The Ministry of Transport and Aviation
and Department of Civil Aviation

Energy & Water Use Conservation Standards

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Energy and Water Strategy for the Bahamas Family Islands Airports

FINAL REPORT

Standards for Energy and Water

Prepared for:
Ministry of Transport and Aviation
Department of Civil Aviation

Prepared by:
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Sign-off Sheet

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Executive Summary

The Commonwealth of The Bahamas' Ministry of Transport and Aviation's (MOTA), Department of Civil Aviation (BCAD), has initiated a major assessment and review of the 28 government-owned and operated Family Islands Airports, as part of the significant Air Transport Institutional Reform that is currently underway. The project is contracted to Stantec Consulting International Ltd. (Stantec), and is organised in four distinct tasks:

1. Comprehensive Strategy for Optimization of the Family Islands Airports
2. Institutional & Organisational Analysis/Development of Guidelines & Standards
3. Hazardous Cargo Management Procedures
4. Energy & Water Use Conservation Standards

This report provides the results of Task 4 – Energy & Water Use Conservation Standards.

Electricity consumption in the Family Islands Airports is estimated at two million kWh per year and water consumption is estimates at almost 4,000,000 gallons per year. In the absence of an energy and water efficiency programme, consumption patterns are likely to be impacted by changes to the level of activity of the Family Islands Airports. Expenditures for energy and water services are projected to increase from current levels of $600,000 per year in 2015 to $710,000[1] per year in 2040.

There is currently limited management of energy and water at the Family Islands Airports. In the short term, and as a means to realize savings through efficiency gains, a number of strategies exist to reduce energy and water consumption at the Family Islands Airports that are cost effective and easy to retrofit. High priority opportunities include:

- Lighting retrofit to LEDs for all interior and exterior lighting;
- Installation of high performance cooling equipment; and
- Low-flow water fixtures.

In the longer term, opportunities for installing renewable resources such as photovoltaic (PV) panels are recommended; however, these retrofits must work within the contexts of broader regulatory changes of the Bahamas Electricity Act. In addition, formalization of a management framework is recommended. A scan of energy standards and management frameworks confirms that ISO50001 provides a comprehensive, robust and transparent framework which is recommended for adoption by MOTA and CAD (Table 1).

A programme budget of $3.4 million dollars over three years is proposed. Activities include outreach and communication as well as financing of retrofit projects. Reduced energy and water consumption and costs will be achieved through the results chain shown in Figure S -1.

[1] This estimate assumes the cost of electricity and water remains constant in real terms.

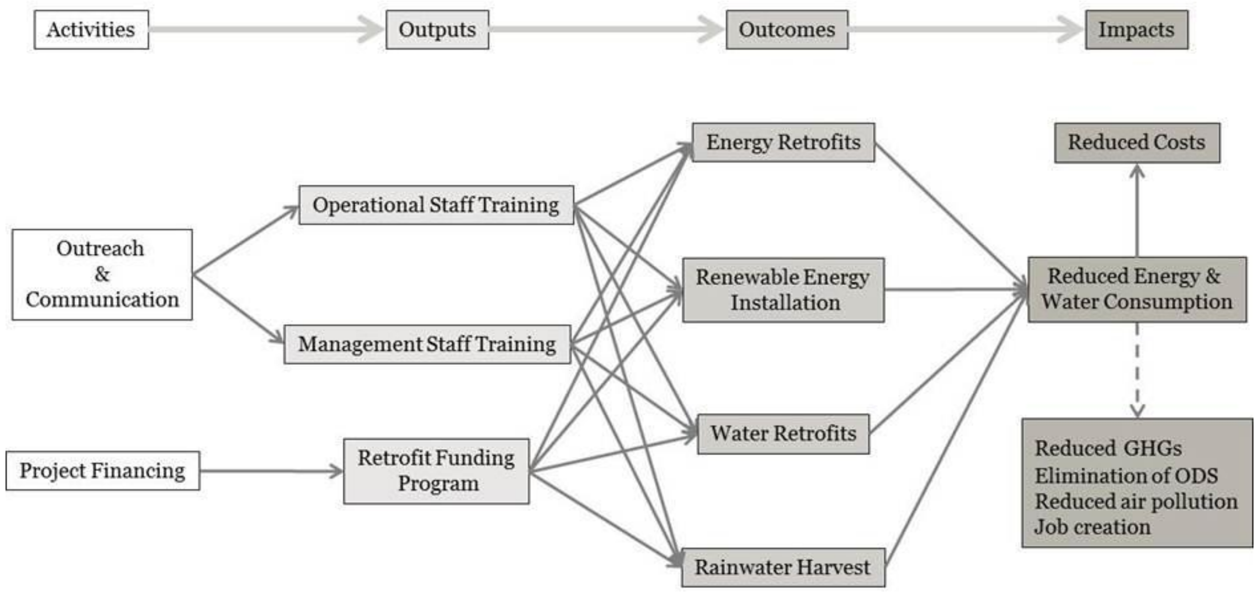


Figure S -1 Energy and Water Standard Programme Logic Model

Table 1: Family Islands Airports Requirements for an Energy and Water Standard

Requirement	Relevance to Family Islands Airports and Current Status
Management responsibility	Based on a jurisdictional scan, no management and institutional standards are currently in place. It is recommended the Manager of Finance assume overall responsibility for energy and water strategies. Short term activities include: 1. Appointment of a representative and establishment of an energy/water management team; and 2. The provision of adequate resources (financial and personnel).
Energy policy	There is currently no energy policy in place in MOTA or CAD. A proposed policy statement is: *The Family Islands Airports Energy and Water Standard Programme will invest in staff and facilities to reduce energy and water use in the Family Islands Airports.* The objectives for this policy are: • To demonstrate government leadership in the promotion energy and water efficiency; • To support innovation and economic development of Family Islands Airport facilities; and • To achieve best practice in the management and operation of Family Islands Airport facilities.
Energy planning	The Family Islands Airports have no energy and water planning components in place. Priority actions include: • Development of a detailed energy and water baseline; and • Working with Airport Managers and conducting audits to establish priority opportunities where appropriate. Given the unique circumstances of individual airports, it is recommended that energy and water planning requirements be defined in Schedule 21 - Aerodrome Standards and Certification with responsibility for implementation of energy and water strategies residing primarily with Airport Managers/senior staff.
Implementation and operation	An implementation plan is presented in this report that includes: • Priority projects; • Implementation schedule; • Target organisations and potential partners; • Programme components; • Project selection criteria; • Programme delivery; • Resource requirements; • Project funding; and • Milestones and reporting.
Checking	Priority activities should be considered as the implementation plan is rolled out; however, no short term activities are required.

Abbreviations

Abbreviation	Full Name
BEC	Bahamas Electricity Corporation
BEPI	Building energy performance index
BMS	Building Management System
CAD	Civil Aviation Department
CDD	Cooling degree days
CFL	Compact fluorescent lamp
DDC	Direct digital control
ECM	Energy conservation measure
GHG	Greenhouse gas
HDD	Heating degree days
HVAC	Heating, ventilation and air conditioning
kWh	Kilowatt hour
LED	Light-emitting diode
MOF	Ministry of Finance
MOTA	Ministry of Transport and Aviation
VFD	Variable frequency drive

1. INTRODUCTION

The Commonwealth of The Bahamas' Ministry of Transport and Aviation's (MOTA), Department of Civil Aviation (BCAD), has initiated a major assessment and review of the 28 government-owned and operated Family Islands Airports, as part of the significant Air Transport Institutional Reform that is currently underway. The project is contracted to Stantec Consulting International Ltd. (Stantec), and is organised in four distinct tasks:

1. Comprehensive Strategy for Optimization of the Family Islands Airports
2. Institutional & Organisational Analysis/Development of Guidelines & Standards
3. Hazardous Cargo Management Procedures
4. Energy & Water Use Conservation Standards

This report provides the results of Task 4 – Energy & Water Use Conservation Standards. This report provides:

- A report on the existing state of energy and water use and conservation at the Family Islands Airports;
- Standards for energy use and conservation at the Family Islands Airports; and
- Standards for water use and conservation at the Family Islands Airports.

1.1 OBJECTIVE

The objective of this report is to provide a functional analysis of the existing management structure of the Family Islands Airports with respect to energy and water use and conservation. This report summarises the existing state of energy and water use and conservation at the Family Islands Airports, provides a baseline of current efforts and recommends an institutional framework for the management of energy and water.

1.2 COMPANION DOCUMENTS

This energy and water standards report is one of a series of documents that have been developed for the Bahamas Ministry of Transport and Aviation and its Department of Civil Aviation. Companion documents include:

1. Technical Analysis;
2. Economic Analysis;
3. Environmental Guidelines;
4. Health and Safety Standards;
5. Emergency Preparedness; and
6. Dangerous Cargo.

While this report may be reviewed in isolation, it is recommended that readers familiarize themselves with all of the companion documents to ensure a comprehensive understanding of the institutional reform that is being proposed as part of this consultancy.

1.3 APPROACH TO COMPLETING THIS ASSIGNMENT

This analysis was undertaken through primary and secondary research. Primary research was completed with the involvement of management and staff at all levels of the Civil Aviation Department and the Ministry of Transport and Aviation, and included a review of 28 airport facilities to document energy and water use. Through workshops and email correspondence, an understanding of the current institutional framework was developed. Secondary research included internet searches and document reviews of energy and water management activities in The Bahamas.

1.3.1 Energy and Water Management Standards

To ensure a fit with the ongoing management of Family Islands Airports, this report has been structured to provide MOTA and CAD with an institutional framework that recognizes the unique opportunities and challenges of airport operations in The Bahamas. Energy and water institutional frameworks are generally structured around five phases (Figure 1-1), including:

1. Development of a baseline;
2. Forecasting of energy and water;
3. Development of a performance framework and evaluation framework of energy conservation measures;
4. Identification of energy management strategies, including conservation, fuel switching and alternative energy strategies; and
5. Creation of an implementation plan.

This structure has been used to provide a conceptual model of the Energy and Water standards proposed for the Family Islands Airports,

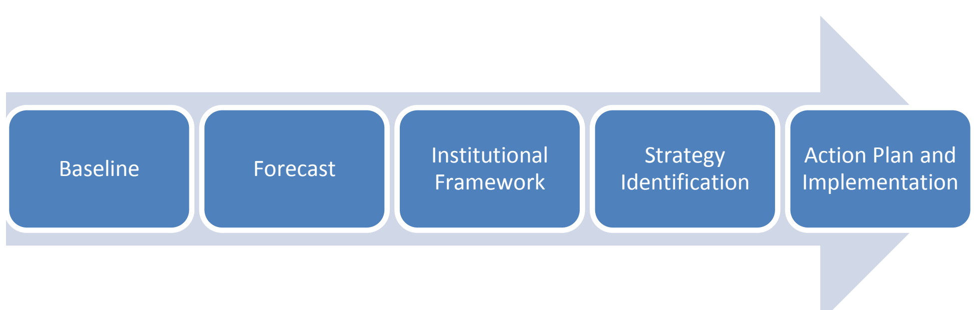


Figure 1-1: Energy and Water Institutional Framework Sequence

1.4 STRUCTURE OF THIS REPORT

This report is presented in seven chapters:

- Chapter 1 provides an introduction to the project requirements and objectives;
- Chapter 2 provides a summary of the current context for an energy and water standard for the Family Islands Airports;
- Chapter 3 presents information on energy and water use of the airports in terms of a baseline and business-as-usual forecast;
- Chapter 4 presents an institutional framework for energy and water management;
- Chapter 5 provides a description of recommended strategies and expected results;
- Chapter 6 provides a programme action plan and implementation strategy; and
- Chapter 7 provides conclusions, recommendations and proposed next steps.

2. CONTEXT

This section provides a review of contextual information including climate, previous guidelines, standards, plans and studies on energy use and water conservation in the Family Islands Airports in The Bahamas.

2.1 CLIMATE

Climate is a significant factor in both energy and water use. The climate of The Bahamas is characterized as hot and humid. Monthly average temperatures range from 770F to 82.4 0F. The average wind speed is modest with winds steady at 9 mph to 12 mph. Solar radiation is constant throughout the year, while precipitation has seasonal variances with the majority of rain falling between June and October (see Figure 2-1). The warm climate eliminates the requirement for heating; however, cooling is required to maintain a comfortable temperature indoors. The moderate breeze throughout the year and the use of passive ventilation strategies reduces ventilation requirements. Hurricanes pose a threat to Family Islands Airports as storms disrupt electricity supply and the high winds can negatively impact equipment.

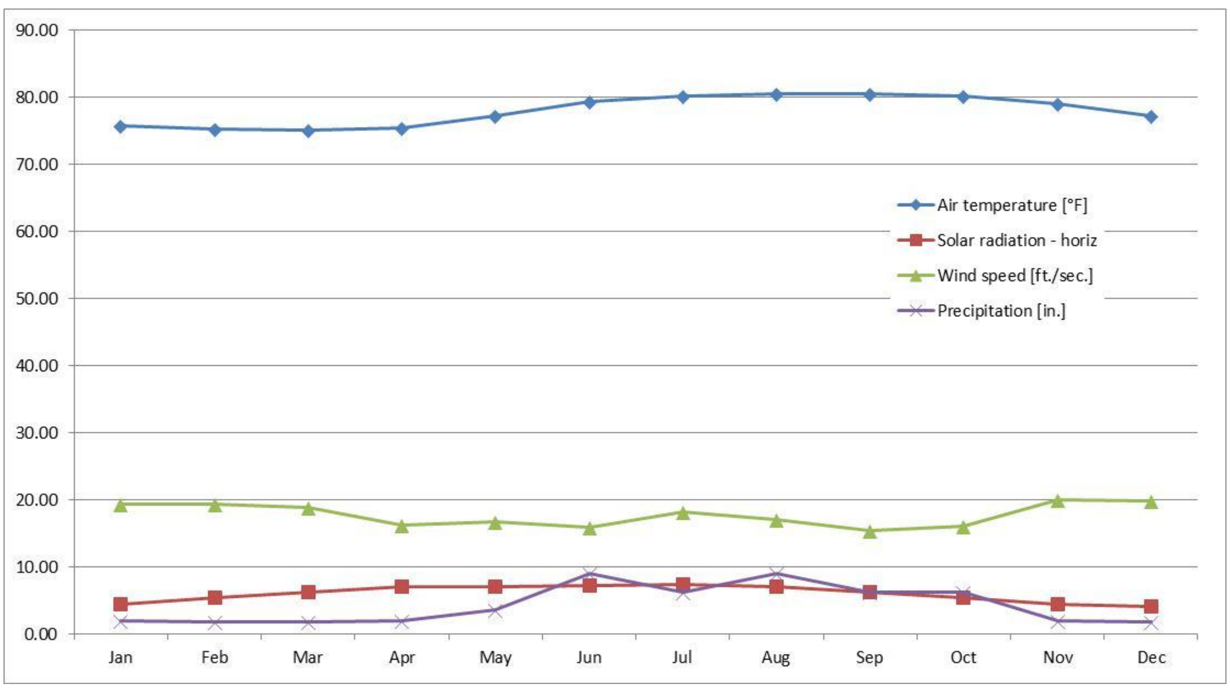


Figure 2-1: Climate Normals for the Bahamas

2.2 UTILITY RATES

Utility rates for energy and water are presented in Table 2 for energy and water. This information is used in subsequent analysis to perform business casing of energy and water conservation measures.

Table 2: Electricity, Water and Sewer Rates

Service	Rate
Electricity	\$0.35/ kWh[2] (including fuel charge)
Water	\$60/ 3000 Gallon (per quarter)
Sewer	\$9.18/3000 gallons (per quarter)

It is worth highlighting the high cost of electricity supply in The Bahamas (see Figure 2-2). While electricity rates are consistent with other Caribbean countries, the cost of electricity is about four times higher than on the mainland. The high cost of electricity can have a negative impact on domestic economic development, but it also makes the case for energy conservation and the cost effective development of renewable electricity resources.

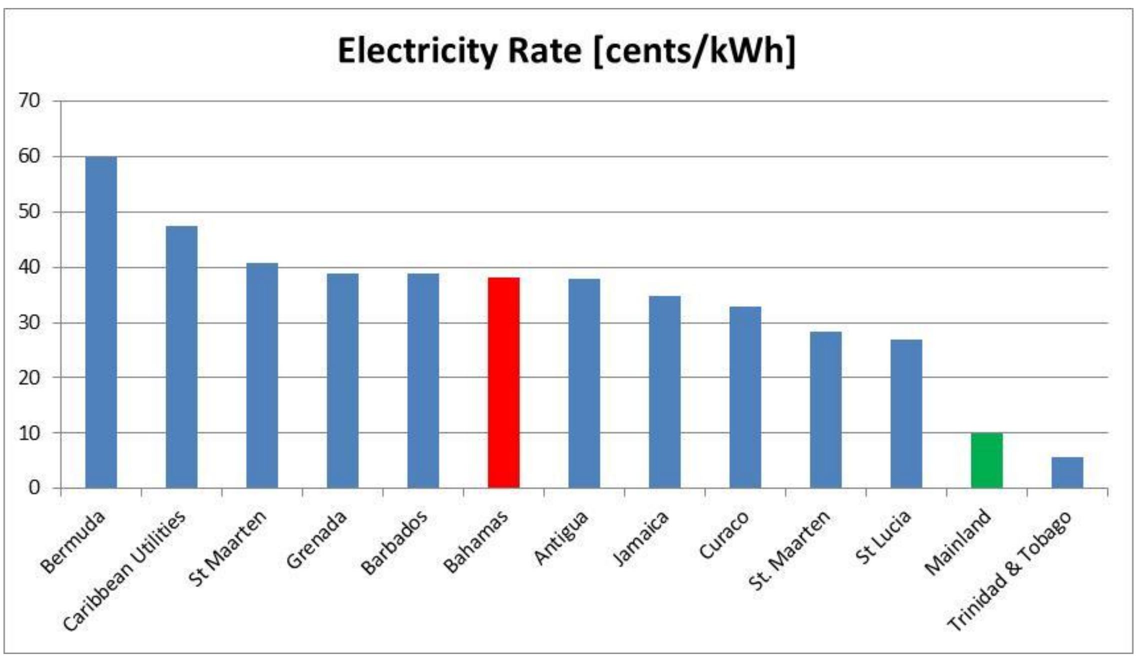


Figure 2-2: Caribbean Electricity Price Comparison[3]

[2] http://www.bahamaselectricity.com/rates.cfm
[3] Inter-American Development Bank, Caribbean Sustainable Energy Roadmap, Phase 1, June 2013

2.3 FAMILY ISLANDS AIRPORTS DESCRIPTION

There are 28 airports in the Family Islands Airports analysed in this report. The location of the airports is presented in Figure 2-3. The airports are classified into Tiers, depending on whether they are ports of entry or smaller regional facilities. A discussion of airport tiers in presented in the companion report related to the economic development of the Family Islands Airports.

Figure 2-3: Map of Family Islands Airport Locations

2.3.1 Physical Description of the Family Islands Airports

A list of the airports within the scope of this assignment is presented in Table 3. Information on building footprint and total visitors is included. This information is used in subsequent sections to estimate energy and water use of the various airports.

Table 3: Family Islands Airports Building Size and Visitor Count

Airport	Interior (ft^2)	Exterior (ft^2)	2008 Visitors (thousands)	2013 Visitors (thousands)
Andros Town (Fresh Creek)	2,600	780	4.3	0.2
Arthur's Town	1,040	312	2.9	7.9
Black Point	0	0	—	—
Clarence A Bain (Mangrove Cay)	1,240	372	—	—
Congo Town	3,400	1,020	21.4	0
Crooked Island (Colonel Hill)	450	135	8.8	9.5
Deadman's Cay	760	228	32.5	45.9
Exuma International	9,000	2,700	140.6	166.5
Farmers Cay	0	0		
Governor's Harbour	5,800	1,740	86.6	84
Great Harbour Cay	7,500	2,250	2.8	3.1
Marsh Harbour	10,000	3,000	239.3	208.4
Matthew Town	850	255	12.9	8.7
Mayaguana	1,860	558	12.5	1.9
Moore's Island	600	180		
New Bight	1,320	396	11.6	34.1
North Eleuthera	3,200	960	141.6	158.6
Port Nelson (Rum Cay)	500	100	—	3.8
Ragged Island (Duncan Town)	460	138	—	—
Rock Sound	5,000	1,500	54.5	96.4
San Andros	2,500	750	18.7	—
Staniel Cay	1,000	300	—	—
San Salvador	3,500	1,050	38.6	73.7
Sandy Point	0	0	—	—
South Bimini	4,600	1,380	12	21.3
Spring Point	1,550	465	8.5	7.4
Stella Maris	2,450	735	17.4	25.7
Treasure Cay	2,800	840	88.6	32.5
Total	**73,980**	**22,144**	**956.1**	**989.6**

2.3.2 Tier 1 Airports

Tier 1 airports are significant Port of Entry gateways for the Family Islands with Customs and Immigration officers on-site, and have enough economic opportunity to be operationally sustainable. In general, these facilities have higher visitation and longer hours of operation that impact both energy and water use.

These buildings are single-storey structures of concrete-block construction, and are typically 2,000 square feet to 8,000 square feet in size. Tier 1 airports are shown in Table 4.

Table 4: Tier 1 Airports

Airport Name	Image
Marsh Harbour	
Exuma International	
San Salvador	

Airport Name	Image
North Eleuthera International	
South Bimini	
Governor's Harbour	

2.3.3 Tier 2 Airports

Tier 2 airports have Port of Entry status and provide Customs and Immigration services to Family Islands where there is existing international traffic and/or economic development to support limited or shared services. These buildings are single-storey structures of concrete-block construction and are typically 2,000 to 8,000 square feet in size. Due to the lower visitor levels, the operating hours are likely more limited resulting in lower energy and water usage characteristics. Tier 2 airports are shown in Table 5.

Table 5: Tier 2 Airports

Airport Name	Image
Great Harbour Cay	
San Andros International	
Andros Town	

Airport Name	Image
New Bight	
Rock Sound	
Matthew Town	

Airport Name	Image
Deadman's Cay	

2.3.4 Tier 3 Airports

Tier 3 airports are smaller than Tier 1 or Tier 2 facilities. These airports provide domestic services only and have limited traffic (or are transitional airport) that requires local coordination with Island Administrators for inspections and maintenance requirements. While most of these are enclosed structures, there are some Tier 3 facilities that only have an un-serviced canopy. Implementation of energy and water standards will likely be a challenge in these facilities due to the limited presence or absence of regular CAD staffing. Tier 3 airports are shown in Table 6.

Table 6: Tier 3 Airports

Airport Name	Image
Mayaguana	

Airport Name	Image
Rum Cay	
Sandy Point	
Stella Maris	

Airport Name	Image
Moore's Island	
Mangrove Cay	
Congo Town	

Airport Name	Image
Staniel Cay	
Black Point	
Farmer's Cay	

Airport Name	Image
Crooked Island	
Spring Point	
Ragged Island	

Airport Name	Image
Treasure Cay	
Arthur's Town	

2.4 INSTITUTIONAL SCAN

A review of ministerial documentation was completed to assess the extent of energy and water standards and guidelines, including:

- Civil Aviation Authority;
- Ministry of Transport and Aviation;
- Ministry of Finance (MOF); and
- Bahamas National Energy Policy.

Relevance to energy and water institutional framework of these references is discussed below.

2.4.1 Civil Aviation Authority

Schedule 21 of the Civil Aviation Authority defines standards and certification requirements for airports. Part D addresses obligations of the airport operator, including operation and maintenance of the facility. Part E of Schedule 21 addresses airport design requirements. There are currently no requirements related to energy and water directly or indirectly noted in these procedures.

2.4.2 Ministry of Transport and Aviation

No information was identified related to energy or water efficiency within the Ministry of Transport and Aviation documents reviewed for this report.

2.4.3 Ministry of Finance

The Ministry of Finance is working with other ministries to reform the structure of electricity generation and distribution in The Bahamas. Based on recent press statements, the vision for The Bahamas energy sector is to achieve "a modern, diversified and efficient energy sector, providing Bahamians with affordable energy supplies and long-term energy security towards enhancing international competitiveness and sustainable prosperity". Specific targets of the energy plan include 30% renewables generation by 2030 and a commitment to greater energy efficiency. It is understood that draft policy reform has been tabled and is awaiting ascension. However, there have been multiple delays in adopting these changes and the current status form for the Bahamas Electricity Act remains unclear.

2.4.4 Bahamas National Energy Policy

The second report of the National Energy Policy Committee provides a roadmap to reduced dependence on imported fuel oil through increased use of alternative and renewable energy resources, applying waste to energy technologies, and promoting energy efficiency and conservation measures. The report emphasizes that innovation in the electricity sector is constrained due to the Bahamas Electricity Act (1956) which limits efficiency and interconnection, and prohibits self-generation.

Recommendations presented in the report include wide ranging organisational and institutional shifts to create a sustainable energy unit responsible for wide ranging efficiency and alternative energy activities.

While the Policy has been submitted to government, ratification of the recommendations remains uncertain.

2.4.5 Other Documents

A range of additional policy documents were reviewed with respect to defining energy and water requirements that may be applied to the Family Islands Airports including:

- ICAO manuals (Annex 16; Aerodrome Planning Manual);
- International Finance Corporation's (IFC) Policy on Environmental and Social Sustainability;
- USGB LEED - Energy and water use and conservation criteria;

- FAA Aviation Environmental Tool Suite;
- Bahamian environmental regulations, as well as of the local environmental background;
- Environmental Impact Assessment requirements by International Institutions and the Bahamas Environmental Science and Technology Commission (BEST);
- Water and Sewerage Corporation (WSC) of The Bahamas' with regards to water usage and conservation;
- Bahamas Electricity Act; and
- Bahamas Building Code.

A summary of these documents with regards to energy and water is presented in Table 7.

Table 7: Policy Scan of Energy and Water Standards

Policy/Standard	Scope of Standard Related to Energy and Water	Specific requirements related to energy and water	Relevance to new construction, building renovation or operations	Integration with other environmental Aspects	Applicability to Family Islands Airport Facilities
ICAO manuals (Annex 16; Aerodrome Planning Manual).	The ICAO manual provides a high level description of energy management requirements for airport terminals (Section 3.6). Energy benchmark requirements and pollutants released are required. Reporting requirements are defined. The guidelines provide examples of energy policy statements and identification of metrics to evaluate energy supply and conservation activities.	The ICAO guidelines provide high level information on energy policy requirements. No specific requirements are defined for facilities and energy related guidelines focus primarily on in-flight activities.	The guidelines may be applied to new, retrofit or operating facilities.	The ICAO guidelines cover a range of environmental aspects and may be integrated with other environmental activities.	The ICAO Guidelines do not provide specific requirements for energy and water management of airport facilities.
International Finance Corporation's (IFC) Policy on Environmental and Social Sustainability	The IFC Mandate is to provide investment and advisory services to developing countries. The IFC has articulated a number of performance standards to guide its activities related to sustainable development. Performance Standards include: • Assessment and Management of Environmental and Social Risks and Impacts; • Labor and Working Conditions; • Resource Efficiency and Pollution Prevention; • Community Health, Safety, and Security; • Land Acquisition and Involuntary Resettlement; • Biodiversity Conservation and Sustainable Management of Living Natural Resources; • Indigenous Peoples; and • Cultural Heritage.	IFC support for water and energy is inferred through the high level performance standards. IFC support for low-carbon economic development includes supporting access to modern, clean, and reliable energy services. IFC, in its efforts to support its climate-related commitments, will build on its experience in energy efficiency, cleaner production, renewable energy, and carbon markets as well as in the development of GHG accounting and approaches to climate change risk assessment. This will help IFC to produce instruments and develop practices that allow its clients to consider climate-related risks and opportunities in their investment decisions. Finally, as the practice and tools for GHG accounting are mainstreamed, IFC will require its clients to include GHG emissions in their regular reporting to IFC in	Projects that seek IFC funding will be evaluated in part on their performance related to energy and water efficiency. The exact formula for this evaluation is project specific	The IFC has a high level of integration with other environmental aspects.	The IFC Guidelines do not provide specific direction on energy and water management of airport facilities.

Policy/Standard	Scope of Standard Related to Energy and Water	Specific requirements related to energy and water	Relevance to new construction, building renovation or operations	Integration with other environmental Aspects	Applicability to Family Islands Airport Facilities
		accordance with the Performance Standard 3 quantification threshold. This will allow IFC to quantify, manage and report on the carbon footprint of its direct investment portfolio in accordance with the emerging state of practice on accounting and reporting.			
USGB LEED - Energy and water use and conservation criteria	USGBC LEED is an environmental assessment methodology that provides guidance on the design of new commercial buildings. Components of the methodology address • Sustainable sites; • Water efficiency; • Energy efficiency; • Materials and resources; • Indoor environmental quality; • Innovation in design; and • Regional priority credits. The tool is designed to enable users to achieve different levels of performance ranging from certified, silver, gold and platinum.	Water Conservation requirements include a 20% reduction relative to baseline consumption. Methods include: • Water efficient landscaping; • Innovative waste water; and • Water use reduction below the prerequisite. Energy requirements in LEED include prerequisites for building commissioning; minimum energy efficiency of 10% below ASHRAE 90.1-2007 and management of CFC based refrigerants. Additional points are available to further reduce energy consumption: • Utilisation of on-site renewables; • Enhanced building commissioning; • Enhanced refrigeration management; and • Measurement and verification.	LEED provides a suite of tools that may be used to evaluate new construction and renovation projects as well as the benchmarking of ongoing operational practices.	LEED is highly integrated with a range of environmental aspects including sites, water, air pollution and climate change, resource depletion, etc.	LEED may be considered for the construction of new facilities. Using LEED EBOM to review the performance of existing facilities may be considered.

Policy/Standard	Scope of Standard Related to Energy and Water	Specific requirements related to energy and water	Relevance to new construction, building renovation or operations	Integration with other environmental Aspects	Applicability to Family Islands Airport Facilities
FAA Aviation Environmenental Tool Suite	The FAA Environmental tool suite offers users a suite of models and analytical tools to address: • Noise; • Dispersion modelling; • Global emissions; • Aviation environmental design tool; • Environmental Design Space; and • Aviation portfolio management tool.	The global emissions module of the FAA tool models aircraft-related sources such as aircraft engines, auxiliary power units and ground support equipment. EDMS also models airport emission sources that are not aircraft-specific, such as ground access vehicles, stationary sources, construction equipment, and training fires that may occur at the airport. Energy use from buildings and water are not explicitly addressed in this tool.	The FAA tool is relevant to operational aspects of aircraft and ground support equipment. The tool is not relevant to energy or water use of airport terminals.	This tool focuses on noise and local air pollution related to aircraft.	This guideline is not applicable to energy use and water conservation of airport terminals.
Bahamian environmental regulations, as well as of the local environmental background	The Ministry of the Environment and Housing under the direction of the Minister, the Hon. Kenred Dorsett, MP has responsibility for: • Bahamas Environment Science & Technology Commission (BEST); • Department of Environmental Health Services; and • Department of Housing Bahamas environmental legislation Legislation pertaining to water and energy: • Planning and Subdivision Act, 2010 Replaces Town Planning Act, 1961; • Building Regulations Act, 1971; • Building Regulation (Extension to the Out Islands) Order, 1975; • Family Islands Development Encouragement Act, No. 14, 1997;	Water and energy provisions come under the guidance of the Water and Sewerage Corporation and the Bahamas Electricity Corporation. Please see table items specific to these corporations for more information.	Environmental legislation may be relevant to new construction or renovations as determined by the permitting authorities.	Legislation in The Bahamas covers a number of environmental aspects including provisions for the protection of species, mining and excavation, and environmental health. However, the legislation is not well integrated with all environmental aspects.	Conformance to environmental legislation of The Bahamas is site specific and based on project specifications. There is no environmental legislation specific to Family Islands Airports. However, receiving a building occupancy certificate requires compliance with WSC and BEC. The Airports Act provides tax exemption for building materials specified in the Act and includes items related to water conservation such as grey-water and solar supplies. The Act expires December 2014 but is

Policy/Standard	Scope of Standard Related to Energy and Water	Specific requirements related to energy and water	Relevance to new construction, building renovation or operations	Integration with other environmental Aspects	Applicability to Family Islands Airport Facilities
	• Out Islands Dilapidated Buildings Act, 1952; • Water and Sewerage Corporation Act, 1976; • Reclamation and Drainage Act, 1937; • Out Islands Utilities Act, 1965; • Local Government Act, 1996; • Electricity Act, 1956; • Out Islands Electricity Act, 1965; • Water Supplies (Out Islands) Act, 1953; • Water Supply Rules, 1953; • Airport (Customs Duties, and Excise Tax Exemption) Regulation, 2009; and • Airports Act 1976.				applicable to Family Islands Airports. The Bahamas Customs and Excise Department controls rates for Frequently Imported Items and Newly Implement Fees for Processing and Environmental Levy Items. Items considered to be more energy efficient are generally classified at lower duty rates, thereby providing monetary incentive for purchase.

Environmental Impact Assessment requirements by International Institutions and the Bahamas Environmental Science and Technology Commission (BEST)	Environmental Impact Assessment requirements follow guidelines developed by the BEST Commission. The terms of reference are determined on a project specific basis during initial consultation with BEST.
	
	International institutions such as the IADB, World Bank or other multilateral lending agency may provide specific requirements in the terms for loan agreement.
	
	General EIA Guidelines include:
	
	• Project Description;
	• Alternatives, No-Action Alternative;
	• Environmental Baseline Conditions:
	  ○ Groundwater resources;
	  ○ Waste Stream;
	  ○ Utilities Required;
		The EIA Guidelines refer to Utilities Requirements and analysis based on utilities required vs. utilities available and source of utility resources. In remote areas power generation is encouraged to incorporate renewable technologies to minimize risks for hydrocarbon spills. There are no specific requirements defined.
		
		Impact Analysis Assess for:
		
		• Utility source;
		• Utility required;
		• Waste Stream;
		• Groundwater resources;
		• Hydrologic Impacts; and
		• Fuelling Requirement and Impact.
			The requirement for an EIA is project specific and determined by the BEST Commission. A new aerodrome would likely require an EIA while building renovations would not.	The EIA itself is an integrated document that provides assessment of environmental aspects in the area of influence as identified in the agreed EIA terms of reference. The EIA identifies applicable legislation that comes under the direction of various Ministries.	The inclusion of an EIA in the application for an aerodrome would include an assessment of utility requirements for that specific aerodrome. Per Civil Aviation Safety Regulations, Schedule 21, Aerodrome Certification and Operation, Section 21.050: Application for Aerodrome Certificate identifies an EIA to accompany the application.
					
					a) An application for the issuance of an aerodrome

Policy/Standard	Scope of Standard Related to Energy and Water	Specific requirements related to energy and water	Relevance to new construction, building renovation or operations	Integration with other environmental Aspects	Applicability to Family Islands Airport Facilities

	• Legal Aspects;
	• Impact Analysis:
	  o Hydrologic Impacts;
	  o Waste Stream Impacts;
	  o Utilities Impact Analysis ;
	• Environmental Mitigation;
	• Environmental Management;
	• Public Consultation; and
	• Recommendations.
					certificate or an amendment thereto, shall be made in the form and manner prescribed by the Authority and accompanied by:
					
					2) An environmental impact assessment report
					
					There is no specific reference to water and energy guidelines for the Family Islands.

Water and Sewerage Corporation (WSC) of The Bahamas with regards to water usage and conservation	The Water and Sewerage Corporation (WSC) in association with the Global Water Partnership (GWP) have developed an Integrated Water Resources Management Plan (IWRMP).	The document is organised in five parts. The first part is the executive summary, which describes why integrated water resources management is important and the varied progress thus far in achieving it. The summary also includes an introduction which describes, inter alia, the process that was used to develop the Plan for The Bahamas. The second part presents a summary of water demands and availability resources. The third part focusing on issues, processes, investments, policies, and scale-up strategies that underpin this plan set out in the conclusions and recommendations. In so doing, it establishes a policy objective for each related issue. The fourth part identifies the elements of the Plan and the fifth provides a set of	The control and administration of water resources of The Bahamas rests with the WSC. 83% of the country's water systems are owned, operated and managed by the WSC with the remaining 17% being managed by the private sector.	The Integrated Water Resources Management Plan is not yet fully implemented.	All groundwater extraction and reverse osmosis plants are subject to permitting and licensing by the WSC.

Policy/Standard	Scope of Standard Related to Energy and Water	Specific requirements related to energy and water	Relevance to new construction, building renovation or operations	Integration with other environmental Aspects	Applicability to Family Islands Airport Facilities
		conclusions and recommendations for implementation at the country level.			
Bahamas Electricity Act	Bahamas Legislation Chapter 194 provides for the establishment of the Bahamas Electricity Corporation (BEC), and for the BEC's exercise and performance of functions relating to the generation and distribution of electricity.	The BEC Act makes provision for the BEC to be the only provider of electricity. In limited instances where BEC generation and distribution does not exist, the BEC may grant franchises.	All new construction requires design approval and construction permitting and review by a BEC licensed inspector	BEC have developed an Environmental Management System (EMS) (1994).	The document outlines the Bahamas Electricity Corporations (BEC) Initial Environmental Management System (EMS), with the major aim being to demonstrate compliance with the Corporate Environmental Policy.
Bahamas Building Code	The current version of this code is Bahamas Building Code Edition 3.	The purpose of this code is to provide certain minimum standards, provisions and requirements for safe and stable building design, methods of construction and uses of materials in building and/or structures hereafter erected, constructed, enlarged, altered, repaired, moved, converted to other uses or demolished. The code also regulates the equipment, materials, use and occupancy of all buildings. The provisions of this code supplement The Building Regulations Act 1971 and the Subsidiary Legislation, and form a condition of the approval of each and every building permit.	All new construction is required to comply with the Building Code.	All new construction requires an inspection by the Department of Environmental Health Services prior to the issuance of a certificate of occupancy.	All Family Islands Airports with the exception of Freeport are required to be code compliant. However, there are no requirements related to energy and water efficiency for new construction.

2.5 SUMMARY OF CONTEXT AND IMPACT ON THE CURRENT ANALYSIS

Based on the scan of relevant documentation, the following observations are submitted:

- The climate of The Bahamas is suitable to the design of buildings that can be operated with minimal use of energy and water. Passive design, daylighting and rainwater capture are technically feasible options. Barriers to the adoption of passive strategies are primarily related to regulations imposed by the Bahamas Electricity Act.
- The costs of electricity in particular and water services to airport facilities are significant. High electrical costs can be reduced through implementation of energy efficient equipment as well as renewable energy resources such as solar photovoltaic systems.
- Workshop participants emphasized the need for training and capacity building to support enhanced management of the Family Islands Airports.
- The airports within this study are relatively small and simple buildings. Typical floor areas range from 1,000 to 8,000 square feet of conditioned space. Energy use is primarily for lighting and cooling. Water use is primarily for toilet facilities.
- Of the 28 airports reviewed, most are in good physical condition and can continue to operate over the next twenty years without complete replacement of the facilities. With a few exceptions, enhanced maintenance of the airports rather than construction of new facilities will define capital planning for the study period.
- Tier 1 and Tier 2 airports offer the greatest opportunity for implementing energy and water standards due to their higher level of institutional and organizational activities. However, the relatively large number of Tier 3 airports requires that attention must also be paid to these smaller facilities.
- The institutional framework defined by CAD, MOTA and MOF do not address energy and water. Schedule 21, which defines the operation and maintenance of existing facilities as well as the design of new facilities, does provide a trigger to address these issues, but currently does not address energy and water issues for existing facilities or in the design of new facilities.
- There are excise taxes discouraging procurement of energy efficient equipment that impede the uptake of energy and water efficient products. However, airports may be exempt from these duties and further analysis of this issue is merited.
- The Electricity Act imposes constraints on the ability to implement self-generation in the short term. However, the Government of The Bahamas has made commitments to reform the Electricity Act that will likely enable self-generation, increase the use of renewable energy and encourage energy conservation.
- There is no management structure in place for energy and water use and conservation.
- Operation of the airports occurs with a high level of autonomy, and airport operators are responsible for operation and maintenance activities. The design of an institutional framework for energy and water management will benefit from a de-centralized approach that builds upon the roles and responsibilities currently defined for airport operations.

These observations have been used to define an energy and water institutional framework in later sections of this report.

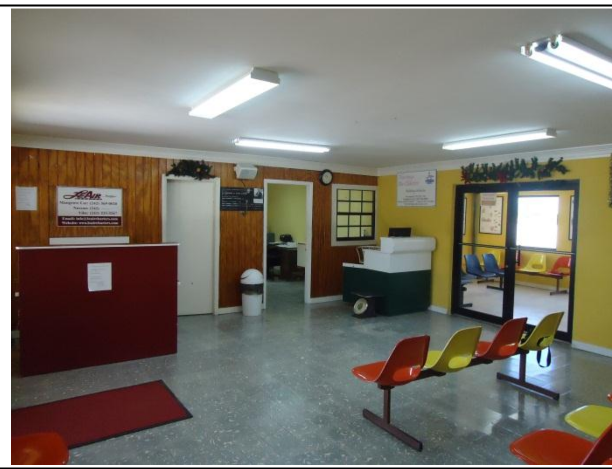
3. ENERGY AND WATER BASELINE AND BUSINESS-AS-USUAL FORECAST

This section provides a baseline and forecast of energy and water at the Family Islands Airports.

3.1 ENERGY AND WATER USING EQUIPMENT AT FAMILY ISLANDS AIRPORTS

Significant sources of energy and water usage are presented in **Error! Reference source not ound.**.

Table 8: Energy and Water End Uses

End Use	Description
Electricity	
Interior Lighting Interior lighting is generally comprised of T12 fixtures with two lamps. It is assumed that ballasts are magnetic. Controls for lighting are manual and there are no occupancy sensors or daylight controls on the equipment.	
Exterior Lighting Exterior lighting appears to use T12 fixtures with two lamps. Based on the visual review, these fixtures appear to be for interior use only. Exterior lighting appears to use manual controls and it was observed that in some facilities, the exterior lights were operating during daylight hours.	

End Use	Description
Runway Lights Runway lights are a mixture of photovoltaic and incandescent units.	
Space Cooling Space cooling includes a mixture of split ductless systems as well as wall units. Air conditioning equipment appears to be of older vintages that use CFC refrigerants and have low levels of energy efficiency ratings.	 

End Use	Description
	
Building Enclosures Buildings are constructed of concrete, concrete block and wood. Windows are generally single glazed and do not have reflective coatings. Roofs are generally concrete tile or asphalt shingles. In many locations it was observed that windows and doors remain open even while cooling equipment is operating. Ensuring windows and doors remain closed is important to the proper operation of air conditioning equipment.	
Manual Thermostat Air conditioning equipment is controlled using non-programmable thermostats. Due to protective covers, cooling equipment appears to run continuously, even when buildings are not occupied.	

End Use	Description
Backup Generator Backup generators used to provide emergency power are installed at a number of the airports; however, no information was available on the condition or operating practices of the units.	

Water Use	
Toilets Toilets appear to be 4.7 gal per flush units at most of the facilities.	
Urinals Men's washrooms are equipped with tank style urinals using manual flush valves. Older style units consume approximately 3.2 gal per flush.	
Faucets Washrooms are generally equipped with faucets. Older units consume approximately 3.2 gal per minute.	

3.2 ENERGY AND WATER BASELINE

Utility data was provided for electricity and used to calibrate the analysis. No water utility data was provided. Using typical lighting and cooling equipment efficiencies and hours of operation, an estimate was developed of the electricity use for the airports. Similarly, by applying water use benchmarks to the facilities, combined with visitor statistics, an estimate of water use was developed. This information is presented in **Error! Reference source not found.**. Total electricity onsumption is estimated at two million kWh per year, and water consumption is estimated at almost 4,000,000 gallons per year. These are preliminary estimates only and further analysis of actual energy use is recommended.

Table 9: Electricity and Water Consumption by Facility

Airport	Electricity Consumption [kWh/yr.]	Water Consumption [gal/yr.]
Andros Town	72,282	8,910
Arthur's Town	28,913	21,384
Black Point	0	0
Clarence A Bain (Mangrove Cay)	34,473	0
Congo Town	94,522	42,372
Crooked Island (Colonel Hill)	12,510	36,234
Deadman's Cay	21,129	155,232
Exuma International	250,206	608,058
Farmers Cay	0	0
Governor's Harbour	161,244	337,788
Great Harbour Cay	208,505	11,682
Marsh Harbour	278,007	886,446
Matthew Town	23,631	42,768
Mayaguana	51,709	28,512
Moore's Island	16,680	0
New Bight	36,697	90,486
North Eleuthera	88,962	594,396
Port Nelson (Rum Cay)	13,721	7,524
Ragged Island (Duncan Town)	12,788	0
Rock Sound	139,004	298,782
San Andros	69,502	37,026
Staniel Cay	27,801	0
San Salvador	97,302	222,354
Sandy Point	0	0
South Bimini	127,883	65,934

Airport	Electricity Consumption [kWh/yr.]	Water Consumption [gal/yr.]
Spring Point	43,091	31,482
Stella Maris	68,112	85,338
Treasure Cay	77,842	239,778
Total	***2,056,516***	***3,852,486***

3.3 BUSINESS-AS-USUAL ENERGY AND WATER FORECAST

In the absence of an energy and water efficiency programme, consumption patterns are likely to be impacted by changes to the level of activity of the Family Islands Airports. The overall growth rate in visitors is a modest 0.7% per year. This growth rate has been applied to the energy and water use estimate to create a business-as-usual forecast for energy and water (**Error! eference source not found.**). Based on this analysis, expenditures for energy and water services are projected to increase from $600,000 per year in 2015 to $710,000[4] per year in 2040.

[4] This estimate assumes the cost of electricity and water remains constant in real terms.

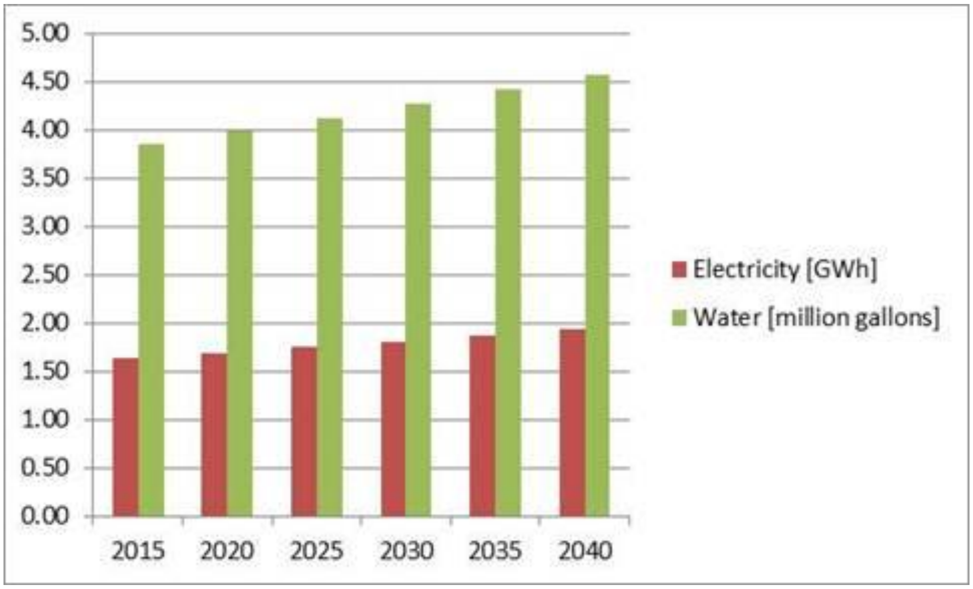


Figure 3-1: Business-As-Usual Forecast for Energy and Water Consumption

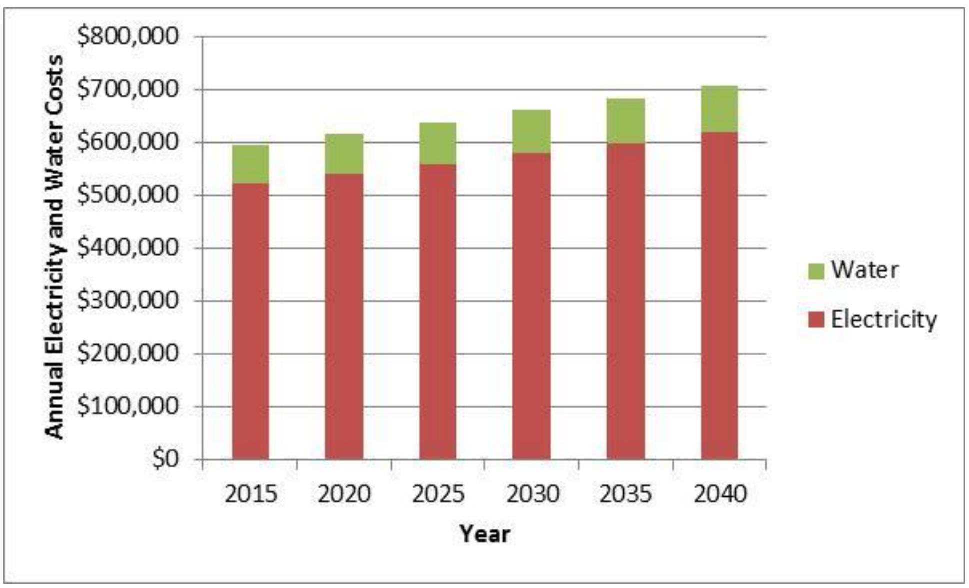


Figure 3-2: Business-As-Usual Forecast for Energy and Water Utility Costs

4. ENERGY AND WATER INSTITUTIONAL FRAMEWORK

4.1 INSTITUTIONAL FRAMEWORK

A range of planning and management tools exist to support organisations to develop and implement an energy and water management strategy. Some of the more prevalent tools include the Natural Step Framework, The Carbon Trust Management guides, and ISO 50001. It is beyond the scope of this analysis to provide a detailed assessment of alternative tools and methods. In general, the institutional frameworks noted above have a number of consistent components, including requirements to:

1. Develop a policy for more efficient use of energy;
2. Establish targets and objectives to meet the policy;
3. Use data to better understand and make decisions concerning energy use and consumption; and
4. Measure the results of actions, policies and programmes.

Of the options reviewed, it is recommended that the Family Islands Airports consider the ISO 50001 framework[5]. In general, ISO 50001 is the reference framework by which leading organisations define their energy and water management processes. The framework can be customised to meet the scope and level of detail appropriate to individual Family Islands Airports as well as to the organisation as a whole, while ensuring an approach that is robust and comprehensive.

As with all ISO systems, the framework is based on the management protocol of "Plan, Do, Check, Act" (**Error! Reference source not found.**). Therefore, an ISO 50001 compliant framework as the potential to integrate with other management systems (such as the safety management system and the environmental management system), and will permit comparisons across airport facilities.

[5] While this analysis recommends use of the ISO 50001, it is beyond the scope of this analysis make recommendation on whether the Family Islands Airports should become certified.

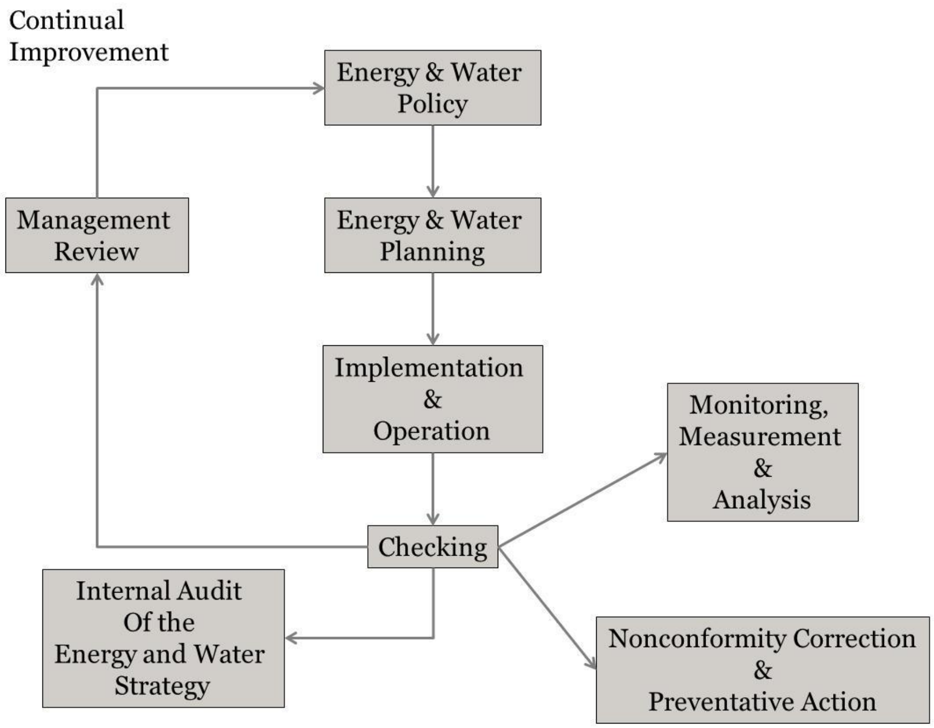


Figure 4-1: ISO 50001 Energy Management Framework

4.2 FAMILY ISLANDS AIRPORTS INSTITUTIONAL FRAMEWORK ASSESSMENT FOR ENERGY AND WATER

A self-assessment methodology to rank organisations in terms of their commitment to energy and water management is presented in **Error! Reference source not found.**. Based on this ssessment, the Family Islands Airports Institutional Framework for managing energy and water is considered weak. In particular:

- Policy for energy and water is not defined;
- Organisation to manage energy and water conservation has not been determined;
- Training does not exist for airport staff on CAD management;
- Performance Measurement of energy use has not been implemented;
- Communication of the importance of energy and water conservation is absent; and
- Investment in energy and water conservation does not exist.

Table 10: Family Islands Airports Energy and Water Institutional Framework Assessment[6]

Score	Policy	Organization	Training	Performance Measurement	Communicating	Investment
Strong	Energy and water policy action plan exists and regular review has active commitment of senior management.	Fully integrated into management structure with clear accountability for energy and water consumption.	Appropriate and comprehensive staff training tailored to training needs with evaluation.	Comprehensive performance measurement against targets with effective management reporting.	Extensive communication of energy issues within and between the Family Islands Airports.	Resources routinely committed to enhance energy and water efficiency in support of business objectives.
Moderate /Strong	Formal policy, but not active commitment from senior management.	Clear line management accountability for consumption and responsibility for improvements.	Energy and water training targeted at major users following training needs analysis.	Scheduled performance measurement for each process, unit or site.	Regular staff briefings, performance reports and energy promotion.	Same appraisal criteria used for energy and water as for other cost reduction projects.
Moderate	Un-adopted policy.	Some delegation of responsibility but line management and authority is unclear.	Ad-hoc training for selected staff, as required.	Monthly monitoring by fuel type.	Some use of organisation communication mechanisms to promote energy and water efficiency.	Low or medium cost measures considered if short payback period is achievable.
Moderate /Weak	Unwritten set of guidelines.	Informal organisation mainly focused on energy and water supply.	Technical staff occasionally attends specialist courses.	Invoice check only.	Ad-hoc informal contacts used to promote energy and water efficiency.	Only low or medium cost measured considered.
Weak	**No explicit energy and water policy.**	**No delegation or responsibility for managing energy or water use.**	**No staff training provided.**	**No measurement of energy or water consumption completed.**	**No communication or promotion of energy and water issues.**	**No investment in improving energy efficiency.**

4.3 RECOMMENDATIONS FOR THE FAMILY AIRPORT ENERGY AND WATER INSTITUTIONAL FRAMEWORK

Based on the requirements defined in ISO 50001 and the results of the management assessment completed in the previous section, recommendations for the Family Islands Airports energy and water institutional framework are summarized in **Error! Reference source not found.**.

[6] Ref http://www.carbontrust.co.uk

Table 11: Recommendations for an Energy Management Framework for Family Islands Airports

Requirement	ISO 50001 Description	Relevance to Family Islands Airports and Status
Management responsibility	The standard places significant emphasis on the role of senior management for the success of implementing the standard. In particular, the standard requires the following from top management: • Development and implementation of an energy and water policy; • The appointment of a representative and establishment of an energy and water management team; • The provision of adequate resources, • Communicate the importance of energy and water management throughout the organisation; • Ensure the identification of objectives and targets that are appropriate to the organisation; • Strategic planning that includes energy and water performance; and • Conduct internal reviews.	Based on the assessment presented in **Error! Reference source not found.**, anagement and institutional requirements are not in place. Based on the organisational structure of the Family Islands Airports (**Error! eference source not found.**), it is recommended the Manager of Finance assume overall responsibility for energy and water strategies. Short term activities include: 1. Appointment of a representative and establishment of an energy/water management team; and 2. The provision of adequate resources (financial and personnel).
Energy and water policy	The energy policy defines the goals and objectives of energy use. It provides a commitment to continual improvement and provision of resources. It also compels the organisation to adhere to all legal and regulatory requirements. Within the scope of the policy, procurement, design and technical aspects of energy and water are defined. The communications requirements are addressed in the energy and water policy. Finally, the limits of the energy and water system are defined.	There is currently no energy policy in place. Priority activities include procurement. Design and operational aspects of energy/water are confirmed for each airport through completion of an energy audit. A proposed policy statement is presented in Chapter 6. It is recommended that audits be completed to establish priority opportunities. This should be done in coordination with airport administrators.

Requirement	ISO 50001 Description	Relevance to Family Islands Airports and Status
Energy and water planning	Energy and water planning ensures that activities and decisions are made in accordance with the energy policy, including: • Action plans, resourcing and implementation plans are documented to ensure the policy is achieved; • Legal and other requirements; • Energy/water review; • Energy baseline for each facility; • Energy and water performance indicators; and • Energy and water objectives, targets and action plans.	The family airport has no planning components in place. Priority actions include development of a detailed energy and water baseline to validate the analysis conducted in previous sections. Given the unique circumstances of individual airports, it is recommended that energy and water planning requirements be defined in Schedule 21 - Aerodrome Standards and Certification with responsibility for implementation of energy and water strategies residing with airport administrators.
Implementation and operation	The organisation will ensure that all persons working in significant areas are trained and educated appropriately. In addition to training, formal policies are required for: • Communication (internal and external); • Documentation and control of records • Operational control; • Design standards; and • Procurement of energy services, products, equipment and energy.	An implementation plan is presented in later sections of this report that include: • Priority projects; • Implementation schedule; • Target organisations and potential partners; • Programme components; • Project selection criteria; • Programme delivery; • Resource requirements; • Project funding; and • Milestones and reporting.
Checking	In the checking stage, the organisation ensures that significant energy and water consuming factors are measured, monitored and reported. Specific requires include: • An measurement plan is formulated and documented; • An internal audit is conducted and the results reported; and • Nonconformities are communicated, and corrective or preventive actions are implemented.	Priority activities should be considered as the implementation plan is rolled out; however, no short term activities are required.

5. ENERGY AND WATER STRATEGIES

Potential energy and water strategies were identified based on the results of the airport condition assessments. These strategies are evaluated on a qualitative basis in **Error! Reference ource not found.**. Based on the review and assessment of resource options, energy efficiency and water efficiency strategies have a high overall ranking.

While self-generation of electricity through solar photovoltaic panels has a high technical potential, there are ongoing institutional barriers that impede the adoption of this technology. For rainwater harvesting, the technology is available and cost effective, and further analysis is required to ensure that systems can be designed to meet all local health requirements.

Table 12: Qualitative Assessment of Energy Strategies for Family Islands Airports

	Energy Strategy	Applicability	Technical Feasibility	Cost Effectiveness	Resource Potential	Additional Benefits	Recommendation
Energy Efficiency	LED Lighting	H	H	H	H	H	H
	High Performance Cooling	H	H	H	H	H	H
Renewable Energy	Solar Thermal	H	H	M	M	L	H
	Solar Photovoltaic	M	H	H	H	M	H
	Wind	M	M	L	L	L	M
Water Efficiency	Water Efficiency	H	H	H	M	H	H
	Rainwater Harvest	H	H	M	M	M	M

Note on Ranking: L – Low, M – Medium, H - High

High priority energy and water strategies are further discussed below.

5.1 ENERGY EFFICIENCY STRATEGIES

5.1.1 LED Lighting

Light emitting diodes (LED) can replace a full range of incandescent, florescent tube and metal halide type lighting products with alternatives that use 50% to 74% less electricity, while providing improved light quality and increased service life. Much of the interior light fixtures in the airports reviewed use older T12 fluorescent bulbs with magnetic ballasts. It is proposed to replace these fixtures and add occupancy and daylighting controls to minimize operating time.

5.1.2 High-Performance Cooling

The older through-the-wall and split systems reviewed on site likely have energy efficiency ratings of 6 to 9. Newer units are available that have an energy efficiency rating of 13 to 15. In addition to replacement of the cooling equipment, replacement of controls to optimize the use of cooling has been budgeted for.

5.1.3 Operational Practices

It was noticed that a number of doors and windows remain open even when cooling equipment is in operation. Training of airport staff and installation of self-closing devices will reduce the loss of cooled air.

5.1.4 Power Quality

Power quality becomes a significant issue as new equipment with solid state electronics is installed. Older magnetic ballasts in lights were not affected by voltage drops, brown outs or black outs. However, to get maximum service life from lights, cooling, computers and other electricity consuming equipment at the Family Islands Airports, it is essential that enhanced voltage regulation and power quality be maintained. This is frequently a challenge on many of the Family Islands.

5.2 RENEWABLE ENERGY STRATEGIES

Analysis of renewable energy options were completed, including solar photovoltaic, wind-generated electricity and solar-thermal hot water systems. An evaluation of these technologies is presented in Appendix 1. Solar photovoltaic systems have the greatest potential application of the three renewable energy options investigated. The wind regime in The Bahamas is insufficient to generate continuous power and the hot water loads at the Family Islands Airports is not sufficient to warrant solar-thermal hot water systems.

In contrast, solar photovoltaic systems are suited to the climate and load profiles of the Family Islands Airports. In the short term, photovoltaic systems can be designed to power standalone equipment such as runway lights and outdoor illumination.

5.3 WATER EFFICIENCY STRATEGIES

Water efficient fixtures and fitting can directly replace older equipment. A summary of flow rates for older style and newer units is shown in **Error! Reference source not found.**.

Table 13: Comparison of water consumption by Fixtures

Fitting/Fixture	Typical Fixtures	Best Practice
Lavatory Faucet	2.5 gal/min	0.8 gal/min to 1.5 gal/min
Water Closet	4.8 gal/flush	1.2 gal/flush – dual flush
Urinal	3.2 gal/flush	1 gal/flush – 0 gal/flush

5.4 RAINWATER HARVESTING

A simplified analysis of the potential for rainwater harvesting was completed, based on the areas of building roofs and typical consumption levels. A schematic concept for a rainwater system is presented in **Error! Reference source not found.**.

Figure 5-1: Rainwater Capture Schematic Design

5.5 COSTS AND SAVINGS FORM ENERGY AND WATER UPGRADES

A financial assessment was made using typical costs and savings for the energy and water upgrades. The results are presented in **Error! Reference source not found.**. Based on this analysis, t is possible to achieve a 75% reduction in energy use with a payback of five years and a reduction in water consumption of 70% with a payback of seven years. An overall investment of $2.6 million dollars is required to achieve these outcomes.

Table 14: Financial Assessment of Energy and Water Savings Upgrades

		Upgrade Cost	Quantity	Cost	Base Consumption [kWh]	Upgrade Consumption [kWh]	Savings		Payback (years)
							kWh	$	
ECM 1	Interior Lighting Retrofit	$700	1059	$741,300	382,500	250,400	132,000	$50,200	14.8
ECM 2	Interior Lighting Occupancy Sensors and Controls	$5,000	28	$140,000	382,500	306,000	76,500	$29,000	4.8
ECM 3	Exterior Lighting Retrofit	$700	158	$110,600	39,800	14,200	25,600	$9,700	11.4
ECM 4	High Performance Cooling	$2,500	211	$528,400	1,211,800	838,900	372,900	$141,700	3.7
ECM 5	Photovoltaic (PV) Panels	$25,000	28	$700,000	1,634,100	1,046,100	588,000	$223,400	3.1
	Energy ECM Subtotal	—	—	$2,220,300	1,634,100	439,100	1,195,000	$454,100	4.9
		Upgrade Cost	Quantity	Cost	Base Consumption [cu m]	Upgrade Consumption [cu m]	Savings		Payback (years)
							Cu m	$	
WCM 1	Low-Flow Plumbing	$4,000	28	$112,000	14,600	10,200	4,400	$22,200	5.1
WCM 2	Rainwater Capture	$8,000	28	$224,000	14,600	8,800	5,800	$29,400	7.6
	Water WCM Subtotal	—	—	$336,000	—	4,408	10,200	$51,600	6.5
Combined				**$2,556,000**				**$506,000**	**5.1**

6. FAMILY ISLANDS AIRPORTS ENERGY AND WATER STANDARD AND IMPLEMENTATION STRATEGY

6.1 INTRODUCTION

This chapter provides a description of the proposed energy and water standard, together with a definition of its objectives and rationale. The expected results from the energy and water standard are also presented within a preliminary performance measurement framework.

6.2 PROGRAMME DESCRIPTION

6.2.1 Programme Name:

Family Islands Airports Energy and Water Standard Programme

6.2.2 Policy Statement

The Family Islands Airports Energy and Water Standard Programme will invest in staff and facilities to reduce energy and water use in the Family Islands Airports.

The objectives for this programme:

1. To demonstrate government leadership in the promotion of energy and water efficiency;
2. To support innovation and economic development of Family Islands Airports facilities; and
3. To achieve best practice in the management and operation of Family Islands Airports facilities.

6.2.3 Family Islands Airports Energy and Water Standard Programme Description:

The proposed Family Islands Airports Energy and Water Standard Programme will be an information and procurement programme. The programme's focus will be in two primary activity areas: outreach and communications; and purchasing of efficient equipment. The programme will seek to play a formative role in supporting airport operations staff with available information, organisational and financial resources. This will be done in order to optimize the performance of airport facilities while recognizing the constraints of access to capital and institutional barriers such as the Bahamas Electricity Act. Consequently, an important strategy for the programme is the leveraging of financial resources from international development funds for the implementation of energy and water retrofit projects in the Family Islands Airports programme. Furthermore, recognizing the tiers of the facilities, the Airports the Energy and water Standards Programme will focus on Tier 1 airports as the priority facilities in the short term. Once energy and water projects are identified and underway in Tier 1 facilities, communication of the results and subsequent extension to Tier 2 and Tier 3 airports will also be a key area of activity.

6.3 RATIONALE

The Family Islands Airports Energy and Water Standard Programme will focus on cost-effective actions to reduce energy and water use to provide significant environmental, economic and social benefits. Energy and water technologies can play a significant role in achieving these objectives, for the following reasons:

- At present, no programme exists in MOTA or CAD to promote energy and water efficiency. The presence of such a programme would help to focus operational budgets, in order to leverage other funding sources and reduce the overall cost of maintaining airports. This approach has proved effective in other sectors and jurisdictions where investment in energy efficiency and renewable energy has proven to be highly cost effective and resulted in multiple co-benefits.
- Energy efficiency and renewable energy resources have gained a greater profile in recent years as a result of drivers such as climate change. By actively promoting energy and water stewardship through a focused programme, MOTA and CAD will be seen as a pro-active supporter of the environment, which will have a positive impact on the tourism industry.
- Investment in energy and water efficiency has been shown to benefit local communities far beyond the purchasing of electricity and water. Investment in the Family Islands Airports Energy and Water Standard Programme will support the economic diversity of the Family Islands.

The rationale for the Family Islands Airports Energy and Water Standard Programme is designed to address the issues and contextual factors defined through the organisational scan (Section 2.5). The implications for programme design are presented in **Error! Reference source not found.**.

Table 15: Programme Design Components

Context	Impact on Programme Design
The climate of The Bahamas is suitable to the design of buildings that can be operated with minimal use of energy and water. Passive design, daylighting and rainwater capture are technically viable options.	The design of the programme focuses specifically on energy and water savings using equipment found in existing airports.
The costs of electricity, in particular, and water services to airport facilities are significant. High electrical costs can be reduced through implementation of energy efficient equipment, as well as renewable energy resources such as solar photovoltaic systems.	Programme activities will focus primarily on energy due to the high cost of electricity services.

Context	Impact on Programme Design
Workshop participants emphasized the need for training and capacity building to support enhanced management of the Family Islands Airports.	Provision of training and capacity building needs to be a central feature of the energy and water standards developed through this assignment.
The airports within this study are relatively small and simple buildings. Typical floor areas range from 1,000 to 8,000 square feet of conditioned space. Energy use is primarily for lighting and cooling. Water use is primarily for washroom facilities.	Programme activities will focus on electricity for lighting and cooling as well as water for toilets and other washroom facilities.
Of the 28 airports reviewed, most are in good physical condition and can continue to operate over the next twenty years without complete replacement of the facilities. Enhanced maintenance of the airports rather than construction of new facilities will define capital planning for the study period.	Programme activities focus on the retrofit of existing facilities rather than construction of new facilities.
Tier 1 and Tier 2 airports offer the greatest opportunity for implementing energy and water standards due to their higher level of institutional and organisational activities. However, the relatively large number of Tier 3 airports requires that attention must also be paid to these smaller facilities.	Programme activities focus in the short term on Tier 1 followed by Tier 2 and Tier 3 in the medium term.
The institutional framework defined by CAD, MOTA and MOF does not address energy and water. Schedule 21, which defines the operation and maintenance of existing facilities as well as the design of new facilities, does not address energy and water concerns of existing facilities or concerns in the design of new facilities.	Schedule 21 does not currently include requirements related to energy and water use of airports. However, this document provides a platform by which airport operators may implement specific activities such as data collection and procurement that will achieve overall programme objectives.
There are excise taxes that discourage procurement of energy efficient equipment, which impedes the uptake of energy and water efficient products.	There are exemptions for airport equipment that may be explored to circumvent excise taxes for the purchase of equipment required to achieve programme outcomes.
The Bahamas Electricity Act imposes constraints on the ability to implement self-generation in the short term. However, the Government of The Bahamas has made commitments to reform the Bahamas Electricity Act that will likely enable self-generation, increase the use of renewable energy and encourage energy conservation.	Working within the context of government reform of the Bahamas Electricity Act may result in deferral of some programme activities until regulations have been updated.
There is no management structure in place for energy and water use and conservation.	Development of a management structure that focuses activities at the local level will have the greatest potential to achieve expected outcomes.
Operation of the airports occurs with a high level of autonomy, and airport operators responsible for operation and maintenance activities. The design of an institutional framework for energy and water management will benefit from a de-centralised approach that builds upon the roles and responsibilities currently defined for airport operations.	Airport operators may be directed to implement programme activities through Schedule 21.

6.4 EXPECTED RESULTS

The proposed Family Islands Airports Energy and Water Standard Programme will be designed to achieve specific and measurable results. Experience with other energy programmes has demonstrated that government support, in collaboration with industry stakeholders, can positively influence the rate of technology deployment and market commercialization through a combination of promotion and facilitation functions. Thus, this programme has been designed to reduce energy usage, through the results chain shown in **Error! Reference source not found.**.

Figure 6-1: Family Islands Airports Energy and Water Standard Programme Logic Model

6.5 PERFORMANCE MEASUREMENT FRAMEWORK

The performance measurement framework is designed to reflect the expected results identified above in the programme logic model. Preliminary indicators and targets have been identified and are presented in **Error! Reference source not found.**. These indicators will need to be eviewed as the programme gains implementation experience.

Table 16: Performance Measurement Framework

	Performance Indicator	Short Term Target 2015 - 2016	Longer Term Target 2030 - 2031
Activities	Outreach and Communications	Training needs confirmed	Staff fully trained
	Project Financing	$2 million	$100,000 per year ongoing
Outputs	Operational Staff Training	In 100% of Tier 1 Airports	In 100% of all Airports
	Management Staff Training	Programme Manager Training provided	Ongoing support for Programme Manager provided
	Retrofit Funding Programme	In 100% of Tier 1 Airports	In 100% of all Airports
Outcomes	Energy Retrofits	In 100% of Tier 1 Airports	In 100% of all Airports
	Renewable Energy Installation	None	In 100% of all Airports
	Water Retrofits	In 100% of Tier 1 Airports	In 100% of all Airports
	Rainwater Harvest	None	In 100% of all Airports
Impacts	Energy Savings	75% energy savings in Tier 1 Airports	All airports are net zero energy
	Water Savings	70% water savings in Tier 1 Airports	All airports are net zero water

6.6 REPORTING REQUIREMENTS

Measuring the success of the programme will require information on the results achieved relative to the expected outcomes described in Section 6.2. It is expected that, on a programme level, this would consist of annual reports that describe monthly energy and water use, savings and technical performance relative to expectations. This programme-level reporting would be facilitated by submission of quarterly reports from Airport Managers (or their designates). These project-level reports could satisfy one or more of the following:

Minimum reporting requirements (Level I):

- Progress on implementation of the project;
- Actual performance in comparison with expectations;
- Investment in energy and water related upgrades; and/or
- Energy and water use reductions and registration of GHG credits (if applicable).

Additional reporting requirements (Level II):

- Qualitative assessment of project visibility and potential for replication (are people aware of the project, and has it spawned other projects?); and/or
- Qualitative assessment of project secondary benefits (social and environmental impacts).

6.7 PROGRAMME IMPLEMENTATION STRATEGY

This section identifies and discusses the proposed programme implementation strategy for meeting the objectives outlined above. Since the ultimate success of the programme will be judged on the achievement of its results (outputs, outcomes and impacts), the design should reflect a judgment by MOTA and CAD of what features are most likely to contribute positively to those results. This involves the application of criteria of practicality, affordability, effectiveness and efficiency.

The following aspects of the programme design are examined:

- Priority projects;
- Implementation schedule;
- Programme components;
- Project selection criteria;
- Programme delivery;
- Risk management;
- Resource requirements; and
- Project funding.

Each component of the strategy is further discussed below.

6.7.1 Priority Projects

Priority projects will focus on lighting and space cooling retrofits for electricity as well as retrofit of plumbing fixtures to low-flow toilets, faucets and urinals. Implementation of photovoltaic (PV) installations may also be considered, contingent on changes to the Bahamas Electricity Act.

6.7.2 Implementation Schedule

Retrofit programme activity can commence immediately as part of regular building maintenance. A three-year work programme is described below as well as funding and a resource estimate.

6.7.3 Programme Components

As outlined in the description provided previously, it is recommended that the programme's major activities be organised into two components:

- Training, outreach and communications; and
- Financing energy and water retrofit project implementation.

A brief discussion of each programme component is presented below.

6.7.3.1 Training, Outreach and Communications

This programme component consists primarily of two groups of activities: those that are designed to facilitate training and capacity building of staff; and those that are designed to communicate energy savings and project results within the organisation. Given the proposed orientation of the programme and the level of resources currently available, a relatively targeted approach to key organisations and potential partners is envisioned. To that end, ongoing monitoring and communication with airports that have secured partial funding will be an important activity, as this will facilitate leveraging of the programme funding.

Although it is not the primary focus of this programme, it is also anticipated that the results of the projects may identify areas of institutional or other constraints. Programme personnel may choose to address these constraints in the government's own policy or regulatory processes.

6.7.3.2 Financing Energy and Water Retrofit Project Implementation

The successful funding and implementation of a retrofit projects is the primary output envisioned from this programme. In the short term, it is recommended that airports with specific and well defined projects be targeted; however, given the capacity of Tier 1 airports, the majority of projects are likely to occur in these facilities. Utilisation of the condition assessment reports developed as part of this assignment will aide in the development and prioritization of energy and water retrofit projects. This general approach will enable the programme to ramp-up quickly and highlight success stories to a broader range of airports within the initial three-year programme timeframe.

A secondary component to the financing programme is to seek external funding from the International Development Bank (IDB) and other lending agents.

6.7.4 Project Selection Criteria

The selection of retrofit projects to be supported by this programme will ultimately be determined on the basis of the specific opportunities that are identified and on the level of available resources, both internal and external to this programme. The project targets, presented previously in the Performance Measurement Framework (**Error! Reference source not ound.**), are based on the programme being able to successfully achieve a financial leverage ratio of 3 to 1. This ratio is the same as is currently employed in Canadian federal government's Energy Efficiency programmes. The balancing of these factors, together with the programme's overall objectives, will require ongoing MOTA and CAD review and assessment.

6.7.5 Programme Delivery

The Family Islands Airports Energy and Water Standard Programme would be administered by the Finance Administrator through the Stores Department, based on the current organisation of the MOTA (**Error! Reference source not found.**). Stantec understands that a separate onsultancy being delivered by IATA is proposing a new organisational structure for BCAD. The outcome of this consultancy may result in a change in the proposed administration of the Family Islands Airports Energy and Water Standard Programme. Schedule 21 - Aerodrome Standards and Certification should be amended to address energy and water related requirements for the operation of existing facilities (Section 21.150) as well as the design of new facilities (Section 21.215). It is anticipated the programme will be delivered in cooperation with Airport Managers. Airport managers/senior administrators will be responsible for day-to-day activities, including training of staff, hiring of energy service professionals, development of tender packages for energy retrofits and contract administration.

MOTA will be responsible for the programme's overall design, ongoing management, funds disbursements, project monitoring and data collection, outcome tracking and technology transfer. Due to the overlap with the environmental management system (EMS), some reporting and tracking activities may be shared with the EMS requirements. The concept of the EMS is presented in the Environmental Guidelines and Institutional Analysis report included in this overall consultancy.

Primary work by MOTA includes:

- Developing and maintaining training resources for staff related to energy and water efficiency;
- Benchmarking energy use intensity of existing facilities and identification of high energy users;
- Amendment of Schedule 21 requirements;
- Procurement of energy efficient equipment;
- Performance monitoring and verification; and,
- Ensuring effective communication of the programme results to senior managers and operational staff.

6.7.6 Schedule of Activities

Year 1 of the initiative will begin with activities designed to:

- Implement the first round of energy and water projects with a focus on Tier 1 airports;
- Finalize the initiative's operating guidelines; and,
- Market the initiative to appropriate external organisations to seek additional funding.

By Year 2, it is expected that an initial core of projects will be in place. The focus in this second year will be on:

- Achieving an escalated number of retrofits by shifting activities to Tier 2 and Tier 3 airports; and
- Ensuring the acquisition of performance monitoring data for each completed retrofit project and the implementation of related technology transfer and communications activities.

By Year 3, the initiative will be in full operation and activities are expected to be divided between ongoing developments and monitoring of retrofits, and the promotion and technology transfer activities required to increase capacity within the organisation. Depending on subsequent government commitments, the programme will either be required to increase implementation of renewable energy projects and rainwater capture, or to define an expanded set of retrofit measures.

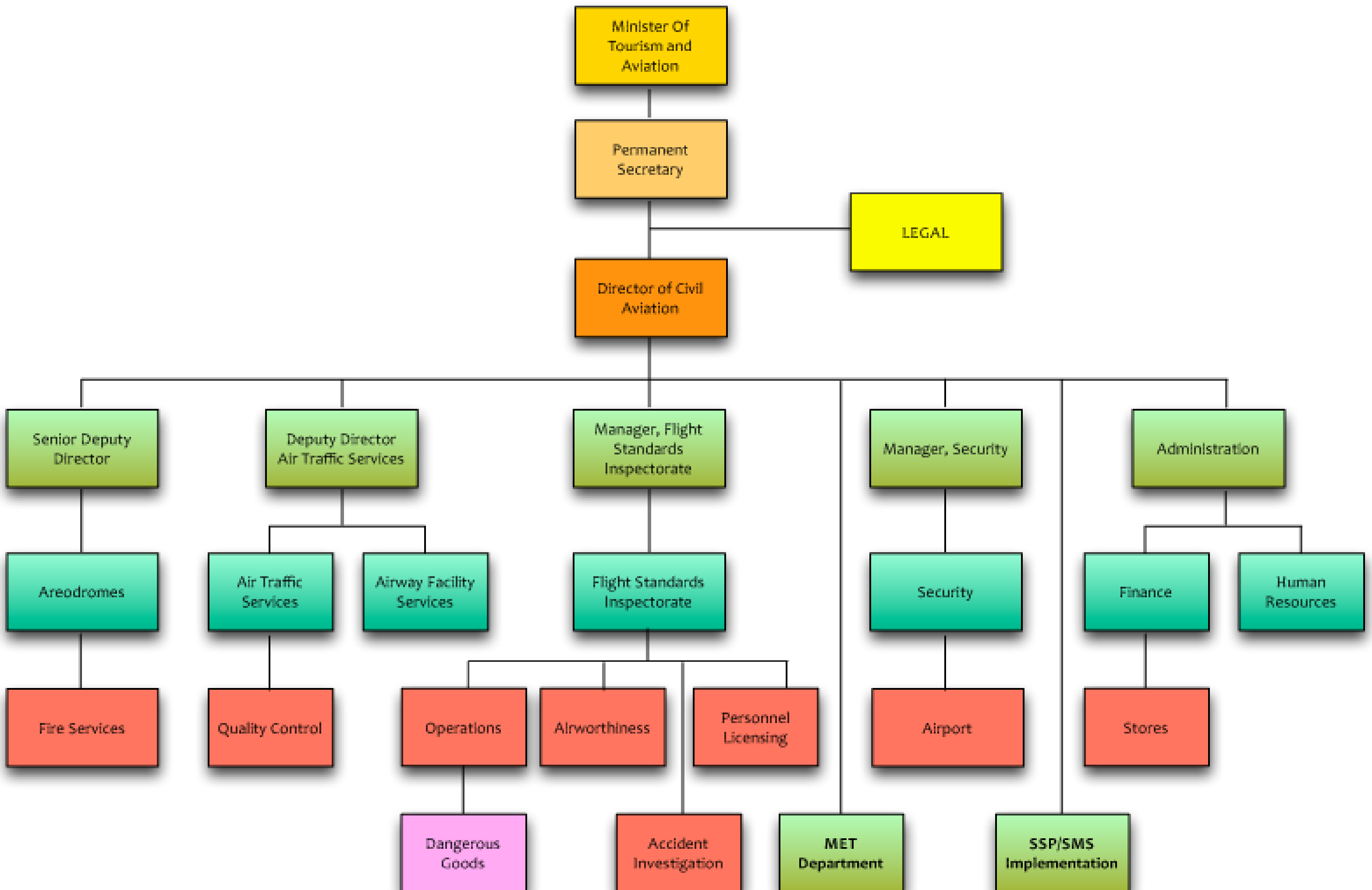


Figure 6-2: Current Organisation Chart for MOTA

6.7.7 Project Risk Management

The approach to risk management is to focus on "no regrets" options that provide direct energy and water savings as well as a broader set of environmental, economic and social benefits. Specific risk management project evaluation criteria include:

- Energy retrofit projects are able to demonstrate a financial return;
- Airport operators have the training and internal capacity to implement and operate such a project;
- Planning and design of the project is sufficiently advanced to the stage where there is a high degree of certainty with respect to costs, savings and ability to obtain necessary financing and required approvals;
- Identification of significant socio-economic benefits to the Family Islands is provided by the proposed project;
- Potential environmental and regulatory concerns have been identified and either assessed as low or have an acceptable mitigation strategy in place; and
- Commercial arrangement provides a purchase cost that is economically attractive to the client giving consideration to anticipated market prices and other benefits to the client.

6.7.8 Resource Requirements

The programme will require a core team within MOTA that consists of an outreach and communications coordinator, procurement staff and a technical expert. It is expected that resourcing can be accomplished using existing staff. Most of the administration and implementation of the programme will occur at the local level by individual Airport Managers, who will implement the energy and water projects as part of their ongoing duties. It is assumed that funding/contracts administration as well as administrative and management support will be provided as part of the overall MOTA resources through external contracts with energy service professionals and electrical or plumbing contractors that will be required for the proposed initiatives.

6.7.9 Programme Funding

The required budget amounts are shown in **Error! Reference source not found.**. Training and ommunication will be used to retain consultants able to support capacity building within the organisation. It is assumed that a dedicated staff person in MOTA will be retained for the institutional alignment. Finally, energy retrofit activities are the largest portion of the budget and can commence immediately. Overall, the budget for three years is estimated at $3.4 million dollars.

Table 17: Energy and Water Standard Resource Allocations ($000)

Category	Fiscal Year			Total
	14-15	15-16	16-17	
Training and Communication	250	250	250	750
Capacity Building & Institutional Alignment	40	40	40	150
Retrofit Projects	850	850	850	2,500
Grand Total	**1,140**	**1,140**	**1,140**	**3,450**

7. CONCLUSIONS AND NEXT STEPS

Energy and water efficiency is not currently a priority in the operations of the Family Islands Airports. The cost of energy and water is currently estimated at $700,000 per year, and this figure is expected to grow to $820,000 per year in the absence of new policies and programmes. Investment in energy and water efficiency can reduce the operating costs at the Family Islands Airports by 70% through retrofit measures. Adoption of renewable energy resources which are not currently permitted but are both technically feasible and financially viable can result in airport facilities that are net zero energy. Similar opportunities also exist for water savings: implementation of low-flow fixtures and rainwater harvest offer the potential to reduce water use by 70%. Retrofit activities are projected to have a five year payback timeframe. The overall investment requirement for the fiscal years of 2014 to 2017 is $3.4 million. This funding will support communication and outreach, institutional development as well as implementation of a range of retrofit measures for energy and water.

Appendix A – Renewable Energy Technical Assessment Outputs

RETScreen Energy Model - Power project

☐ Show alternative units

Proposed case power system | **Incremental initial costs**

Technology		Photovoltaic		
Analysis type		◉ Method 1 / ○ Method 2		
Photovoltaic				
Power capacity	kW	10.00	$ 25,000	See product database
Manufacturer				
Model				
Capacity factor	%	25.0%		
Electricity exported to grid	MWh	21.9		
Electricity export rate	$/MWh	34.00		

Emission Analysis

Base case electricity system (Baseline)	Fuel type	GHG emission factor (excl. T&D)	T&D losses	GHG emission factor
Country - region		tCO2/MWh	%	tCO2/MWh
Bahamas	Oil (#6)	0.700	15.0%	0.824
Electricity exported to grid	MWh	22	T&D losses	

GHG emission					
Base case	tCO2	18.0			
Proposed case	tCO2	0.0			
Gross annual GHG emission reduction	tCO2	18.0			
GHG credits transaction fee	%				
Net annual GHG emission reduction	tCO2	18.0	is equivalent to	3.3	Cars & light trucks not used
GHG reduction income					
GHG reduction credit rate	$/tCO2				

Financial Analysis

Financial parameters			
Inflation rate	%	2.0%	
Project life	yr	20	
Debt ratio	%	60%	
Debt interest rate	%		
Debt term	yr		
Initial costs			
Power system	$	25,000	100.0%
Other	$		0.0%
Total initial costs	$	25,000	100.0%
Incentives and grants	$		0.0%
Annual costs and debt payments			
O&M (savings) costs	$		
Fuel cost - proposed case	$	0	
Debt payments - 0 yrs	$	#NUM!	
	$		
Total annual costs	$	#NUM!	
Annual savings and income			
Fuel cost - base case	$	0	
Electricity export income	$	745	
	$		
Total annual savings and income	$	745	
Financial viability			
Pre-tax IRR - equity	%	6.2%	
Pre-tax IRR - assets	%	-2.6%	
Simple payback	yr		
Equity payback	yr	11.8	

Cumulative cash flows graph

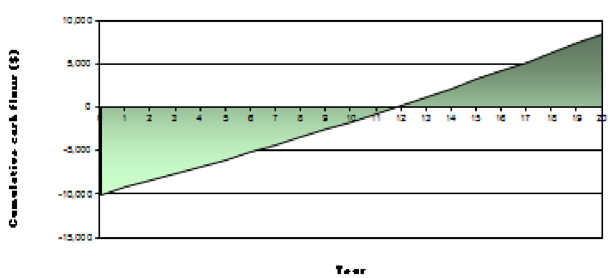


Figure A-1: Photovoltaic Assessment

RETScreen Energy Model - Power project

☐ Show alternative units

Proposed case power system				Incremental initial costs	
Technology		Wind turbine			
Analysis type		⦿ Method 1 ○ Method 2 ○ Method 3			
Wind turbine					
Power capacity	kW	4.0		$ 25,000	See product database
Manufacturer		Atlantic Orient			
Model		AOC 8/12 - 25m	1 unit(s)		
Capacity factor	%	60.0%			
Electricity exported to grid	MWh	21			
Electricity export rate	$/MWh	34.00			

Emission Analysis

Base case electricity system (Baseline) Country - region	Fuel type	GHG emission factor (excl. T&D) tCO2/MWh	T&D losses %	GHG emission factor tCO2/MWh
Bahamas	Oil (#6)	0.700	15.0%	0.824

Electricity exported to grid	MWh	21	T&D losses		
GHG emission					
Base case	tCO2	17.3			
Proposed case	tCO2	0.0			
Gross annual GHG emission reduction	tCO2	17.3			
GHG credits transaction fee	%				
Net annual GHG emission reduction	tCO2	17.3	is equivalent to	3.2	Cars & light trucks not used
GHG reduction income					
GHG reduction credit rate	$/tCO2				

Financial Analysis

Financial parameters			
Inflation rate	%	2.0%	
Project life	yr	20	
Debt ratio	%	60%	
Debt interest rate	%		
Debt term	yr		
Initial costs			
Power system	$	25,000	100.0%
Other	$		0.0%
Total initial costs	$	25,000	100.0%
Incentives and grants	$		0.0%
Annual costs and debt payments			
O&M (savings) costs	$		
Fuel cost - proposed case	$	0	
Debt payments - 0 yrs	$	#NUM!	
	$		
Total annual costs	$	#NUM!	
Annual savings and income			
Fuel cost - base case	$	0	
Electricity export income	$	715	
	$		
Total annual savings and income	$	715	
Financial viability			
Pre-tax IRR - equity	%	5.7%	
Pre-tax IRR - assets	%	-2.3%	
Simple payback	yr		
Equity payback	yr	12.2	

Cumulative cash flows graph

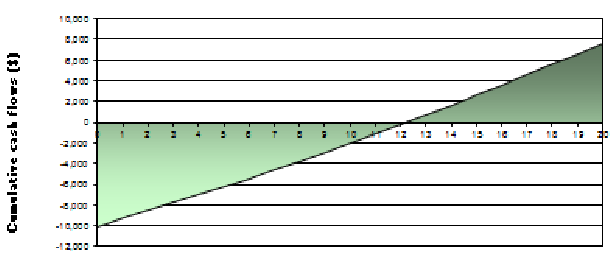


Figure A-2: Wind Turbine Assessment

RETScreen Energy Model - Heating project

Heating project						
Technology		Solar water heater				
Load characteristics						
Application		○ Swimming pool ⦿ Hot water				
	Unit	**Base case**	**Proposed**			
Load type		Other				
Daily hot water use	L/d	1,000	1,000			
Temperature	°C	35	35			
Operating days per week	d	80	80			
☐ **Percent of month used**						
Supply temperature method		Formula				
Water temperature - minimum	°C	25.0				
Water temperature - maximum	°C	26.1				
	Unit	**Base case**	**Proposed case**	**Energy saved**	**Incremental initial costs**	
Heating	MWh	4.0	4.0	0%		
Resource assessment						
Solar tracking mode		Fixed				
Slope	°	35.0				
Azimuth	°	0.0				
☐ **Show data**						
Solar water heater						
Type		Glazed			$ 8,000	See technical note
Manufacturer		ACR Solar International				See product database
Model		Fireball Fireball 2001				
Gross area per solar collector	m²	1.87				
Aperture area per solar collector	m²	1.72				
Fr (tau alpha) coefficient		0.60				
Fr UL coefficient	(W/m²)/°C	3.73				
Temperature coefficient for Fr UL	(W/m²)/°C²	0.000				
Number of collectors		1	1			
Solar collector area	m²	1.87				
Capacity	kW	1.20				
Miscellaneous losses	%	10.0%				
Balance of system & miscellaneous						
Storage		No				
Heat exchanger	yes/no	No				
Miscellaneous losses	%	10.0%				
Pump power / solar collector area	W/m²	10.00				
Electricity rate	$/kWh	0.350				
Summary						
Electricity - pump	MWh	0.1				
Heating delivered	MWh	1.9				
Solar fraction	%	48%				
Heating system						
☐ Project verification		**Base case**	**Proposed**			
Fuel type		Electricity	Electricity			
Seasonal efficiency		80%	80%			
Fuel consumption - annual	MWh	5.0	2.6	MWh		
Fuel rate	$/kWh	0.350	0.350	$/kWh		
Fuel cost	$	1,755	910			

Cont….

Emission Analysis

Base case electricity system (Baseline) Country - region	Fuel type	GHG emission factor tCO2/MWh	T&D losses %	GHG emission factor tCO2/MWh
Bahamas	Oil (#6)	0.700	15.0%	0.824

GHG emission					
Base case	tCO2	4.1			
Proposed case	tCO2	2.2			
Gross annual GHG emission reducti	tCO2	1.9			
GHG credits transaction fee	%				
Net annual GHG emission reduction	tCO2	1.9	is equivalent to	0.4	Cars & light trucks not used
GHG reduction income					
GHG reduction credit rate	$/tCO2				

Financial Analysis

Financial parameters			
Inflation rate	%	2.0%	
Project life	yr	20	
Debt ratio	%	60%	
Debt interest rate	%		
Debt term	yr		
Initial costs			
Heating system	$	8,000	100.0%
Other	$		0.0%
Total initial costs	$	8,000	100.0%
Incentives and grants	$		0.0%
Annual costs and debt payments			
O&M (savings) costs	$		
Fuel cost - proposed case	$	932	
Debt payments - 0 yrs	$	#NUM!	
Other	$		
Total annual costs	$	#NUM!	
Annual savings and income			
Fuel cost - base case	$	1,755	
Other	$		
Total annual savings and income	$	1,755	
Financial viability			
Pre-tax IRR - equity	%	28.0%	
Pre-tax IRR - assets	%	10.3%	
Simple payback	yr		
Equity payback	yr	3.7	

Cumulative cash flows graph

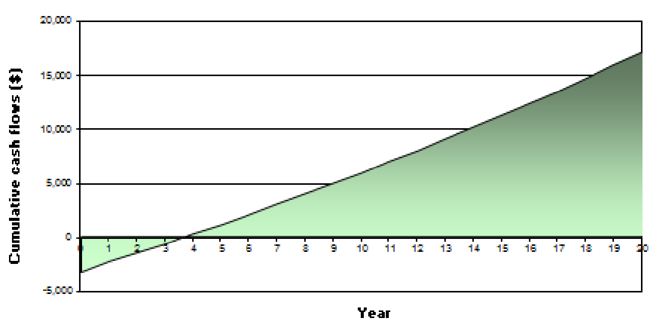


Figure A-3: Solar Domestic Hot Water Assessment

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