concepts involved in this lesson will help understand the student the different components of electricity, the difference of electrical potential in a circuit and an overview of what implies electricity generation, transmission and distribution throughout the country.

d) Honduras's Social Economical Development

Using the book written by Maria Emildre-Torres de Paz ⁷⁸ (3rd edition, 2000), there is a summary explaining which are the major issues in Honduras through the years and how international institutions and countries have helped the Honduran government to improve its major programs for the sustainable development of the country. People are usually unaware about voluntary programs in Honduras, but also most of the Honduran citizens are not used to participate in these kinds of programs. Stewardship has a high participation of the people other societies (like in the US), reason that the materials seen in this course will help introduce the student to understand the problems in the Honduran society and help encourage the student to help solve those problems.

e) Educative Social Work (TES):

In the community or neighborhood where the students are working for their TES, students could finally apply all the knowledge learned about Energy-Savings during High School into a macro or micro project. Some of the projects that could be given are a small presentation of electric energy savings to a local elementary school or to the local leaders, so that the knowledge of electric energy savings could be extended to other sectors of society.

8.0.0 Samples of energy-saving education guidelines

In section 8.2.0, samples lessons of each course for each grade (except for the Physics class) will be shown per trimester beginning by 10th grade. Each lesson plan will describe the concepts to be learned, student objectives, overview, background and an activity to do to support the ideas. Because there could be different textbooks or projects used for each course, in the lesson there is a description of what the student should need to understand this lesson and what should the person learned at the end.

(77) Newspaper La Tribuna. "Ingles y computacion seran impartidas en las escuelas". 2/06

(78) Libros Latinos. "Libros Centroamericanos" 2006. <http://www.libroslatinos.com/cgi-bin/libros/CA19942.html>

8.1.0 Considerations of the education standards used for the lesson plans

As mentioned on page 17, there are no High School education standards in Honduras; for the moment, there are under design. In order to propose energy-savings education guidelines for the high school level, then this document analyses what the Honduran student should have learned by 9th grade, based on the Honduran National Curriculum Design for Basic Education (DCNB) from the Department of Education ⁷⁹. In addition, it will follow the US Science and Technology Concepts for Middle Schools (STC /MS TM) lessons design. STC /MS TM is an inquiry-based middle school science curriculum developed by the National Science Resources Center, from the Smithsonian/The National Academies ⁸⁰. The concepts to be learned in the high school level are based on the Science Content Standards 9-12 grades from the US National Science Education Standards ⁸¹. The ideas of each lesson will be based on many sources, but their content will be modified to adapt the issues developed in Honduras.

The design of each lesson plan is to be a group of lessons for each course proposed on page 17. This means that, if there is a Teacher' edition of each textbook used on the courses proposed, then this document is shown lesson plans that will be added to the curriculum of each course. There is no Student's guide proposed in this document because the energy-savings guidelines are suggested to be a complement to the contents of each course, and not as a formal knowledge of the course. Each lesson will have the following divisions:

- a) Concepts: The knowledge to be learned is based on those in the US National Science Education Standards.
- b) Student objectives: A list of things students are expected to accomplish in the lesson.
- c) Overview: Description of the antecedents from the DCNB to support what it is suggested to be accomplished by following the US National Science Education Standards.
- d) Background: Information intended to provide teachers who are not unfamiliar with the lesson's content concepts for answering student questions and facts from the Honduran reality.
- e) Materials: A list of materials for the teacher as well as students needed for the lesson plan. Realizing that most of the Honduran high schools are not equipped with multimedia equipment, and then some things are mentioned as options to use.
- f) Getting started: Steps suggested to the teacher to introduce the contents of the lesson.
- g) Extensions: Activities recommended extending the student's experience of the topic in other fields of science to insure a more integrated curriculum or to go deeper into the field discussed.

A section for homework is not proposed directly, but can be suggested to be done in the "extensions" section. A preparation for a next lesson will depend on the contents followed in the course. The School Facilitator (SF) can organize with the rest of the teachers assignments that will also help follow up the energy-savings education guidelines, for example, a Science-Fair. In this case, the Physics, Chemistry and Biology courses can propose ideas for the students who want a guidance of what activity to do.

(79) Department of Education. "Diseño Curricular Nacional para la Educación Básica, III ciclo. Inter American Development Bank. 2005

(80) Smithsonian /The National Academies. "Energy, Machines and Motion". 2006. <http://www.stcms.si.edu/emm/energy.htm>

(81) National Science Education Standards. "Science Content Standards: 9-12". 20006. <http://newton.nap.edu/html/nses/html/6e.html#ps>



Fig. 6 Dowall School, Tegucigalpa

In addition to these type of events, the SF could invite a speaker from the government, (ie. Department of Natural Resources and Environment (SERNA)) to talk about of a specific topic about energy-savings. It is also important to know that if from the student’s parents there are stakeholders from the energy, environment, globalization and sustainable development issues because through these representatives they could obtain additional funds to make an activity.

Figure 6 is an example of how the Minister of Foreign Relations was invited as a judge of the Science Fair at Dowall School, because she is at the same time mother of one of the student of the school. An example of an activity that will require some funding is visit to the biggest hydroelectric dam in Honduras, “El Cajon”, would possible need the hiring of an additional driver, renting a bus and providing meals.

8.2.0 Evaluation of the energy-saving education guidelines

8.2.1 Statistical records

In page 13, section 6.2.0 it was mentioned that through the collection of electricity bills from the schools participating in the Energy-Savings campaign, it was possible to make an estimate of the potential saved energy in the residential sector. However, not all the Honduran states participated in the energy study. In addition, the information collected were more coming from bilingual schools (middle to high-class families) than schools where students were from low-incomes. If the energy-savings education guidelines become official, then it will be easier to have a better cooperation of a larger group of schools and then collect electricity bills. These bills need to be collected at the beginning of the school year, given to the SF so he/she could be in contact with ENEE to check the monthly electricity consumption per student’ household. It is planned that the students during their high school education will share the acquire knowledge in their houses, consequently influence in a multiple approach to save electricity. The monitoring of the electricity consumption will help the SF and ENEE verify which problems to analyze in order to have more success. At the end of the school year, after ENEE has calculated the electricity savings made through all the schools, will verify which things need to be improved. The electric energy savings calculated will be based on the sum of kWh saved in all the represented households and compare these savings with previous years and the number of students involved.

A second form to evaluate the program is to calculate the decrease of carbon dioxide emissions coming from the energy sector. In 2001, the carbon dioxide emission from the energy sector was 25.3% of the total emissions in Honduras⁸². In table 6, oil and diesel are used to generate electricity in 63% of the total made.

Table 6: Energy-related carbon dioxide emissions

▼ Measure ► Year	2000	2001	2002	2003
Million Metric tons of CO ₂	4.54	5.28	6.23	6.03

Source: International Atomic Energy Agency (IAEA). 2006. <http://www.iaea.org/inis/aws/eedrb/data/HN-enem.html>

(82) Earthtrends. “Carbon dioxide emissions by economic sector 2005”. http://earthtrends.wri.org/pdf_library/data_tables/cli2_2005.pdf

Rand Corporation, a NGO whose task is to give environmental information to the governments with the purpose of making better decisions with regard to the environment, found out that in Honduras' capital, Tegucigalpa MDC, is the Central American capital with the highest rate of air contamination. The contamination rate is causing an impact in the normal growth of children and in the ability to think⁸³. Although the greatest contributor to emissions is the internal transportation sector (40.9%), a change of attitude of the people by saving electricity will contribute to some decrease in carbon dioxide emissions.

A third way to evaluate success is by introducing a nationwide test to the students at the end of the high school level. There are no tests for the moment of any kind to evaluate the school education. In India, the Energy and Resources Institute (TERI) and the Ministry of Environment and Resources every year organizes the Green Olympiad, a series of tests based on nationwide environmental problems and general environmental knowledge. Therefore, TERI hopes to create an informed citizenry in the country that could become part of the leaders by 2047 (when India celebrates 100 years of independence)⁸⁴. In the same way, international and Honduran stakeholders could design a test at the end of high school to verify the knowledge acquired and energy savings education given. This test should contain general knowledge and national energy-concerns and be recommendable with a format of multiple-choice questions in order to have unique answers to check at the end.

8.2.2 Energy education system evaluation

In order to verify the quality of the guidelines (ie, changes in knowledge, skills and behavior) a survey could be designed for the residential sector evaluating their impact caused after some years of conducting the program. The survey might ask an adult family member basic knowledge about energy savings, if they have changed attitude towards energy use and the environment, and if they have changed some electrical appliances for better energy-efficient models (for example, incandescent light bulbs by compact-fluorescent light bulbs). The survey might also ask how the behavior of teenagers have influenced other people in saving energy.

A second way to verify the impact of the energy-saving guidelines is to analyze the contribution to the sustainability outcomes. For example, has the program helped to save energy in order to be redistributed to other areas where electrification was not available before? Has this program motivated other fields of the environment to be strengthened or integrated, for example, water conservation? Does it meet the needs of stakeholders? These questions can be answered through a multi-level situational analysis, community consultation, increase the number of professionals in the area of energy and the environment, and a state of environment report.

Finally, has the energy-savings influenced to improve environmental indexes? For example, the World Wildlife Foundation (WWF), in its Living Report from 2004, declares that there are 2.2 hectares of natural resources per person, where usually the person uses most of these resources as energy⁸⁵. Saving electricity will manage the use of natural resources, but also motivate the people to monitor what is damaging the environment.

8.3.0 Example of lesson plans

(83) Newspaper "La Tribuna". "En la capital, ¡alta contaminación! Pg 2. 01/15/2005.

(84) Energy and Resources Institute. "The Green Olympiad". Ministry of Environment and Forests / Hero Honda. 2005. www.teriin.org

(85) WWF 2004 Report. "Energy footprint". www.panda.org 6/02/05

Physics Lesson 34.2: Watt does it cost to do it? ^a

CONCEPTS

1. *Power* is the rate at which mechanical work is done (studied during the 9th grade Natural science class), but Power is also the rate at which electrical energy is supplied to a circuit or consumed by a load. Like current, power is a rate quantity: $\text{Power} = \text{energy consumed by load}/\text{time} = \text{Joule}/\text{second} = \text{watt}$.
2. When the power is more than 1000 watts, the unit is called kilowatt (kW). When a kilowatt is used in one hour, it is called *kilowatt-hour* (kWh). The electricity meter reads the amount of kWh that each household consumes per month. If an electrical appliance consumes 2 kW and it is used four hours, then the energy consumed by the appliance will be $(2 \text{ kW}) \times (4 \text{ h}) = 8 \text{ kWh}$.
3. In order to charge the energy consumption per household, each kWh has a price of Lps. 8.03 = US\$ 0.43 ^e (18.89 Lempiras = 1 US\$) ^b. When there is a calculation of the energy consumption of a entire house, then there is a chart of prices according to the total amount of kWh monthly consumed.
4. *Law of Conservation of Energy*: States that energy may neither be created nor destroyed. The sum of all energies in the system (which may take various forms, like heat, light and sound) is a constant ^c.

STUDENT OBJECTIVES

1. Students will learn that electricity is measured in units of kWh.
2. The students will determine the power needs (wattage) of representative electrical items in homes and business, and then calculate the kWh consumed by the amount of time each item is being used. After having calculated the amount of kWh consumed, then calculate the cost of each item used.
3. With the list of electrical items analyzed above, each student will design an inventory of the most used electrical appliances in their house and make energy-savings recommendations ^d.

OVERVIEW

According to the Honduran Curricular design of 9th grade, in the section “Matter and Energy” (pg 547), the student is able at the end of this grade, to know the basic concepts of electricity and manage some concepts of electricity savings. If the Honduran student meet this criteria, then he is able to understand what is studied in the 10th grade Physics course (US National Science Education Standards): “in all energy transfers, the overall effect is that the energy is spread out uniformly” . The transfer implies that some electric energy is turn to mechanical power, heat, sound or light.

(a) Alliance to Save Energy. “High school lesson plans. 2006. <http://www.ase.org/images/lib/educators/Watt...%20It%20Cost.pdf>

(b) Empresa Nacional de Energía Eléctrica (ENEE). “ENEE tarifas”. 2006. <http://www.enee.hn/Tarifas.htm>

(c) Banco Central de Honduras. “Cotizacion del dólar” 7/07/2006. www.bcn.hn

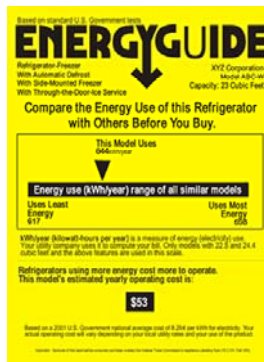
(d) Thinkquest. “The Law of Conservation of Energy”. 2006. <http://library.thinkquest.org/2745/data/lawce1.htm>

The US Content Standard B, in the section about Conservation of Energy and the increase in disorder, mentions that “the total energy of the universe is constant.....it can ever be destroyed. As these transfers occur, the matter involved becomes steadily less ordered”^e. All this conversions of electricity into heat (radiation, convection and conduction) is wasted energy. The best way to avoid this waste is to use appliances that generate the minimum heat (except if it is a heater), therefore it is convenient to know how much an electrical appliance consumes in the house and new a one is planned to be bought.

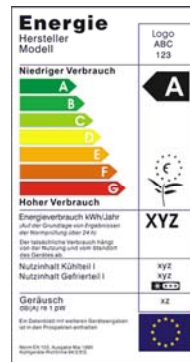
BACKGROUND

When power consumption is measured per appliance, usually the unit *watt* is being used. When the appliance is used over time, then *watt-hours* is the energy unit used. The unit for electricity consumption of more or equal than 1000 watts is called kilowatt-hour (kWh). As the energy consumption increases, then the prefix is changed (ie, Megawatt-hours (MWh)). Some electrical appliances, like small motors, their energy consumption is measured in *horse-power hour* (hph, which is equivalent to 0.746 kWh) or air-conditioner units, which are measured in British thermal units (Btu, equivalent to 0.000 293 kWh)^f. All this units are important to know, but for the matter of the lesson, the kilowatt-hour unit will be used.

Most Hondurans are not concerned about how much energy an electrical appliance consumes and do not know the cost of electricity each one has. Additionally, there are no energy-efficient policies about the appliances sold in the market, which usually come from Japan, US, China and South Korea. Some people might be interested in learning the energy consumption of each appliance, but do not understand the energy level label on the appliances. The following pictures show how in some countries people learn about electricity consumption in US and European Union appliances:



US energy consumption and energy efficiency labels^{g,h}



European Union Energy guide and energy efficiency labelⁱ



- (e) Nacional Science Education Standards. “Science Content Standards: 9-12. 2006 <http://newton.nap.edu/html/nses/html/6e.html#ps>
- (f) University of Exeter. “Energy Conversion calculator”. 2004. <http://www.projects.ex.ac.uk/trol/scol/ccenrgy.htm>
- (g) Mid American Energy. “Use energy efficiently”. 2006. www.midamericanenergy.com/.../5b_energyguide.gif
- (h) Jenn-Air. “Planning your kitchen? Creating an energy efficient kitchen” 2004. <http://www.jennair.com/ja>
- (i) Beratungs-UND Service. “Energy labels”. 2006. www.energy-labels.de/index.php?id=20

When electrical appliances have either of these labels, it means that compared with other brands that do not have the labels but with the same dimensions and functions, they do the same service but with less electricity. What is shown on a label is not how much power they actually draw continuously, but the maximum they draw. Thanks to these labels, people are able to notice that the model of an appliance consume less energy than the older models. If there is no label available, a *wattmeter* is used.

PERIOD Approximately 2 classes of 45 minutes each, for the discussion and elaboration of table

MATERIALS FOR THE LESSON

- a) For the teacher: Calculator, 2 representative electrical appliances, watt meter (optional)
- b) Each student: Information of energy label of 2 electrical appliances, calculator, electricity bill

GETTING STARTED

- a) Review the concepts of energy, watt, kilowatt, and kilowatt-hour
- b) Students read the labels of several electrical appliances on display. Let them identify from which country were the appliances made in and rate each appliance according to their consumptions. If the appliance consumes more than 200 watts, make a note of them as “big users”.
- c) Then make a note classifying each appliance according the biggest time of usage. Let them define how much time is each appliance used and then calculate the energy used in kWh. According to the energy spent by each appliance, calculate the amount of money (Lempiras and US\$) to see how much money is invested per usage. Ask them which are the appliances that produce more heat. Request each student to design a table ^j as is it shown below, write down their discoveries and discuss reasons to save energy according to their classification of the appliances brought.

Watt Does it Cost to Use It?							
Name _____				Period _____			
Item	Power needs	Big Users (>200 W)	On > 1 hour/day	Hours left on/day	Energy/day	Cost per day	Cost per year
incandescent lamp							
fluorescent lamp							
egg beater							

EXTENSION

Since some appliances might have their energy consumption in other units, teach the different unit conversions and assign them to bring a chart with the conversions from kWh to BTU and Hph.

(j) Alliance to Save Energy. “High school lesson plans. 2006. www.ase.org/images/lib/educators/Watt%20Does%20It%20Cost.pdf

Chemistry Lesson 6.4: How does energy get into fossil fuels? ^k

CONCEPTS

1. A *chemical change* occurs whenever compounds are formed or decomposed ^l
2. *Fossil fuels* are the remains of plant and animal life that are used to provide energy by combustion; coal, oil, natural gas^m.
3. *Chemical energy*: Energy that is the result of a chemical reaction or chemical change ⁿ.

STUDENT OBJECTIVES

1. The lesson will help students to understand that fossil fuels are actually a form of stored solar energy.
2. Students will remember that Honduras used to depend more in hydroelectricity during the 1980s than in fossil fuels to generate electricity. Today, the country depends more in fossil fuel to supply the demand of electricity. Since Honduras needs to import fossil fuels to generate electricity, then it becomes more expensive when buying it.
3. The worldwide petroleum reserves are decreasing and getting more expensive. Since Honduras is a developing country, there has to be efforts to wisely use the disposition of electricity to avoid the increasing purchase of fossil fuels in the short tem.

OVERVIEW

According to the Honduran Curricular design of 9th grade ^o, in the section “Matter and Energy” (pg 587), the student is able at the end of this grade, to manage some concepts of electricity savings. In addition, on section (pg 572), from 8th grade the student already understands photosynthesis and that light is a form of energy. If the Honduran student meet this criteria, then he is able to understand what is studied in the 10th grade Physics course (US National Science Education Standards): “The energy for life primarily derives from the sun.” From the Life Science section (Standard C): “As matter and energy flows through different levels of organization of living systems- cells, organs, organisms, communities- and between living systems and the physical environment, chemical elements are recombined in different ways” ^p.

BACKGROUND

In 1982, Honduras depended on 75% hydroelectricity and almost a 25% in hydrocarbons. In 1994, due to the atmospheric phenomenon of La Niña, the reservoir of the dam “El Cajon” decreased from 280 to 226 meters above sea level, near the minimum limit to generate electricity.

(k) McInerney, Karin. “Energy in the Environment: teaching kit”. Environmental Protection Authority of New South Wales, Pg. 34. Y96

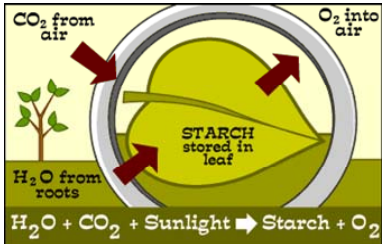
(l) Earth 991. “Environmental glossary”. 2006. washingtondc.earth911.org/usa/master.asp

(m) Frostburg University. “Chemical change”. 2005. <http://antoine.frostburg.edu/chem/senese/101/reactions/>


(n) Valemount BC. “Glossary”. <http://www.valemount.com/joel/lightoptics/glossary.htm>

(p) National Science Education Standards. “Science Content Standards: 9-12. 2006 <http://newton.nap.edu/html/nses/html/6e.html#ps>

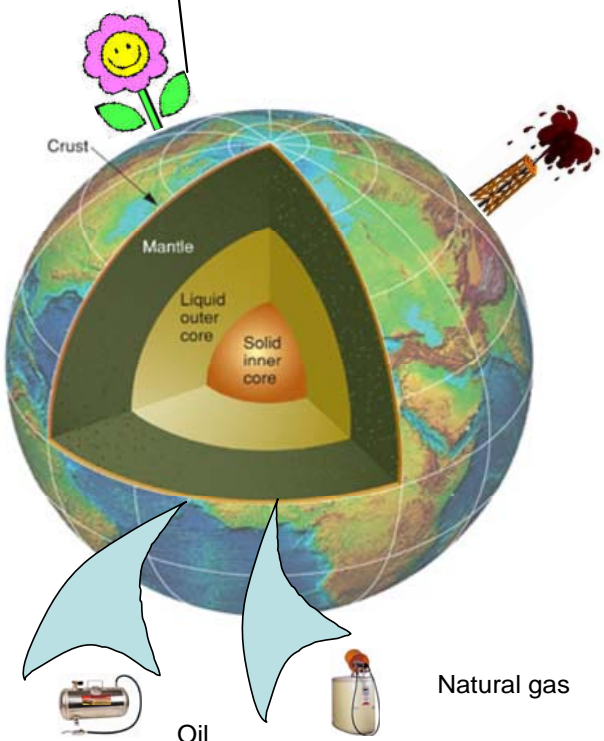
Because of this shortage of water, ENEE began making rationings in the national level. At first, rationings were two hours per day, but as the water supply got worse, the interruptions were enlarged, causing drastic impacts in all the economic sectors until 1996. Since then, ENEE was forced to greatly depend on thermal energy through diesel and gasoline. The following section describes the formation of these fossil fuels:




$H_2O + CO_2 + \text{Sunlight} \rightarrow \text{Starch} + O_2$



1. The sun radiates energy
2. In the process called **photosynthesis**, plants use this energy radiated from the sun (solar energy) to make food from carbon dioxide and water. Photosynthesis allows plants to convert **solar energy** into **chemical energy**. This means that the food made by the plants can be considered a form



Oil Natural gas



Buried plant material

3. To form coal the ancient plant swamps were buried in mud. As more and more layers of mud and other sediments began to build up on top of them, they stayed to undergo chemical changes.
4. Over millions of years, the energy rich chemicals in the remains of the plants were compressed and heated deep within the earth's crust. Under this heat and pressure, they slowly underwent **chemical changes** and become concentrated, forming mostly **hydrocarbons** (chemicals made up mainly of hydrogen and carbon atoms) with some impurities.

Sources of the pictures: www.energex.com.au
www.missourigrapegrowers.org, www.llnl.gov

Oil and gas were formed in a similar way to coal except that the buried organisms probably lived in lakes or shallow seas rather than swamps.

By 2004, Honduras was depending on a 63.4% from fossil fuels, 34.5% hydropower and 2.1% in renewable energy.

(q) Newspaper "La Tribuna". ENEE says that the El Cajon is causing the problem" 4/4/04
 (r) Latin American Organization of Energy and University of Calgary. "Energy statistics 2005. 2005. <http://www.olade.org>
 (s) Environmental Literacy Council. "Fossil fuels", 2006. <http://www.enviroliteracy.org/subcategory.php/21.html>

The levels of the water are not stable most of the time, causing new contracts of thermal energy to be done to cushion the possible emergencies⁹. The contracts do not allow the government to easily expand the electricity grid, which is only covering 65.9% of Honduras. The situation worsens when the electricity consumption per Honduran is also increasing: from 350 kWh/person in 1997 to 572.96 kWh/person in 2004^r. Fossil fuels have been the dominant energy source for over a century around the world (in a 90%^s) because of their fast disposition for generation and their concentration of energy. The great dependency on fuels is not only because of electricity generation, but also by transportation and other products derived from hydrocarbons. The worldwide reserves have been estimated to last from 17-70 years^t.

PERIOD Two classes of 45 minutes each, for the discussion and elaboration of worksheet




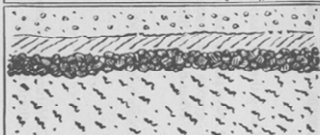
MATERIALS FOR THE LESSON

a) For the teacher: Make copies of worksheet below.

GETTING STARTED

a) Ask the students what are fossil fuels, which are their uses and if they are aware of the national and international situation of them

b) Explain the formation of fossil fuels (previous page) and relate this idea with the different conversions of energy taken place in the process. Ask the students to complete the chart below, and ask which are the

How does energy get into coal?		
	What is happening at each stage?	Changes occurring
1	 Sun is radiating energy	Heat and light are striking the earth
2	 Plants absorb solar energy (light)	Photosynthesis Chemical Energy Chemical energy
3	 Sediments laid down, burying swamp plants	Buried plants start to undergo chemical change
4	 Buried swamp plants subjected to a high degree of heat and pressure	Heat and pressure cause chemical change of hydrocarbons to form fossil fuels

possible solutions that might help decrease the use of fossil fuels (answers provided).

EXTENSION

Plan a visit to one of the thermal plants near your town and find out how many people and cities depend on their generation. Check out the places at

www.enee.hn.

(t) Chughtai, Osman. David Shannon, David. "Fossil Fuels". <http://www.umich.edu/~gs265/society/fossilfuels.htm>

Honduras's History Lesson 3.2: How Honduras is affected by the availability of electricity

CONCEPTS

1. Electric energy is provided to the cities by generating electricity through water, fossil fuels, nuclear energy (not available in Honduras) and renewable energy. In rural areas, renewable sources and water are used to generate electricity.
2. During the 1990s, there were many sociopolitical changes in Honduras, for example, reduction in the economic deficit and the decrease of barriers for foreign investment. The introduction of the apparel sector increased the welfare in the northern part of Honduras, as well as electricity demand. The Central American Free Trade Agreement (CAFTA) is under operation in Central America, which will introduce new industry to the country as well as choices for new labor, social and technological changes ^u. The European Union is also beginning a free trade agreement with Central America, causing the Presidents of the region to plan ahead how electricity is going to be supplied with 2 trade agreements. ^w.
3. Governmental investment in the electricity sector has decreased because it is unable to immediately satisfy the demand. The private participation is annually increasing 15.3% ^x and internationally fossil fuel prices are usually increasing, causing the government difficulties to control prices per kWh being sold.

STUDENT OBJECTIVES

1. Students are planned to relate Honduran historical events, especially the electricity sector and make a linkage to Central American and worldwide issues.
2. Students are asked to do research of historical events in Honduras that have contributed to the actual situation of the electricity sector. Through the linkage of Honduran history and electricity, have a brainstorm of ideas that will explain to them the how these events have contributed to increasing poverty in the country and which other sectors might be affected as a consequence. At the end, discuss how they can individually be committed in their lives in order to decrease the problems in the electricity sector.

OVERVIEW

According to the Honduran Curricular design of 9th grade, in the section “Societies and Geographical spaces” (pg 366, National Curriculum Design for Basic Education), the student is able at the end of this grade, to understand how Honduras is doing in political, economical, social and diplomatic issues. Meeting this criteria, the student is able to understand what is studied in the 10th grade content standard F from the US National Science Education Standards about Science in Personal and Social Perspectives: “The limitation is not the availability of space, but the number of people in relation to resources and the

(u) Newspaper “El Heraldó”. “Economy: They cease the beginning of CAFTA until April” . Pg. 20 02/11/06.

(w) Newspaper “La Tribuna”. Central America is planning to deal a Free Trade Agreement with the EU”. 7/12/06 www.latribuna.hn

(x) Department of Nat. Resources and Envir. (SERNA) “Informe del Estado del Ambiente, Honduras 2000”. Pg 46. World Bank. 2001

capacity of earth systems to support human beings. Changes in technology can cause significant changes, either positive or negative, in carrying capacity”.

BACKGROUND

During the 1980s, Honduras’ electricity was generated on 75% from water and almost a 25% from fossil fuels, when the population was 3.6 million and the GDP averaged 4.6%, but during the 1990s the GDP decreased to the point that it became almost negative because of the poor private investment ^y. Because of this GDP, economic liberalization was an essential element during President Rafael Callejas-Romero. He then devaluated the currency so more foreign investment to the country could come, which caused the apparel industry to grow in the north ^z, while non traditional agriculture in the south (which caused massive deforestation), thus decreasing the water supply and hydroelectric capability . By that time, hydropower generation was decreasing, the population was still increasing 2.5% year and the phenomenon “El Niño” worsened the hydropower potential. Now the country is dependent in 63.4% from fossil fuels, 34.5% hydropower and 2.1% in renewable energy.

CAFTA, the free trade agreement between the US and Central America will surely bring changes in technology and social conditions and a treaty between Central America and the European Union is under planning. The problem is from where is economically and environmentally convenient to have electricity to supply this potential new demand of coming infrastructure and change of lifestyles.

PERIOD One class of 45 minutes for the discussion. Elaboration of report is for the rest of trimester.

MATERIALS FOR THE LESSON For the teacher: Historical newspaper articles about topic

GETTING STARTED (note: this lesson is ideally to be made at least 4 weeks before examinations)

- a) Discuss with the students the historical events that led to the changes in the Honduran electricity sector
- b) Assign the students to start collecting articles from issues related to the electricity sector through newspapers, internet (if possible), local library and local government. The articles include water supply, deforestation, fossil fuel imports, population trends, globalization and governmental policies. With these sources of information, propose a small research paper that will relate them with electricity.
- c) In a week before examinations, let the students make an oral presentation of 10 minutes, where they will summarize their findings and correlate them to the lifestyles that their families have felt because of the changes in the electricity sector and how electric energy savings could help decrease these impacts.

EXTENSION: Have a forum discussing “Can limiting population growth protect the environment?”
Make comments on what is happening in Thailand and China, where there is population control ^α.

(y) Painter, Michael and Dirham, William. “The social causes of environmental destruction in Latin America. U Michigan. ‘95. Pg 88
(z) American Momory from the Library Congress. “Honduras, macroeconomic trends: recent growths. 1992. <http://lcweb2.loc.gov>
(α) Goldfarb, Theodore. “Taking sides, Clashing views on controversial environmental issues”. Mac Graw-Hill. 2001. Pg 132

History of Cultures Lesson 8.5: Life cycle cost

CONCEPTS

1. *Power* is the rate at which mechanical work is done (studied during the 9th grade Natural science class), but Power is also the rate at which electrical energy is supplied to a circuit or consumed by a load. Like current, power is a rate quantity: $\text{Power} = \text{energy consumed by load}/\text{time} = \text{Joule/second} = \text{watt}$
2. When the power is more than 1000 watts, the unit is called *kilowatt* (kW). When a kilowatt is used in one hour, it is called kilowatt-hour (kWh). The electricity meter reads the amount of kWh that each household consumes per month.
3. In order to charge the energy consumption per household, each kWh has a price of Lps. 8.03 = US\$ 0.43 (18.89 Lempiras = 1 US\$). When there is a calculation of the energy consumption of a entire house, then there is a chart of prices according to the total amount of kWh monthly consumed.

STUDENT OBJECTIVES

1. The student will learn that when there is a release of new design of an electric appliance, usually the new models have a technology that will do the same work old models did (or even a better job) but with less electricity. This is the case of a common light bulb and a compact florescent lamp.
2. Since there are no energy-efficient policies in Honduras, then it is convenient for every student to be concerned in what type of electric appliance they buy according to their electric consumption and price.
3. After the student has learned some ways to buy efficient appliances, use them and substitute old equipment, then find out ways where they can still use their old electric appliances.
4. Introduction to eco-friendly products: ECO-labeling and environmental certifications, ie LEED.

OVERVIEW

According to the Honduran Curricular design of 9th grade, in the section “Technology, Society and Natural environment” (pg 511, National Curriculum Design for Basic Education), the student is able at the end of this grade, to know how history in cultures and customs have changed as a result of new and/or better materials, transportation and information. If the Honduran student meet this criteria, then he is able to understand what is studied in the Science and Technology Content Standard E for 10th grade (US National Science Education Standards): “Identify a problem or design an opportunity” and “Technological knowledge is often not made public because of patents and the financial potential of the idea or invention. Scientific knowledge is made public through presentations at professional meetings and publications in scientific journals”.

BACKGROUND

Operating costs are often not considered when the initial purchase decision is made of an electrical appliance. Not all the appliances are energy-efficient, suppliers do not readily provide information and purchasers don't ask usually for it, and there is no control from the government. However, during the 1990s, few appliances are now labeled and/or promoted as energy-efficient, for example, the compact-fluorescent light bulbs. Today, many houses, buildings and industries are using them. Dishwashers and microwaves are now displayed on sale with energy efficiency labels, but people still do not know how to compare which labeled products with the same size and functions are more energy-efficient. By comparing the *life cycle* cost of 2 similar products, then it is possible to know the total cost to be spent for each one and plan ahead better purchases. Compare 2 different light bulbs:

Type of lamp	Wattage	Efficiency of power ^β	Lifetime	Color
Incandescent	60 w	5%	1000 hrs	yellow
Compact fluorescent	17 w	20%	10,000 hrs	white

The 17w fluorescent lamp directly substitutes the luminosity given by a 60w incandescent lamp. The efficiency means that for 100% of the electricity consumed, there is only an amount of wattage transformed into light. Compact lamps are more expensive than incandescent lamps, but they save money in the electricity bill and replacement because they last longer. The only cases where incandescent lamps are better than fluorescent lamps is whenever the lamp is used for less than four daily hours or the lamp is used very infrequently.

PERIOD One class of 45 minutes for the discussion.

MATERIALS FOR THE LESSON For the teacher: Bring a compact-fluorescent bulb, incandescent bulb and if possible a tester for light bulbs with a incrustrated wattmeter and a catalog of appliances.

GETTING STARTED

- Describe the problems involved when purchasing electrical appliances: lack of information given to the consumer, identification of energy efficient labels and eco-labels, suggestion of places where information about electricity consumption or/and labels are provided.
- The students should understand that a cheap electrical appliance does not mean obtaining economical savings in the future because of advances made in technology.
- Review the meaning of watts, kilowatts and price of every kWh.
- Compare as an example of convenient purchase a fluorescent-compact lamp and a incandescent lamp.
- Design a table^γ like the shown in the next page and allow the students to calculate the operations. If there is a tester for light bulbs with a wattmeter, then compare how each light bulb consumes electricity.

(β) Wikipedia. "Incandescent light bulb". 2006. http://en.wikipedia.org/wiki/Incandescent_light_bulb

(γ) Lawrence Hall of Fame: "Global Systems Science: Energy Use" .Student edit. 2006. <http://www.lawrencehalloffscience.org/gss>

Type of light bulb	Operations to make	Calculations
Incandescent	Material cost of ten 60w bulbs	_____ Lps
	Energy used over life cycle is 60 w x 10,000 hrs	_____ watt-hr
	Divided by 1000 watt-hr/kilowatt-hour	_____ kWh
	Operating cost over lifecycle	_____ kWh
	Times 8.03 Lps/kWh	
	TOTAL COST (material cost + operating cost)	_____ Lps
Compact fluorescent	Material cost of one 17w bulb	_____ Lps
	Energy used over life cycle is 60 w x 10,000 hrs	_____ watt-hr
	Divided by 1000 watt-hr/kilowatt-hour	_____ kWh
	Operating cost over lifecycle	_____ kWh
	Times 8.03 Lps/kWh	
	TOTAL COST (material cost + operating cost)	_____ Lps

f) Now compare the consumption of other appliances and a incandescent light bulb so the students can understand how big is the electricity usage of other similar appliances. For example:

A new 32" TV consumes 200 w, which is the equivalent to the consumption of 3.33 incandescent light bulbs, whereas an old TV from 1970 with the same dimensions consumes 500 w, which means the equivalent of 8.33 incandescent lamps.

g) Since it is not recommendable to get rid of old appliances if they are still usable, at least they can be used for emergency cases, in sporadic occasions or sell them. Discuss which are alternatives of usage of some common appliances, for example, an old stove, radio or computer.

EXTENSION:

a) Request each student to design a table like the one shown above, where they will compare five old and new appliances and request them to perform a life cycle cost between them.

b) Using efficient appliances in buildings is part of the US program called LEED (Leadership in Energy & Environmental Design). It is a voluntary standard that defines high performance, sustainable buildings, which shows that a building is a environmentally-friendly structure (www.usgb.org)^δ. Other programs promote the design of Sustainable Houses, through the BASIX certificate from the Australian Greenhouse Office^ε (www.basix.nsw.gov.au). Discuss with the students the advantages of these programs and how similar approaches are possible in the Honduran residential design.

c) Recommend to read the Energy Star (energystar.gov) and Efficient Products (efficientproducts.org) websites which give information to the consumer of the energy efficiency of electrical appliances.

(δ) LEED Green Building Rating System. www.usgbg.org

(ε) Ferrier, Ross. Private designer consultant. ferricon@optusnet.com.au. Reference: www.basix.nsw.gov.au

Arts Lesson 3.2: Making sense of an electricity bill

CONCEPTS

1. Electric energy is provided to the cities by generating electricity through water, fossil fuels, nuclear energy (not available in Honduras) and renewable energy. In rural areas, renewable sources and water are used to generate electricity.
2. *Power* is the rate at which mechanical work is done (studied during the 9th grade Natural science class), but Power is also the rate at which electrical energy is supplied to a circuit or consumed by a load. Like current, power is a rate quantity: $\text{Power} = \text{energy consumed by load}/\text{time} = \text{Joule/second} = \text{watt}^a$
3. Electrical utilities like the National Electric energy Utility (ENEE) provide energy for homes, which is charged through a monthly bill.
4. When the power is more than 1000 watts, the unit is called *kilowatt* (kW). When a kilowatt is used in one hour, it is called kilowatt-hour (kWh). The electricity meter reads the amount of kWh that each household consumes per month.

STUDENT OBJECTIVES

1. Students should be able to find and interpret relevant information on an electricity bill and meter.
2. Students should understand that electricity usage can vary per month and season, according to cooling requirements, usage of electricity and price of sources of electricity ^b. For this purpose, students will be able to read the information displayed in the electricity bill.
3. In groups, students will design a poster to be placed in the school, neighborhood and the community where the 11th graders are making their project, which will contain explanations of how to interpret an electricity bill. The design of the poster is free for the student/group of students.

OVERVIEW

According to the Honduran Curricular design of 9th grade ^c, in the section “Matter and Energy” (pg 547), the student is able at the end of this grade, to know the basic concepts of electricity and manage some concepts of electricity savings. If the Honduran student meet this criteria, then he is able to understand what is studied in the 10th grade Physics course (US National Science Education Standards): “in all energy transfers, the overall effect is that the energy is spread out uniformly”^d. The transfer implies that some electric energy is turn to mechanical power, heat, sound or light.

(a) Glenbrook High School. “The Physics Classroom”. 2005. <http://www.glenbrook.k12.il.us/gbssci/phys/CLass/circuits/u9l2d.html>

(b).McInerney, Karin. “Energy in the Environment: teaching kit”. Environmental Protection Authority of New South Wales, Pg. 8. ‘96

(c) Department of Education. “Diseño Curricular Nacional para la Educación Básica, III ciclo. Inter American Development Bank. ‘05

(d) National Science Education Standards. “Science Content Standards: 9-12. 2006 <http://newton.nap.edu/html/nses/html/6e.html#ps>

All this conversions of electricity into heat (radiation, convection and conduction), if they are not well used, they are still paid by the customer. For example, leaving the iron turned on without use is a waste of electricity. The sample of an electricity bill below with some marks will help the student identify which are the key elements on the electricity bill. The importance of reviewing what is printed on the electricity bill is to help the student's family be aware how they consume electricity periodically and verify if the fees with other similar periods of time. Few people know how to understand what is printed on the electricity bill. By understanding the lectures on the bill, then the people would like to know procedures to save electricity in order to save money.

BACKGROUND

The electricity bill has undergo through some changes over time, but the bill below (used in the late 1990s) contains the basic information needed to understand any change on the bill. The amount paid by unit of electricity (kWh) is constant because there are no different tariffs of electricity per hour.

EMPRESA NACIONAL DE ENERGIA ELECTRICA				
Payment Bill		Key to secondary Line 002005402		
Billed month 08/01/2004	Emission date 07/01/2004	Bill number F5820567		
Current lecture date 08/01/2004	Previous lecture date 07/01/04	Days 30	Daily consumption (kWh) 24.33	
Code 33919	Power meter 9700069522			
Name of client MERCEDES ALONZO-BRITO from MARTINEZ				
Address 3 rd avenue between 3 rd and 4 th streets, house no. 330, Comayagüela, MDC				
Current lecture 40278	Previous lecture 39548	Multiplier 1.0	Consumption 730	Tariff 101
Current balance				0.00 Lps
Plus charges of the month				
Charge of electricity				957.69 Lps
Public light				47.63
Other charges / credits				378.00
Total charges of the month				1341.00 Lps
Total to pay				1341.00
Total paid				1341.00
Remainder to pay				00.00

Hondurans usually do not pay attention to what the bill says except to what they owe in money; others do not understand what the bill says. These factors do not allow people to really know if what they are paying is correct: sometimes the electricity meter is possibly not working well or there might be persons stealing what the household is really consuming. In order to detect this possible theft, it is important to request the utility to verify how the electricity meter works well.

In the picture above, the colored squares show the most important facts to learn from a bill. The square in green reflects the difference on consumption of energy between the first day of July to the first day of August (blue and red squares respectively). The orange square shows the average energy consumption per day. The monthly consumption greatly varies especially during national holidays and seasons. The cheapest months are usually April or May if the family goes to vacation during Easter (usually the week is given for free by the employer) and because Mother's day is celebrated outside the house. The most expensive month is usually is December because there are many family reunions. There are possible some increases in the bill during April or May if the prices of fossil fuels to generate electricity also increase (the government has had charged the people a fee to help pay the increase).

PERIOD Two classes of 45 minutes each, for the discussion and elaboration of poster

MATERIALS FOR THE LESSON

a) For the teacher: Overhead or slide projector (optional) in case a electricity bill could be shown in this way. The design of a poster containing a copy of an electricity bill with notes and references is needed in order to show the quality of the details to be explained by poster.

b) For each equal group of students: One of the members of each group must bring copy of the electricity bill of the same month and among the classmates decide the adequate material to design the poster depending on the economic solvency of each. This means that a poster could be made from basically color markers and papers joined by tape up to the use of plywood and stickers.

GETTING STARTED

a) Ask the students to determine the use of an electricity bill and possible misconceptions of usage.

b) Ask if any of the members of the students' family understand the key elements of an electric bill, and if they do, ask if this knowledge is shared among the other members of the family.

c) Ask to fill in the following questionnaire and respond the questions through the poster the teacher has designed. With the answers provided per group, compare the possible mistakes done in all the groups and clear them out. Through the design of the poster, let them suggest what additional information should be placed in order for the people of any academic background understand the basic things to understand in an electricity bill.

(1) What is the amount of money owed?

(2) How many kilowatt hours in total were used during the billing period covered by this bill?

(3) What dates are covered by this billing period? Which were the festivities celebrated in this period?

(4) What major electrical appliances in the houses of the students who brought the electricity bill were used in the festivities celebrated during that billed month that could have affected the biggest consumption of electricity?

(5) Suggest reasons for the people need to pay the section "Other charges/credits" on the bill. During which season was this bill issued in? How can this season helped to charge this additional charge?

(6) During what festivities or activities of the school academic year would be appropriate to place the poster to be designed so that parents as other students can also learn to understand the electricity bill?

Biology Lesson 29.5: Ecological footprint ^ζ

CONCEPTS

1. *Ecology* is the scientific study of the processes influencing the distribution and abundance of organisms, the interactions among organisms, and the interactions between organisms and the transformation and flux of energy and matter ^η.
2. The *ecological footprint* concept is a way to roughly measure the impact of a person's choices on the environment. It expresses the relationship between consumption and availability of natural resources. Comparing the ecological footprint with the global availability of productive area gives an indicator of environmental sustainability, which can then be monitored over time to determine trends. The ecological footprint involves collecting data from the resource flow analysis and other sources, about a range of activities such as transport, energy use, materials and product consumption, waste production and water use. The impacts of these activities are converted into a common currency, global hectares (gha) ^θ.

STUDENT OBJECTIVES

1. Increase their awareness of the impact of their choices on the Earth. This awareness is to result in a goal to reduce their personal impact (footprint).
2. Identify the mean of a set of data and use of graphs to visualize trends.
3. Students should be able to relate their ecological footprint with their electricity consumption.

OVERVIEW

According to the Honduran Curricular design of 8th grade, in the section “The living beings in their environment” (pg 560), the student makes conscience that every organism has a special function in nature. In addition, in the 9th grade, section “Technology, society and natural environment” (pg 511), the student is able to understand the changes in the environment caused by electricity generation and risks generated obtaining it. If the Honduran student meet this criteria, then he is able to study the Life Science content standard C for 9-12 grades (US National Science Education Standards): “The complexity and organization of organisms accommodates the need for obtaining, transforming, transporting, releasing, and eliminating the matter and energy used to sustain the organism.”

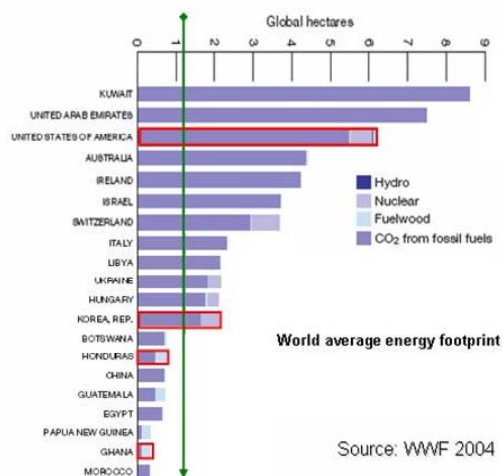
BACKGROUND

The World Wild Foundation's (WWF) 2004 report mentions that humans are extracting 20% more material to sustain themselves than normal. In addition, terrestrial and aquatic life forms have decreased around 40% between the years 1970-2000. The human ecological footprint in 2001 was 2.2 hectares per

(ζ) Alliance to save energy. “How big is your footprint?” 2006. http://www.ase.org/section/_audience/educators/lessons/high/

(η) Institute of Ecosystems Studies. “Defining ecology”. http://www.ecostudies.org/definition_ecology.html

(θ) Stepping forward. “Ecological footprint report”. 2005. <http://www.steppingforward.org.uk/ef/directenergy.htm>



person, when there are only 1.8 hectares/person available (Global hectare is a hectare whose biological productivity equals the global average). Between 1996 and 1998, the population in Central America grew in an annual average of 2.43%, while the commercial energy and electricity was annually 3.24% and 4.5% respectively, causing many electricity shortages and voltage irregularities. Honduras increased fossil fuel importations to generate electricity from 38% to 43% (years 1994 to 1998)ⁱ. In 2002, Honduras ranked in the 110th position (from 204) in the electricity consumption in the world (Costa Rica is 93rd and the 2nd most developed country in Central America ^k.

While there is no an specific electricity footprint study available, there is an energy footprint study where besides electricity there are other primary sources of energy considered (ie wood). In the graph shown above, while Honduras in 2001 has a ecological footprint of 1.6 hectares/person, it also has a energy footprint of 0.8 hectares/person (when the average is 1.2 hectares per person worldwide) ^λ.

PERIOD Two classes of 45 minutes each, for the discussion and research

MATERIALS FOR THE LESSON (most of the small Honduran cities have now internet access)

Teacher: Have access to the internet, either in the school or by planning going to a cybercafé

Students: Graph paper or poster paper, calculators

GETTING STARTED (note: Hondurans usually use electric showers and need to boil water to drink)

- 1) Explain the concept of Ecology and Ecological Footprint
- 2) Browse into either one of the following websites www.mec.ca/Apps/ecoCalc/ecoCalc.jsp or <http://www.earthday.net/footprint/index.asp> and request the students to individually answer the questions and record their final result. Their input will be transformed into the amount of acres and planets needed to sustain their individual needs. Calculate the mean number of the students and tell them to plot the result into a graph or number line and to identify at the same time the lowest and highest values for the class.
- 3) Discuss with the students which are probably the factors that led to the mean calculated, especially related to electricity. In addition, discuss how electricity is invested in the preparation of food, heating water, and taking a shower, and consequently the importance of not wasting the electricity invested in them. Finally, discuss how other countries have different degrees of ecological footprints.

(i) Estado de la Nacion. “ 2nd Central America’s human development report”. 2003 <http://www.estadonacion.or.cr/.../indice.html>
(k) GLOBALIS. “Indicator: electricity consumption 2002”. <http://globalis.gvu.unu.edu>
(λ) World Wildlife Fund (WWF). “ Living planet report 2004.” <http://www.panda.org>

(Honduras') Social Economical Development Lesson 3.4: The case of the energy subsidy

CONCEPTS

1. Renewable energy: Energy resources that are “unlimited” in supply because they can be replenished.
2. Types of renewable energy: *Hydropower* (coming from the force of moving water), *Wind Energy* (air in motion), *Biomass* (energy extracted from organic substances like wood and crops), Geothermal (comes from the intense heat within the earth).

STUDENT OBJECTIVES

1. Learn about the types of renewable energy, their advantages and disadvantages.
2. Learn through role playing the way to encourage students to look at the trade-offs in energy policy and to recognize the role of values and self-interest in determining the appropriate public policy, and learn some social-economical concerns in Honduras. Using these characteristics, the students will consider if a tax break will motivate renewable energies developers to invest more in the Honduran electricity market.

OVERVIEW

According to the Honduran Curricular design of 9th grade, in the section “Technology, society and natural environment” (pg 560), students in teamwork consider opportunities for designing a technical project. In addition, from section “Matter and Energy” (pg 570), the student learns about the efforts done to improve human beings through the different types of energy. If the Honduran student meet this criteria, then he is able to study the Science in Personal and Social Perspectives content standard F for 9-12 grades (US National Science Education Standards): “Human populations use resources in the environment in order to maintain and improve their existence.”

BACKGROUND

During the 1980s, Honduras' electricity depended on 75% from water and almost a 25% from fossil fuels, when the population was 3.6 million. Since the 1990s, hydropower generation has been decreasing because the phenomenon “El Niño” and deforestation have caused the water availability for generation to decrease severely. Now the country is dependent in 63.4% from fossil fuels, 34.5% hydropower and 2.1% in renewable energy (biomass from sugar cane and solar energy). To decrease the impact of the increase of government's budget in buying fossil fuels, Hondurans have been charged with an extra fee in their electricity bill, but alternatives with renewable sources are being looked. Renewable energy began with the introduction of photovoltaic energy in 1996, consisting of three systems of 35 kW each in isolated zones which are not connected to the grid. Some people have a great interest in utilizing biomass

energy resulting from producing paper and beverages (when processing wood, sugar or coffee husk) ^μ, but for the moment only through sugar cane there has been some electricity generation. During the Flores-Facusse Administration (1998-2002) many renewable energy projects (60 MW of wind power, 60 projects of solar energy, 5 projects using biomass and 18 small hydroelectric projects) have been approved, but governmental official procedures have not allowed to easily start these projects. Honduras has also the capacity to generate 500 MW through geothermic sources, but there are only studies for the moment.^ν With the purpose of decrease the dependency in fossil fuels, the current Honduran president, Manuel Zelaya-Rosales, has planned at the end of his administration with a National Energy Policy, make available for the public the governmental budget and give a better protection for the forest ^ξ. Trade agreements with the US (CAFTA) and possibly with the European Union will increase the demand for electricity; the Honduran population is increasing 2.5%/year, so if the government plans to meet the Millennium Development Goals by 2015 to reduce poverty, an investment of US\$ 704 million has to be spent until 2015 ^π. The next chart shows some characteristics of the energies which are part of the solution to expand the electricity coverage from 63% (year 2006) to 100% (year 2015).

A = Advantages D= Disadvantages

Type	F	Characteristics of the type of energy ^ρ
Hydropower	A	Abundant, clean and safe. Easily stored in reservoirs
	D	Can have a significant environmental impact and depends of feasibility study
Geothermal	A	Provides an unlimited supply of energy and do not produces air/water pollution
	D	Start-up and development costs can be expensive
Solar	A	Unlimited supply and does not cause air or water pollution
	D	May not be cost effective, and storage as backup are necessary
Wind	A	Does not pollute and where the land around the installations can have other uses
	D	Requires constant flow and quantity of wind and may cause visual impacts
Energy savings	A	It can start up with no investment and also take very small amounts of time
	D	Needs knowledge to be transmitted and commitment from the people

PERIOD Two classes of 45 minutes each, for the discussion and activity

MATERIALS FOR THE LESSON

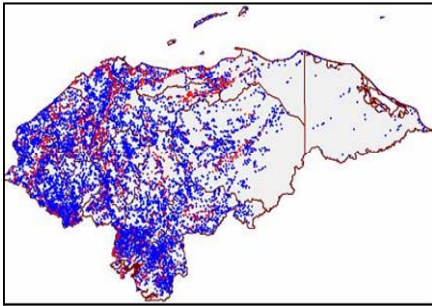
Teacher: Newspaper articles supporting the discussion, projector is optional

(μ) Canales Martinez, Raul. *SERNA places obstacles for the introduction of renewable energy*. Newspaper “El Libertador”. 2005
 (ν) Geothermal Energy Association. “Geothermal energy: Trustable clean energy for the Americas” www.geo-energy.org
 (ξ) Newspaper “El Libertador”. “ A democracy that impoverishes the people is not sustainable”.5/06 Pg. 17
 (π) Natural Disasters Regional Information Center (GRI). www.ns.rds.org. 2005
 (ρ) Alliance to save energy. “The issue of renewable energy” <http://www.ase.org/section/audience/educators/lessons/high/>

Group of students: Collect newspaper or on-line articles to support research, stay tuned to TV newscasts

GETTING STARTED

1. In the first class session, discuss how Honduras has changed socio-economically due to the changes in the electricity sector and could change due to the upcoming free agreements. Then review the types of energy generated, which are possible to be used and the problems to use them.



2. The map to the left side shows the current electricity coverage in Honduras. Review with them the kind of activities done in each region (north: manufacturing, center: lodging, south: shrimp industry) and why there are regions that have not been primarily being electrified before (eastern Honduras is scarcely populated because there is a natural reservoir, the “Mosquitia Rainforest” is protected by the United Nations).

3. Divide the students into 5 groups, the first one will be called “fossil fuel producers and consumers”, the second “developers of renewable energy”, the third group is the “environmental group”, the fourth group “the government” and the last one “the senate”. Assign them to collect and read newspaper or on-line articles and stay tuned to radio or TV newscasts related to electricity and organize their position for a forum in the next class. The forum will consist in “the senate” will hear the testimony from the first four groups exposing their reasons to approve a bill where developers of renewable energy will have a tax break incentive. The professor will become the moderator of the discussion in the forum. At the end, each debating group will expose their conclusions to the senate, and the senate will fill in the worksheet similar to the one below and decide from their conclusions if the bill is decided to be approved.

Criteria					
Alternatives	Fairness	Environmental Impact	Deals with Spillover Costs	Growth and Jobs	Budget Deficit
Free market only	- Pollution hurts others	- Benign neglect	- Does not deal with spillover	+ Growth continues	0 No direct impact
Tax credits	+/- Why single out this industry?	+ Encourages cleaner fuels	? Could level playing field with fossil fuels, but hard to measure	+ Growth continues	- Reduces tax revenues
Fossil fuel tax	+ Those responsible would pay	+ Incentive to develop cleaner fuels	+ Would internalize spillover costs	- Energy costs would rise, slowing the economy	+ Increases tax revenues

(c) Alliance to save energy. “The issue of renewable energy” http://www.ase.org/section/_audience/educators/lessons/high/

Computers Lesson 8. 3: Design of Home energy audit worksheet

CONCEPTS

1. *Power* is the rate at which mechanical work is done (studied during the 9th grade Natural science class), but Power is also the rate at which electrical energy is supplied to a circuit or consumed by a load. Like current, power is a rate quantity: $\text{Power} = \text{energy consumed by load}/\text{time} = \text{Joule}/\text{second} = \text{watt}$. In order to know the electrical consumption of an appliance, $\text{power} = \text{amperes} \times \text{voltage}$.

2. *Energy audit*: Is the compilation of the average usage of electricity appliances and equipment size in order to give a general idea of how the electricity is being distributed throughout the house.

3. When the power is more than 1000 watts, the unit is called *kilowatt* (kW). When a kilowatt is used in one hour, it is called kilowatt-hour (kWh). Some electrical appliances, like small motors, their energy consumption is measured in *horse-power hour* (hph, which is equivalent to 0.746 kWh) or air-conditioner units, which are measured in British thermal units (Btu, equivalent to 0.000 293 kWh). All this units are important to know, but for the matter of the lesson, the kilowatt-hour unit will be used.

4. In order to charge the energy consumption per household, each kWh has a price of Lps. 8.03 = US\$ 0.43 (18.89 Lempiras = 1 US\$). When there is a calculation of the energy consumption of a entire house, then there is a chart of prices according to the total amount of kWh monthly consumed.

5. *Service factor* describes the capacity of a motor to work under certain conditions whenever there is an increase or overload in power σ . (this concept is shown only as a reference for technical high schools)

STUDENT OBJECTIVES

1. Students will be able to perform a basic electricity audit of their houses by calculating the power and time used of every electrical appliance.

2. Students will design a excel sheet where they will place the information collected from the electricity audit and show through a pie chart the distribution of electricity per occupation.

OVERVIEW

According to the Honduran Curricular design of 9th grade, in the section “Matter and Energy” (pg 547), the student is able at the end of this grade, to know the basic concepts of electricity and manage some concepts of electricity savings. In addition, also able to use computers for organizing information into tables and construct statistical graphs (pg 432). If the Honduran student meet this criteria, then he is able to understand what is studied in the 10th grade Physics course (US National Science Education Standards): “in all energy transfers, the overall effect is that the energy is spread our uniformly”.

(σ) Universidad Nacional de la Plata. “ Usage and programs application, appendix 5. 2006 <http://www.ing.unlp.edu.ar>.

BACKGROUND

The National Electric Energy Utility (ENEE) has done home energy audits since 2001. The purpose for this activity is to compile information about which are the electrical appliances most used in the two biggest Honduran cities. Today, in the capital city, Tegucigalpa MDC, the TV is the electrical appliance most used, while in San Pedro Sula, the air conditioner is the most used. A factor that contributes for this difference between these two is that Tegucigalpa has a dry climate and San Pedro has a humid climate.

A complete energy audit tells you how efficient electricity is used, if there is space for an energy saving and if there is an equipment malfunction ^τ. For the purpose of this paper, the excel sheet to be designed will check how electricity is distributed per occupation (see below in the section “Getting Started”).

PERIOD Two classes of 45 minutes each, for the discussion and activity

MATERIALS FOR THE LESSON

Teacher: Projector and internet access are optional and a computer.

Students: Information about the electricity usage in their houses.

GETTING STARTED

1) In the first class, there is going to be a review of the concepts mentioned in the beginning of this lesson and how to calculate the information of each appliance from their houses. Within the definitions used, the *service factor* is a technical term that it is better to be fully understandable in a technical school than in a normal high school because its comprehension comes along after some technical background in technical middle schools. In spite of this concern, the calculation of the energy consumption will not be accurate without placing this factor in the equation; the service factor values to be used will be about the same to the appliances shown in the sample worksheet of the next page.

2) For the second class, the students need to bring with them information about the electricity and time consumption of every appliance; they will have to check the technical tag of each appliance and calculate if needed, their wattage. When the student is writing down the energy consumption of every appliance, it is important to know how much time the family uses it per day. Not every appliance is used daily; some appliances could be used every other day, some days of the week or fraction of an hour. For the purpose of this lesson, any electrical appliance used in the conditions previously mentioned, a value of 0.5 will be used for the calculations. Make sure that when there are 2 appliances of the same type, they also consume the same energy. If two appliances of the same type consume different amounts of energy, then place both of them as 2 separate appliances. Place every appliance under the occupation it belongs (cleaning, entertainment, kitchen and miscellaneous equipment).

(τ) SMECO. “Online Home Energy Audit”. 2006. <http://www.smeco.com/customer/audit/index.html>

3) The sample below is how the student could begin designing the excel table. Request the students that the for the column named “Power”, its values will depend of the multiplications of the columns “watts” and “amount”. The same procedure will also be for the column “energy”, which is the product of the columns “service factor”, “power” and “hrs” (hours). The “cost” column will be the multiplication of the column “energy” time 8.03, which is the price of every kWh in Lempiras).

Type	Equipment	Watts	Amount	Power	SF	Hrs.	Energy	Cost
Cleaning Appl.	Clothes washer	450.0	1	0.45	0.90	1	0.41	3.252
	Clothes dryer	3,000.0	1	3.00	0.90	1	2.70	21.681
	Vaccum cleaner	1,200.0	1	1.20	1.00	1	1.20	9.636
				4.65			4.31	34.569

4) After placing all the appliances considered to belong to “cleaning appliances”, then add all the power consumptions per occupation at the end and color the box in a different color (ie yellow and pink). Do the same procedure with the “energy” and “cost” columns.

5) The student now needs to proceed to do the same thing with the other occupations (ie entertainment). After the student has done all the computational work with all the occupations, then at the end add up all the power and energy consumptions, and all the costs in 3 different spaces separately.

6) From the costs per each occupation, design a box containing the percentage that each has from the total costs the homeowner has to pay. For example, if the cost of all the cleaning appliances per day is Lps 34.57, but the total cost is Lps 449.16, then the % = $(34.57/449.16) \times 100 = 7.70$. After finishing designing the box containing the % of consumption per occupation, then design a pie-chart showing the percentages. The final table should look similar to the shown below.

Type	Equipment	Watts	Amount	Power	SF	Hrs.	Energy	Cost
Cleaning Appl.	Clothes washer	450.0	1	0.45	0.90	1	0.41	3.25
	Clothes dryer	3,000.0	1	3.00	0.90	1	2.70	21.68
	Vaccum cleaner	1,200.0	1	1.20	1.00	1	1.20	9.64
				4.65			4.31	34.57
Equipment	Computer	300.0	1	0.30	0.80	6	1.44	11.56
	PC	120.0	1	0.12	0.80	4	0.38	3.08
	Small Printer	30.0	1	0.03	0.50	6	0.09	0.72
	UPS	300.0	1	0.30	0.10	24	0.72	5.78
	Diskman	10.0	1	0.01	0.40	4	0.02	0.13
	Radio	10.0	1	0.01	0.40	6	0.02	0.19
	Tape recorder	20.0	1	0.02	0.40	2	0.02	0.13
	Fax	180.0	1	0.18	0.20	24	0.86	6.94
Scanner	120.0	1	0.12	0.01	1	0.00	0.01	
				1.09			3.56	28.55
Kitchen	Stove 4 burners	12,000.0	1	12.00	1.00	3	36.00	289.08
	Coffee pot	900.0	1	0.90	0.50	2	0.90	7.23
	Refrigerator	400.0	1	0.40	0.85	24	8.16	65.52
	Microwave	900.0	1	0.90	0.05	1	0.05	0.36
				14.20			45.11	362.19
Entertainment	TV	190.0	2	0.38	1.00	7	2.66	21.36
	Video game	70.0	1	0.07	1.00	4	0.28	2.25
	DVD	30.0	1	0.03	1.00	1	0.03	0.24
				0.48			2.97	23.85
Total				20.42			55.94	449.16
				kW		kWh		Lempiras

Average daily consumption chart

Type	%
Cleaning	7.70
Equipment	6.36
Kitchen	80.64
Entertainment	5.31

Power is given in kW
SF = Service Factor
Energy is given in kWh

Educative Social Work (TES) Lesson 7.5: Energy saving in the community ^φ

CONCEPTS

1. *Power* is the rate at which mechanical work is done (studied during the 9th grade Natural science class), but Power is also the rate at which electrical energy is supplied to a circuit or consumed by a load. Like current, power is a rate quantity: $\text{Power} = \text{energy consumed by load/time} = \text{Joule/second} = \text{watt}$. In order to know the electrical consumption of an appliance, $\text{power} = \text{amperes} \times \text{voltage}$.

2. *Energy audit*: Is the compilation of the average usage of electricity appliances and equipment size in order to give a general idea of how the electricity is being distributed throughout the house.

3. S When the power is more than 1000 watts, the unit is called *kilowatt* (kW). When a kilowatt is used in one hour, it is called kilowatt-hour (kWh). Some electrical appliances, like small motors, their energy consumption is measured in *horse-power hour* (hph, which is equivalent to 0.746 kWh) or air-conditioner units, which are measured in British thermal units (Btu, equivalent to 0.000 293 kWh). All this units are important to know, but for the matter of the lesson, the kilowatt-hour unit will be used.

4. In order to charge the energy consumption per household, each kWh has a price of Lps. 8.03 = US\$ 0.43 (18.89 Lempiras = 1 US\$). When there is a calculation of the energy consumption of a entire house, then there is a chart of prices according to the total amount of kWh monthly consumed.

5. *Service factor* describes the capacity of a motor to work under certain conditions whenever there is an increase or overload in power ^σ. (this concept is shown only as a reference for technical high schools)

STUDENT OBJECTIVES

1. After the knowledge gathered throughout 10th and 11th grades, the students now have the opportunity to apply their skills in working cooperatively with others in communicating – with their group, with members of the community and with the class. Students by now in their third trimester of 11th grade have the basic concepts of how to perform an energy audit in a house; now they will apply their skills to the local businesses in a community or neighborhood.

OVERVIEW

According to the Honduran Curricular design of 9th grade, in the section “Matter and Energy” (pg 547), the student is able at the end of this grade, to know the basic concepts of electricity and manage some concepts of electricity savings. In addition, also able to use computers for organizing information into tables and construct statistical graphs (pg 432). If the Honduran student meet this criteria, then he is able to understand what is studied in the 10th grade Physics course (US National Science Education Standards): “in all energy transfers, the overall effect is that the energy is spread our uniformly”.

(φ) McInerney, Karin. “Energy in the Environment: teaching kit”. Environmental Protection Authority of New South Wales, Pg. 109. Y96

In addition, the Science and Technology Content (standard E), recommends that design tasks should explore a range of contexts including both those immediately familiar in the homes, school, and community of the students and those from wider regional, national, or global contexts.

BACKGROUND

The Educative Social Work (TES) usually takes place around poor neighborhoods from the cities or in small communities outside the city (which are not suburbs). The idea is to introduce the student to the social problems existing in a population and help the people solve situations that take time, persons and some money (ie reforestation, cleaning of neighborhood and placement of transit signs). These communities are only accessible by bus or private transportation. The neighborhoods in the city are accessible through public transportation, reason why most of the TES take place in these areas.

The neighborhoods of all the Honduran cities contain at least a small supermarket (like a 7 Eleven store) and a barber/beauty shop. The neighbors usually know each other and there have members which represent them in issues they need to discuss with the municipality. A low-class house does not mean it does not have electrical appliances like video games or big TVs because these equipment is usually brought through relatives abroad of the household. In order to perform this activity, the students will have to delimit the area of the activity and talk to the representatives of the neighborhood to start the project.

PERIOD: Possibly half or an entire trimester depending on the other activities made along the TES.

GETTING STARTED

1) The students need to prepare a list of local businesses (ie shops, restaurants, food outlets) and public facilities (ie library, garbage collection facility) that could be suitable for them to consider. The project will only be successful and enjoyable if the places selected are prepared to cooperate with the students. Make any possible verbal communication and a note from the school to these facilities about the purpose of the activity and let them know that the students will prepare a brief report to them of their findings.

2) Before visiting the facilities, the students need to plan ahead to discuss what kind of activity they will audit and make some research of energy-saving tactics (which are supposed to be ideal for their level of education). When visiting each facility, make a research how they use electricity and prepare a report where they will suggest energy-saving strategies and the specific benefits that would follow (both environmental and cost).

3) If possible, the students could make a presentation of their findings to each business, but most importantly, make one to the rest of the class and to the junior students from their school. The presentations and reports are supposed to have contents reviewed in the previous courses during their high school study, for example, graphs from the computer class, an ecological footprint analysis, etc.

9.0.0 Conclusions

- a) Electric Energy savings education in the high school curriculum is a short term tool to make people aware of not only the problems in the electricity sector, but also other interrelated fields because in order to explain how electricity affects a country, aspects of sustainable development, politics, economy and sociology are needed to be referred.
- b) In the long term, electric energy savings education is a tool used to prepare more people responsible for managing natural resources and be more aware how humans are affected economically and in health when there is no electricity provision and destruction of the environment.
- c) Electric Energy Savings education is part of the sustainable development procedures that Honduras could follow to extend the electricity grid up to 100%. Electric utilities need fewer fossil fuels (and consequently fewer carbon dioxide emissions are generated) when students and their families save electricity. The electricity saved could be redistributed to other parts of the country, especially the rural underdeveloped areas.
- d) When Hondurans individually started to buy their own electrical appliances, receive appliances from their relatives abroad or/and some others steal electricity, they have caused more demand of electricity besides the one caused by population growth and incoming businesses. Because the electric utility has not been able to control these external actions, the central government has begun to restructure the electric sector and seek the incorporation of private generators to satisfy the accumulated demand of electricity.
- e) The customers receiving subsidies when paying their electricity bill cause the utility not able to receive the appropriate reimbursement of the electricity generated. If the subsidies decrease or become more limited, then many people would start to care about saving energy and would help encourage the learning of energy education in schools.
- f) The current Honduran educative system has not met the expectancies needed by the students to face the realities of the country and from the world, because schoolteachers are not well prepared, there is limited budget for public schools and the High school curriculum still has not been defined yet. Three transversal axes are given through the school curriculum – National Identity, Work and Democratic Participation – do not promote enough a international perspective to students. Electric Energy savings education could help show students how energy savings work in other countries and global warming by caused by fossil fuels generation affect the world.
- g) Some results have been given through the Honduran energy-savings campaign that started in 1994, but greater results could be obtained if there is energy-savings education officially given through all the high school system because all the Honduran states will be participating in the program, and not only some schools.
- h) The discontinuity of education after elementary and high school of students has a relationship with the generations of Honduran people that have been living in poverty. The success of the Energy-savings education guidelines could also become affected by these problems, especially in the rural areas. However, the introduction of computers and bilingual education, knowledge needed today for living, could help improve the encouragement of students and therefore energy-savings education could become more attractive to study.

j) In the Biology Lesson sample (pg 42), it was mentioned that from 204 countries in the world, Honduras is ranked in the 110th position in electricity consumption and has an energy footprint of 0.8 hectares/Honduran when its ecological footprint is 1.6 (from 148 countries, year 2001). The average worldwide energy footprint was 1.2 hectares/person and the ecological footprint in 2001 was 1.8 hectares/person. This means that the electricity consumption and energy consumption of a country has a relationship with its development and ecological footprint. If Honduras has a higher development, then there is a tendency that its energy footprint and electricity consumption will also increase.

10.0.0 Recommendations

10.1.0 Recommendations for the educational system

- a) Energy-savings education is possible to be taught in three ways, by explaining how to use electricity efficiently (using less energy to accomplish the same task), conserving it (changing habits) and by rationalization (systematic organization of energy).
- b) Besides learning electric energy savings education learned through classes, student clubs would help students to organize collective activities. Interaction between schools could motivate even to organize electric energy savings inter-high school competitions.
- c) The research on education made by the US National Science Resource Center (NSRC) could help Honduran students to understand to understand the new science and concepts given by electric energy savings education. The research suggests that students learn best in an environment in which they can make discoveries and actively construct their own understanding of new science and concepts. NSRC recommends a learning cycle⁸⁶:
 - Focus: Students and teachers focus on the ideas students already have about a topic and develop new goals for learning through brainstorming and discussion.
 - Explore: Students engage in hands-on-explorations of objects, organisms and science phenomena.
 - Reflect: Students analyze their observations and data, review their original ideas related to the phenomena investigated and develop new explanations of what they have observed.
 - Apply: Students apply their recently developed understanding of science concepts to new situations
- d) To achieve and demonstrate environmental performance of electric energy savings education into the Social Educative Work (TES), the environmental management system *ISO 14000* could be useful when determining the steps and limitations of a project⁸⁷ and *Natural Step* to determine the root of the environmental problems that might cause the same project to be incompleting.
- e) People have a strong desire to be seen as consistent by others when committing, because a person behaving inconsistently are often perceived as untrustworthy and unreliable. When the students are proposed to save electricity in their next years, written commitments are better than verbal, and the results are then better⁸⁸.

(86) National Science Resource Center. "Energy, machines and motion. Teacher's Guide." Smithsonian Institute. 2000. Pgs xix -xxxii.

(87) Burns, Susan., Kranz, Dorie. "Combining ISO 14001 and the Natural Step" Natural Strategies. 2006 www.naturalstrategies.com

(88) McKenzie-Mohr, Doug and Smith, William. "Fostering Sustainable Behavior". New Society Publishers. 1999 Chapter 3

Schoolteachers are then recommended to encourage students do written statements, especially if the students are placed in committed groups, where there is a better chance that each member will support each other actions.

f) The nature of electricity is a difficult environmental-science concept to make clear to the students. Traditional classroom lectures, textbook readings, and assignments are typically insufficient for the understanding of the concepts. If the government or the private schools are able to supply computers, internet and revised teaching methods to achieve a deeper understanding of electricity ⁸⁹ to their students, then there are going to be better results of understanding and comprehension of the electricity saving guidelines.

g) When teaching students in groups or individually, values taught by religions practiced in Honduras (Catholicism and Protestantism) and the Latin American culture (communitarian) are suggested to be considered in the success of the energy education guidelines. These factors greatly influence the Honduran lifestyles and could be used to promote electric energy savings, because using dates like the Bible week (celebrated during September in Honduras) families and schools can help students to relate what the scriptures mention about stewardship of the Earth with electricity savings.

h) The learning of how the US and Europeans have developed the practice electric energy savings will contribute the students to understand the reasons some events and regulations are now taking place and will take place in Honduras' electricity sector. New living practices could emerge through CAFTA, possibly with the European Union and other free-trade agreements because electrical appliances will be introduced in the country.

i) Students need to have a better contact with nature, especially with those influencing the electricity sector (ie water, forests). The reason is that when the students become older, they will be able to understand better the motives they need to save electricity and protect the environment. People not having a previous contact with the environment have a smaller concern about the environment ⁹⁰.

10.2.0 Recommendations for the energy-savings guidelines and the electricity sector

a) It will be interesting to know which companies promoting new appliances do some community investment or have satisfactory environmental impact policies. If these new companies are Socially Responsible Investing (SRI) ⁹¹, then Department of Natural Resources and Environment (SERNA), the communities affected and students will learn which appliances are energy efficient and if the company is environmentally friendly.

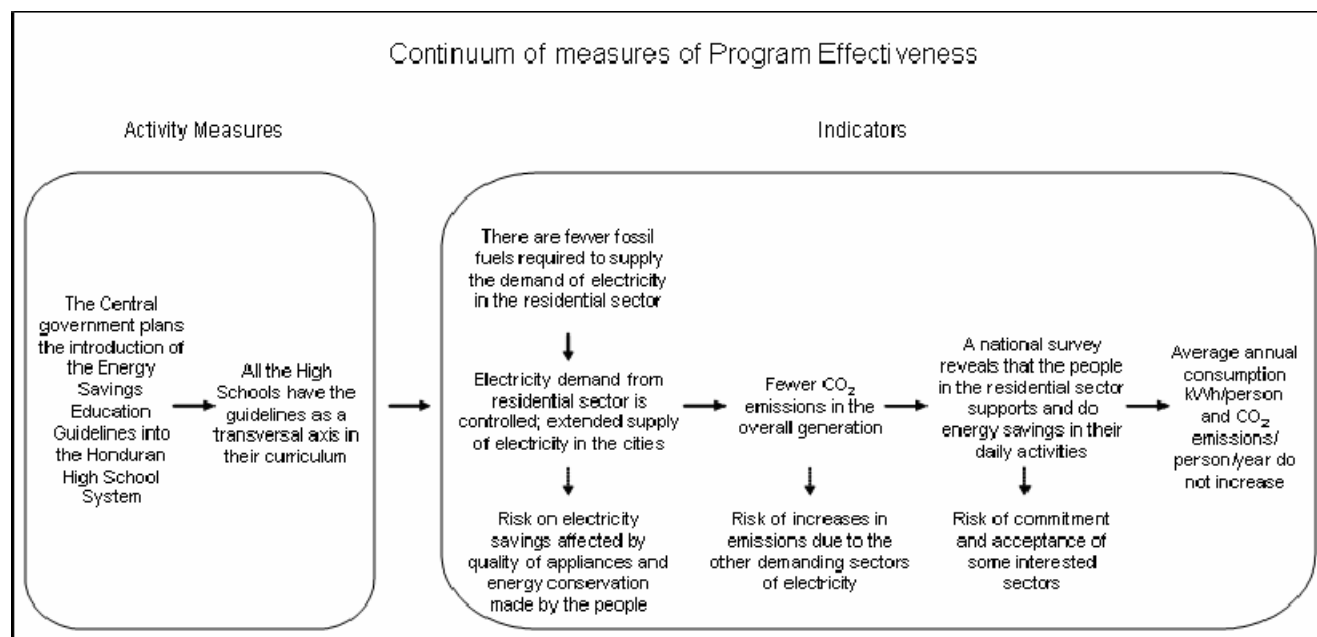
b) The eastern Honduran states contain rivers where many potential hydroelectric projects are planned and contain the United Nation's natural reservoir "La Mosquitia". Because there has been unauthorized logging of forests, the water levels from the rivers are decreasing, harming the ecosystem. Through the Social Educative Work (TES), high school students could plan to reforest the harmed areas and engage with the surrounding communities to care about the ecosystem. If the students are bilingual (Spanish and an ethnic language spoken in the region), then they could also integrate the ethnic groups around the area.

(89) Environmental Protection. "Classroom vision". September 2005 edition. Stevens Publication. Pg 16-18. www.eponline.com

(90) Kellert, Stephen. Kahn Jr., Peter. "Children and Nature: Psychological, sociocultural and evolutionary investigations". MIT Press. 2002. Pgs.117-147, 242-246

(91) Social Investment Forum. "Introduction to Socially Responsible Investing. 2005. www.socialinvest.org/Areas?SRIGuide

c) The following diagram shows an example how some activity measures and environmental indicators determine the success of the development of the energy-savings education guidelines in respect with the residential sector and electricity supply. At the end, the direct indicators are going to be the sustainable supply of electricity given to the residential sector.



Main Goal: Through the energy-savings education guidelines, the annual electricity consumption per person (kWh/person) and the annual carbon dioxide emissions/Honduran (metric tons) will be better controlled or decreased to help to the sustainable supply of electricity in the residential sector.

- * Objective 1: By the year 2015, the Per Capita Electricity Consumption (PCEC) will equal or less than 572.96 kWh/person/year and the carbon dioxide per capita will be equal or less than 0.9 metric tons.
- Sub objective 1.1 From the year the electric energy savings education guidelines were introduced, to 2015, the test given at the end of the High School education satisfactorily verifies the quality of the electric energy savings education obtained and shows a big proportion of written commitments by the students to continue saving electricity through their lives.
- Sub objective 2.2 From the year the electric energy savings education guidelines were introduced, to 2015, through the electricity bills collected during the academic year from each senior student (11th grade), it could be verified that annual electricity savings were 5% annually in the residential sector.
- Sub objective 2.3 From the year the electric energy savings education guidelines were introduced, to 2015, the residential sector of all the Honduran cities will reach 100% in electricity coverage, meeting at the same time Honduras' Millennium Development goals (100% electricity coverage in all Honduras).
- Sub objective 2.4 Introduction of renewable energy each to decrease the overall carbon dioxide emissions, especially through hydroelectricity and biomass, equivalent to the annually energy saved in the residential sector through the electric energy savings education
- Sub objective 2.5 Introduction of an energy label guide to let the people know which appliances are energy efficient through the development of CAFTA and other free trades.
- Sub objective 2.6 A residential and nationwide survey annually given after the introduction of the energy-savings education guidelines, will verify the multiplicative effects of the program in the majority of the Honduran households.

Baseline: By the year 1997 the electricity coverage in the total residential sector in Honduras was 78.29%, Honduras' PCEC was 572.96 kWh/person/year and by 2002 the CO₂ emissions per Honduran were 0.9 metric tons/year

Source: Central America and the Caribbean: Energy. www.nationmaster.com. 6/02/05

Source: United Nations. "Statistics division.2006. http://unstats.un.org/unsd/mi/mi_series_results.asp?rowID=751

Source: Users Network. Guide for electric energy generators through renewable energy.

<http://www.bun-ca.org/publicaciones/Honduras.pdf> 1997

Note: There are many environmental factors not taken into account in order to have better environmental indicators, for example, trans boundary pollution from the rest of Central America, increases in prices of oil, carbon dioxide accumulation coming from transportation (which may cause increases in asthma in children ⁹²) and if people cannot afford buying efficient appliances. The proposal given is considering some environmental factors available and updated.

(92) Wright, Elaine. Former professor of the Environmental Impacts of Urban Housing course (ENVS 409). Spring 2005.

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