

Final Report on the Implementation of the NATIONAL ENERGY AUDIT INITIATIVE

In Antigua and Barbuda,
Grenada, Saint Kitts and
Nevis, and the
Commonwealth of Dominica



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Author of the study:

Christine Wilkinson
MF 7038
Castries, St. Lucia

Tel: 1 758 485 5777
e-mail: e3-consulting@hotmail.com



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Foreword

A country's energy resources affect nearly every aspect of its economic development. This is true for all countries, but is particularly crucial for those in the Eastern Caribbean where most energy resources are imported and the high cost of modern energy services directly affects national development.

It has become clear that utilizing renewable energy and increasing energy efficiency play a pivotal role in mitigating climate change, enhancing energy security, and moving toward sustainable economic development.

In support of these, the OAS, through its Department of Sustainable Development (DSD) in collaboration with the U.S. National Renewable Energy Laboratory (NREL) submitted an application under the Low-Carbon Communities in the Americas (LCCA), which is a facility under the U.S. Department of Energy. This resulted in the 2010 launch of a program entitled Low Carbon Communities in the Caribbean (LCCC).

LCCC is one of the initiatives under the Energy and Climate Change Partnership of the Americas (ECPA), which aims to enable participating countries to implement actions and strategies geared toward increasing the sustainability of their energy supplies while reducing carbon emissions from the energy sector through the development and use of renewable energy and energy efficient systems.

One of the objectives of LCCC is to cultivate knowledge and expertise in participant countries so that local personnel is able to conduct energy efficiency audits and deploy technologies and other measures that capitalize on the opportunities for efficiency improvements identified in said countries.

Additionally, the OAS/DSD is executing a four-year initiative funded by the EU called the Caribbean Sustainable Energy Program (CSEP). CSEP is jointly implemented by the Caribbean Community (CARICOM) Secretariat, the Caribbean Energy Utility Services Corporation (CARILEC), and the Renewable Energy and Energy Efficiency Partnership (REEEP), in close association with various Caribbean agencies, such as the Organisation of Eastern Caribbean States (OECS) Secretariat and the Caribbean Renewable Energy Development Programme (CREDP), which receives financial support from the government of Germany.

Since its inception in 2008, CSEP recognized that it is imperative that the issues of energy conservation and sustainable energy, particularly as it relates to energy efficiency and renewable energy, be prioritized at the top of the Caribbean islands' national agendas, given the fact that the islands have a particular vulnerability arising from their dependency on imported fuels and the concomitant local and global environmental damage caused by fuel generation.

Therefore, the OAS/CSEP project team has been working with policymakers to develop and implement national energy policies (NEPs) and/or national sustainable energy plans (NSEPs) in each participating country as a means of articulating each nation's plan to incorporate sustainable energy solutions into its overall energy matrix.

The establishment of NEPs in participating countries enabled goals and policies that maximize the efficient use of energy resources and ensure significant energy conservation in the production and end-use of energy in all sectors of the economy and in society to be identified. As a result, governments were able to modify their nations' NEPs with provisions for demand-side management (DSM) programs.

The beneficiary countries for both LCCC and CSEP include Antigua and Barbuda, Grenada, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, the Commonwealth of the Bahamas, and the Commonwealth of Dominica. As one of its core actions, the OAS/DSD aims to attract relevant individual and institutional stakeholders with opportunities that will not only support the aforementioned countries' use of sustainable energy, but encourage further development in the target areas. This goal places further emphasis on an aforementioned priority: addressing capacity-building in each participating nation.

In keeping with the capacity-building goal, the CSEP and UNIDO established the National Energy Auditing Initiative (NEAI) as a component of LCCC. NEAI is a continuation of the LCCC initiative and also represents one of the activities conducted under the CSEP. NEAI is supported by in-kind contributions from participating project countries, EU-funded CSEP, and UNIDO. NEAI aims to reinforce the institutional and technical capacities of the participant-country ministries in charge of energy with the overarching goal of creating a qualified and certified local energy-auditing team that is capable of identifying energy- and cost-saving opportunities within government buildings while raising public awareness about using energy responsibly.

The OAS/DSD contacted each of the seven CSEP Focal Points and informed about the NEAI. After individual discussions, it was identified that in Antigua and Barbuda, Dominica, Grenada, Saint Kitts and Nevis will be conducted energy audits in two buildings including the hand-over of energy audit equipment. In Saint Lucia and Saint Vincent and the Grenadines will be implemented energy conservation measures identified during energy audits conducted in government buildings.

It is our strong belief that demand-side management programs are critical for reducing energy use and minimizing the environmental impact associated with the use of non-renewables. In addition, should the education goals of DSM be successful, the Caribbean would benefit from a workforce that is well trained regarding the region's specific energy needs and characteristics. Once a desirable level of technical expertise is achieved, each nation will be able to manage its energy sources in a more sustainable manner.

The following publication is a comprehensive presentation of the results of the energy audits conducted in Antigua and Barbuda, Grenada, Saint Kitts and Nevis, and the Commonwealth of Dominica. In addition, it provides energy saving recommendations that can be implemented not only by the tenants of government buildings, but by any individual who wishes to manage energy consumption more responsibly.

Organization of American States
Executive Secretariat for Integral Development – SEDI
Department of Sustainable Development – DSD

ABBREVIATIONS:

AEE	Association of Energy Engineers
APUA	Antigua's Public Utilities Authority (water and electricity supplier)
CEM	Certified Energy Manager
CFL	Compact Fluorescent Lamp
CRT	Cathode Ray Tube
CSEP	Caribbean Sustainable Energy Program
DSD	Department of Sustainable Development
EC\$	Eastern Caribbean Dollar (with a fixed exchange rate of 2.68 to the US\$)
ECM	Energy Conservation Measure
kWh	Kilowatt hour (unit of energy)
LCCC	Low Carbon Communities in the Caribbean
LED	Light Emitting Diode
NEAI	National Energy Audit Initiative
NEVLEC	Nevis Electricity Company
OAS	Organization of American States
PV	Photovoltaic
UNIDO	United Nations Industrial Development Organization
UPS	Uninterrupted Power Supply

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1. EXECUTIVE SUMMARY

The objective of the consultancy that produced this publication was to assist the OAS/DSD with the implementation of the NEAI in Antigua and Barbuda, Grenada, Saint Kitts and Nevis and the Commonwealth of Dominica. This initiative was conceptualized as being tailored to the specific conditions, characteristics, and resultant needs of these countries to facilitate the identification of areas within their facilities (mainly government buildings) that may offer energy- and cost-saving opportunities.

The NEAI necessitated the sourcing of certified national, regional, and/or international energy auditors to conduct energy audits in facilities endorsed by government officials and also to prepare audit reports that include ECMs. The Initiative also facilitated the acquisition of equipment and tools for the use of the auditors during the auditing phase. The purchase of these was financed by the OAS/DSD.

The auditors were selected by each country's CSEP focal point, who, with the approval of the permanent secretaries of the relevant ministries, also chose the buildings to be audited.

Those buildings were:

Antigua:	Ministry of Agriculture Free Trade Zone
Dominica:	Government Headquarters Financial Centre
Grenada:	Ministry of Education Bureau of Standards
Nevis:	Administration Building Complex Alexandra Hospital
St. Kitts:	private home of Mrs. Willet Island Auto Suppliers

A summarization of the individual energy audit reports shows that:

94.5 % of the annual cost for utilities is created by electricity consumption, while the remaining 5.5% is created by water consumption.

As the majority of employees is unaware of consumption costs for electricity and water, an energy management program paired with a maintenance program could save up to 10% on the average costs for utilities. The average investment is under EC\$ 13 000 per building, with operational savings of EC\$ 25 000, and a payback period of under 6 months.

None of the buildings audited showed insulation on the walls, ceilings, or floors. All buildings had single pane glass windows and some of the louvered glass windows

remained partially open with big gaps even when in the closed position. The doors to air conditioned areas also showed big gaps, especially along the bottoms.

An investment in weather strips would cost approximately EC\$ 55 per door, yielding savings of approximately 1-10% on air conditioning consumption. Payback occurs in less than 1 year.

Double pane glass windows, which are ENERGY STAR-rated, are available from EC\$ 390 and upwards. Payback for those windows is on average within 3 years, but they will create savings of at least 10% on air conditioning consumption costs. The lifetime of the windows is 20 years on average.

The shading of windows either by planting trees in front of them or by shading them from the inside by using жалюзи and/or drapes will further reduce the heat load accumulated over the weekend and on holidays.

Air conditioning systems are the biggest consumers of electricity. All of the systems found in the audited buildings were oversized, using more electricity than needed. Only two buildings had a central system; all others used individual split systems.

Implementing air conditioning ECMs involves changing the existing systems to either energy-labelled split systems, or to variable refrigerant flow (VRF) systems or chilled water systems.

Investing in energy-labelled split systems is 10% more costly than using unrated systems. VRF or chilled water systems cost EC\$ 5 000 per ton of refrigeration, saving up to 35% of operational costs with a payback of under 3 years and a life expectancy of 10 years.

Further, air curtains and automatic door closures are recommended. These cost approximately EC\$ 7 000 with payback within 6 months.

The ECM for retrofitting the insulation of the refrigerant line costs about EC\$ 60 per unit and saves at least 3% on air conditioning consumption costs, further extending the lifetime of the AC system.

An investment in solar cooling (which is only possible for chilled water AC systems) costs EC\$ 800 000 and upwards with operational cost savings of 75% and payback in around 7 years, depending on the costs for electricity. The lifetime of a solar cooling system, however, exceeds 20 years.

On average, a savings margin of 40% on AC systems could be achieved by implementing the recommendations.

Lighting is the second biggest consumer of electricity in government buildings and, fortunately, one of the easiest to be addressed.

The recommended ECMs are to replace incandescent light bulbs with compact fluorescents or LEDs with removal of the ballast. Outdoor lighting should be switched to new LED fixtures and brightly-lit areas should be de-lamped.

With an investment of approximately EC\$ 718 000, the annual operational cost of EC\$ 455 541 can be saved, resulting in a payback period of under 2 years on average.

For office machinery proposed ECMs include changing the default computer setting to power save mode, replacing cathode ray tube (CRT) monitors with flat LED screens, switching from desktops to laptops, and using ENERGY STAR-certified printers, copiers, and multifunctional devices.

By investing only 10% more than the current spending on unrated office machinery, up to 54% could be saved on current operational costs.

An excess of refrigerators and water coolers was found during the audits of the government buildings. Refrigerators, in particular, should be purchased according to their consumption over their lifetime (which is approximately 12 years) and not according to the cheapest purchase price.

The ECM recommends the purchase of energy-labelled refrigerators, as they consume up to 30% less electricity than unrated models. Small refrigerators should be consolidated into bigger ones, on which the energy-saving setting should be utilized.

Transformers consume electricity, 0.5 to 15% of which manifests itself as heat that is released into the surroundings. The amount of heat released depends on the model, size, and condition of transformer. Transformers use electricity even when the appliance, for example, a computer is turned off.

The use of PV panels is recommended as all of the participant countries have included the need for renewable power generation in their NEPs.

PV panels are becoming increasingly affordable and the installations have an average payback period of 4 to 6 years, depending on the tariff which is paid by the electricity companies for feedback into the grid.

PV panels can be installed in increments, for example, it is possible to start with a smaller system and annually add panels until all the available space is used.

It is difficult to establish whether or not the expectations of the CSEP focal points were met; however, it can be said that the audits were conducted as planned and the local auditors were trained by the NEAI's auditors in regard to identifying energy situations, collecting the relevant information, and processing said information in order to make useful recommendations in the form of ECMs. Audit reports containing ECMs were compiled by the countries' respective auditors as was agreed, with the exception of Saint

Kitts. Antigua and Barbuda and Dominica remains the only two countries with a second report (that is a report prepared by the trainee auditors) outstanding.

Open Door Day was held in Nevis, Saint Kitts, and Antigua. The event encouraged the implementation of the ECMs proposed in the audit reports by highlighting the benefits they could offer to the government and by extension to the tax payers. Public discourse on this topic set the tone for higher levels of energy efficiency in the target countries. All attendees received the event well and benefitted from knowledge about possibilities for the practical application of energy conservation. Grenada and Dominica opted not to host Open Door Day.

Electricity consumption	Nevis		St. Kitts		Antigua		Dominica		Grenada	
	Alexandra Hospital	Administrative Complex	private Home	Island Auto Suppliers	Min. of Agriculture	Free Trade Zone	Government Head Quarters	Financial Center	Min. of Education	Bureau of Standards
Total before	654,785	105,317	5,895	24,509	111,263	41,498	531,770	1,415,800	470,571	40,767
Total after	436,545	81,168	2,483	13,377	0	19,601	282,775	1,035,437	286,702	16,603
kWh Saved	218,240	24,149	3,413	11,132	111,263	18,649	248,995	380,363	183,869	24,164
EC\$ Saved	210,320	23,183	3,332	13,438	129,023	21,626	342,405	521,626	215,272	28,301
% saved	33.33%	22.93%	57.89%	45.42%	100.00%	44.94%	46.82%	26.87%	39.07%	59.27%
CO2 avoided	158.31	17.52	2.56	6.77	83.45	12.89	186.75	285.27	137.91	18.12

Table 1: Reduction on Consumption

In summary of all of the project's activities it is concluded that the local auditors were successfully trained in all participating countries except in Saint Kitts where inapt choices were made in regard to the selection of local personnel.

The recommended ECMs for saving on energy expenditure can be achieved as shown in Table 1 below (excluding the installation of PV panels):

Table 1 shows that on average 47% of the electricity currently consumed could be saved and at least 852 tons of carbon dioxide emissions could be eliminated.

Whether the project's participating island-nations will use the knowledge imparted to perform more regular and sufficiently thorough audits is solely up to them. The outcome will be determined by local authorities' willingness to conduct energy audits as well as their governments' willingness to implement the recommended ECMs and measure their effectiveness over time in order to record proof that sustainability goals are achievable.

The OAS and its partners hope that the NEAI will lead to more opportunities for the Caribbean islands to become greener by changing the public sector's energy lifestyle, and reconditioning the citizenry so that support is garnered for the government's goal of increased energy-use and carbon-emission responsibility.

2. OBJECTIVE

To reiterate, the objective of the consultancy that produced this publication was to assist the OAS/DSD with the implementation of the NEAI in Antigua and Barbuda, Dominica, Grenada, and Saint Kitts and Nevis. It was stipulated at the outset that the NEAI be tailored to the specific conditions, characteristics, and resultant needs of each of the aforementioned countries to identify areas within their facilities (mainly government buildings) that may offer energy- and cost-saving opportunities.

2.1 ACTIVITIES PERFORMED IN THE PREPARATORY PHASE

On June 19, 2012, CSEP Project Manager Carolina Peña made introductions between the auditors and the CSEP focal points of all the participant countries in which audits were to be conducted.

As previously mentioned, the CSEP focal points were entrusted with the responsibility of selecting the auditing teams due to the focal points' prior OAS-sponsored participation in the CEM preparation course during which they learned about energy audits, how audits should be conducted, and how audit reports should be compiled.

In addition, some of the focal points, namely Girvan Pigott and Jerry King from Antigua, Eversley Colaire and Vaughn Royer from Dominica, and John Auguste from Grenada, had additional expertise, having also participated in a 2010 energy auditing course sponsored by the OAS under LCCC.

The LCCC training session was made available as a result of a regional collaboration between the US Department of Energy and OAS' CSEP to support the development and use of renewable energy and energy efficiency alternatives in seven small-island Caribbean states. The Energy Auditing Workshop provided the fundamental knowledge necessary to strengthen participants' capacity to carry out energy audits and recommend efficiency measures for public, commercial, and hotel buildings. The workshop explored all major aspects of energy use, energy systems and technologies, energy conservation measures, energy auditing methodology, hands-on building, and energy assessments involving on-site data collection and energy modelling tools.

With this pool of knowledge, the focal points gave consideration to a plethora of detailed information regarding choosing buildings and gathering an inventory of items, conditions, and permissions required to conduct the audits. Auditing teams were then assembled and tasks distributed among the relevant parties.

The target sector for the energy audits comprised buildings that were endorsed by the government and identified and selected by the permanent secretary of the relevant ministries together with the CSEP focal points. Given that two government buildings were selected in Nevis, it was accepted that a private residence and a commercial

building were selected in Saint Kitts in order to provide a more broadly representative sample of energy consumption.

The buildings that were selected to undergo energy audits in each participant country are listed again below:

- Antigua: Ministry of Agriculture
Free Trade Zone
- Dominica: Government Headquarters
Financial Centre
- Grenada: Ministry of Education
Bureau of Standards
- Nevis: Administration Building Complex
Alexandra Hospital
- Saint Kitts: Private home of Mrs. Willet
Island Auto Suppliers

The list of instruments requested by the focal points for conducting energy audits in each of the above-mentioned buildings was discussed prior to the placement of the order for those items that were deemed necessary. The majority of the tools were sent to Saint Lucia, as this was the most cost-efficient course of action. Specifically, the data loggers were all ordered directly out of Saint Lucia and sent to OAS offices in Saint Kitts and Nevis, Dominica, and Grenada. For Antigua and Barbuda, the data logger was sent directly to Permanent Secretary in the Office of the Prime Minister, Mrs Paula Frederick.

The other tools (excluding the data loggers) were delivered to Saint Lucia and then hand delivered by the lead auditor upon commencement of auditing.

Table 2 below itemizes the tools that were ordered and delivered.

Quantity	Description	Cost US\$				
		Antigua	Grenada	St. Kitts	Dominica	Nevis
1	Pyle PLMT56 Light Meter with Lux Measures Up To 50000 Lux	36.99	(2) 73.98	36.99	(2) 73.98	(2) 73.98
1	Klein Tools CL2000 AC/DC True RMS Clamp Meter	104.99	104.99	104.99	104.99	104.99
1	Klein Tools CL1000 AC/DC True RMS Clamp Meter				71.99	71.99
1	HDE Temperature Gun Infrared Thermometer w/ Laser Sight	29.99	29.99	29.99	(2) 59.98	(2) 59.98
1	Energenie Power Meter	18.32	18.32	18.32	(2) 36.64	(2) 36.64
1	Komelon 4930IM The Professional 30-Foot Inch/Metric Scale Power Tape, Yellow	10.87	10.87	10.87		
1	Kodac EasyShare Mini M200 incl. 4 GB memory and pouch	79.44	78.49	79.44		
2	HOBO U12 4-Channel Indoor External	108.00	108.00	108	(2) 216.00	(2) 216.00
1	HOBO Pro Software	99.00	99.00	99	99.00	99.00
1	"Transformer, 0-100 AMP AC"	90.00	90.00	90	(2) 180.00	(2) 180.00
1	Straight Line - Infrared meter		27.95			
	Shipping	151.65	151.64	120.64	170.35	139.35
	Customs Broker					
	Total US\$	729.25	793.26	698.24	1,012.93	981.93

Table 2: List of tools ordered and delivered

With the approval of the various ministries, CSEP focal points, and auditors, the audits were scheduled for the year 2012 as follows:

Nevis: 23 – 27 July
Saint Kitts: 30 July – 3 August
Antigua 13 – 17 August
Grenada 20 – 24 August
Dominica 20 – 24 August

A sample showing how to perform data collection for electricity and water consumption was sent to all CSEP focal points well in advance of the commencement of the auditing phase. Furthermore, the contractor created a document itemizing and explaining each step of a standard audit. This information was accompanied by instructions on how to compile emergent information.

As part of the preparatory phase, a request for utility data was sent to each participant country. Only some countries complied before the completion of the preparatory phase. A portion of the remainder made the data available at the commencement of the auditing phase. In Saint Kitts, the data had to be collected by the auditors.

Near the conclusion of the preparatory phase, the OAS/DSD created a document for the transfer of ownership of the Energy Auditing Equipment Package, which was shared with each participant country via OAS country representatives and presented to the relevant permanent secretaries for signature.

2.2 ACTIVITIES PERFORMED IN THE AUDITING PHASE

Documents describing the pre-audit and audit phases were produced and sent to the CSEP focal points to be distributed to the local auditing teams.

The necessary tools were all delivered, with the exception of the power meters for Nevis, Saint Kitts, and Grenada, which arrived late and were not handed over until Open Door Day. Antigua and Dominica received everything at once.

All of the energy audits were conducted as scheduled, with the exception of Dominica's where only Government Headquarters building was audited. Due to the size of the second of Dominica's target buildings, the Financial Centre, as well as weather constraints on the relevant days, only a brief walk-through audit was conducted by the lead NEAI auditor. A walk-through audit of the Financial Centre was later conducted by the local Dominican auditing team that resulted as a deliverable of NEAI.

All of the participant countries' local auditing teams showed evidence of having successfully been taught how to construct energy consumption models based on the data collected from the building audits performed under NEAI. This statement excludes Saint Kitts where the local team required significant additional training before its members were able to demonstrate proper use of the modelling software.

The observations and findings of the NEAI audits were discussed with the teams and the ECMs were reviewed.

2.3 PREPARATION OF ENERGY CONSERVATION MEASURE REPORTS

The lead NEAI auditors completed the audits for the first target building of each participant country and shared them as Microsoft Excel documents with the local auditing teams. It was the intention of the NEAI, in keeping with its training and long-term sustainability goal, that each participant country's local team would prepare the second buildings' audits under the supervision of one of the lead auditors using the format of the first buildings' audits as a template. It was agreed that the members of the local auditing teams would then use Microsoft Excel to produce reports based on the calculations they recorded for the second buildings' audits. The only participant country that attempted to comply with this requirement is Antigua.

The following is an overview of each participant country's local auditing teams and its activities.

NEVIS:

Audit dates: 23 – 26 July 2012

The auditing team consisted of:

- Anelda Maynard, NEVLEC
- Jervan Swanston, NEVLEC
- Teron Lawrence, Trainee Inspector
- Bernarde Nanton, Electrician, Public Works
- Jerome Daniel, Electrician, Public Works
- Ryan Walters, Electrician, Public Works

In compliance with the NEAI's request for utility data prior to the commencement of the auditing phase, both target buildings were audited in advance by the NEVLEC-affiliated team members. As a result, only details like the size of the air conditioning systems, the printer models, etc., needed to be collected by the NEAI's auditors at the beginning of the auditing phase.

The ECM report on the Administrative Complex was written by Anelda Maynard, and the report on the Alexandra Hospital by Jervan Swanston.



Alexandra Hospital



Administrative Complex

SAINT KITTS

Audit dates: 30 July – 2 August 2012

The auditing team consisted of:

- Kelvin Reid, Electrical Inspector, Ministry of Energy
- Erroll Dorset, Electrical Inspector, Ministry of Energy

The audits of the residential and commercial buildings were conducted as planned. However, the data for past consumption had to be collected by the NEAI's lead auditors and information about black-out dates and billing schemes proved difficult to obtain. The calculations and reports for both audits were completed by the NEAI's lead auditor.



Private Home of Mrs. Willet



Island Auto Suppliers

GRENADA:

Audit dates: 20 - 24 August 2012

The auditing team consisted of:

Erwin Roden, Lead Auditor, Grenada

John Auguste, CSEP Focal Point, Energy Unit

Robert Medford, Head of Metrology/ Quality Department, Bureau of Standards

Raphael Noel, Laboratory Technician, Bureau of Standards

The buildings were audited as planned. The reports were prepared by Lead Auditor Erwin Roden.



Ministry of Education



Bureau of Standards

ANTIGUA:

Audit dates: 13 – 17 August 2012

The auditing team consisted of:

Girvan Pigott, CSEP Focal Point, Office of the Prime Minister, and APUA

Tesfa Francis, Water Unit, APUA

Jerry King, Tertiary-Level Instructor, former APUA employee

The audits were conducted as planned. The reports were prepared by CSEP Focal Point Girvan Pigott, who requested clearance to perform the calculations for the second target building by himself.



Ministry of Agriculture



Free Trade Zone

DOMINICA:

Audit dates: 20 – 24 Aug. 2012

The auditing team consisted of:

Mr. Eversley Collaire, Maintenance Building Officer

Mr. Vaughn Royer, Ministry of Public Works



Government Headquarters



Financial Centre

The audit of the first target building, Government Headquarters, was completed as planned, though, as previously mentioned, due to time and weather constraints, only a brief walk-through audit was performed at the second target building, the Financial Centre, by the NEAI's lead auditor. The more thorough follow-up audit of the Financial Centre was performed by Vaughn Royer.

Although both reports were supposed to be prepared by the local auditing team, to date, only a draft version of the report for the Government Headquarters is available.

2.4 SYNERGY WITH OPEN DOOR DAY

Because the contract's end date was extended to November 30th 2012, Open Door Day for each participant country was scheduled to be held during the CARICOM Energy Awareness Week that was conducted on each island between November 12 and 17, 2012. It was decided, then, that Open Door Day was an appropriate forum for the introduction of the findings of the audits to interested persons, including the ministers responsible for the buildings, the employees that work in the buildings (where relevant), and private parties.

To this end, power point presentations were prepared under the title Energy Efficiency in Government Buildings. In an additional effort to increase awareness, flyers and posters about energy efficiency as it relates to lighting, refrigeration, and other electrical needs were distributed.

The ECMs for each country were highlighted and presented in detail. Only Nevis, Saint Kitts, and Antigua participated in this activity.

3. OUTCOME

The following summaries are based on all the calculations and reports that emerged from the energy audits. Apart from representing the findings of the audits, they delineate the various possibilities for the participant countries to reduce their energy and water consumption with little to no investment of resources. The potential for the significant reduction of carbon dioxide emissions is also highlighted in keeping with the participant countries ‘obligation to reduce greenhouse gas (GHS) emissions.

3.1 ENERGY AND WATER CONSUMPTION AND COSTS

The buildings that were audited presented as a heterogeneous group with differences in the way they were set up as well their age and the how the space was utilized.

Table 3 below lists the audited buildings along with measurements corresponding to area, percentage and area under air conditioning (listed as separate values), indicators for electricity consumption divided by total area, and energy utilisation index (which is calculated using energy consumption divided by number of employees and number of working days). The last index, the water consumption index, is calculated using water consumption divided by the number of employees and the number of working days.

Building Name	Nevis		St. Kitts		Antigua		Dominica		Grenada	
	Alexandra Hospital	Administrative Complex	private Home	Island Auto Suppliers	Min. of Agriculture	Free Trade Zone	Government Head Quarters	Financial Center	Min. of Education	Bureau of Standards
Area of Building (m ²)	5,180	947	208	994	1,296	285	5,912	7,497	2,550	466
Area under A/C	42.15%	87.50%	10.00%	22.00%	85.00%	100.00%	67.65%	92.86%	80.00%	100.00%
Area under A/C (m2)	2,183	828	21	219	1,102	285	3,999	6,962	2,040	466
Number of Employees	215	43	2.5	12	31	31	214	203	113	15
Electrical Energy Index Jun11 - May 12 (kWh/total area)	126.40	111.24	28.34	23.49	85.85	134.21	89.95	188.85	184.55	87.46
Electrical Energy Index Jun11 - May 12 (kWh/ area under A/C)	299.93	127.13	283.43	90.93	101.00	134.21	132.96	203.38	230.69	87.46
Total EUI (kWh/employee/days)	5.88	9.80	6.46	4.77	14.53	5.00	10.06	28.24	16.70	10.90
Water consumption Index 2011 in liters/ employee/day	70.11	27.58	279.56	205.90	746.10	0.00	50.18	51.37	159.40	91.80

Table 3: Property Descriptions

The average electrical energy index¹ (electricity consumed divided by area under air conditioning) for office buildings is 251.38 kWh/ m². Referring to Table 3, it is evident that the Bureau of Standards in Grenada is below average at 87.46 kWh/m² and the Alexandra Hospital in Nevis is above average at 299.93 kWh/m².

¹Guide to Energy Management, 7th edition, Barnel L. Capehart, Wayne C Turner, William J. Kennedey

The energy utilization index ranges from a low of 4.77 kWh at Island Auto Suppliers, in Saint Kitts to a high of 28.24 kWh at the Financial Centre in Dominica.

Similarly, the values for the water consumption index² range from a low of 27.58 liters per employee per working day at the Administrative Complex in Nevis to a high of 746.79 liters per employee per person at the Ministry of Agriculture in Antigua. Those high consumption rates are indicative of leaks and water wastage when compared against the 25-30 liters per person per working day that should be used in an office building.

Table 4 below represents electricity consumption over the year prior to the energy audits.

Country	Location	Annual Electricity Consumption in kWh	Total Cost in ECS	Unit Cost ECS
Nevis	Alexandra Hospital	654,785	630,742	0.96
	Administrative Complex	105,317	101,080	0.96
Saint Kitts	Private Home	5,895	5,755	0.98
	Island Auto Suppliers	19,880	23,998	1.21
Antigua	Min. of Agriculture	111,263	129,359	1.16
	Free Trade Zone	38,250	44,370	1.16
Dominica	Government Headquarters	531,770	731,264	1.38
	Financial Centre	1,415,800	1,941,614	1.37
Grenada	Min. of Education	470,606	550,980	1.17
	Bureau of Standards	40,755	48,080	1.18

Table 4: Electricity Consumption

Data representing water consumption for the same period was made available for almost every audited building apart from the two buildings in Dominica and one of the buildings in Antigua, namely the Free Trade Zone. That data is represented in Table 5 below.

It appears that the inhabitants of the audited buildings do not give much consideration to water consumption. Despite the fact that water is necessary for survival, it is treated as having little value due to its presently low cost.

²http://ec.europa.eu/environment/water/quantity/pdf/Water%20Performance%20of%20Buildings_Study2009.pdf

Country	Location	Annual Water Consumption in liters	Total Cost in EC\$	Unit Cost EC\$
Nevis	Alexandra Hospital	7,804,854	42,922	0.0055
	Administrative Complex	299,445	728	0.0024
Saint Kitts	Private Home	255,094	442	0.0017
	Island Auto Suppliers	857,353	2,849	0.0033
Antigua	Min. of Agriculture	2,438,446	11,263	0.0046
	Free Trade Zone	N/A	N/A	N/A
Dominica	Government Headquarters	2,652,636	N/A	N/A
	Financial Centre	2,575,764	N/A	N/A
Grenada	Ministry of Education	4,503,000	23,568	0.0052
	Bureau of Standards	344,000	2,237	0.0065

Table 5: Water Consumption

It can be concluded from the collection of afore-presented data that 94.5% of the utility cost accrued in the audited government buildings (and if extrapolation is permitted, likely in similar buildings) is due to electricity consumption while 5.5% of that cost is due to water consumption.

3.2 ENERGY USAGE

In order to produce a detailed account of electricity consumption, each electrically-powered piece of equipment was inventoried and its consumption as per its nameplate rating as well as the hours for which it was used was compiled. The calculated consumption was then compared to actual consumption.

Separated into consumer groups, the profile appears as show in Table 6 below.

Percentage of Total Consumption	Nevis		St. Kitts		Antigua		Dominica		Grenada	
	Alexandra Hospital	Administrative Complex	private Home	Island Auto Suppliers	Min. of Agriculture	Free Trade Zone	Government Head Quarters	Financial Center	Min. of Education	Bureau of Standards
Air Conditioning & Fans	47.89%	67.53%	2.74%	42.08%	53.45%	57.44%	58.57%	56.52%	71.00%	54.00%
Lights	24.05%	10.79%	52.72%	39.35%	25.15%	29.99%	13.86%	16.77%	19.00%	19.00%
Refrigeration	4.86%	3.31%	10.01%		5.28%		3.43%			
Office Equipment	0.78%	17.15%		11.93%	14.50%	9.12%	19.10%	6.98%	5.00%	9.00%
Other Equipment	12.98%	1.22%	20.42%	4.86%	0.73%	2.48%	1.55%	2.02%	5.00%	18.00%
Transformer	0.42%			1.79%	0.89%	0.97%	3.50%	1.34%		
Waterheater/ Elevator	9.44%		14.11%					16.38%		

Table 6: Electricity Consumption Profile

Air conditioning systems form the biggest consumer group averaging at 51.12%. Lighting is the second largest consumer group averaging at 25.07%, followed by electric water heaters and elevators. Office equipment follows at fourth with 9.36%, while other equipment is fifth at 6.92% and refrigeration is sixth at 5.38%.

Figure 1 represents the values for each electricity-consuming group.

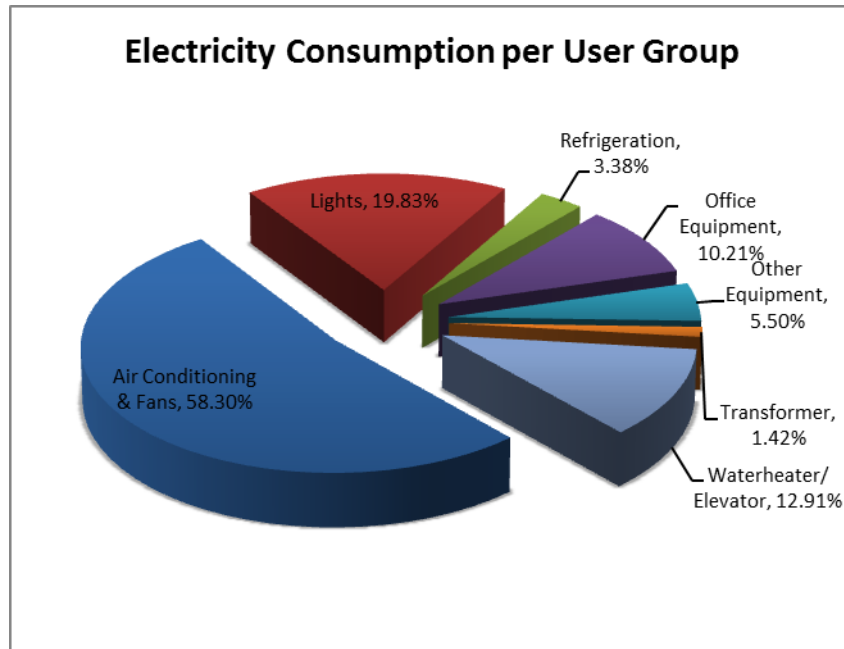


Figure 1: Electricity Consumers

3.3 ORGANIZATIONAL ANALYSIS

An analysis of the current state of energy management at the relevant properties was done using the energy management matrix as a self-assessment tool. The matrix was developed by the Carbon Trust's Energy Efficiency Best Practice Programme (EEBPP) based in Oxfordshire, United Kingdom. It appears in *The Good Practice Guide*, "119: Organizing Energy Management, a Corporate Approach" and was further developed by the Building Research Energy Conservation Support Unit (BRECSU).

Using the matrix (which is reproduced in Table 7 below), an organization is rated in each of the six different areas of energy management: policy, organization, motivation (training), information (performance measurements), marketing (communication), and investment.

During the implementation of the NEAI, the matrix was shared with the permanent secretaries of the relevant ministries and each one was asked to produce a self-rating. In cases where this information was not available by the commencement of the auditing phase, a rating was made by the auditors. Because the permanent secretaries, with the exception of the Nevis', were not available to produce the ratings at the time, the majority of the rating was done by the auditors.

	Policy	Organising	Training	Performance measurements	Communicating	Investment
LEVEL 0	No explicit energy policy.	No delegation of responsibility for managing energy	No energy related staff training provided	No measurement of energy costs or consumption	No communication or promotion of energy issues	No investment in improving energy efficiency
LEVEL 1	Unwritten set of guidelines	Informal mainly focused on energy supply	Technical staff occasionally attend specialist courses	Invoice checking only	Ad hoc informal contact used to promote energy efficiency	Only low-cost or no cost measures taken
LEVEL 2	Unadopted energy policy	Some delegation of responsibility but line management and authority unclear	ad-hoc internal training for selected people as required	Monthly monitoring by fuel type	Some use of company communication mechanics to promote energy efficiency	Low or medium cost measures considered if short payback period
LEVEL 3	Formal energy policy, but no active commitment from top management	Clear line management accountability for consumption and responsibility for improvement	Energy training targeted at major users, following training needs analysis	Weekly performance measurement for each process, unit or building	Regular staff briefings, performance reporting and energy promotion	Same appraisal criteria used as for other cost reduction projects
LEVEL 4	Energy Policy, action plan and regular review have active commitment of top management	Fully integrated into Management structure with clear accountability for energy consumption	Appropriate and comprehensive staff training tailored to identify needs, with evaluation	Comprehensive performance measurement against targets with effective management reporting	Extensive communication of energy issues within and outside organisation	Resources routinely committed to energy efficiency in support of business objectives

Table 7: Energy Management Matrix

Each participant country's scores (individuated by category) are shown in Table 8 below. Keeping in mind that a total of 24 points can be reached, it is clear that all of the countries have room for improvement. To that end, it is suggested that the energy management matrix be used as an instrumental tool to increase awareness at all levels of society.

Country	Policy	Organising	Training	Performance measurements	Communication	Investment	TOTAL
Nevis	3	1	1	0	1	1	7
St. Kitts	1	0	0	0	0	0	1
Antigua	2	0	0	0	2	1	5
Dominica	1	1	0	0	0	0	2
Grenada	1	1	1	2	2	2	9

Table 8: Energy Management Matrix Summary

3.4 CARBON DIOXIDE ANALYSIS

To obtain a value that is representative of the buildings' carbon foot print, the NEAI used the guidelines extracted from the Department of Environment, Food, and Rural Affairs and the Department of Energy and Climate Change's (DEFRA/DECC) "GHG Conversion Factors for Company Reporting". Version 2.0 of the guidelines, which were updated on August 6, 2010, produced for DEFRA/DECC by the American Energy Auditors (AEA).

Because no records of liquefied petroleum gas (LPG), natural gas, or diesel consumption for back-up generators were compiled, the summary of the countries as per the audited buildings is based on electricity consumption and appears as shown in Table 9 below.

Country	Annual Carbon Footprint	Electricity Consumption	Factor	CO2 in kg	CO2 in tonnes	CO2 in kg/ Person
Nevis	Alexandra Hospital	654,785	0.73	474,981	474.98	1,557
	Administrative Complex	105,317	0.73	76,397	76.40	1,777
St. Kitts	Private home	5,895	0.75	4,422	4.42	1,769
	Island Auto Suppliers	19,880	0.75	14,910	14.91	5,964
Antigua	Min. of Agriculture	111,263	0.75	83,447	83.45	2,692
	Free Trade Zone	38,250	0.75	28,688	28.69	925
Dominica	Government Headquarters	531,770	0.75	398,828	398.83	1,864
	Financial Centre	1,415,800	0.75	1,061,850	1,061.85	5,231
Grenada	Ministry of Education	470,606	0.75	352,950	352.95	3,123
	Bureau of Standards	40,755	0.75	30,570	30.57	2,038
TOTAL		3,394,321		2,527,042	2,527	

Table 9: Carbon Dioxide Emissions

The sum total for carbon dioxide emissions released into the air annually by all of the audited buildings was 2 527 tonnes. Relative to other countries, this may not seem like a level that warrants concern; however, it is important to remember that the effects of global warming will devastate the Caribbean region to a much greater extent than others, so the small-island societies and their allies should try to their best to reduce emissions to the lowest level possible.

4. ANALYSIS OF ENERGY CONSERVATION MEASURES

A list of ECMs was compiled for each of the audited buildings. Each ECM was designed specifically for a particular application and a payback period was calculated.

All calculations for energy savings are based on the average price for electricity for the applicable building.

All price values used to represent the cost of replacements or recommended purchases are based on credible Internet research and are available in the appendix. Note that the cost for replacements and items recommended for purchase were calculated without consideration to shipping and labor costs.

The most urgent, beneficial ECMs were placed in a priority group and the internal rate of return over a period of ten years was calculated.

The sections that follow, 4.1 to 4.8, provide a summary of the ECMs suggested for almost all of the audited buildings. Details of the ECMs identified for implementation can be found in the appendix.

4.1 ENERGY MANAGEMENT AND MAINTENANCE

It was observed that most of the permanent secretaries of the ministries in charge of the audited buildings as well as the employees that work in those buildings are unaware of the rate of consumption of electricity and water. With the understanding that measurement is the first step to controlling consumption, the energy management and maintenance ECM proposes as a first step to energy efficiency the implementation of a system wherein electricity and water consumption are measured on at least a monthly basis if not more regularly and published in a report that is copied to all employees.

The relevant government departments should be concerned about the large sums spent annually on utilities and should take all possible action to reduce this expenditure. A high level of commitment from the minister and all other levels of employees is essential in ensuring the success of any energy management program.

In order to achieve and perpetuate sustainable results, the ECMs identified in this section need to be effectively incorporated into an overall strategic plan. In order to succeed, it is essential that staff across all departments is motivated and that the identified technological projects are well managed. This can only be achieved by developing a strategic energy management plan and program.

The energy management plan and program will provide sustainable performance because of the following:

- It will have support from top executives via the energy policy
- It provides a clear sense of direction as outlined in its objectives
- It provides a viable method of achieving its objectives through organization
- It indicates the action steps for the execution phase
- It provides for controlling and monitoring progress during the review phase

The effective management of energy will reduce operating costs, without affecting production capabilities or quality, and ultimately result in increased profitability.

The implementation of an effective energy management program has, on its own, been proven to save between 5% to 10% of a facility's energy and energy-related expenses through no-cost and/or low-cost strategies.

Each building should develop a policy that is based on its local NEP and that is comprehensible to all. Goals should be developed and set by each department and then measured and controlled regularly, whether or not they are immediately achieved.

One person, who can either be an existing member of staff or an individual who is present on a need-be contractual basis, should be made responsible for producing and disseminating consumption reports, executing training sessions, implementing ECMs, keeping records, assisting in the purchase of energy-efficient appliances and other equipment, and performing other related tasks.

The initial cost of developing a policy and the annual cost of managing and operating an effective energy management program varies according to the size of the building, the number of employees, the condition of the building, and other similar factors. See Table 10 below for itemized costs applicable to each of the audited buildings.

	Nevis		Antigua		Dominica		Grenada	
	Alexandra Hospital	Administrative Complex	Min. of Agriculture	Free Trade Zone	Government Headquarters	Financial Centre	Min. of Education	Bureau of Standards
Developing Policy & Programme	5,000	5,000	5,000	5,000	20,000	20,000	10,000	5,000
Energy Manager							12,000	
Staff Training	10,000	3,000	1,000	500	5,000	5,000	4,000	4,000
Maintenance Training	5,000	1,000	1,000		5,000	5,000	4,000	
Annual Management System Au	10,000	3,000	6,000	3,000	5,000	5,000	6,000	
TOTAL	25,000	7,000	8,000	3,500	15,000	15,000	26,000	4,000
Investment	25,000	7,000	8,000	3,500	15,000	15,000	26,000	4,000
Annual Savings in kWh	45,835	7,372	8,345	3,060	21,271	56,632	24,553	4,264
Annual savings in EC\$	44,172	7,077	9,677	3,548	29,251	77,665	28,727	5,032
Annual CO2 savings in Tonnes	33.25	5.35	6.05	2.22	15.43	41.08	18.40	3.20
Payback	0.55	0.95	0.96	0.99	0.71	0.26	0.91	0.79

Table 10: Energy Management Program

On average the investment is under EC\$ 13 000 per building, with operational savings of EC\$ 25 000, and payback in under 6 months.

As it pertains to the management of Government Headquarters in Dominica in particular, the ad-hoc maintenance system which functions by personnel reacting to breakdowns or crises as they occur is a weak point that could negatively affect sustainability goals by increasing consumption rates and costs.

Proactive maintenance plans should be formulated and installed accompanied by good record keeping. There should be a system for identifying the optimal time to change lights, service and/or replace air conditioning units, and so on. This measure would help to ensure the efficient use of electricity as well as save on costs; for example, mass re-lamping is cheaper than the individual re-lamping of blown or broken bulbs.

The responsibility of supervising the maintenance team could logically be assumed by the same person assigned to lead the energy management program.

4.2 BUILDING ENVELOPE

None of the buildings audited showed insulation on the walls, ceilings or floors. Furthermore, all buildings had single-pane glass windows, and even some of the louvered glass windows exhibited large gaps in the closed position.

In addition, most of the doors were not flush with the floor in the closed position, allowing conditioned air to escape. This means that any air conditioning system operating in such buildings works harder than it should, wasting energy.

A simple solution is for weather strips to be placed between the bottom of the doors and the floor to fill the gaps. The investment will cost approximately \$ 55 per door with savings of approximately 1 to 10% on air conditioning consumption. Payback occurs in under one (1) year.

ENERGY STAR-rated double-pane glass windows are available in different sizes and shapes from EC\$ 390 upwards. Payback for these windows (which have a lifetime of 20 years, on average) occurs, on average, within 3 years, but they will create savings of at least 10% on air conditioning consumption and costs.

Windows can be shaded from the exterior of the buildings with the installation of overhangs or by planting trees in strategic places. Interior shading options include the use of жалусии or drapes or blinds, any of which will reduce the heat load accumulated over the weekend and on holidays.

In relation to roofing, studies have shown that white rooves are 39°C cooler than black rooves. The same color concept is valid for walls that are not insulated: the lighter the color, the less heat is absorbed.

4.3 AIR CONDITIONING

In buildings where an air conditioning system is in operation, the AC is the biggest consumer of electricity. Observations have shown that even when weather conditions encourage natural ventilation, persons occupying buildings in which a working AC system is available are still likely to use it.

The audits show that the buildings' AC systems are oversized; consuming more energy than needed and cooling areas that do not need to be cooled. The only audited building that approaches exception is the Financial Centre in Dominica, although it contains some unnecessary split units.

One of the problems identified during the NEAI's auditing phase occurs when doors leading from the exterior of the building open into an air conditioned lobby. Each time the door, which is usually the main entrance, is open, hot air from outside mixes with the cool air inside. This influx of hot air heats the lobby, its ceiling, and the rooms directly overhead thereby increasing the cooling demand placed on the AC system.

The proposed ECM for this problem is the installation of an air curtain on the interior side of the door. The air curtain will create a barrier between the cool and hot air.

Automatic door closures further assist in keeping the conditioned air inside. Investment in these solutions is approximately EC\$ 7 000.00 with payback within half a year.

Most of the audited buildings have split AC units, which are easy to install and easy to change if one of the units fail; however, these systems are not energy efficient when compared to their ENERGY STAR-rated counterparts.

The ECM therefore proposes the purchase of ENERGY STAR-rated split units, which save between 10% and 30% on the electricity and other operational costs associated with cooling systems. The initial caveat, which is offset by the payback, is that investment in rated, energy efficient models is approximately 10% higher than in unrated units.

Another problem that was identified is that the insulation around the refrigerant lines that lead from the outside compressor to the internally installed air handler has a tendency to deteriorate quickly in the salty tropical air. In almost all of the systems inspected, the insulation was partially missing, rotten, or simply no longer existent.

The ECM that suggests retrofitting the insulation costs about EC\$ 60.00 per unit and saves at least 3% on air conditioning consumption and costs while further extending the lifetime of the AC system.

Alternatively, chilled water and variable refrigerant flow (VRF) systems are much more economical not to mention durable (they have a lifetime of 10 years compared to 4 years for split units) and they do not force users to sacrifice the flexibility to control the settings for each room individually.

The investment associated with this ECM is approximately EC\$ 5 000.00 per ton of cooled air. This is alongside operational cost savings averaging 35%, and payback in less than 3 years. Savings accumulate over the subsequent years of the systems' lifetime.

For big buildings, solar cooling is an option, as the need for cooling coincides proportionally with the sun's heat. High temperature panels utilize solar energy to heat water and an absorption chiller provides the chilled water needed to cool the building.

Investment is from EC\$ 800 000 and up with operational cost savings of 75% and payback in about 7 years, depending on electricity costs. The lifetime of a solar cooling system exceeds 20 years.

Country	Air Conditioning	kWh before	Cost in EC\$	kWh after	Cost EC%	Savings in kWh	Savings in EC\$	% saved
Nevis	Alexandra Hospital	313,566	302,187	42,256	40,722	271,310	261,465	86.52%
	Administrative Complex	71,117	68,320	29,808	28,635	41,309	39,684	58.09%
St. Kitts	Private home	0	0	0	0	0	0	0.00%
	Island Auto Suppliers	9,034	10,905	5,338	6,444	3,695	4,461	40.91%
Antigua	Min. of Agriculture	59,469	68,962	35,340	40,981	24,129	27,981	40.57%
	Free Trade Zone	23,552	27,312	12,768	14,806	10,784	12,506	45.79%
Dominica	Government Headquarters	311,437	428,274	202,471	278,429	108,966	149,845	34.99%
	Financial Centre	799,840	1,096,893	754,064	1,034,116	45,776	62,777	5.72%
Grenada	Min. of Education	259,759.53	304,124	117,895	138,142	141,864	165,981	54.58%
	Bureau of Standards	21,879	25,812	15,204	17,935	6,675	7,877	30.52%
TOTAL		1,869,655	2,332,788	1,215,144	1,600,211	654,510	732,577	40%

Table 11: Air Conditioning saving possibilities

As shown in Table 11 below, on average, the implementation of the aforementioned ECMs could result in 40% savings over the current AC systems.

4.4 LIGHTING

The results of the audits show that lighting is the second biggest consumer of electricity in government buildings. Fortuitously, it is also one of the easiest to address.

The audits revealed that the use of incandescent light bulbs is significantly lower as compared to more energy-efficient lighting options. Nevertheless, any remaining incandescent heating lamps – so called due to the fact that 95% of their energy consumption is released into the surroundings as heat - should be replaced with either CFLs or LEDs. The implementation of this ECM reduces lighting’s electricity consumption by up to 90% with payback in less than 1 year.

T12 and T8 fluorescent tubes are currently the most commonly used light bulbs throughout the audited buildings. These lights are not as wasteful as incandescent bulbs, but because they are on for at least 8 hours per working day, it is efficient to replace them with LEDs. LEDs reduce the amount of electricity consumed by about 50% and would eliminate the energy drain introduced by the ballast. LED installation is associated with payback in between 1 and 3 years, depending on the usage hours and the cost of electricity. Because LEDs have a bulb lifetime of up to 50 000 hours, they are well worth the higher initial investment.

When purchasing LED linear tubes, it is important to compare the lumen output, the expected lifetime, and the length of the stated guarantee, which should be between 3 and 5 years.

In connection with fixtures for fluorescent lighting, it should be noted that even if there is no light bulb inside the fixture, the ballast will still consume electricity when it is turned on if it is on the same wire with other lights.

Apart from lighting hardware, the audit revealed that some areas are over-illuminated. Removing tubes and unnecessary ballasts is a zero investment ECM which just produces savings.

Outdoor lighting is done by either high pressure sodium or incandescent PAR 38 spotlights. In order to comply with the ECM, those fixtures would need to be replaced (light bulbs included) with new LED fixtures, which have a much lower consumption of 50 to 150 Watts.

In total, an annual operational cost of EC\$ 455 541 can be saved with an investment of approximately EC\$ 718 000 and payback in under 2 years on average. This 65% savings over the current lighting systems can be achieved by using CFLs instead of incandescent lights, changing fluorescents to linear LEDs, and replacing high pressure sodium and incandescent PAR 38 spotlights with LED fixtures.

Table 12 below provides a summary of potential operational cost savings for each audited building.

Country	Lighting	kWh before	Cost in EC\$	kWh after	Cost EC%	Savings in kWh	Savings in EC\$	% saved
Nevis	Alexandra Hospital	157,472	151,757	50,654	48,816	106,818	102,941	67.83%
	Administrative Complex	11,177	10,737	4,619	4,434	6,558	6,303	58.71%
St. Kitts	Private home	3,108	3,034	527	514	2,581	2,520	83.04%
	Island Auto Suppliers	9,644	11,642	2,860	3,453	6,784	8,189	70.34%
Antigua	Min. of Agriculture	27,985	32,452	9,747	11,303	18,238	21,149	65.17%
	Free Trade Zone	12,446	14,433	2,780	3,224	9,666	11,209	77.66%
Dominica	Government Headquarters	73,687	101,331	28,910	39,755	44,778	61,576	60.77%
	Financial Centre	237,361	325,515	115,915	158,964	121,447	166,551	51.17%
Grenada	Min. of Education	90,230	105,641	29,799	34,889	60,431	70,752	66.97%
	Bureau of Standards	7,856	9,268	4,083	4,817	3,773	4,451	48.03%
TOTAL		630,967	765,811	249,894	310,170	381,073	455,641	65%

Table 12: Lighting ECMs

4.5 OFFICE MACHINERY

Office machinery includes computers and their monitors, printers, copiers, multifunctional devices (MFD), scanners, etc. In order to arrive at calculations for this group, the standards developed by ENERGY STAR were used.

It was observed that none of the computers and monitors were set to power save mode (screen savers are indicators of that). However, most employees said that they turn off their equipment when they are leaving the office at the end of the working day.

The ECMs for computers necessitate the replacement of cathode ray tube monitors (CRT) with flat screen monitors that save on electricity consumption. It is also suggested that a member of staff specialized in information technology set all employees' computers and monitors to power save mode.

An additional computer-related ECM proposes a switch from desktop models to laptops. Laptops are far more energy efficient than desktops and the investment costs are approximately equal. Operational costs, on the other hand, are approximately 80% lower with laptops than with desktops.

In regard to printers, copiers and MFDs, the audits revealed that while there are some - ENERGY STAR-rated products in use, there is a lot of room for improvement in the area of energy efficiency.

The ECM for computer-connected devices suggests purchasing ENERGY STAR-rated products only. This requires an investment that is, on average, 10% higher than with unrated products, but operational costs are at least 30% lower.

There is a host of energy efficient products on the market, for example, the most energy efficient scanners do not have their own power supply; they are USB-connected to the computer - most efficiently, a laptop - and do not directly consume any power themselves.

As shown in Table 13 below, electricity consumption savings of 54% could be achieved with the implementation of the office machinery ECMs.

Country	Office Machinery	kWh before	Cost in EC\$	kWh after	Cost EC%	Savings in kWh	Savings in EC\$	% saved
Nevis	Alexandra Hospital	5,113	4,927	1,953	1,882	3,160	3,045	61.80%
	Administrative Complex	18,058	17,348	7,711	7,408	10,347	9,940	57.30%
St. Kitts	Private home	0	0	0	0	0	0	0.00%
	Island Auto Suppliers	2,754	3,324	978	1,181	1,776	2,144	64.48%
Antigua	Min. of Agriculture	16,137	18,712	9,963	11,553	6,174	7,160	38.26%
	Free Trade Zone	4,188	4,856	1,576	1,828	2,612	3,029	62.37%
Dominica	Government Headquarter	101,588	139,699	51,503	70,824	50,085	68,875	49.30%
	Financial Centre	98,844	135,554	51,878	71,145	46,966	64,409	47.52%
Grenada	Min. of Education	11,900	13,932	2,741	3,209	9,159	10,723	76.97%
	Bureau of Standards	3,832	4,520	840	991	2,992	3,530	78.08%
TOTAL		262,413	342,874	129,142	170,020	133,271	172,854	60%

Table 13: Office Machinery ECMs

4.6 REFRIGERATION

There were many refrigerators found in the audited buildings.

When refrigerators are purchased, consideration should be given to their energy consumption over their lifetime (which spans approximately 12 years) in addition to their purchase price.

The refrigeration ECM recommends purchasing ENERGY STAR-labelled refrigerators, as they consume up to 50% less electricity than unrated models.

The audits also revealed that a high volume of water coolers is in use in the sample buildings. Most of them are only set on cooling mode, although a few were found to be set on both heating and cooling mode.

The investment for both ENERGY STAR-rated refrigerators and water coolers is approximately 10% higher than the investment required for unrated models, but the former option results in a 30% reduction in operating costs.

The water cooler ECM recommends that the heating mode on all water coolers be turned off permanently; water heating needs can be satisfied using a kettle, which is a readily available appliance in most settings. The ECM also suggests the use of ENERGY STAR - labelled water coolers with timers that automatically turn the coolers off at the end of the working day and on weekends and holidays.

Country	Refrigeration	kWh before	Cost in EC\$	kWh after	Cost EC%	Savings in kWh	Savings in EC\$	% saved
Nevis	Alexandra Hospital	31,847	30,691	28,352	27,323	3,495	3,368	10.98%
	Administrative Complex	3,490	3,353	2,988	2,870	502	482	14.39%
Saint Kitts	Private home	0	0	0	0	0	0	0.00%
	Island Auto Suppliers	458	553	339	409	119	144	25.98%
Antigua	Min. of Agriculture	5,871	6,808	4,433	5,141	1,438	1,668	24.50%
	Free Trade Zone	781	906	606	703	175	203	22.41%
Dominica	Government Headquarter	18,232	25,072	12,544	17,250	5,689	7,823	31.20%
	Financial Centre	14,851	20,367	8,964	12,293	5,887	8,074	39.64%
Grenada	Min. of Education	13,309	15,701	766	6,655	7,851	9,047	57.62%
	Bureau of Standards	2,197	2,592	1,090	1,286	1,107	1,306	50.39%
TOTAL		91,038	106,044	60,082	73,929	26,264	32,115	31%

Table 14: Refrigeration ECMs

The implementation of refrigeration and water cooling ECMs will produce annual savings (inclusive of all audited buildings) of EC\$ 32 115, which, over twelve years, accumulates to more than EC\$ 380 000 (assuming the maintenance of current electricity costs). Details are shown in Table 14 above.

4.7 TRANSFORMERS & UNINTERRUPTED POWER SUPPLY (UPS)

Transformers consume electricity, 0.5 to 15 % of which is released into the surroundings as heat. The percentage of energy released as heat by any given transformer depends on the transformer's model, size, and condition. In addition, transformers use electricity when they are plugged into an outlet even if the appliance it is supplying is switched off.

Furthermore, transformers are designed to change current, not frequency, so, depending on the original frequency; the machine that the transformer is supplying may not be reaching its potential.

All computers, printers, and similar devices are now available with dual voltage. All office equipment is available in 220 Volts, 50/60 Hz. The same applies to kitchen appliances. With the proliferation and viability (in terms of availability and cost) of these devices, it is no longer necessary to use transformers.

UPS is used to prevent short-term loss of power to desktop computers in the event of an interruption in the main power supply. Tests have shown that UPS devices can release up to 10% of the electricity they consume into the environment as heat.

The UPS ECM suggests the use of laptops as opposed to desktops. Because laptops have built-in battery power, UPS would no longer be necessary.

See the details of the results of the implementation of the aforementioned ECMs in Table 15 below.

Country	Transformer & UPS	kWh before	Cost in EC\$	kWh after	Cost EC%	Savings in kWh	Savings in EC\$	% saved
Nevis	Alexandra Hospital	0	0	0	0	0	0	0.00%
	Administrative Complex	0	0	0	0	0	0	0.00%
St. Kitts	Private home	0	0	0	0	0	0	0.00%
	Island Auto Suppliers	438	995	0	0	438	995	100.00%
Antigua	Min. of Agriculture	1,120	1,298	0	0	1,120	1,298	100.00%
	Free Trade Zone	403	467	0	0	403	467	100.00%
Dominica	Government Headquarter	18,596	25,573	0	0	18,596	25,573	100.00%
	Financial Centre	18,947	25,983	0	0	18,947	25,983	100.00%
Grenada	Min. of Education	4,380	5,128	0	0	4,380	5,128	100.00%
	Bureau of Standards	876	1,033	0	0	876	1,033	100.00%
TOTAL		44,760	60,478	0	0	44,760	60,478	

Table 15: Transformer and UPS ECMs

4.8 RENEWABLE ENERGY

Two of the audited buildings, namely the Alexandra Hospital in Nevis and the private home of Mrs. Willet in Saint Kitts, were found to operate electrical water heaters. Water heaters use approximately 800 kWh per water heater per annum under circumstances of normal usage. The rate of water consumption for the hospital is unknown, so it is difficult

to produce a value for hot water use; however it is known than in Europe, hospitals on average consume 120 liters of hot water per admitted patient per day.

Despite the unknown value, the applicable ECM proposes that solar panels be added to the buildings with existent electrical water heaters. The panels will supply the heaters with water that has been pre-heated using renewable energy, thus reducing the work the electrical heater has to undertake. Concomitant with a reduction in the heater's work is a reduction in the non-renewable energy it uses.

PV panels are specifically recommended because PVs are addressed in each participant country's NEP under renewable power generation.

PV panels are becoming increasingly affordable as initial investments. It is possible to reduce the initial investment even further by installing the panels in increments; that is, by starting with a small system and making periodical (for example, annual) additions until all of the available space is used. Payback is tangible within 4 to 6 years, depending on the tariff paid by the electricity companies for feedback into the grid.

5. CONCLUSION

Energy efficiency has long been recognized as the low-hanging fruit of developing a clean energy economy. This is especially true when the resources necessary to increase energy efficiency are compared to the capital-intensive investments associated with energy generation technologies. Becoming energy efficient is neither difficult nor exorbitant. We simply need to be aware of how much energy we consume and how we consume it. Because there are accessible solutions, once we are self-conscious, we can implement energy conservation measures step by step.

Nevertheless, becoming a low carbon economy will not be an easy task for the Caribbean region. Energy goals must be set and all social actors must be committed to achieving them.

Governments cannot achieve energy goals without team work. A successful team must include all actors, from the highest authorities to entry level employees, in order to implement the necessary changes. Everyone's participation is needed to change the way things are done, for example, taking equipment's operational costs into consideration alongside purchase cost, since operational costs are proportional to energy consumption as well the maintenance required across a device's lifetime.

The capacity-building of local personnel during the NEAI is a powerful baseline for uncovering operational practices and equipment purchases that will save energy, reduce operational costs, and lead to higher overall performance.

As stated before, it is unclear whether the expectations of the CSEP focal points were met; however, the following points were established:

1. The audits were conducted as planned and the local auditors were trained to conduct similar audits.
2. ECMs were formulated based on calculations made using the data collected prior to and during the audits.
3. Audit reports that included the ECMs were compiled by the participant countries' auditors as agreed, although Dominica's second report is still outstanding.
4. Open Door Day was hosted in Nevis, Saint Kitts, and Antigua. The event helped to sensitize the attendees to energy efficiency and encouraged the implementation of the locally applicable ECMs by highlighting the potential for reduction in public expenditure. Although Grenada and Dominica opted not to host Open Door Day, the events were received well and it is believed that they disseminated knowledge about energy conservation possibilities.

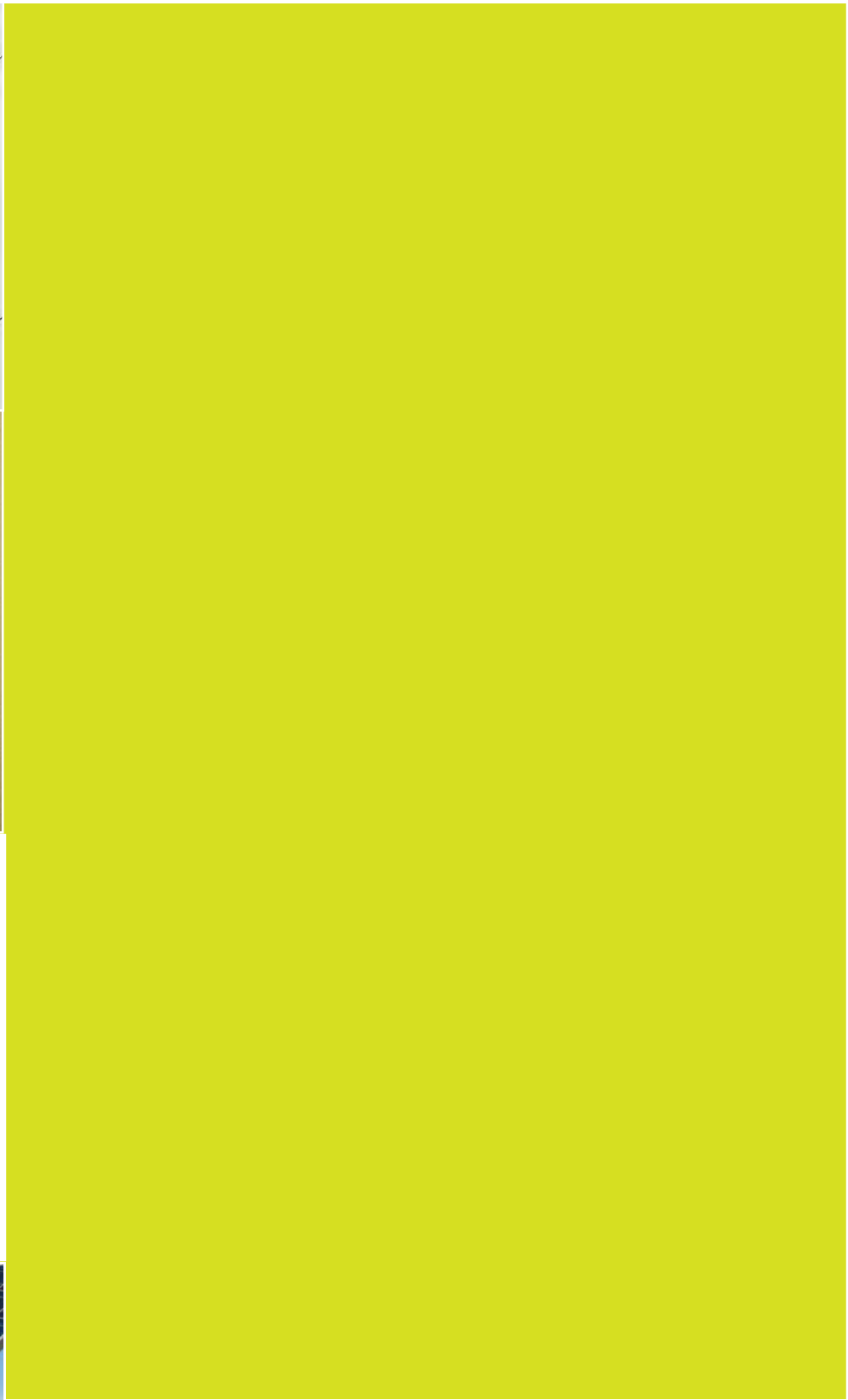
When summarizing this project's qualitative activities, it should be restated that the training of the local auditors was successful, with the exception of St. Kitts, where unsuitable candidates were selected.

In quantitative conclusion, the ECMs, if implemented, could produce energy savings as shown in Table 16 below. Note that the data excludes the installation of PV panels and measurements are expressed in kWh per annum.

Table 1 on Page 10 above shows that, on average, 47% of the electricity currently consumed in the audited buildings, and likely in other similar buildings, could be saved before the installation of PV systems. In addition to electrical savings, at least 852 tons of carbon dioxide emission could be eliminated.

Whether the project's participant countries will seize the opportunity to continue and intensify local audits is yet to be seen. It is important to remember that every audit has its unique conditions and challenges, so continuous auditing requires constant learning and adaptability on the part of the auditor(s). The fate of auditing in the participant countries is dependent on local authorities' willingness to conduct energy audits as well as their willingness to implement the NEAI-recommended ECMs. The fact that all of the NEAI-trained auditors hold full-time jobs is a foreseeable challenge which means that the time that can be dedicated to auditing will be affected by the attitudes and decisions of their employers.

Despite these challenges, the OAS and its partners hope that the National Energy Audit Initiative will lead to more opportunities for the Caribbean countries to become greener, by changing the public sector's outlook and ultimately the citizens' mind-sets in order to support the governments' cause to become more energy efficient and reduce the nations' carbon footprint.



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