

# **Final Draft of the Energy Policy (2017 -2037)**

**Presented to the Division of Energy  
and Telecommunications in the Prime  
Minister's Office**

**by David Ince, Energy Policy Consultant**



# FINAL DRAFT OF THE BARBADOS NATIONAL ENERGY POLICY (2017-2037)

## TABLE OF CONTENTS

<b>TABLE OF CONTENTS</b> .....	<b>II</b>
<b>LIST OF TABLES</b> .....	<b>V</b>
<b>LIST OF FIGURES</b> .....	<b>V</b>
<b>LIST OF ACRONYMS</b> .....	<b>VI</b>
<b>EXECUTIVE SUMMARY</b> .....	<b>IX</b>
<b>EXECUTIVE SUMMARY</b> .....	<b>X</b>
CORE VALUES.....	XIII
VISIONARY GOALS:.....	XV
OVERALL OBJECTIVES .....	XVI
TARGET ENERGY MIX.....	XVIII
<b>SECTION 1: INTRODUCTION</b> .....	<b>1</b>
<b>1. INTRODUCTION</b> .....	<b>2</b>
1.1 PURPOSE OF THE BARBADOS NATIONAL ENERGY POLICY (BNEP) (2017-2037).....	2
<i>What is BNEP designed to achieve?</i> .....	2
1.2 CHAPTER 1 OVERVIEW .....	3
1.3. BARBADOS ENERGY SECTOR- BRIEF DISCUSSION.....	4
<i>Electricity</i> .....	4
<i>Solar Water Heaters</i> .....	4
<i>Solar PV</i> .....	5
<i>Wind Energy</i> .....	5
<i>Bio energy</i> .....	6
<i>Natural Gas for Domestic Cooking</i> .....	6
<i>Transportation</i> .....	6
<i>Energy Efficiency</i> .....	7
<i>BREA</i> .....	7
<i>Barbados Energy Roadmap- Produced by IRENA</i> .....	8
1.4 REGIONAL ENERGY CONTEXT AND ITS INFLUENCE ON BARBADOS.....	9
1.5. INTERNATIONAL ENERGY CONTEXT AND ITS INFLUENCE ON BARBADOS.....	11
1.5.1 <i>Economy</i> .....	11
Expected Future International Energy Market .....	13
1.5.2 <i>Climate Change</i> .....	16
1.5.3 <i>Technology</i> .....	17
1.6 REGULATORY AND LEGISLATIVE CONTEXT .....	19
1.7 BARBADOS ENERGY CONSUMPTION AND DEMAND- SUMMARY CHARTS AND TABLES .....	23
1.7.1 <i>National Energy Use</i> .....	23
1.7.2 <i>Electricity Generation</i> .....	26
1.8 MULTI-CRITERIA APPROACH (MCA).....	32
<b>SECTION 2: PRELIMINARY ENERGY MIX TARGETS</b> .....	<b>33</b>
<b>2. PRELIMINARY ENERGY MIX TARGETS</b> .....	<b>34</b>
2.1 POLICY ANALYSIS MATRIX (PAM) – THE ANALYTICAL TOOL .....	35
<i>Important Components of the PAM</i> .....	35
Tradable Inputs .....	36
Domestic Factors .....	36
Non-tradable Intermediate Inputs .....	36
Transfers.....	37
Domestic Resource Cost (DRC) .....	37

# FINAL DRAFT OF THE BARBADOS NATIONAL ENERGY POLICY (2017-2037)

Private Profits.....	37
Economic Profits.....	37
Energy Efficiency Target:.....	39
Energy Storage:.....	39
THE NATURAL GAS FACTOR.....	39
<b>SECTION 3: VISION, GOALS, AND OVERALL OBJECTIVES .....</b>	<b>43</b>
<b>3. VISION, GOALS, AND OVERALL OBJECTIVES .....</b>	<b>44</b>
3.1 STRUCTURE.....	44
3.2 CORE VALUES.....	47
3.3 VISIONARY GOALS.....	49
3.4 OVERALL OBJECTIVES .....	52
<b>SECTION 4: SECTOR SPECIFIC OBJECTIVES &amp; MEASURES .....</b>	<b>55</b>
<b>4. SECTOR SPECIFIC OBJECTIVES AND MEASURES .....</b>	<b>56</b>
4.1 INTRODUCTION.....	56
4.2 ENERGY SUPPLY .....	56
<i>Natural Gas.....</i>	<i>57</i>
4.2.1 <i>Oil and Gas Supply Sector Objectives.....</i>	<i>58</i>
Policy Measures- Oil and Gas Supply .....	60
4.2.2 <i>Renewable Energy Supply.....</i>	<i>61</i>
Renewable Energy Supply Sector Objectives.....	63
Sector Objectives Specific to solar energy .....	66
Sector Objectives Specific to bioenergy .....	66
Sector Objectives Specific to wind energy.....	67
Energy Storage- Renewable Energy .....	68
Policy Measures- Renewable Energy Sector.....	69
4.3 ENERGY EFFICIENCY AND ENERGY CONSERVATION .....	71
<i>Energy Efficiency and Conservation Sector Specific Objectives .....</i>	<i>73</i>
<i>Policy Measures- Energy Efficiency and Conservation.....</i>	<i>73</i>
4.4 ELECTRICITY SECTOR.....	75
<i>Electricity Sector Specific Objectives .....</i>	<i>76</i>
<i>Policy Measures Electricity Supply .....</i>	<i>79</i>
4.5 ENERGY AND TRANSPORTATION .....	80
<i>Transport Sector Specific Objectives.....</i>	<i>81</i>
<i>Policy Measures Transport Sector .....</i>	<i>82</i>
4.6 ENERGY AND THE ENVIRONMENT.....	84
<i>Energy and Environment Sector Objectives .....</i>	<i>85</i>
<i>Policy Measures -Energy and the Environment.....</i>	<i>85</i>
<i>Climate Change.....</i>	<i>86</i>
<i>Climate Change Sector Specific Objectives.....</i>	<i>87</i>
<i>Policy Measures for Climate Change.....</i>	<i>87</i>
<i>Human Resources and Institutions: Capacity and Development.....</i>	<i>87</i>
4.7 HUMAN RESOURCE AND INSTITUTIONS CAPACITY SPECIFIC OBJECTIVES .....	89
<i>Policy Measures for Human Resources Institutions: Capacity and Development.....</i>	<i>90</i>
4.8 ENERGY AND THE CROSS-CUTTING SECTORS .....	92
OVERVIEW OF CROSS CUTTING SECTORS.....	94
4.8.1 <i>Agriculture.....</i>	<i>94</i>
Agriculture Sector Specific Objectives.....	94
4.8.2 <i>Tourism .....</i>	<i>95</i>
Tourism Sector Specific Objectives.....	96
Industry, Manufacturing and Construction.....	97

# FINAL DRAFT OF THE BARBADOS NATIONAL ENERGY POLICY (2017-2037)

4.8.3 Manufacturing, Construction and Building Sector Specific Objectives .....	98
Key Policy Measures for Manufacturing, Building and Construction Sector .....	98
4.8.4 Waste Management Sector Specific Objectives .....	99
Water Sector Specific Objectives .....	100
4.8.5 Health and Safety.....	100
Health and Safety and Environment Sector Specific Objectives .....	101
Disaster Management:.....	101
Sector Specific Objectives Disaster Management .....	102
Key Policy Measures; Cross Cutting Areas .....	102
4.9 TRADE IN GOODS AND SERVICES WITHIN THE ENERGY SECTOR .....	104
Trade in Energy Specific Objectives.....	105
Policy Measures Energy Trade.....	105
4.10 ENERGY ACCESS AND INFRASTRUCTURE.....	106
Energy Access and infrastructure Specific Sector Objectives.....	106
Policy Measures for Energy Access and Infrastructure.....	107
4.11 ENERGY INVESTMENT AND FINANCING.....	107
Investment and Financing Sector Objectives .....	108
Policy Measures Energy Investment and Financing .....	108
4.12 IMPLEMENTATION, GOVERNANCE AND REGULATORY FRAMEWORK.....	109
Governance and Regulatory Framework Sector Specific Objectives .....	111
Policy Measures- Governance and Regulatory Framework.....	111
<b>SECTION 5: POLICY TARGETS &amp; DEVELOPMENT OF IMPLEMENTATION PLAN.....</b>	<b>112</b>
<b>5. POLICY TARGETS AND DEVELOPMENT OF IMPLEMENTATION PLAN .....</b>	<b>113</b>
<b>SECTION 6: DEVELOPMENT OF INDICATORS &amp; MONITORING SYSTEM .....</b>	<b>115</b>
<b>6. DEVELOPMENT OF INDICATORS AND MONITORING SYSTEM.....</b>	<b>116</b>
<b>REFERENCES .....</b>	<b>121</b>

# FINAL DRAFT OF THE BARBADOS NATIONAL ENERGY POLICY (2017-2037)

## List of Tables

Table 1 - List of Main Indicators .....	xx
Table 2 - Total Fuel Consumption for Electricity Production 2015 ....	27
Table 3 - Structure of the Policy Analysis Matrix .....	36
Table 4 - Energy Mix Breakdown .....	38
Table 5 - Main Indicators And Targets For BNEP .....	114

## List of Figures

Figure 1 - Total Barrels of Oil Demand per Day .....	23
Figure 2 - Demand by Energy Source 2006 to 2015 .....	24
Figure 3 - Fuel Inputs for Electricity Production 2015 Barbados .....	28
Figure 4 - Electricity Sales By Demand Group .....	29
Figure 5 - Share of Electricity Generated from Renewable Energy Technologies as a percentage of Total Consumption (Business as Usual and Sustainable Energy Scenarios) .....	31
Figure 6 - Policy Inverted Pyramid .....	45
Figure 7 - Summary Table of Vision Statement and Visionary Goals	51

# FINAL DRAFT OF THE BARBADOS NATIONAL ENERGY POLICY (2017-2037)

## List of Acronyms

BCC	Barbados Community College
BDS\$	Barbados dollar
BFF	Bridging Fossil Fuel
BL&P	Barbados Light & Power Co. Ltd
BNEP	Barbados National Energy Policy
BNOC	Barbados National Oil Company
BREA	Barbados Renewable Energy Association
BTU	British Thermal Unit
BWA	Barbados Water Authority
CIF	Cost Insurance and Freight
C-SERMS	Caribbean Sustainable Energy Roadmap and Strategy
CARICOM	Caribbean Community
DET	Division of Energy and Telecommunications
DRC	Domestic Resource Cost
EIA	Energy Information Administration
ELPA	Electric Light & Power Act
EU	European Union

## FINAL DRAFT OF THE BARBADOS NATIONAL ENERGY POLICY (2017-2037)

EV	Electric Vehicle
FCA	Fuel Clause Adjustment
FOB	Freight on Board
FTC	Fair Trading Commission
GDP	Gross Domestic Product
GWh	Giga-watt hours
IADB	Inter-American Development Bank
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
kW	Kilowatt
kWh	kilowatt hours
LEED	Leadership in Energy and Environmental Design
MCA	Multi-Criteria Approach
MMBTU	Million British Thermal Units
MTBE	Methyl Tertiary Butyl Ether
MWh	Megawatt hours
NDC	Nationally Determined Contributions

## **FINAL DRAFT OF THE BARBADOS NATIONAL ENERGY POLICY (2017-2037)**

NGO	Non-Governmental Organisation
NPC	National Petroleum Corporation
OTEC	Ocean Thermal Energy Conversion
PAM	Policy Analysis Matrix
PPA	Power Purchase Agreements
PUB	Public Utilities Board
PV	Photovoltaics
RER	Renewable Energy Rider
RFP	Request for Proposals
SEFB	Sustainable Energy Framework for Barbados
SIDS	Small Island Developing States
SJPP	Samuel Jackman Prescod Polytechnic
TCF	Trillion Cubic Feet
TVET	Technical, Vocational Education and Training
UNEP	United Nations Environment Programme
UWI	University of the West Indies
WDA	Woodbourne Development Area



# EXECUTIVE SUMMARY

# FINAL DRAFT OF THE BARBADOS NATIONAL ENERGY POLICY (2017-2037)

## EXECUTIVE SUMMARY

This Barbados National Energy Policy (BNEP) 2017-2037 Document is designed to ensure:

*“Energy security and affordability through diversity and collaboration: Establishing and maintaining a sustainable energy sector for Barbados.”*

The BNEP builds on efforts of previous projects and activities to establish a comprehensive policy for Barbados in areas relating to the supply and consumption of energy across all associated sectors. BNEP was developed using a collaborative approach which including several rounds of interviews and consultations throughout Barbados’ energy sector in 2016 and 2017. The policy also benefitted from considering research and documented accounts of regional and international jurisdictions that have experienced challenges and opportunities.

The key approach used in developing BNEP was a Multi Criteria Approach (MCA) , where the impacts of the policies chosen were considered from as wide ranging a perspective as possible. This meant that the cross cutting nature of the sector was highlighted and issues related to finance, economics, natural environment, technology and social development were considered in a consolidated manner.

BNEP as a policy that spans all the aspects of the energy sector, examines aspects related to both renewable and fossil fuel based energy. However, it aims to provide a framework for moving the island from a fossil fuel based economy to one based principally on renewable energy sources. The rate at which this can be achieved still has a level of uncertainty, but there is no doubt that increased sustainability in terms of more dependence on renewable energy will be a boost to Barbados’ economic and environmental future. This BNEP provides direction for managing the transition and ensuring viability from all points of view along the way.

## **FINAL DRAFT OF THE BARBADOS NATIONAL ENERGY POLICY (2017-2037)**

There is reason for optimism in Barbados' attempts to embrace more renewable energy technology, as it builds on its reputation of being a leader in the Caribbean and the western hemisphere. The success of the solar water heating industry is a source of pride for the country, and the recent development of the local solar photovoltaic (PV) industry in Barbados is also encouraging. BNEP provides a basis for building on these successes while seeking to extend and expand the use of these and other renewable energy technologies such as wind and biofuels.

However, even as Barbados promotes development of renewable energy, there is ongoing exploration for fossil fuel resources offshore. Given the MCA, development of these resources can be reasonable if they can occur in a manner where the economic or social, benefits can compensate to a degree for any environmental degradation that may occur.

Recognising the importance of prudent use of resources in energy as a way to ensuring sustainability and a thriving economy, BNEP also highlights the importance of energy efficiency throughout the various sectors and subsectors in the industry.

Giving the foregoing, major sectors of the energy economy that were identified inter alia in completing BNEP were the following:

- Oil and Gas Supply
- Renewable Energy Supply
- Energy Efficiency and Conservation
- Electricity
- Transportation
- Environment
- Human Resources
- Health and Safety
- Trade
- Governance and Regulation and

**FINAL DRAFT OF THE BARBADOS NATIONAL ENERGY POLICY  
(2017-2037)**

- Other Cross Cutting Sectors

## **FINAL DRAFT OF THE BARBADOS NATIONAL ENERGY POLICY (2017-2037)**

This MCA deviated to some extent from previous approaches where the Least Cost Approach was more dominant. It was thought that in considering these sometimes conflicting elements of development, a number of core values for energy development in Barbados had to be identified. While these core values were not ranked, they clarified some of the priorities to be considered in making the decisions. The values formed the basis of the Visionary Statement and Visionary Goals discussed later.

### **Core Values**

The Core values identified were:

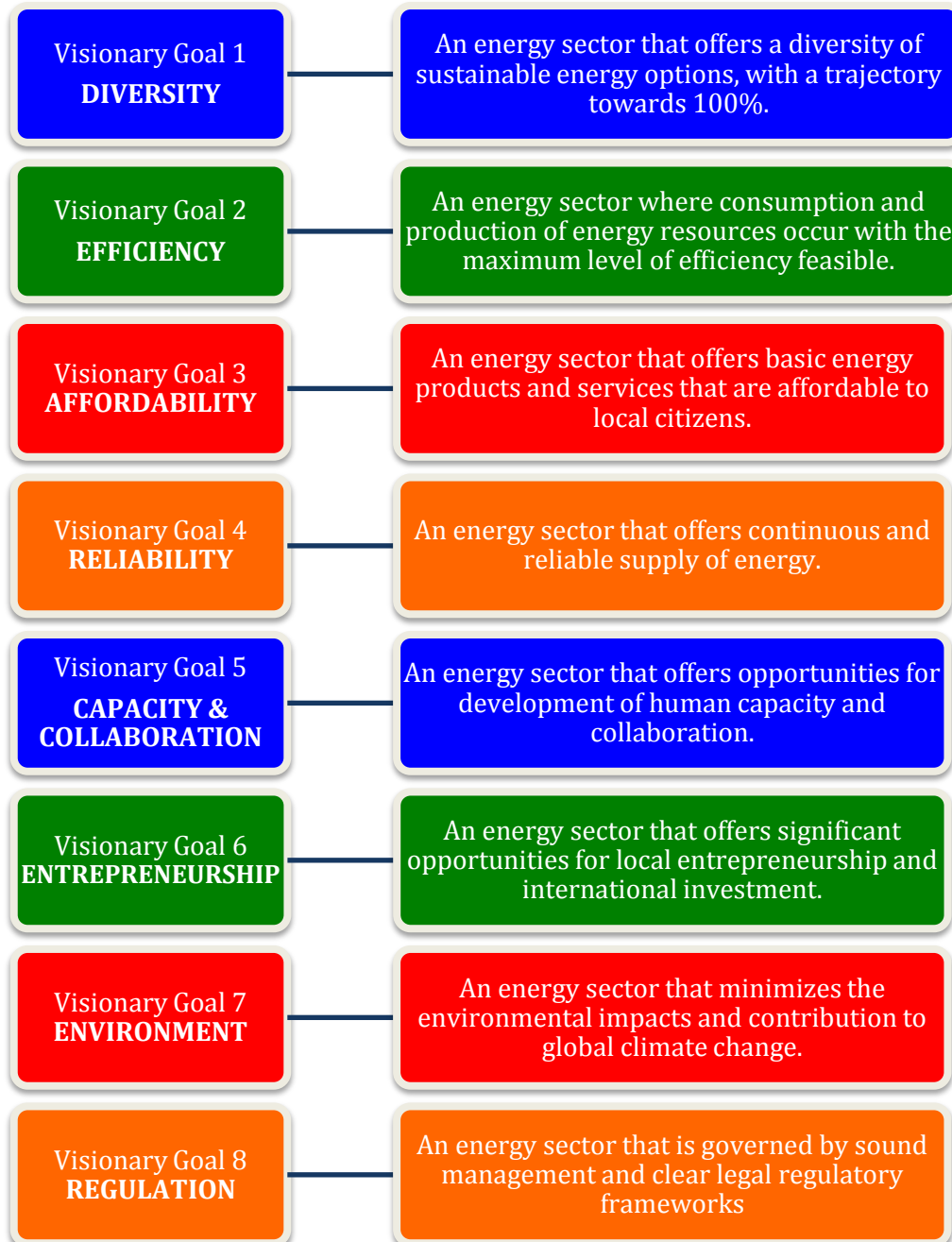
- Stability- price, regulatory, technical
- Reliability- including continued access to energy
- Efficiency in the production and consumption of all energy resources
- Diversity- reduction of vulnerability through use of multiple sources
- Ownership of business: Opportunities for local investment
- Maximum use of Indigenous energy resources
- Entrepreneurship development
- Maximum level of collaboration
- Multidisciplinary cross cutting approach
- Gradual, systematic evolution to an energy sector based on renewable energy
- Education, Awareness and Capacity Building
- Environmental Protection, Ecology- especially in connection with public health

From these analyses the following Vision Statement and Visionary goals were developed for Barbados.

**FINAL DRAFT OF THE BARBADOS NATIONAL ENERGY POLICY  
(2017-2037)**

**BNEP Vision Statement:**

**“Energy security and affordability through diversity and collaboration:  
Establishing and maintaining a sustainable energy sector for Barbados.”**



## **FINAL DRAFT OF THE BARBADOS NATIONAL ENERGY POLICY (2017-2037)**

**Vision Statement:** *“Energy security and affordability through diversity and collaboration: Establishing and maintaining a sustainable energy sector for Barbados.”*

### **Visionary Goals:**

**Visionary Goal 1:** An energy sector that offers a diversity of sustainable energy options, with a trajectory towards 100%.  
(core value-diversity)

**Visionary Goal 2:** An energy sector where consumption and production of energy resources occur with the maximum level of efficiency feasible (core value- efficiency)

**Visionary Goal 3:** An energy sector that offers basic energy products and services that are affordable to local citizens.  
(core value-affordability)

**Visionary Goal 4:** An energy sector that offers continuous and reliable supply of energy. (core value- reliability)

**Visionary Goal 5:** An energy sector that offers opportunities for development of human capacity and collaboration. (core value-capacity and collaboration)

**Visionary Goal 6:** An energy sector that offers significant opportunities for local entrepreneurship and international investment. (core value- entrepreneurship)

**Visionary Goal 7:** An energy sector that minimizes the environmental impacts and contribution to global climate change.  
(core value- environment)

**Visionary Goal 8:** An energy sector that is governed by sound management and clear legal regulatory frameworks. (core value-

## **FINAL DRAFT OF THE BARBADOS NATIONAL ENERGY POLICY (2017-2037)**

regulation)

### **Overall Objectives**

From these Visionary Goals the Following Overall Objectives were developed for the energy sector.

**Overall Objective 1:** Achieving stability, predictability in energy product prices over the long term. (Related to Visionary Goal 3)

**Overall Objective 2:** Achieving affordability and access to all classes of consumers in energy products and services (Related to Visionary Goal 3)

**Overall Objective 3:** Establishing a consistent and comprehensive regulatory framework to govern activities in various energy sub-sectors. (Related to Visionary Goal 8)

**Overall Objective 4:** Increasing the amount of renewable energy sources used in the energy mix to the extent that it can be accommodated from a technical and socio-economic perspective. (Related to Visionary Goal 1)

**Overall Objective 5:** Increasing the diversity in types of energy sources utilized within both the renewable energy and fossil fuel energy sectors. (Related to Visionary Goal 1)

**Overall Objective 6:** Increasing the extent of energy resources used in Barbados that are obtained from indigenous sources. (Related to Visionary Goal 6)

**Overall Objective 7:** Encouraging local investment in energy projects and programmes within Barbados, with a view to increasing number of shareholders and players in the various energy subsectors. (Related to Visionary Goal 6)

**Overall Objective 8:** Promoting increased entrepreneurial activities



## **FINAL DRAFT OF THE BARBADOS NATIONAL ENERGY POLICY (2017-2037)**

locally in renewable energy and fossil fuel energy development throughout the energy subsectors. (Related to Visionary Goal 6)

**Overall Objective 9:** Increasing collaboration within the energy subsectors and among the cross cutting sectors that have an impact on energy supply or consumption. (Related to Visionary Goal 5)

**Overall Objective 10:** Improving the efficiency in the production and consumption of energy products within the various subsectors. (Related to Visionary Goal 2)

**Overall Objective 11:** Improving the awareness and understanding of energy production and consumption, its impacts and the associated environmental and socio-economic consequences within all sections of the public. (Related to Visionary Goal 5)

**Overall Objective 12:** Increasing the number of persons locally with qualifications and skills relating to energy production and management of renewable and fossil fuel sources. (Related to Visionary Goal 5)

**Overall Objective 13:** Reducing the environmental impacts associated with the production and consumption of energy resources locally. (Related to Visionary Goal 7)

**Overall Objective 14:** Ensuring reliability and continuity of energy supply in the various local energy subsectors. (Related to Visionary Goals 4)

**Overall Objective 15:** Attaining the lowest price that can be sustained by the local economy for various energy sources consumed within Barbados while maintaining environmental efficiency (Related to Visionary Goal 3)

**Overall Objective 16:** Establishing effective partnerships between national and international entities for local energy projects (Related to

## **FINAL DRAFT OF THE BARBADOS NATIONAL ENERGY POLICY (2017-2037)**

### Visionary Goal 6)

These Overall Objectives were used as the basis for Specific Sector Objectives within the different sectors, some of which were identified above. The discussion and list of Specific Sector Objectives are included in the main document.

The Specific Sector Objectives were used as the basis of some suggested Measures also included in the main document. These Measures will be expanded on in the development of the Implementation Plan, which is expected to emerge as the next stage of the work after completion of BNEP.



### **Target Energy Mix**

The BNEP used a planning horizon of 20 years, 2017-2037 and assessed current activities and projections in energy use for Barbados in order to develop targets in percentage mix in terms of energy use in GWh. These targets were set more as a basis for discussion than as 'absolute' goals. They generated much debate throughout the

## FINAL DRAFT OF THE BARBADOS NATIONAL ENERGY POLICY (2017-2037)

consultation process and are expected to be reviewed and modified if necessary along the planning horizon.

It should be noted that targets can be viewed as a minimum level to be obtained. If stakeholders are able to exceed the targets this would be desirable, especially if they improve, financial, environmental economic or technological performance. There is at the moment no decision on whether to make targets mandatory, but this remains an option on the table.

The proposed target mix is anticipated to result in an annual total energy discounted cost, from total supply to final consumption, of \$720 million per year at current market prices. This is estimated to be a reduction of 40%. The initial cost of production of electricity is estimated to be \$438.0 million per year. The discounted social profit or benefit to Barbados is estimated \$2.2 billion annually from the removal of fossil fuels. In order to achieve the above benefits the heavy fossil fuel reductions required are

- 19% heavy fossil fuel reduction by 2022;
- 38% heavy fossil fuel reduction by 2027;
- 56% heavy fossil fuel reduction by 2032;
- 75% heavy fossil fuel reduction by 2037.

It should be noted here that rather than discussing reduction in fossil fuels, reduction in heavy fossil fuels is specified. This is because in the transition to a more sustainable energy mix, the use of natural gas as a bridging fossil fuel (BFF) is contemplated. In spite of its reduced environmental impact, natural gas is still a fossil fuel source. The identification of heavy fossil fuels here is defined as fossil fuel resources excluding natural gas.

The above fossil fuel reduction targets can be stated as increased production of energy from renewable energy and natural gas targets for electricity generation. Below the targets are expressed in terms of

## FINAL DRAFT OF THE BARBADOS NATIONAL ENERGY POLICY (2017-2037)

renewable energy and (BFFs )to account for the possibility of natural gas derived from fossil fuels in the mix.

- 34% increase in renewable energy and BFFs by 2022;
- 50% increase in renewable energy and BFFs by 2027;
- 56% increase in renewable energy and BFFs by 2032;
- 75% by increase in renewable energy and BFFs by 2037

In this approach, natural gas scenarios, factors such as economic deficits, level of taxation, GDP, oil prices and costs of tradeable and non-tradeable goods were considered.

The indicators below are among those that will be used to monitor the performance of the energy sector over the planning horizon:

*Table 1 – List of Main Indicators*

<b>Name of Indicator (Units)</b>	<b>Baseline (2015)</b>
Aggregate Energy Intensity(BOE/MUS\$)	324
Total Energy Consumption per Capita (BOE/Persons)	5.03
Percent Share of Renewable Energy of Total Energy (%)	2
CO <sub>2</sub> Emissions/Final Consumption (kt/BOE)	0.0029
Total No. of Persons Employed in the Energy Sector (No.)	
Electricity Generation Efficiency (%)	37
Percent Share of Renewable Energy Investment of Total GDP (%)	

## **FINAL DRAFT OF THE BARBADOS NATIONAL ENERGY POLICY (2017-2037)**

Establishment of the appropriate indicators is critical in determining an effective system of monitoring that will allow BNEP to be updated and revised on a timely basis, in order to ensure continuous improvement. It is expected that the government will work with members within the different sectors to develop the Implementation Plan.

The recently developed NGO, Barbados Renewable Energy Association (BREA) is expected to play a role in the area renewable energy development and energy efficiency, in developing appropriate standards and indicators. Other stakeholders likely to be involved will include Barbados Light & Power Co. Ltd, BNOC, FTC, various Ministries in government in energy and other cross cutting sectors.

It is important to note that the “Implementation Plan” will not only develop indicators and targets but will also identify more specific programmes, determine strategies and assigned the roles and responsibilities to various groups, organisations and agencies in achieving these. There will also be an assessment of resources needed for various actions and some suggestions of funding options that can be considered.



# SECTION 1: INTRODUCTION



## **1. Introduction**

### **1.1 Purpose of the Barbados National Energy Policy (BNEP) (2017-2037)**

The BNEP has been developed for Barbados with the aim of providing clear direction to the government in the short, medium and long term, for various areas of development both in the renewable and non-renewable aspects of energy. Issues related to energy production, energy consumption and energy efficiency are considered and addressed.

#### **What is BNEP designed to achieve?**

BNEP is intended to provide a framework to guide decision making in the various sectors that come under the umbrella of energy development. It defines at the outset a broad Vision Statement followed by Visionary Goals and Overall Objectives up to 2037. Later on in the document, specific objectives under the various sub sectors are identified. There are also some recommended measures given, that are expected to play a role in achieving the goals identified.

It is important to note that BNEP is NOT designed to prescribe specific, detailed actions that need to be taken in any of the subsectors identified. It also does not determine specific targets within the various subsectors, strategies needed within the sector or specific roles and responsibilities of individuals or agencies that are required to ensure that the goals or objectives outlined in the policy are achieved.

All these aspects are undeniably important if BNEP is to be effective, but it is expected that these will be explored in more detail in the “Implementation Plan” which will be developed as a follow up to this document.



Nonetheless, BNEP suggests some sector wide targets for energy mix based on the Division of Energy and Telecommunications (DET) data, highlighting the availability and cost of various energy sources. Given that the availability and costs of resources such as natural gas may change over the coming years, these targets are presented assuming a large degree of flexibility.

BNEP uses a planning horizon of 20 years, allowing for assessment of long term scenarios and impacts. In the course of the policy planning horizon, it is expected that there will be frequent reviews of the document as circumstances change. It is recommended that a policy review is undertaken at least once every five years. Modifications to policy recommendations are not only possible, but expected.

## **1.2 Chapter 1 Overview**

In this first chapter, a discussion of the Barbados energy sector highlighting achievements, activities and challenges up to 2017 are presented. This is followed by an assessment of likely present and future influencing factors on the sector from a regional and international perspective. Emerging from these factors, the legislative and regulatory framework that governs activities within the energy sector in Barbados is presented.

Later in the chapter, charts with details of the current energy mix with associated costs are presented. The Chapter continues with a description of the Multi Criteria Approach (MCA) , which is used as the underlying approach for developing BNEP.

The chapter as a whole is important in setting the context for the Objectives and Targets in later chapters.

### **1.3. Barbados Energy Sector- Brief Discussion**

Over the years, Barbados has sought to maintain an energy sector where energy resources are universally available at reasonable prices.

The island can be proud of the fact that there is virtually 100% access to electricity and that gradually more sustainable forms of energy are being integrated into the energy mix, both in terms of electricity delivery and other energy services. However, the main fuel for electricity generation remains Bunker “C” heavy fuel oil.

#### **Electricity**

The island’s electric utility Barbados Light & Power Co Ltd (BL&P) established in 1899, was one of the earliest in the Caribbean. It is a vertically integrated monopoly, regulated by the Fair Trading Commission (FTC), and is now totally owned by Emera Inc. a Canadian based company. Their existing license, which was gained in 1986, allows BL&P to have the sole franchise to sell electricity in Barbados up to 2036.

Given the planning horizon of BNEP, the issue of extension of the license or a change in the structure of the electricity market will need to be addressed as this policy goes into implementation. We discuss later how changes in technology towards more renewable decentralised forms of energy may necessitate a change in the sector structure of the industry. However, details on the electricity industry and opportunities for competition or new business models are outside the scope of BNEP.

#### **Solar Water Heaters**

Starting in 1974 in the midst of the international oil crisis, Barbados invested in the area of solar water heating and that industry stands out like a beacon in terms of its success in the Caribbean. A series of government economic incentives and tax write offs coupled with

strong entrepreneurship shown by early developers led to significant growth of the industry. At the moment, Barbados one of the leading countries in terms of solar water heaters per capita, both in the western hemisphere and the world. There are local companies that now export to the rest of the Caribbean and even further afield.

Barbados having established itself as a regional leader in renewable energy through its success in solar water heating, seeks to build on that reputation by achieving similar levels of success in developing other renewable energy technologies. However, while there are definitely successes that can be identified, there is still much more that can be done within the island to make sure that the desired level of sustainability is achieved.

### **Solar PV**

There are some recent efforts in securing a more sustainable energy mix, which provide reason for optimism. The establishment of a number of photovoltaic projects throughout the island in the last five years has led to many new players getting involved or expanding in the market. The local utility has played its part also by establishing a 10 MW solar farm.

### **Wind Energy**

While wind energy has not taken off significantly, there are still plans to develop this technology to operate in a complementary way with existing solar installations. BL&P continues to investigate the possibility of establishing a wind farm in Lambert's St. Lucy alongside the existing PV farm there.

## **Bio energy**

Also, in the light of a declining sugar cane industry in the island, there is increasing confidence among the agriculture sector that there is room for increased use of biomass and biogas in the energy sector. Bagasse has at times been used to generate energy in the sugar cane industry and there is considerable interest on building on this experience

## **Natural Gas for Domestic Cooking**

The expansion of the use of natural gas within Barbados for cooking has had an impact as well, with this fuel replacing less sustainable forms of fossil fuel energy as well as electric burners.

While the use of the solar water heaters for hot water and natural gas for cooking still only contribute a tiny percentage of energy in terms of the overall energy mix, there is no doubt that these industries have made a significant social impact at a household level, and signal to consumers that it is possible to achieve environmental sustainability in energy use while achieving economic benefits as well.

## **Transportation**

Discussions with those in the transport sector also suggest that improvements in sustainability are possible, with local car dealers becoming involved in bringing electric vehicles into the island. More renewable energy in the production of electricity in Barbados coupled with a greater level of electric vehicles (EV)s, could significantly improve the sustainability of the energy mix in both the transport and electricity sectors.

While, there is still a lot to be done in terms of establishing suitable infrastructure for increased use of EVs and other vehicles from alternative fuels, the local petroleum companies are open to

facilitating the change so long as the costs for such transitions can be done in the most equitable manner feasible.

## **Energy Efficiency**

Efforts in Barbados have not been limited to energy production. In the area of energy conservation and energy efficiency there have also been projects designed to retrofit incandescent and fluorescent lights with LEDs and efforts are ongoing to establish and implement efficiency standards for buildings, refrigeration and air conditioners.

## **BREA**

Such has been the interest in going further in efforts of renewable energy and energy efficiency, that a new (NGO) the Barbados Renewable Energy Association (BREA) has been established in the last five years. BREA has been established to play an advocacy role for the use of renewable energy as well as a facilitator for the continued growth of the industry and in establishing standards of performance and efficiency within this new sector of the economy.

Apart from efforts made at the domestic level and at the individual entrepreneurship level, large consumers of electricity have also begun to address sustainability, through moving to self generation or developing large scale renewable energy projects for themselves. The Barbados Water Authority (BWA) is one such entity that has been exploring going that route.

Meanwhile, even as there are considerable efforts to develop renewable energy projects and improve energy efficiency in the sector, there are continued efforts to gain more fossil fuel resources as well through government's drilling and exploration efforts offshore. The possibility of a significant oil or gas find could potentially lead to a considerable economic benefits for Barbados whether used on island or sold overseas. Any such fossil fuel resource should be developed in a way that it does not affect the overall trajectory to sustainability of the entire energy sector.

The BNEP is seen as a tool in the midst of all of this activity in the energy sector, to provide some direction and seek to balance the sometimes conflicting priorities that can occur.

### **Barbados Energy Roadmap- Produced by IRENA**

During the development of this BNEP, the Division of Energy and Telecommunications (DET) also engaged the International Renewable Energy Agency (IRENA) to develop a Renewable Energy Roadmap for Barbados.

IRENA's study focused to a large extent on the electricity sector and the possibilities for greater efficiency and an increase use of renewable energy. That roadmap identified the following goals as part of the Barbados government vision.

An energy sector that:

- enhances economic growth by reducing energy costs
- Improves energy security by reducing dependency on imported fossil fuels
- Reduces cost of energy service for consumers
- Reduces investments needed for power generation by promoting energy efficiency and conservation.
- Reduces the emission of greenhouse gases and local pollutants from fossil fuels.

The economic, environmental and social goals identified in their study are in keeping with the goals identified through the analysis of the Barbados energy sector in developing this policy. The BNEP's identified goals are consistent with many of the goals presented in the Roadmap and provide a framework for further actions that can be developed from the Roadmap.

The roadmap considers future scenarios with increased energy efficiency on the demand customer side, a low oil price scenario and

a scenario where a greater number of electric vehicles are imported. All of this is considered within the context of the Government's Nationally Determined Contributions (NDC) emerging from the Paris Agreement in 2015. This NDC sets a goal of 65% of electricity generated to be produced from renewable sources by 2030.

BNEP takes into consideration the identified path within the Roadmap in the broader context of the overall energy sector, including the fossil fuel based industries, recognizing how these potential changes in the electricity and transport sector will impact other cross cutting sectors within the energy space.

It should be noted that although BNEP attempts as much as possible to give direction to activities in the various sectors, and for the implementation plan, there was need for a level of flexibility to remain to allow for the ability to assess and evaluate technologies not considered viable at the moment that may become major players in the next 30 years.

BNEP therefore is designed to focus on the 'how' rather than the 'what' with respect to energy sector development.

In addition to the focus on flexibility, it is recognised that BNEP will need to be considered in the context of broader economic policy documents in other subsectors of the Barbados government. This will include policies such as the Industrial Policy, Trade Policy, Transport Policy and Disaster Management Policy.

It is expected as well that BNEP will help in giving further guidance and make existing processes that are in place more streamlined.

## **1.4 Regional Energy Context and its Influence on Barbados**

The Caribbean Community (CARICOM) encompasses twenty countries in the Caribbean region focusing on “economic integration; foreign policy coordination; human and social development; and

security” (CARICOM, 2016). CARICOM seeks to safeguard each member’s access to clean, reliable, affordable and stable energy and also aids the progression of comparable regional industries.

Within the Caribbean, the energy context is dictated by the international energy market, as fossil fuels account for 80% of the primary energy supply. Other major resources of energy within the region are hydro, solar, wind, biomass, and geothermal. The Caribbean Community has established targets of 47% reduction in fossil fuel use by 2027 (C-SERMS)

The CARICOM Energy Policy (2013) is a wide-ranging framework document that considers issues of energy production and consumption (both renewable and non-renewable programmes) from a regional perspective. The issue of trade between territories and the impacts of programmes such as Petro Caribe are discussed in this policy. However, it should be noted that Barbados was not a signatory to the Petro Caribe agreement. The main goals of the CARICOM Energy Policy are below:

- “(a) Provision of sustainable and secure supplies of energy, accessible to all CARICOM citizens;*
- (b) Fundamental transformation of the energy sectors of the Member States of the Community so that they can contribute to the sustainable development of the Community;*
- (c) Optimization of domestic production of energy in an environmentally sound manner;*
- (d) Facilitating the growth of internationally competitive regional industries.”*

These goals are similar to some of the core values of BNEP that are discussed in the next section.

Regional integration with other Caribbean countries is an option for meeting future energy supply needs (regional projects, sharing of research and development, harmonization of policies, laws etc.). However, there are distinct challenges in the coordination of relevant



policies, strategies and plans. There are also issues pertaining to the unavailability of timely and relevant data, pricing and the increasing international demand for petroleum, rising petroleum prices, and the security of supplies for regional trade (CARICOM Energy Policy, 2013).

## **1.5. International Energy Context and its Influence on Barbados**

### **1.5.1 Economy**

The state of the international or global economy can impact the economic performance of Barbados and can affect attitudes to spending and investments as well. Over the last eight years the international economy experienced contraction and low growth in some major industrialized countries. The global economy according to the United Nations grew at a slower pace of 1.8% over the period 2008 to 2015. The global economy during the last 8 to 10 years was characterized by:

- A financial debt crisis;
- High and escalating oil prices;
- Declining and low interest rates;
- High liquidity in the banking sector;
- Weak demand for goods and services;
- Fluctuating employment.

The global economy is comprised of countries and trading blocs that are recovering, as well as those that continue to grapple with economic uncertainty. The USA, for example, employed monetary policies such as quantitative easing to address its debt problem, while the European Union (EU) initially used austerity but with limited success. However, the EU has engaged its own brand of quantitative easing, which has resulted in some stabilization in employment, inflation, and GDP. Other countries whose economies are based on commodities, especially those based on oil, experienced economic contraction beginning in 2014.

China, which operates a planned (not market driven) economy, has engaged in a controlled decline of economic output of 7%. This controlled decline has resulted in decline in other markets, and in commodity based economies in particular. It is expected that global economic growth will continue to be uneven over the next decade. Small Island Developing States (SIDS) such as Barbados are especially vulnerable to international factors, mainly because of their remoteness, lack of economic diversification and high reliance on international imports.

International oil prices have an impact on short and medium term renewable energy development. Higher oil prices often result in greater local interest in renewable energy development to offset the high cost of energy from fossil fuels.

For example, as oil prices soared to \$147 per barrel in 2008 (far above the long-run average of \$45 per barrel), there was considerable interest in the development of renewable energy technologies throughout the Caribbean, to mitigate the impact of the higher cost of energy from fossil fuels. In 2010, the Renewable Energy Rider (RER) was introduced and this led to a substantial increase in the number of PV installations. During the period 2013 to 2015, PV installations expanded five-fold, moving capacity from 1.6 megawatts to 9MW (Investigation of Likely Reactions to the Removal of Green Energy Incentives - Antilles Economics 2016).

The expansion of PV installations benefited in large measure from the facilitation of the RER, and the fiscal incentives implemented in 2013 to support the use of renewable energy in electricity supply by homes and businesses (Investigation of Likely Reactions to the Removal of Green Energy Incentives - Antilles Economics 2016). This proved to be a good incentive for development and installation of PV and other renewable energy technologies. However, as oil prices have fallen, the fuel clause adjustment (FCA) of BL&P has also been reduced, resulting in considerably less incentive for new individuals to start generating electricity to sell to the grid through renewable energy

technologies. Meanwhile, higher oil prices internationally also increased the incentive to explore and extract petroleum resources that may be more costly to produce.

One of the main aspects of the BNEP and the Implementation Plan that will follow, is to ensure that the incentives for renewable energy generation remains high both in times when oil prices are high and when oil prices are low. There will also be needed to ensure that Barbados is able to take advantage of onshore and offshore petroleum resources when prices on the international market are favourable to their development.

### *Expected Future International Energy Market*

According to the U.S. Energy Information Administration (EIA), it is expected that global energy consumption will continue on its upward trend over the next thirty years. This view of future demand is driven by the conclusion that economies such as China and India will account for more than half of the world's total increase in energy by 2040. The International Energy Outlook 2016 as presented by the EIA, projects that by 2040 global energy consumption will increase by 48% from 549 quadrillion BTUs (99.2 billion barrels of oil) to 815 quadrillion BTUs (147.2 billion barrels of oil). It is further anticipated that much of the increased consumption of global energy will be derived from the developing and emerging economies, which are expected to register an increase in energy consumption of 71% by 2040.

The increased consumption in global energy is expected to be driven by increased economic growth in the developing and emerging economies. Indeed the International Energy Outlook 2016 has projected that the world's GDP, adjusted for purchasing power, will increase at an annual rate of 3.3%. Furthermore, the Outlook projects that economic growth in the developing and emerging economies will expand on average by 4.2% per annum.

The International Energy Outlook 2016 further indicates that its expectation is for increased consumption across all the major energy sources. Interestingly, the Outlook points to renewable energy sources being the fastest growing energy source for the period up to 2040, with consumption of this resource growing at an annual rate of 2.6%. The view of the International Energy Outlook 2016 is that nuclear power will be the second-fastest growing energy source by 2040, expanding at an annual rate of 2.3%. The long term international consumption of natural gas is expected to increase at a rate of 1.9% per year where annual consumption is forecasted to be approximately 203 Tcf by 2040. According to the US Energy Information Administration – International Energy Outlook 2016, natural gas is an important fuel in the production of electricity. This is the case, as natural gas is viewed as an attractive fuel source because of its fuel efficiency. As a consequence, several governments worldwide, as a means of reducing CO<sub>2</sub> emissions, promoted the use of natural gas to displace the more carbon-intensive fuels. To meet the expected growing demand world producers are projected to increase natural gas supplies by an estimated 69% by 2040. Although consumption of non-fossil fuels is expected to grow at a faster rate than fossil fuel, the Outlook projects that fossil fuel will account for 78% of energy use by 2040.

Given the foregoing, oil prices are expected to continue to be volatile, contributing to uncertainty within the energy sector in the future. If expectations for future consumption within the developing and emerging economies hold true the follow-on would be significant increases in oil prices. However, a countervailing factor to this view is that renewable energy is projected to hold more prominence within the energy market and will be a constraining factor on energy prices. The International Energy Outlook 2016 proffers a reference oil price forecast of US\$141.00 per barrel for the period up to 2040. Of course this forecast may vary, and consequently, the Outlook points to a minimum price of US\$76.00 per barrel and a maximum oil price of US\$252.00 per barrel in the very long-run. However, in the short to medium international oil prices are expected to fluctuate between

US\$20.00 to US\$52.00 for the most part, with some occasions where there may be breaches of these support and resistance boundaries

Over the last ten years Barbados faced significant constraints which led to weak economic performance where average Gross Domestic Product registered flat growth (Barbados Economic Report, 2015) Additionally, Barbados has been grappling with high fiscal deficits. For example, the fiscal deficit as a percentage of GDP was 11.8% in 2013. Rising debt has also presented a significant challenge to Barbados over the last ten (10) years in terms of the unemployment rate in Barbados. This unemployment rate has hovered between 10% and 12%. The economic challenges that Barbados faced over the last ten years have been observed through the several credit downgrades by international agencies. These downgrades have had a negative impact on the cost of debt to the Barbados Government and the private sector

The previous target for renewable energy consumption, was that 29% of its electricity consumption is to be supplied by renewable energy by 2029 (Draft Energy Policy, 2013). The long-term energy price outlook for Barbados will be influenced by the global price of energy on the one hand, and its ability to move in a significant way away from fossil based consumption on the other hand. One of the fundamental constraints to moving towards more renewable energy sources is the heavy reliance Government has on the revenue that is derived from fossil fuel consumption. Indeed, this is a paradox in that fossil fuel consumption contributes significantly to the loss of the national resource. Therefore, if Barbados is to move towards significant reduction in fossil fuel by 2037, the Government of Barbados must overcome its dependence on fossil fuel for revenue. This will be one of the key issues to be addressed in determining the measures and strategies the Implementation Plan which follows this BNEP and for the long term energy development of Barbados.

## 1.5.2 Climate Change

In seeking to develop BNEP it was important to examine Barbados in the regional and international context, including its position as one of the group of countries known as Small Island Developing States (SIDS).

Barbados, as a SIDS, is vulnerable to international and regional trends and momentary shocks that can affect technology, resource availability and the pricing of energy products. Barbados and other Caribbean Community (CARICOM) members face challenges with regard to Climate Change. These impacts can be felt through effects such as higher frequency of extreme weather events, rising sea levels, destruction of coastlines and inundation of ground water. Generally, small islands lack the natural and financial resources to alleviate these ongoing challenges. (UN 2015).

*“Due to their size and location, Caribbean SIDS are particularly susceptible to the impacts of climate change. As developing economies relying on sectors vulnerable to climate patterns such as tourism, agriculture and fishing, Caribbean nations would be greatly affected by the ongoing rise in sea levels, changes in rain patterns and temperatures, and increasing intensity of natural disasters identified by the Intergovernmental Panel on Climate Change (IPCC).”*  
(IADB, 2016)

These types of impacts can have a profound effect on the economy and are in a large part caused by carbon dioxide emissions related to combustion of fossil fuels. The economic consequence of fossil fuel consumption in Barbados is that there is a loss of resource as a result of the foreign exchange, efficiency and environmental costs associated with fossil fuel consumption. The analysis which was conducted indicates that under a ‘Business- as – Usual’ scenario the Barbados Economy is likely to lose on average \$0.64 for every dollar of benefit it receives from the supply and consumption of fossil fuel.

Barbados is energy import-dependent and relies on trade to meet its energy needs. Consequently, a momentary disruption or trade imbalance can lead to uncertainty in access to energy as prices fluctuate on the world market.

A way of mitigating these impacts is to reduce the volume of carbon dioxide emissions by increasing the use of renewable energy technologies or investing more in energy efficiency. Over the years, there have been attempts at the international level to develop schemes to reduce carbon dioxide emissions worldwide. Carbon trading schemes such as the Clean Development Mechanism, have provided in some cases funding opportunities for Caribbean islands to develop renewable energy and energy efficiency projects.

### **1.5.3 Technology**

The development of technology, to more easily extract petroleum resources or to use renewable resources more efficiently and at lower cost, can increase the economic viability of activities in the energy sector. This can result in more attractive costs to investors with lower payback times. Additionally, improvements in energy storage technologies improve the stability and reliability of renewable energy technologies.

There have been developments in technology worldwide that have affected energy development within Barbados and the Caribbean on the whole. For example, the development of fracking as a means of extracting natural gas reserves has increased the availability of this particular commodity worldwide and costs have been reduced as a result. This factor has meant that some traditional natural gas producers, such as Trinidad and Tobago, have lost market share in locations such as the US. There has been as a result greater incentive to look for markets in the Caribbean, including Barbados to purchase this natural gas. BNEP takes this factor into consideration as well.

Developments in renewable energy technologies such as wind and solar, have also led to reduction in prices per kilowatt hour in recent

years. This increased economic viability of many renewable energy technologies, has led to growth in the industries worldwide, as investors and IPPs can now have lower payback times and higher rates of return for their investments. Barbados and Caribbean islands, with their high resource availability of wind and solar energy and comparatively high cost of conventional fossil fuels, have become more attractive to investors in renewable energy technologies in various parts of the world. However, a balanced view of the energy sector and renewable energy subsector as an important element to reducing Barbados' dependence is warranted at this juncture. In Barbados, solar electricity from PVs is the renewable energy technology that is growing to the greatest extent, with prices per kilowatt hour steadily declining. BNEP promotes a practical approach that engages solar electricity technologies that result in an overall benefit for Barbados. The policy advances an energy mix that considers both intermittent and base load renewable energy technologies, as well as clean fossil fuels such as natural gas.

For further development of renewable energy technologies, there will also need to be improvements in energy storage technologies. This will reduce the variability of grid tied renewable energy technologies which due to their intermittent nature affect the stability of the grid.

The opportunity for energy storage is particularly relevant to a small island such as Barbados, as the grid is isolated, with no provision to interconnect to other islands. This means that in many cases the installed capacity for renewable energy sources is far greater than that which would be needed for a conventional fossil fuel generator to produce the same amount of energy in GWh. This factor is discussed later when considering specific challenges to renewable energy development and associated targets.



## 1.6 Regulatory and Legislative Context

In developing BNEP, it was important to take into consideration the current regulatory and legislative framework within Barbados. In 2007 the Government of Barbados produced a Draft Energy Policy to give direction to the development of the overall sector. This wide ranging policy addressed issues of relevance to the fossil fuel sector as well as renewable energy resources. At that time, the Barbados government was seeking to explore new potential offshore petroleum wells while taking advantage of emerging renewable energy technologies and markets.

In keeping with the interest in developing offshore petroleum, the government developed the Offshore Petroleum Act and the Offshore Petroleum Taxation Act in 2007. The Offshore Petroleum Act, Cap 281, Petroleum Winning Operations Act, Cap 281, Petroleum Winning (Drilling and Production) Regulations, Cap 281 and Storage of Petroleum Act, Cap 172. These Acts contain the rules governing the exploration and production of offshore oil in Barbados and consider the limits and optimum levels of production that would ensure the long term sustainability of the petroleum sector.

Recognising the changes and recent advances in energy technologies, a number of legislative and regulatory provisions have been introduced or updated in anticipation of development of new energy markets in Barbados.

Many of these changes in regulation and legislation have been in the area of the electricity sector. In January 2001, the Fair Trading Commission (FTC) was established, taking over from the Public Utilities Board (PUB) in ensuring that rates and standards of service for the Barbados Light & Power Company Ltd (BL&P) were maintained at a reasonable level. The provisions governing the regulation of the electricity utility are contained in the Utilities Regulations Act Cap 282.

The electricity sector has changed significantly in recent years, with the company being now wholly owned by a Canadian company Emera Inc. The introduction of more renewable energy sources has made it more likely that the BL&P will face competition from other companies with the ability to generate electricity at a commercial level. In anticipation of such continuing developments, a new Electric Light & Power Act (ELPA) was produced in 2013. This Act, established in 2013, was revised for the first time since the early 1900s.

In view of the changing energy markets and technologies, there were also further energy policy documents produced in 2010 and 2013. In 2010 the Sustainable Energy Framework for Barbados (SEF B) was executed through the Inter-American Development Bank (IADB). The programme was designed to establish areas of technical assistance and support for sustainable energy programmes in Barbados. One element of this technical assistance was the development of the Energy Smart Fund.

Below are the six facilities provided through the Energy Smart Fund provided by the IADB.

- **Technical Assistance Facility** (BDS \$1 million) Grants for pre-investment studies as well as economic and technical feasibility studies
- **Energy Efficiency Retrofit and Renewable Energy Finance Facility** (BDS \$12 million): Provides subsidized loans for implementing renewable energy projects that have been demonstrated to be financially viable.
- **Pilot Consumer Finance Facility (BDS \$ 1 million)**- Provides interest rate rebates for commercial entities offering renewable energy or energy efficiency products

- **CFL Distribution Facility (BDS \$ 2 million)**- Provides free compact fluorescent lamps to identified residential BL&P customers
- **A/C Rebate Trade in Facility (BDS \$3 million)** - A 50 percent rebate to residences and businesses who replace older air conditioners for more energy efficient models.
- **Discretionary Grant Facility (BDS 2 million)** - Funds for institutional support to execute and implement the Smart Fund. This includes education and awareness programmes.

In 2013, a Draft National Sustainable Energy Policy was produced. This draft sustainable energy policy attempted to build on many of the aspects of the draft energy policy developed in 2007. The emphasis of the 2013 document was on the sustainable production and use of various energy resources. Efficient use of fossil fuel production and consumption was one of the foci of this draft policy along with the development of renewable energy technologies.

Further incentive for developing renewable energy technologies, was given through the establishment of the Renewable Energy Rider (RER) that was proposed by BL&P and approved by the FTC in 2010. The RER allowed for domestic customers to sell renewable energy back to the utility at the rate of 1.6 times the level of the fuel clause adjustment (FCA). This was under either a 'sale of excess' or a 'buy all, sell all" arrangement, depending on the metering configuration. In July 2016 the RER credit changed, and the rate is now no longer tied to the FCA but rather is calculated using a resource cost approach. The temporary RER credit is now \$0.416/ kWh for OV and \$0.315/kWh for wind energy, for systems up to 500 kW of installed capacity.

BNEP further facilitates economic and environmental sustainability through development of regulatory and legislative mechanisms to build on and support those that currently exist.

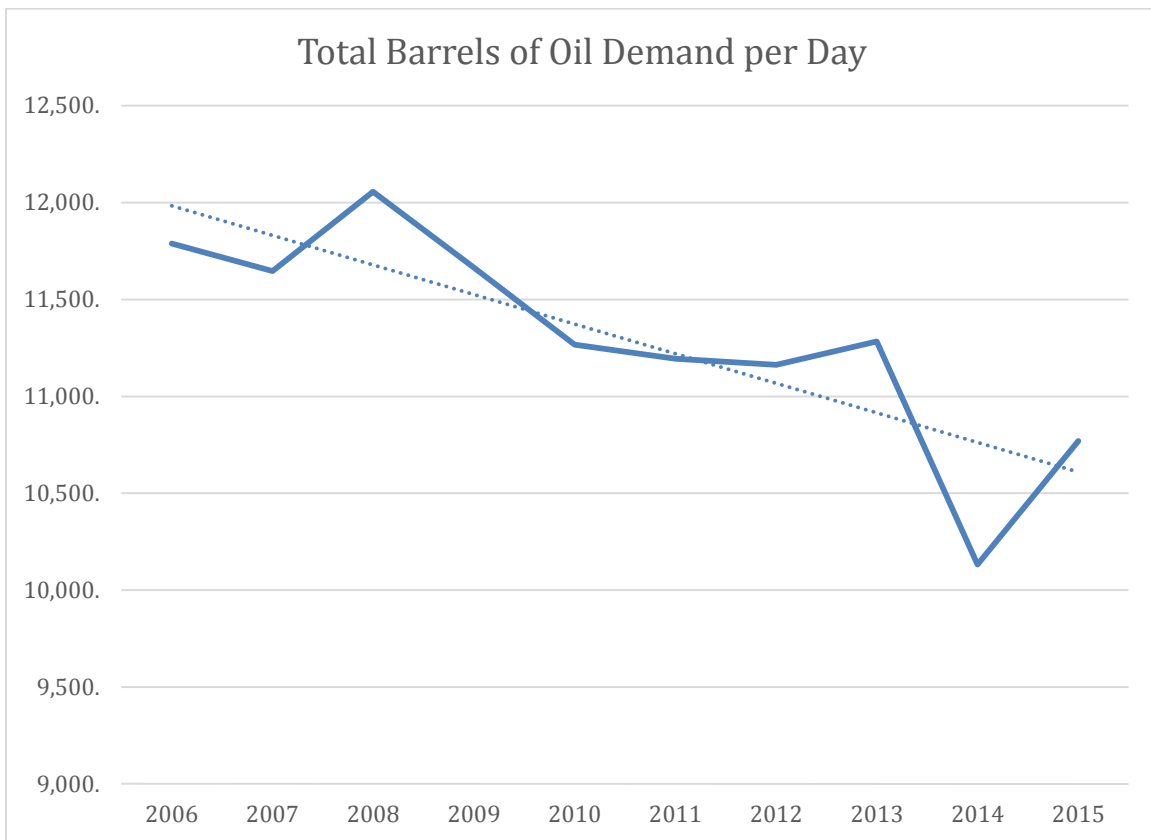


## 1.7 Barbados Energy Consumption and Demand- Summary Charts and Tables

### 1.7.1 National Energy Use

The demand for energy in Barbados over the last ten years is characterized by a declining trend. The average demand of primary and secondary energy was estimated at 11,297 BOE per day. Energy demand over the period declined reflecting the economic challenges that Barbados has been facing. Barbados' demand for energy peaked in 2008 at an estimated 12,056 barrels per day (bpd) while the lowest level of demand was observed in 2014, estimated at 10,132 bpd..

*Figure 1 – Total Barrels of Oil Demand per Day*

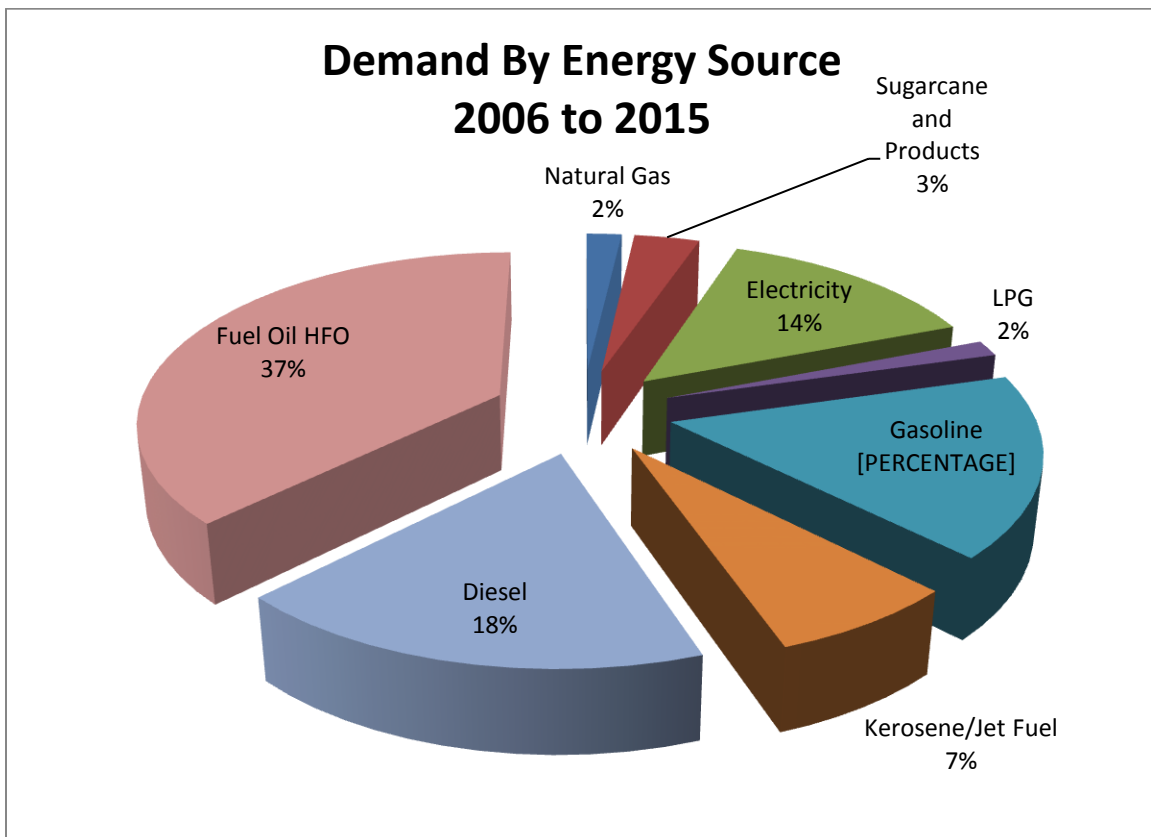


Currently, fossil fuels, predominantly heavy fuel oil, dominate Barbados's energy mix:

- Heavy Fuel Oil - 37%
- Diesel - 18%;
- Gasoline - 17%;
- Kerosene - 7%;
- LPG - 2%;
- Sugar Cane Bagasse - 3%;
- Natural Gas - 2%;
- Other (Electricity produced within utility) - 14%
- Solar water heaters- < 1%

The heavy fuel oil is mainly used in the generation of electricity

*Figure 2 – Demand by Energy Source 2006 to 2015*



Natural gas is not a significant contributor in the energy sector, contributing only 2% to the energy mix. However, natural gas has widespread use in the country for domestic cooking and use in the tourism and industrial sectors and therefore a considerable social impact. The benefit of this fuel source is that it is less carbon intensive than other fossil fuels and can also lead to stability in prices, as natural gas does not have the same level of fluctuation in price as heavy fuel oil. The use of natural gas within Barbados may well increase in the long term with current exploration for oil and gas offshore as well as due to importation, stability in world pricing and improvements in technologies. It should however be noted that the volumes of offshore oil discovered will determine whether it is more economically desirable to save it for domestic use, or whether it will be more prudent to sell overseas on the world market. It will be important to determine an optimum balance between the amount for domestic and the amount for sale on the international market.

The use of solar water heaters for domestic water heating has also risen significantly since being introduced in 1974. However, its effect on the overall energy mix is still under 1%.

Oil was discovered in Barbados as far back as the 18<sup>th</sup> Century. Currently, oil that is produced on the island is sent to Trinidad for refining. The Barbados National Oil Company (BNOC) a government owned company that engages in the production of oil and gas onshore in the country and imports fossil fuels. Onshore oil production is mainly from the Scotland Sand Formation located in the Woodbourne Development Area (WDA) field; Barbados produces approximately 1000 bpd (barrels of oil per day). Regarding natural gas, 500 bopd equivalent is produced by BNOC under the operation of the National Petroleum Corporations (NPC). It should be noted that there is a merger in 2017 between BNOC and NPC.

## 1.7.2 Electricity Generation

### **Fuel Feed Stock for Electricity Production:**

Over the last 20 years the fuel feedstock used in Barbados for the production of electricity consisted in large measure of fossil fuels. The main fuels included heavy fuel oil, kerosene, diesel, and natural gas. Within the sugar industry, electricity production was mainly fuelled by bagasse. In recent times solar energy has become a small but growing contributor to electricity production. In 2015, the fuel input sources for electricity production was registered as follows:

- Heavy Fuel Oil - 74%;
- Kerosene - 17.4%;
- Bagasse - 5.6%;
- Diesel - 2.2%;
- Natural Gas - 0.2%;
- Solar - 0.6%

The above configuration demonstrates the high trade dependence required for Barbados to produce its electricity. However, it must be noted that in 2016, Barbados' production capacity for solar electricity increased from 10MW to over 22 MW, contributing an estimated 2.4% of the total electricity distributed. The table and chart below demonstrate the current fuel contribution to total electricity production:

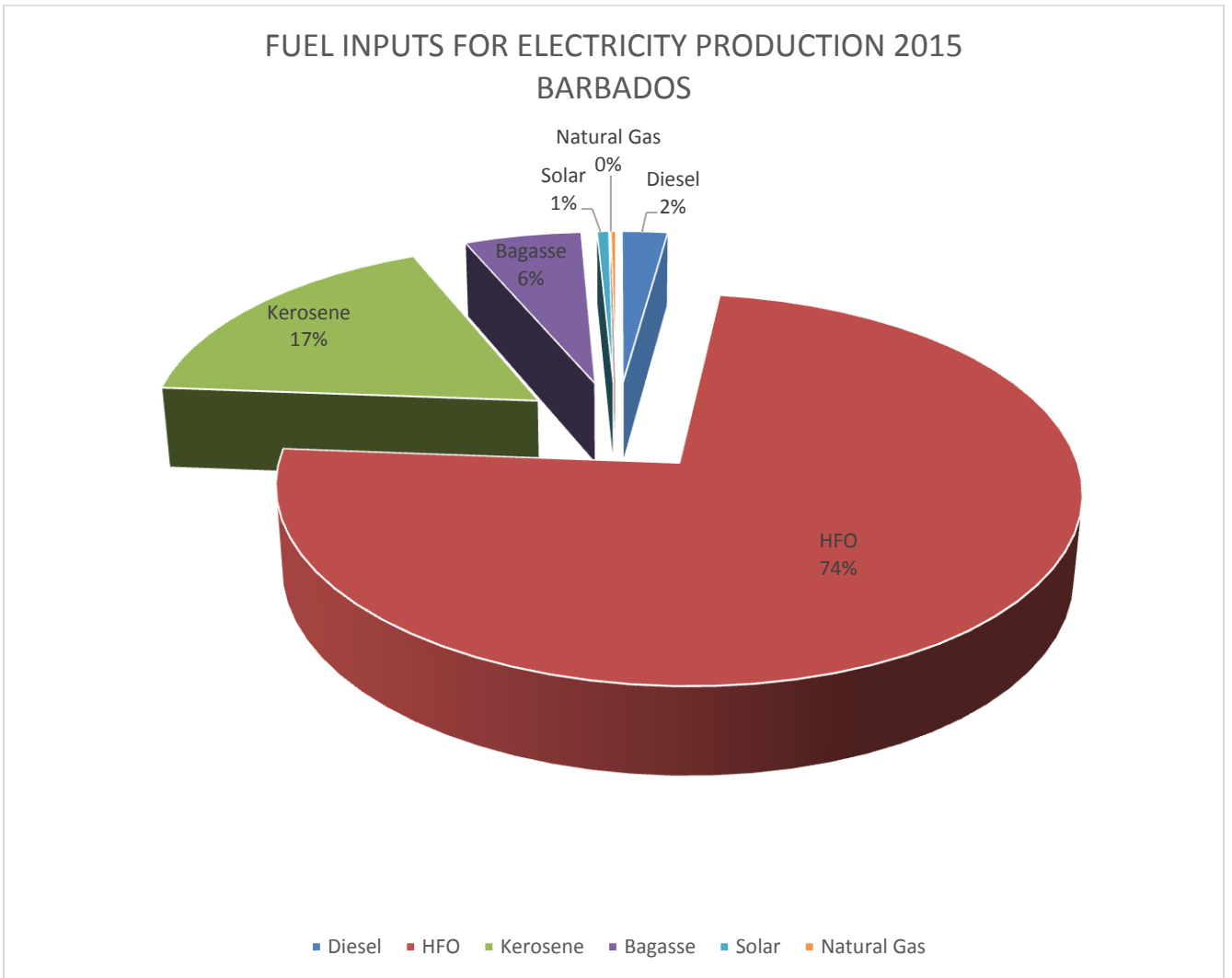


*Table 2 - Total Fuel Consumption for Electricity Production 2015*

Fuels	Fuel Feedstock MMBTUs
Diesel	230,426.80
HFO	7,830,143.87
Kerosene	1,841,808.78
Bagasse	592,962.40
Solar	59,022.04
Natural Gas*	24,522.80
Total MMBTUS	10,578,886.69

\* Accounts for use of natural gas to produce electricity in the manufacturing sector

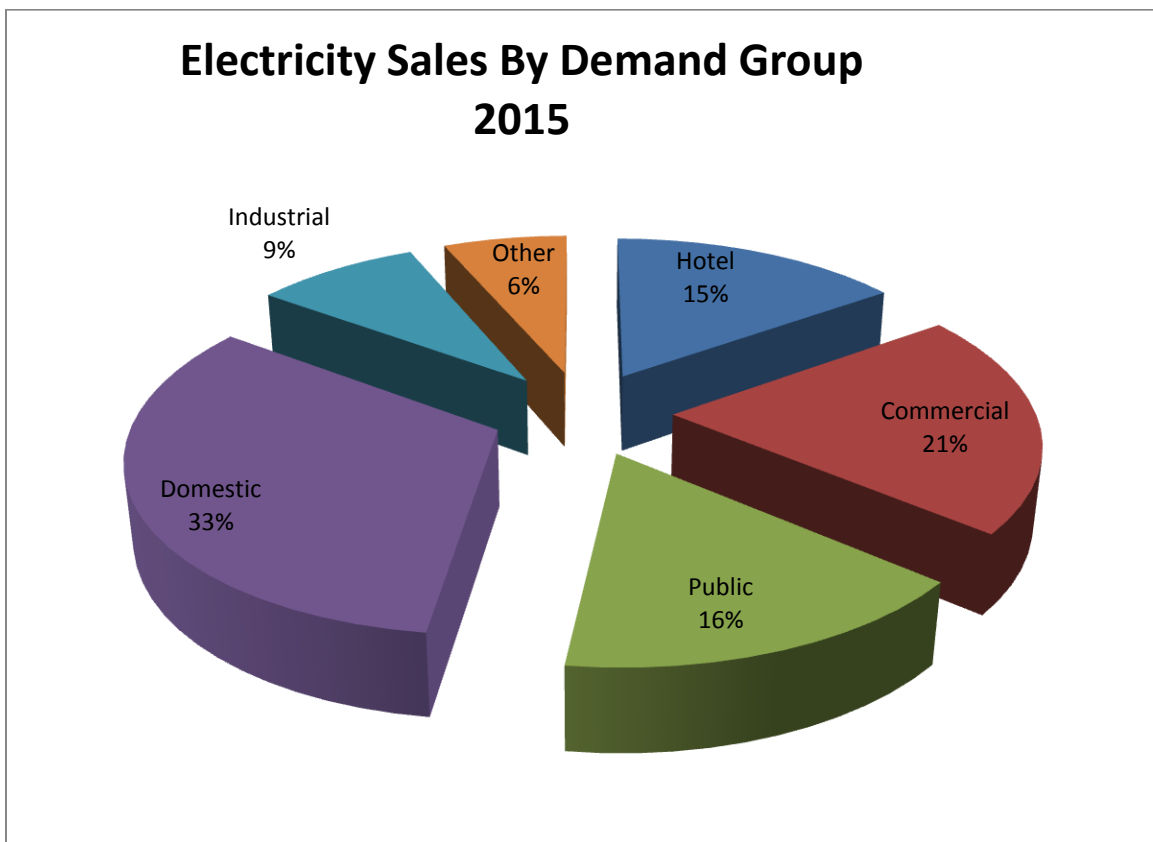
Figure 3 – Fuel Inputs for Electricity Production 2015 Barbados



Electricity consumption over the last ten years was distributed as follows:

- Domestic - 33%;
- Commercial - 21%;
- Public - 16%;
- Tourism/Hotel - 15%;
- Industrial - 9%; and
- Other - 6%.

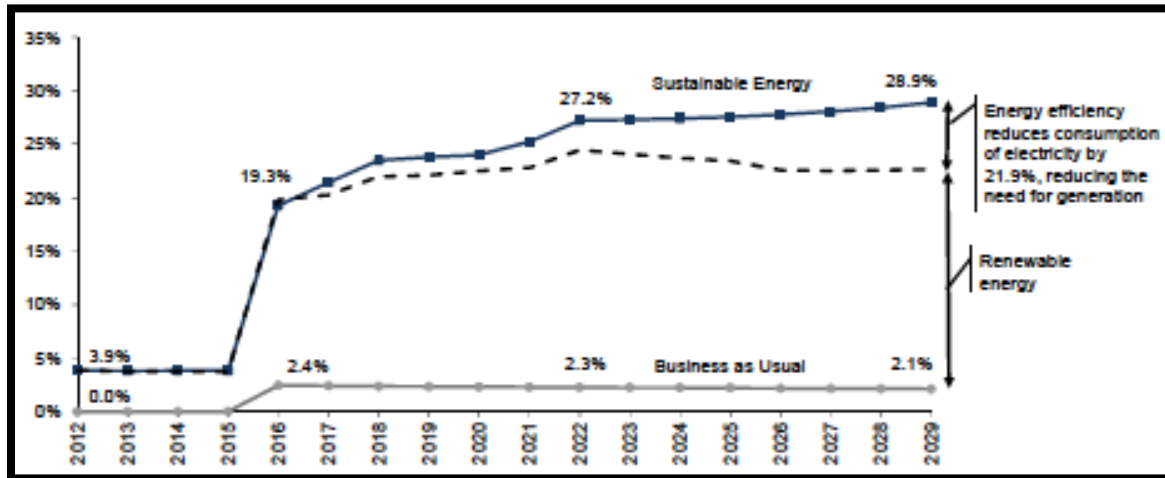
*Figure 4 – Electricity Sales By Demand Group*



The average consumption for electricity in Barbados during the period under consideration is 926.8 MWh. Electricity is central to economic output in Barbados and brings significant value to the country from a social perspective as well. In general terms, the social cost of the production of electricity was estimated to be \$0.06 for every dollar earned from the production and distribution of electricity. It is also important to note that the Barbados Economy produced on average, BDS\$8.00 from every KWh produced and distributed. BNEP seeks to build on the value that the electricity sector brings to Barbados by introducing the appropriate energy sources and seeking to ensure that the highest level of efficiency in the generation of electricity from these sources is achieved and maintained. This focus and the resulting activities will be important in improving the sustainability of the electricity supply. Additionally, the policy will attempt to provide a balance between the interest of the society and that of the producers of electricity.

Barbados hopes to steadily increase its share of renewable energy in the local market, increasing the diversification of energy resources, promoting energy security and decreasing the reliance on imported fossil fuels, which is now based on about 90% imported resources (Draft National Sustainable Energy Policy for Barbados, 2013). The Draft National Sustainable Energy Policy in 2013 set a goal of 29% renewable energy share in the Barbados energy mix by 2029. However, an analysis conducted by the DET suggests that this PV target could lead to high electricity prices. There may be a more sustainable mix of energy resources which will lead to a reduced long term cost. Possible ways for achieving this target were identified as increased use of renewable energy technologies such as waste to energy, biomass, cogeneration, wind energy, solar photovoltaic and solar thermal. If this goal were to be achieved, it was suggested that fuel costs could be reduced by BDS\$1,338 million (6% discount rate). (Draft National Sustainable Energy Policy for Barbados, 2013).

*Figure 5 - Share of Electricity Generated from Renewable Energy Technologies as a percentage of Total Consumption (Business as Usual and Sustainable Energy Scenarios)*



(Source: National Sustainable Energy Policy, 2013)

Energy efficiency, the use of fossil fuels with a lower environmental impact (e.g. natural gas) and increased energy education and awareness are the other tools discussed in the Draft National Sustainable Energy Policy for Barbados (2013), as means to achieve a more sustainable energy sector. The Government has increased its efforts to achieve increased energy efficiency and sustainability by promoting energy efficient technologies and their vision of "Green Economics", which provides incentives to the public to be energy efficient. Barriers to this sustainability effort have been identified as limited access to capital, lack of detailed regulations limited access to technology and lack of grid connection rules.

BNEP further considers these issues as it seeks to provide strategies for overcoming some of these limitations to sustainable development within Barbados identified above.

## 1.8 Multi-Criteria Approach (MCA)

Given the discussions above in this section, it is clear that there is a need to consider the broad factors that influence energy availability, cost and global environmental impacts in Barbados. It is recognized that policies which consider energy in terms of its overall impact on economic, environmental and social systems, will allow the country to become more energy independent (UNEP, 2014). BNEP attempts to achieve sustainability in the energy sector by using a MCA.

Throughout this policy, in seeking to determine the ideal option or path of energy development, there will be a consideration of the broad economic, environmental and social impacts. This means that an option that may have a higher per kilowatt hour cost, may still be chosen if it is deemed to have a significant benefit in terms of lower environmental impact or can provide wider social benefits.

In all of the subsectors, various stakeholders are encouraged to take energy, economic and social factors in determining the best energy options. This approach is consistent with more recent international approaches to global sustainability, where issues of social equity and global environmental impact of issues such as climate change are strongly considered before any change or expansion of energy production or development.

This Multi Criteria approach was the basis on which the preliminary targets presented in the next chapter, Chapter 2 were chosen. Further details on the specific model used to determine targets are given in Chapter 2.

Consideration was given to the use of rankings and weights for the model, however at this stage with the number of stakeholders to be considered and in recognition that the value or objective that takes precedence will depend on context, these aspects were omitted.

However, it is possible that they will be considered in the course of developing the Implementation Plan.

**SECTION 2:**  
**PRELIMINARY**  
**ENERGY MIX**  
**TARGETS**

## 2. Preliminary Energy Mix Targets

Using the MCA to determine the energy mix targets discussed below, cognizance was given to some key factors which included:

- The market cost of energy;
- The socio-economic and environmental cost of energy;
- The maturity of energy technologies;
- The financial and economic benefits of applying various energy sources and technologies; and
- The economic and fiscal context of Barbados.

The market and economic costs of energy dictated the rate at which fuel switching could occur given the need to ensure that the competitiveness of Barbados was not negatively impacted over the twenty year planning horizon of BNEP. This factor had to be balanced against the fact that fossil fuel represents a significant drain on the economic resources of the country. From the outset it was recognised that a move towards more use of renewable energy was attractive for both economic and environmental reasons.

The major constraint in moving from an economy based on fossil fuels to one based principally on renewable energy is the fact that many of the renewable energy sources are intermittent in nature. This means that they are unable to be dispatched on demand. This is in contrast to traditional fossil fuels, which are available whenever needed. Renewable energy sources therefore operate at less than full capacity much of the time and this increases the cost of generation from a utility's perspective.



## **2.1 Policy Analysis Matrix (PAM) - The Analytical Tool**

One of the principal tools used in the MCA described above was the Policy Analysis Matrix (PAM), which is discussed below.

The PAM, which uses a partial equilibrium approach, provides a convenient way of estimating divergence, thus allowing for an understanding of the level of distortion in the product market and the extent to which resources are being efficiently allocated.

The calculations of the PAM are done using the simple accounting identity: profit = revenue - costs, where the costs of both tradable and non-tradable inputs, also known as domestic resources or factors, are used. These costs are calculated using both market prices and efficiency prices, with the difference being transfers.

The PAM takes all the commodities, services, and factors, which are inputs, and classifies them as tradable inputs, domestic factors, non-tradable inputs and transfers.

### **Important Components of the PAM**

The PAM takes all the commodities, services, and factors, which are inputs, and classifies them as tradable inputs, domestic factors, non-tradable inputs and transfers. Table 1 below presents the basic structure of the PAM used for the purposes of this paper.

*Table 3 - Structure of the Policy Analysis Matrix*

	Costs			
	Revenues	Tradable Inputs	Domestic Factors	Profits
Valuation in Private Prices	A	B	C	D
Valuation in Social Prices	E	F	G	H
Transfers (Divergences)	I	J	K	L
Policy Transfers	$I_P$	$J_P$	$K_P$	$L_P$
Market Transfers	$I_M$	$J_M$	$K_M$	$L_M$
Domestic Resource Cost		$G/(A-B)$		
Private Profits		$D = A-B-C$		
Social Profits		$H = E-F-G$		

Source: Adapted from Monke and Pearson (1989)

### *Tradable Inputs*

Inputs that are or can be traded, and for which there are world market prices. The border Cost Insurance and Freight (CIF) or Freight on Board (FOB) prices are used to derive efficiency prices.

### *Domestic Factors*

These are primary factors of production, such as land, labour and capital for which no world price exists. The efficiency prices of such factors are determined by their domestic opportunity costs.

### *Non-tradable Intermediate Inputs*

The inputs that fall under this category include domestic transport, electricity and other utilities, insurance services which can contain both traded and domestic factors in their own costs of production but which are not themselves tradable goods.

### *Transfers*

These include taxes and subsidies and are reflected in market prices; since transfers are not a cost of production, which has an opportunity cost, they are not included in social prices.

### *Domestic Resource Cost (DRC)*

The DRC is the value of domestic inputs at economic prices to the value-added at economic prices. Therefore, the interpretation of DRC is indicated by the cost required to earn a unit of foreign exchange. The DRC is a summary measure of efficiency of domestic production or comparative advantage.

### *Private Profits*

Private profits are the result of taking total revenue at market or private prices and deducting the costs of tradable inputs cost and domestic resource at private prices.

### *Economic Profits*

Economic profit is total revenue at economic prices less tradable inputs and domestic resource costs at their opportunity costs.

## Further Discussion on Energy Mix Targets

Another significant challenge is that the benefits i.e. savings in foreign exchange from renewable energy sources are not immediately transferred to Government's revenues. The concern here is that in order to progress in a substantial way to a more sustainable energy mix, Government will likely be required to provide further incentives.

The energy mix target in BNEP consists of renewable energy, variable and intermittent technologies, as well as cleaner fossil fuel such as natural gas. The target proposed in BNEP requires 75% reduction in total heavy fossil fuel (heavy fuel oil, diesel, gasoline, kerosene and LPG) consumption and replaced accordingly with the following. These percentages refer to energy and NOT installed capacity:

- 15% Solar;
- 20% Wind;
- 30% Biomass;
- 15% Biofuels;
- 20% Natural Gas.

It should be noted that this suggested mixed is based only on current prices and predicted availability, and may change as further developments in renewable resources and technology as well as exploration of natural gas occur over the next five to ten years.

More details on how these percentages were determined are given below and in the Annex to BNEP.

The percentages as established above translate into energy output and installed capacity as follows:

*Table 4 - Energy Mix Breakdown*

Energy Source	Energy (GWh)	Installed Capacity (MW)	Physical Units
Solar	320	195	
Wind	411	127	
Biomass (Including WTE)	643	79*	
Natural Gas (Also Includes Biogas)	152	49	21 974 523m <sup>3**</sup>
Biofuels (B20)			141 500 (BBL)

\*Biomass from Sugarcane, River Tamarind, and King Grass 39 MW, as well as Waste to Energy 40 MW.

\*\*Methane from Biogas.

NB: The energy output is based on a long run output of 1600 GWh which includes power for transportation.

It is envisaged that the BNEP will allow for the targets to be modified by the DET in accordance with rules that will be defined by the DET in consultation with stakeholders in the energy sector. Under BNEP it is expected that the DET will be able to adjust the targets by a maximum of 40MW in the case of installed capacity to produce electricity after the first three years of a defined implementation period.

#### *Energy Efficiency Target:*

The implementation of the BNEP is expected to reduce fuel consumption from 11 000 BOE/day to 5 400 BOE/day. This represents an estimated fuel reduction of 51%. Further, energy efficiency policy measures for electricity consumption are expected to result in a reduction in consumption of electricity of 22% over the planning period. It is important to stress that energy efficiency targets will be implemented where it is financially and economically viable.

#### *Energy Storage:*

Energy storage will be required for large intermittent systems where financially and economically feasible.

### **The Natural Gas Factor**

The above energy mix target views natural gas as potentially a bridge to the eventual complete removal of fossil fuels from Barbados' energy consumption. It could conceivably reduce the environmental impact of the energy mix by replacing some of the Bunker "C" fuel as a base load, while activities to include more renewable energy sources to replace more intermediate and peaking plant continue.

It is recognised that natural gas is not a renewable energy source and the intention is not to give it that categorisation within this document. However, in including as a source that can take the mix away from more carbon intensive options such as diesel, jet fuel and

heavy fuel oil, it can play a role in developing a more sustainable energy mix.

It should also be noted that some of the natural gas being discussed is produced from biogas sources that are renewable. Indeed, the potential of biogas to produce methane makes it likely to become a viable source of domestic natural gas.

The use of natural gas may not require significant additional investment in plant as available electricity generation plant can be converted to use natural gas as a base load fuel. However, it should be recognised as well that the use of natural gas for electricity production could increase the cost of production if the volumes are not at significant levels to make use of economies of scale.

There may also be investments in heavy fuel oil, diesel generation that cannot be readily transferred to accommodate natural gas as a base load. In such cases a mix that maximises renewable energy sources without the use of natural gas as a bridge may prove to be a viable long term investment.

Given that there appears to be a viable path to sustainability with and without significant use of natural gas, it is considered to be prudent to allow for the potential use of natural gas at the stage.

Notwithstanding the issue of natural gas for the production of electricity, it is expected that natural gas production for domestic cooking will expand as well and that there may be also greater uptake of natural gas as a fuel for commercial and industrial consumers who decide to go the route of self-generation. Natural gas as a product of biogas can also significantly contribute to energy sustainability as well as the sustainability of the agriculture sector in the medium to long term.

Biomass, which is expected to consist of bagasse and river tamarind was allocated the largest portion of the mix among the renewables, as its costs of production was among the lowest for renewables at \$0.28 per kWh and can contribute to base load energy production

effectively. Its major constraint for use is the land requirement which is about 25, 000 acres.

The FTC's decision in 2016 to amend the Renewable Energy Rider has resulted in a fixed price for electricity from solar and wind of \$0.416 per kwh and \$0.315 per kwh respectively. It must be noted however, that the cost of PVs and wind turbines are declining annually. The fuel cost of natural gas is estimated at \$0.15 per kwh.

The proposed target mix is anticipated to result in an annual total energy discounted cost, from total supply to final consumption, of \$720 million per year at market prices. This is estimated to be a reduction of 40% given an energy cost of \$1.2 billion. In the case of electricity, it is estimated that the discounted costs of electricity production will be \$329.1 million per year, representing a reduction of 24%. The initial cost of production of electricity is estimated to be \$438.0 million per year. From a socio-economic perspective the discounted social profit or benefit to the wider Barbados society is estimated at \$2.2 billion annually from the removal of fossil fuels. In order to achieve the above benefits discussed above a reduction in the volumes of heavy fossil fuels currently used in energy generation will have to occur by the increments listed below over the twenty year planning horizon.

- 19% heavy fossil fuel reduction by 2022;
- 38% heavy fossil fuel reduction by 2027;
- 56% heavy fossil fuel reduction by 2032;
- 75% heavy fossil fuel reduction by 2037.

It should be noted here that rather than discussing reduction in fossil fuels, reduction in heavy fossil fuels is specified. This is because in the transition to a more sustainable energy mix, the use of natural gas as a bridging fossil fuel (BFF) is contemplated. In spite of its reduced environmental impact, natural gas is still a fossil fuel source. The identification of heavy fossil fuels here is defined as fossil fuel resources excluding natural gas.

The above fossil fuel reduction targets can be stated as increased production of energy from renewable energy and natural gas targets for electricity generation. Below the targets are expressed in terms of renewable energy and (BFFs) to account for the possibility of natural gas derived from fossil fuels in the mix.

- 34% increase in renewable energy and BFFs by 2022;
- 50% increase in renewable energy and BFFs by 2027;
- 56% increase in renewable energy and BFFs by 2032;
- 75% by increase in renewable energy and BFFs by 2037



**SECTION 3:**  
**VISION, GOALS,**  
**AND OVERALL**  
**OBJECTIVES**

## 3. Vision, Goals, and Overall Objectives

### 3.1 Structure

BNEP provides a broad policy framework, which has a Vision Statement, Visionary Goals, Overall Objectives, Specific Objectives that are presented at different levels of abstraction. Higher levels of abstractions present statements that are more general and overarching whereas lower levels of abstraction provide statements that are more specific.

- First Level (Highest Level of Abstraction)- Vision Statement**
- Second Level- Visionary Goals**
- Third Level- Overall Objectives**
- Fourth Level- Specific Objectives**
- Fifth Level (Lowest Level of Abstraction) - Measures**

The Vision Statement and Visionary Goals are given with the general public and overall government policy makers in mind. For this reason, Visionary Goals are limited to eight, making them easier to memorise or integrate into shorter presentations. It is not expected that these will be changed over the time of the BNEP planning horizon as they represent broad wide ranging goals.

The Overall Objectives are seen as appropriate for the Policy makers in the energy sector, and are not seen as critical to communicate to the general public. They however set the tone for the Specific Objectives and are the basis for moving towards results and activities that are more tangible. These Overall Objectives can be modified over the planning horizon of BNEP as the economic and social circumstances change and as new technologies emerge to become commercially viable.

The Specific Objectives are expected to be developed by members working within those specific sectors and can be modified as priorities change and new industries develop. Although these will be modified, it's important to make sure that each level of abstraction,

directly flows from the one above it.  
This relationship is illustrated in Fig 6 below, which presents the **Policy Inverted Pyramid**.

*Figure 6 – Policy Inverted Pyramid*



In the BNEP, the overarching statement is the Visionary Statement. This statement flows in to the Visionary Goals, which then give rise to the Overall Objectives. These Overall Objectives inform the Specific Objectives which relate to individual sub sectors of the energy economy. The measures chosen for each sector will feed in to those Specific Objectives.

Structuring the BNEP in this way ensures that there is coordination and cohesion between activities within the sector, the Objectives and the overarching Visionary Statement.

Below is an example showing how the Vision Statement can be traced all the way to a measure, through different levels of abstraction.

- Vision Statement- Energy security and affordability through diversity and collaboration- establishing and maintaining a sustainable energy sector
- Visionary goal- An energy sector that offers diversity of sustainable energy options with a trajectory towards an increasing % of renewable energy
- Overall Objective: Increasing diversity in types of energy sources utilized in both renewable and fossil fuels sectors
- Specific Objective: A renewable energy sector that has a greater involvement of smaller investors in system.
- Measure: Establish a system to ensure protection of intellectual property and patents

The Visionary Statement and all of the emerging goals and objectives were structured around a number of ‘Core Values’ that were obtained from interviews and consultations with local stakeholders, as well as assessment of issues identified in previous policy documents made for Barbados and members of CARICOM. The Caricom Energy Policy as well as the Jamaica National Energy Policy was referred to in this regard. Recent research conducted by the consultant into factors affecting the development of renewable energy in the Caribbean was also considered (Ince, Vredenburg, Liu, 2016).

In general, stakeholders thought that the policy should aim to provide a level playing field to support anyone with an interest in participating in renewable and sustainable energy activities in the energy markets. The view was that with the size of the Barbados’ market, a collaborative approach was likely to be more effective than a competitive one.

With respect to the electricity sector in particular, it was thought that the most important aspect was to maintain standards and reliability of production and supply for all customers in Barbados at a reasonable price, whatever the eventual structure of the market and the regulatory environment. It was considered essential that those

standards of production and service should be safeguarded throughout the sector.

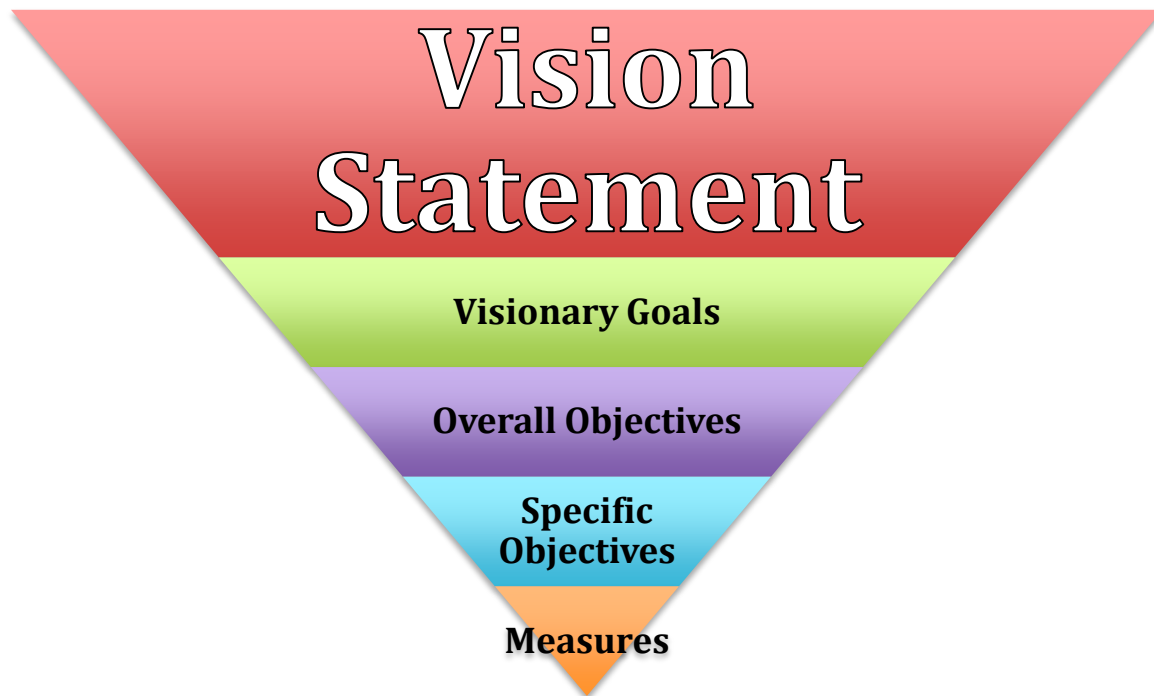
### **3.2 Core Values**

Below is a list of some of the general core values identified.

- Stability- price, regulatory, technical
- Reliability- including continued access to energy
- Efficiency in the production and consumption of all energy resources
- Diversity- reduction of vulnerability through use of multiple sources
- Ownership of business: Opportunities for local investment
- Maximum use of Indigenous energy resources
- Entrepreneurship development
- Maximum level of collaboration
- Multidisciplinary cross cutting approach
- Gradual, systematic evolution to an energy sector based on renewable energy
- Education, Awareness and Capacity Building
- Environmental Protection, Ecology- especially connection with public health

Based on the Core Values identified above, the following Vision Statement was developed.

**Vision Statement:** *“Energy security and affordability through diversity and collaboration: Establishing and maintaining a sustainable energy sector for Barbados.”*



The following are potential visionary goals for Barbados emerging from the Vision Statement and are supporting statements that reflect the general direction where stakeholders wished the sector to go and what they wanted to see the sector achieve. These are also consistent with previous policy documents produced in Barbados and the wider Caribbean.

### 3.3 Visionary Goals



**Visionary Goal 1:** An energy sector that offers a diversity of sustainable energy options, with a trajectory towards 100% renewable energy.  
(core value-diversity)

**Visionary Goal 2:** An energy sector where consumption and production of energy resources occur with the maximum level of efficiency feasible (core value- efficiency)

**Visionary Goal 3:** An energy sector that offers basic energy products and services that are affordable to local citizens.  
(core value-affordability)

**Visionary Goal 4:** An energy sector that offers continuous and reliable supply of energy. (core value- reliability)

**Visionary Goal 5:** An energy sector that offers opportunities for development of human capacity and collaboration. (core value-capacity and collaboration)

**Visionary Goal 6:** An energy sector that offers significant opportunities for local entrepreneurship and international investment. (core value- entrepreneurship)

**Visionary Goal 7:** An energy sector that minimizes the environmental impacts and contribution to global climate change. (core value- environment)

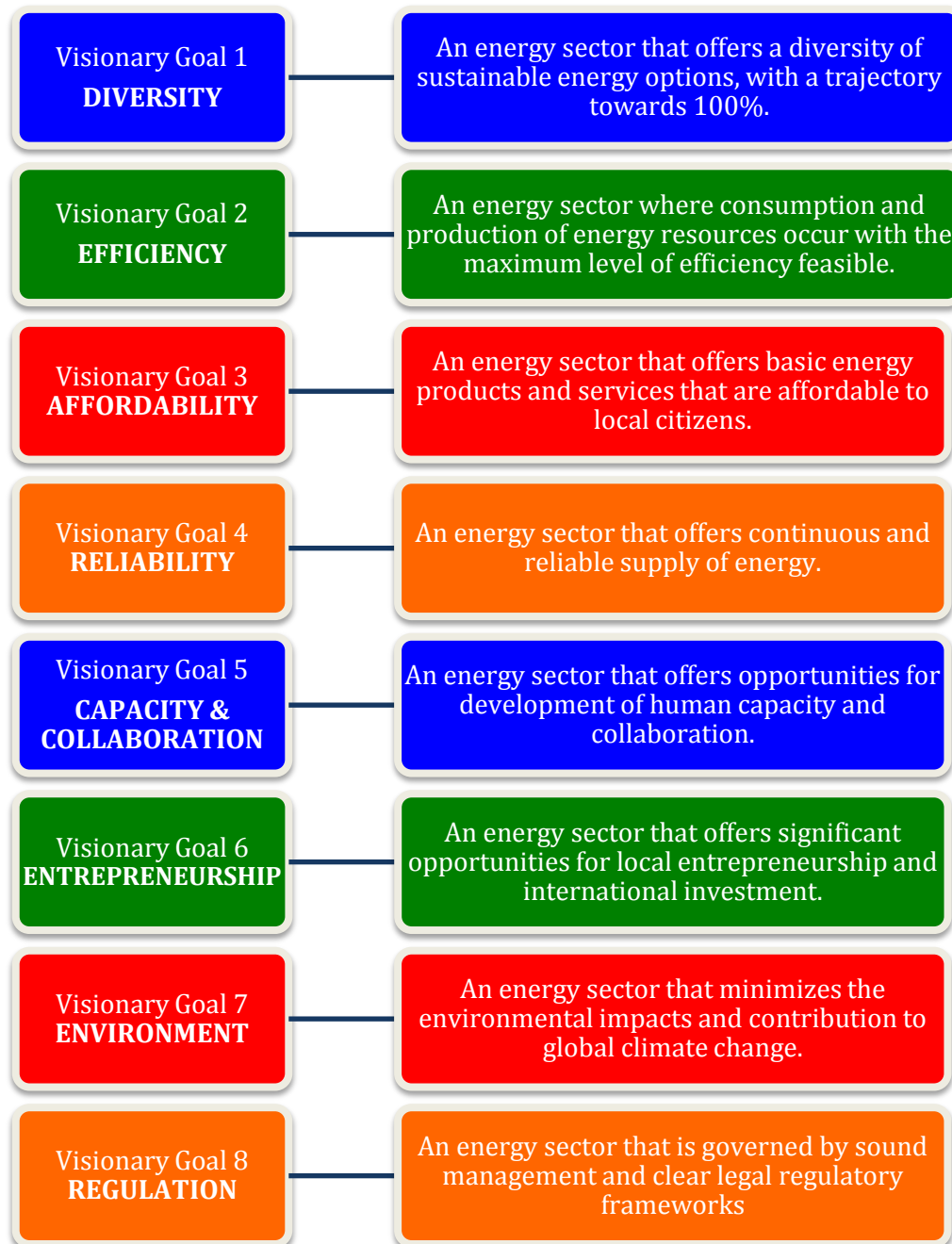
**Visionary Goal 8:** An energy sector that is governed by sound management and clear legal regulatory frameworks. (core value- regulation)



Figure 7 - Summary Table of Vision Statement and Visionary Goals

### BNEP Vision Statement:

**“Energy security and affordability through diversity and collaboration:  
Establishing and maintaining a sustainable energy sector for Barbados.”**



### 3.4 Overall Objectives



From these Visionary Goals, the following overall objectives were developed. These objectives are not specific to any sector within the industry but are relevant to the general energy sector:

**Overall Objective 1:** Achieving stability, predictability in energy product prices over the long term. (Related to Visionary Goal 1)

**Overall Objective 2:** Achieving affordability and access to all classes of consumers in energy products and services (Related to Visionary Goal 3)

**Overall Objective 3:** Establishing a consistent and comprehensive regulatory framework, (regulations and legislation) to govern activities in various energy sub-sectors. (Related to Visionary Goal 8)

**Overall Objective 4:** Increasing the amount of renewable energy sources used in the energy mix to the extent that it can be accommodated from a technical and socio-economic perspective. (Related to Visionary Goal 1)

**Overall Objective 5:** Increasing the diversity in types of energy sources utilized within both the renewable energy and fossil fuel energy sectors. (Related to Visionary Goal 1)

**Overall Objective 6:** Increasing the extent of energy resources used in Barbados that are obtained from indigenous sources. (Related to Visionary Goal 6)

**Overall Objective 7:** Encouraging local investment in energy projects and programmes within Barbados, with a view to increasing number of shareholders and players in the various energy subsectors. (Related to Visionary Goal 6)

**Overall Objective 8:** Promoting increased entrepreneurial activities locally in renewable energy and fossil fuel energy development throughout the energy subsectors. (Related to Visionary Goal 6)

**Overall Objective 9:** Increasing collaboration within the energy subsectors and among the cross cutting sectors that have an impact on energy supply or consumption. (Related to Visionary Goal 5)

**Overall Objective 10:** Improving the efficiency in the production and consumption of energy products within the various subsectors. (Related to Visionary Goal 2)

**Overall Objective 11:** Improving the awareness and understanding of energy production and consumption, its impacts and the associated environmental and socio-economic consequences within all sections of the public. (Related to Visionary Goal 5)

**Overall Objective 12:** Increasing the number of persons locally with qualifications and skills relating to energy production and management of renewable and fossil fuel sources. (Related to Visionary Goal 5)

**Overall Objective 13:** Reducing the environmental impacts associated with the production and consumption of energy resources

locally. (Related to Visionary Goal 7)

**Overall Objective 14:** Ensuring reliability and continuity of energy supply in the various local energy subsectors. (Related to Visionary Goal 4)

**Overall Objective 15:** Attaining the lowest price that can be sustained by the local economy for various energy sources consumed within Barbados while maintaining environmental efficiency (Related to Visionary Goal 3)

**Overall Objective 16:** Establishing effective partnerships between national and international entities for local energy projects (Related to Visionary Goal 6)

**SECTION 4:**  
**SECTOR SPECIFIC**  
**OBJECTIVES &**  
**MEASURES**

## 4. Sector Specific Objectives and Measures

### 4.1 Introduction

The following Sector Specific Objectives emerged from the Overall Objectives in Chapter 3. They also reflect specific objectives that were suggested during the interviews with members of the various sectors identified. Based on the Sector Specific Objectives, possible measures under the various themes were identified. The categorization of the themes and the sectors were based in part on those suggested by the Energy Task Force in the document “Policy Outline and Thematic Areas” (2016).



### 4.2 Energy Supply

The theme of “Energy Supply” considers both the sectors of renewable and fossil fuel energy. It was considered that a critical part of the policy was setting a path for the necessary transition from a

fossil fuel economy to one based primarily on renewable energy. Barbados being cognisant of the reality that its transition to an economy based on renewable energy will be gradual, has also turned its attention to exploring for hydrocarbon resources in its Economic Exclusive Zone. Indeed, BNEP recognizes that if Barbados locates significant quantities of natural gas, this resource could play a role in assisting the country in its transition to renewable energy and in reducing its overall carbon footprint.

In the meantime, it was considered that the discoveries of oil and gas within Barbados should be developed in a way that strengthens the overall economy as well as safeguards long term environmental protection.

## **Natural Gas**

Natural gas in particular, is a fossil fuel resource that has a lower environmental impact than other types of petroleum based fuels. Bearing this in mind, there are objectives identified that seek to increase natural gas use as part of the strategy to act as a bridging fuel to move towards a greater use of renewable energy.

The objectives identified in this section relate to the following important Energy Supply issues and are separated into 'Oil and Gas' and 'Renewable Energy' supply sectors.

- Production - Renewable Energy and the Exploration and Production of oil and gas;
- Distribution and sale of energy output;
- Fuel and energy diversification;
- Energy Pricing and Affordability;
- Energy Security;
- Cross-border trade in Energy;
- Energy integration; and
- Storage - energy and fuel.

## 4.2.1 Oil and Gas Supply Sector Objectives

The importance of optimising the use of fossil fuel resources relates to the Overall Objectives discussed in Chapter 3. Particularly objectives relating to stability of supply, efficiency of operation, development of indigenous resources, development of human resources in the potential new oil and gas industry and the establishment of appropriate regulatory and legislative frameworks. Recently, there have also been significant technological advancements in terms of deep water oil and gas exploration, drilling and production. These advances have made deep water basins more economic to explore. Developments that have improved efficiency, have occurred in areas such as compression systems, pipeline technology and drilling equipment, make it advantageous for Barbados to continue to develop its oil and gas resource to the greatest extent possible while maintaining the quality of the terrestrial and marine environment.

The Specific Objectives listed below will be important in helping the overall energy sector in attaining the Overall Objectives. The importance of sustainability in the Oil and Gas sector relates to the following Visionary Goals and Overall Objectives.

**Visionary Goal 3:** An energy sector that offers basic energy products and services that are affordable to local citizens.

**Visionary Goal 6:** An energy sector that offers significant opportunities for local entrepreneurship and international investment.

**Overall Objective 5:** Increasing the diversity in types of energy sources utilized within both the renewable energy and fossil fuel energy sectors.

**Overall Objective 6:** Increasing the extent of energy resources used in Barbados that are obtained from indigenous sources.



The Specific Objectives below will result in a sector that:

- ensures security of supply of oil and gas products where economically and financially viable;
- ensures a suitable legal and administrative regime to promote the successful exploration and development of commercial discoveries of oil and gas;
- clearly identifies agencies such as National Petroleum Corporation (NPC) and Barbados National Oil Company (BNOC) as the implementing agencies for government policies in various energy areas;
- maximizes exploration, production and distribution of petroleum products available locally;
- includes activities that seek to promote greater use of natural gas and/or cleaner fossil fuels as a means to establish more internationally competitive local industries;
- promotes the use of natural gas in new applications and industries
- clearly defines rules surrounding allocation of economic rent payable to government and developers;
- has a system to allow for a fraction of the revenues generated in petroleum resources to be used in advancing a renewable energy based economy that is self-sustaining.
- encourages increased use of natural gas and/ or cleaner fossil fuels to improve economic performance and reduce barriers to entrepreneurship;
- Has a 'zero harm' health, safety and environment protocol that governs activities in oil and gas sector
- promotes increased use of natural gas for cooking;
- includes a clear retirement strategy for generation plant owned by the utility and other regulated energy producing entities;
- considers the use of LNG and natural gas in local mass public transit;

- has stability in as many components of energy pricing as possible;
- has well understood links between upstream and downstream process in the energy systems by energy providers and consumers;

### *Policy Measures- Oil and Gas Supply*

In order to achieve sustainable production of oil and gas within Barbados' Exclusive Economic Zone Barbados shall:

- establish regularly held investor conferences to inform potential developers about the rules and requirements needed to undertake activities in the oil and gas sector;
- increase cultivation of data relating to the geological and geophysical conditions in the offshore oil and gas sector to aid the government in setting license fees and determining levels of royalties;
- develop a licensing system with clear criteria on the ranking of various factors critical to the decision on bids. This system should be made available widely to potential bidders as well as the general public;
- develop a clear legislation governing environmental management in off shore oil and gas activities with provisions for removal of licenses if stipulations are not met;
- develop a capacity building program locally to prepare the workforce to be able to find employment in the emerging oil and gas offshore sector;
- develop an enabling environment that will empower local businesses to effectively participate in the supply of goods and services to the offshore oil and gas sector;
- establish fiscal incentives for developers which are tied to factors such as the expected internal rate of return;
- establish a wealth management programme to ensure that revenues from the offshore oil and gas sector are effectively used;

- establish an unambiguous system for determining whether a future gas find should be used for export or included as part of the domestic market;
- develop legislation that identifies limits on the amount of oil and gas resources that can be exploited in the short term; and
- develop and establish a defence and security framework to protect the Exclusive Economic Zone.

#### **4.2.2 Renewable Energy Supply**

The development of renewable energy resources available in Barbados will be essential to maintaining and improving the overall sustainability of the sector. Barbados is proud to be seen as one of the leaders in renewable energy in the Caribbean, particularly in the area of solar water heaters.

The success in solar water heaters was one of the spurs for the solar PV industry which has expanded exponentially over the last five years, due in part to the introduction of the Renewable Energy Rider by BL&P. In spite of these successes however, there is still a lot that can be done in terms of expanding solar thermal and PV technologies to their full potential as well as extending the use of renewable energy resources to include more energy generated from wind, biomass and biogas.

In the area of solar thermal there is an interest in making solar water heaters even more widely used in the country taking the rate of penetration for household solar water heaters as close to 100% as possible. The development of solar water heaters for low income residents could be pursued under a suitable regulatory framework.

Development of solar thermal technology for air conditioning systems, distillation and electricity using concentrated solar are all areas where solar thermal could be part of long term sustainability solutions for Barbados. Additionally, there needs to be consideration

given to potential for these and other innovations in renewable energy to be exported to other Caribbean markets, offering the opportunity for further entrepreneurship in Barbados. If such markets can be developed, Barbados can establish a goal in the medium and long term to be a renewable energy hub for the Caribbean.

In connection with this, there is also potential for research into improving efficiencies and technology designs of some of the existing solar and other renewable energy technologies.

There is a need to identify overall strategies to increase the penetration of renewable energy technologies in the energy generation mix, but there is also a need to identify what is the appropriate level of development of specific renewable energy technologies for Barbados given the various factors. Proposed targets for renewable energy are proposed in Chapter 2.

While discussing the opportunities for further use of renewable energy within Barbados, there is a need to also explore the potential for exporting technologies to other countries in the Caribbean and further afield. This is especially so in the area of solar thermal and solar photovoltaic technologies.

It is expected that solar PV, solar thermal, wind, biofuels and biogas will all form part of the mix of renewable energy as described above. There will also need to be development in storage technology to increase possible off grid applications and to improve capacity factor for grid tied technologies.

It is important to determine the activities that will be needed to ensure that each of these technologies is developed to their full potential. As a result, some of the objectives identified will relate to renewable energy as a whole, while others will speak to a specific technology or a subset of technologies.

In addition to the existing renewable energy technologies that are currently viable in the Caribbean, there are a number of emerging

renewable energy technologies that may become more feasible for development over the planning horizon of BNEP. Technologies such as Ocean Thermal, tidal, geothermal or ground source heat are a few that are not factored in at the moment but that may play a part in the energy portfolio before 2037.

### *Renewable Energy Supply Sector Objectives*

The importance of the renewable energy sector is high in the context of all sectors, especially as the transition towards the aspirational goal of 100% renewable energy is one of the key aspects of the energy policy which is encapsulated in Visionary Goal 1 and Overall Objective 3.

*Visionary Goal 1: An energy sector that offers a diversity of sustainable energy options, with a trajectory towards 100%. (diversity)*

*Overall Objective 3: Increasing the amount of renewable energy sources used in the energy mix to the extent that it can be accommodated from a technical and socio-economic perspective.*

Sustainability within the renewable energy supply side is also important for objectives relating to stability of supply, costs and affordability of energy, efficiency of operation, development of indigenous resources, development of human capacity, and the establishment of appropriate regulatory and legislative frameworks.

The main issues which will be addressed by the transition to an economy powered significantly by renewable energy are:

- The need for reduced importation and consumption of fossil fuels which result in loss of foreign exchange;
- The need for more efficient energy producing technologies;
- The need for reduction in Barbados' dependence on fossil fuel;

- The need to preserve the natural environment of Barbados.

In order to increase the consumption of renewable energy, the Specific Objectives below will ensure a renewable energy sector that:

- takes into context the need for retooling the workforce to be able to work with newer renewable energy technologies;
- allows for the greatest viable number of competing players in the market and provides significant opportunities to generate wealth;
- includes a fair, transparent and stable tariff regime to facilitate greater integration of renewables in the electricity grid;
- has greater involvement of smaller investors in the system, playing an important role in sector decision making;
- has a strong relationship between local renewable energy projects and regional and international renewable energy initiatives;
- demonstrates clarity in determining the long term strategies that would be needed in order to get to 100% energy from renewable energy sources in the long term and support economic growth and competitiveness in the process;
- facilitates investments in storage technologies to make renewable energy technologies more technically and environmentally viable;
- provides for a greater access to studies conducted on the renewable energy sector;
- has optimum account separation of generation from transmission and distribution assets;
- establishes a clear direction for level of optimum diversification of energy resources within the renewable energy sub sector;
- provides clarity for the electric utility on the direction regarding the type of energy market that is desired.
- encourages ongoing research into newer, less mature renewable energy technologies to allow for effective development in the long term;

- has clear understanding of roles and accountability for installation and maintenance of new renewable energy systems;
- has strong NGO representation, that has capacity to promote awareness and understanding of issues in the general community;
- establishes clear measurements of indicators and standards for various renewable energy technologies;
- maximizes the amount of manufacturing or assembly of renewable energy products within the country that is financially and economically viable;
- maximizes training opportunities in the application of new established and emerging renewable energy technologies;
- has appropriate tax incentives to motivate investment in new renewable energy technologies that are adjusted with the maturity of technology;
- Has a regulatory regime that incentivises investment;
- shows an increased use of renewable energy in vehicles (e.g. biofuels and electric vehicles (EVs));
- promotes a greater use of renewable resources produced in a business for manufacture of energy within that business (e.g. use of biogas rather than PV for farms);
- has programme that allows for low income households to benefit from renewable energy installations such as solar water heaters, PV and wind.
- has a high level of transparency in granting of licenses to players within the renewable energy sector;
- has highly skilled technicians in maintenance of EVs;
- contains an optimum level of diversity in energy resources used in the renewable energy sub sector (cost to be balanced against the level of diversity);
- provides equity for customers unable to pay for renewable energy installations;
- has effective collaboration and coordination of players in the renewable energy industry;
- includes a programme to stimulate job creation within the renewable energy sector;

- includes a clear system for disposal at end of life of renewable energy equipment and associated technologies such as batteries;
- has greater emphasis paid to the development of renewable energy technologies ideally suited to Barbados or Caribbean conditions;

### *Sector Objectives Specific to solar energy*

A sector that:

- has a penetration of the use of solar water heaters that is close to 100 % for residential customers.
- has increased use of solar water heaters in other commercial and industrial sectors including the hotel sector.
- offers improved economic incentives for installation of both solar thermal and solar PV technologies.
- shows significant use of solar thermal applications beyond the use of domestic solar water heaters (e.g. solar cooling, distillation, parabolic solar for power production);
- shows a greater integration of electric installation companies into the solar PV and other renewable energy grid connected technology industries; and
- makes use of economies of scale that can be gained through utility scale solar installations, to ensure viability and sustainability.

### *Sector Objectives Specific to bioenergy*

A sector that:

- shows increased use of liquid fuels prepared from local crops on unused land (e.g. biodiesel) to replace imported fossil fuel where feasible;
- has a requirement for larger farms to install capacity on site for producing biogas for electricity production;



- has streamlined systems for waste management/ separation in order to facilitate waste to energy projects;
- has an adequate amount of agricultural land set aside for development of bioenergy;
- includes the production of biodiesel for transportation; and
- optimises land use in the production of energy from biofuels
- Has a bio-methane industry based on fermentation technologies, and with clearly defined markets;
- Has clearly established standards for methane production from biogas;
- Allows for great choice to promote energy supply flexibility;
- Has specific regulations for storage of bio-methane;
- Has clear regulation for health, safety and environment;
- Has appropriate fiscal and financial support framework for the bio-methane industry;
- Has strong systems to support research and development.

Policy Measures:

### *Sector Objectives Specific to wind energy*

A sector that:

- has specific clearly defined wind energy zones.
- includes planning standards and a system for public engagement
- establishes an environment conducive to joint ventures for wind energy
- promotes removal of barriers to investment for wind energy
- establishes a system of investment to facilitate transportation, cranes and construction equipment to support large scale wind development
- promotes understanding and awareness of issues surrounding wind energy in the general public

- provides economic incentives for setting up small wind installations for domestic and commercial purposes.

### *Energy Storage- Renewable Energy*

Given the fact that many of the renewable energy technologies are intermittent in nature, development of technologies that enable the storing of energy from sources such as wind, solar and tidal energy will be important. This is especially so if the establishment of off grid renewable energy technologies are expected to become more prominent.

Even with grid connected renewable energy, there are limits for renewable energy penetration. The Barbados Solar and Wind Integrated Study (2015) discusses this in more detail. The larger the amount of renewable energy in the energy mix, the greater the need for spinning reserves at the electric utility.

It is clear that without investment in energy storage the capacity factors for renewable energy technologies will remain low, with a far greater investment of installed capacity needed in order to produce similar amounts of energy to that provided by traditional, conventional energy sources.

Technologies using batteries, compressed air and pumped storage have all been discussed as possibilities for energy storage in Barbados. Although at the moment there is no storage option that can lead to any of the intermittent renewable energy becoming a base load source.

In an effort to satisfy the long term vision of attaining 100% of energy produced from renewable energy, there will need to be significant investment into research and development in energy storage.

At this point in the process, there are no specific targets set for storage technologies per se. However, it is recognised that in

determining the final targets for intermittent renewable energy technologies there will need to be concomitant increases and investment in energy storage technologies.

Below are Specific Objectives in Energy Storage to ensure a sector that:

- has access to research detailing the potential for use of various energy storage technologies such as (batteries, pumped storage, compressed air)
- has standards for energy storage technologies that are used in combination with renewable energy technologies
- Has concessions and economic incentives to promote development of energy storage technologies that work in conjunction with renewable energy technologies to improve stability and reliability.

### *Policy Measures- Renewable Energy Sector*

In order to achieve a sustainable transition to a sector more strongly based on renewable energy Barbados shall:

- diversify and optimize the renewable energy mix that results in the maximization of socio-economic and financial benefits to Barbados;
- establish a capacity building program locally to prepare the workforce for employment in the renewable energy sector;
- develop a central database containing details on the extent of renewable energy resource available at various locations in Barbados (solar, wind, bioenergy potential);
- establish legislation and regulations that provide for a transparent process in acquiring licences for supplying electricity from renewable energy sources;
- provide an enabling environment that encourages collaborative approaches to producing renewable energy that is financially, economically, and environmentally viable, as well as

- technically sound;
- establish a program of international financing and ‘in kind’ support that can effectively support the supply of renewable energy within Barbados in a way that supports economic growth and competitiveness;
  - increase staffing (secretariat) and human capacity to support local NGOs such as BREA;
  - establish a clear protocol for clients to follow for investigating and trouble shooting in new renewable energy systems with a method of recourse for clients in case of unsatisfactory company performance;
  - establish regular and clear communication to the public on developments within the renewable energy industry;
  - establish efficiency standards for manufacturing of local renewable energy products such as solar water heaters;
  - establish appropriate fiscal incentives for emerging renewable energy and storage technologies;
  - promote an enabling environment that encourages local involvement in renewable energy projects.
  - Establish a system to ensure protection of intellectual property and patents for renewable energy technologies.
- 
- Define within the physical and development plan of Barbados land area for bio-energy and wind production;
  - Establish and support infrastructure for the collection, handling, and processing of organic material to produce energy;
  - Establish fiscal and financial support for research and development in bio-energy technologies and methods;
  - Establish standards of production for bio-methane from biogas;
  - Establish standards for electricity generation efficiency within the bio-energy, wind energy and other renewable energy sub sectors;
  - Establish a legislative and regulatory framework for bio-energy production, distribution, storage, and plant decommissioning

- Establish a strategy for expansion of the renewable energy markets in Barbados into the Caribbean region.

#### Policy Measures- Energy Storage

- Establishment of transparent decision protocol for choosing between energy storage measures
- Clear guidelines for integration of battery technology in PV systems
- Implementation of proven storage technologies and systems that promote renewable energy that are economically, environmentally and financially viable
- Establishment of a system for recycling and disposing of batteries at end of use. (Cradle to cradle)

### **4.3 Energy Efficiency and Energy Conservation**

Energy efficiency and conservation are critical to achieving the national desire to contain the foreign exchange expenditure relating to the fuel import bill. Changing energy use in a way to allow for more output for less input is a way to improve both economic and environmental performance of any technology. Looking across the planning horizon of BNEP, it is expected that the economy will experience growth which will also potentially increase the demand for energy. In looking to promote energy efficiency and conservation, growth across the sectors such as manufacturing and construction should not be compromised. The indicators developed and the measures pursued should lead to improvements in the way that energy is produced even if there is long term growth in overall use.

One of the main strategies for attaining an energy production and consumption sector that is sustainable, is to attain the maximum possible efficiency that is feasible. A focus on energy efficiency can improve the performance in both the renewable energy and fossil fuel sectors.

This importance of energy efficiency is stated in Visionary Goal 2.

*Visionary Goal 2: An energy sector where consumption and production of energy resources occur with the maximum level of efficiency that is feasible.*

The importance of the issue of 'energy efficiency' is further emphasised in Overall Objective 9.

*Overall Objective 9: Improving the efficiency in the production and consumption of energy products within the various subsectors*

The importance of Energy Efficiency and the overarching nature of this aspect in improving sustainability throughout the sectors, makes it large enough to merit its own policy or plan emerging from BNEP. For this reason the development of an "Energy Efficiency Plan" is included among the recommended measures below. This "Energy Efficiency Plan" recommended would have sub sections to consider areas of Energy Management and Planning, Lighting and Exterior Energy Efficiency Activities.

BNEP seeks to address and promote energy efficiency activities through the following:

- Retrofitting;
- Energy efficiency management;
- Energy efficiency and electricity;
- Incentive development for energy efficiency and energy conservation;
- Standards for energy efficiency and energy conservation;
- Regulatory development;

- Promotion of public awareness and;
- Human Resources development.

## **Energy Efficiency and Conservation Sector Specific Objectives**

The efficient consumption energy in Barbados will result in a sector that:

- establishes efficiency standards for manufacturing of local renewable energy products;
- has energy efficiency standards for importation of electrical and electronic equipment that come to Barbados
- Establishes energy efficiency labelling protocol for electric and electronic equipment.
- integrates energy efficiency activities with renewable energy, viewing renewable energy as energy efficiency with zero cost; and
- establishes retrofits or energy efficiency where feasible e.g. LED light replacement of florescent lights.
- Considers energy efficiency alongside renewable energy development in an integrated approach to sustainability that is seen throughout the sector.

## **Policy Measures- Energy Efficiency and Conservation**

To improve the efficiency of energy use in the country, Barbados shall:

- establish efficiency standards for electricity production for utility scale and distribution scale operations;
- establish a maximum useful life and cost/ performance ratio of operations for generation equipment;
- develop and establish legislation and regulations to govern movement towards greater energy efficiency in businesses and residences within Barbados;
- develop an 'Energy Efficiency Plan' as a policy guideline document

- establish an energy conservation education and awareness programme that will promote life style changes of Barbadians in the consumption of energy;
- promote energy efficiency in the productive and trading sectors
- develop building energy consumption standards by sector and encode these standards in the Town and Country Planning Act;
- establish or adopt business standards for design of energy efficient homes and offices.
- Develop and enforce energy efficiency standards for buildings.
- Develop energy efficiency standards for consumption of appliances and equipment used for residential, commercial and industrial purposes.
- Develop a set of regulations in tandem with all government ministries involved within the energy sector which identifies a clear and defined process for new applicants in energy efficiency projects
- Develop a system of duties, taxes and economic incentives to promote greater use of high efficient energy technologies.
- Develop standards for insulation in buildings to reduce heat losses
- Use of Life Cycle Analysis to determine best materials to be use for buildings and other construction projects



## 4.4 Electricity Sector

The electricity sector is a critical sector to be addressed in the movement towards a sustainable energy sector and the goal of 100% renewable energy. In order to obtain the maximum benefit of renewable energy technologies, there will need to be integration of these technologies into the existing grid.

The resulting agreements between the electric utility and renewable energy developers should share the risks and opportunities in an appropriate way. The involvement of the utility is also important in promoting demand side management and energy efficiency in the consumption of energy in various customer classes.

Given that 50% of energy used within Barbados is provided by the electricity utility, more renewable sources in the generation of electricity will go a long way to reach long term targets. It is important that the electric utility is clear on government's long term strategy, in order to ensure that appropriate decisions in investment in technologies are made that support the achievement of the targets set out. The utility should also play a part in determining targets and establishing plans for the transition towards a grid with a greater use of renewable energy and more sustainable fossil fuels. One of the ways in which transitions to renewable energy and energy efficiency technology will be included is through the use of SMART grids, which will need to be integrated into the existing distribution system.

One other significant policy aspect to consider is the degree to which liberalisation of the market is possible. This can be looked at in terms of generation, transmission and distribution, but there may be other specific services that the utility is currently responsible for that may be appropriate for involvement of a third party. These could include aspects of energy storage used to facilitate more use of renewable energy technologies.

## Electricity Sector Specific Objectives

The production and distribution of affordable electricity to all citizens in Barbados will be maintained, as Barbados transitions towards a renewable energy based economy as stated in Overall Objective 1.

*Overall Objective 1: Achieving stability, predictability in energy product prices over the long term.*

Other Objectives and Visionary goals related to efficiency and environmental quality also speak directly to the electric utility's ability to achieve the objectives within their sector.

Important in considering the electricity sector, are issues related to regulation and licensing. This is because the extent to which investments can be undertaken by the utility is determined to some extent by the regulator, the FTC.

A utility in a single buyer market such as Barbados requires a licence to operate. A degree of certainty in terms of their licence is important for a utility in order to invest in technologies and programmes in the long run.

There may also be an opening up of the electricity market for competition or other participation in order to facilitate Overall Objective 6.

*Overall Objective 6: Encouraging local investment in energy projects and programmes within Barbados, with a view to increasing number of shareholders and players in the various energy subsectors.*

The sustainability of the energy sector BNEP will be achieved through an electricity sector that:

- provides a reliable service, minimizing brown outs and black outs;
- provides an affordable service to customers in all categories;
- establishes a greater percentage of renewable energy in the fuel mix for electricity generation. (Aspirational goal of 100%);
- establishes clear rules governing the participation of Independent Power Producers (IPPs) in the sector;
- has specific pricing for each renewable energy source in any pricing agreement;
- establishes clear rules governing the writing off of sunk assets by BL&P, NPC and BNOB and other electricity producing entities that may be regulated;
- Establishes clear rules defining investments for firm capacity and intermittent capacity;
- establishes a demarcation of obligations for provision of universal service between the incumbent utility and the potential new renewable energy players;
- establishes an optimum mix of technologies in renewable energy, i.e Percentage to be provided by wind, solar, biomass etc.;
- provides an optimisation for size of components of the renewable energy system (Utility scale vs. distributed renewable energy);
- Establishes a transparent system for determining when to include newer renewable technologies into long term utility planning (OTEC, wave, etc.);
- shows increased use of natural gas and less environmentally deleterious fossil fuel used in electricity generation where financially and economically feasible;
- maximizes the potential in using storage technologies to improve dispatchability of supply;

- has clear rules on how utility planning should be undertaken. Moving away from a 'Least Cost model' to MCA 'Sustainable model';
- has transparency in roles of the utility, the government ministry and regulator in establishing long term planning and integration of IPPs in the new competitive market;
- prioritizes reduction of carbon emissions in line with climate change national and global targets;
- increases involvement of the electricity utility in other sectors such as transport (e.g. Supply of energy for EVs vehicle to home and vehicle to grid technologies);
- determines the optimum level of competition and collaboration in the sector while maintaining reliability of supply;
- establishes clear and transparent rules for dispatch of generation, with assigned roles and responsibilities;
- has streamlined and transparent rules determining the issue of licenses for IPPs (Could be an auctioning or RFP process to an independent body);
- establishes a market with maximum participation of local entrepreneurs and international partners that can be accommodated;
- establishes an equitable pricing regime with stability in prices that is consistent with social and environmental values;
- offers financial incentives for investors that promote renewable or more sustainable energy sources;
- establishes tariff and pricing regimes for the utility that include consideration of the cost of storage technologies
- includes the integration of SMART grid technologies.
- has improvements in efficiency of electricity generation
- establishes efficiency in consumption practices including the use of demand side management.

## Policy Measures Electricity Supply

In order to establish an electricity sector that is powered by affordable renewable energy Barbados shall:

- establish electric market structures that reduce effects of monopolistic operations where financially and economically feasible;
- establish a pricing mechanism for electricity from renewable energy suppliers;
- establish protocols for interconnectivity between IPPs and the utility to supply electricity;
- expand electricity regulation to include the wide ranging aspects of market, generation, distribution, supply, dispatch, transmission, distribution and electricity use within the electricity sector;
- establish standards and specifications for generation, supply, dispatch, transmission, distribution, storage and consumption that allow the electricity sector to operate in a financially, economically, environmentally, and technically viable manner;
- establish targets for limits on CO<sub>2</sub> emissions in the electricity sector
- promote the use of renewable and other clean sources of energy to produce electricity;
- establish clear rules for determining roles and timelines for updating the Integrated Resource Plan; and
- use SMART meters as part of an advanced communication infra-structure for distribution management, to facilitate use of more intermittent technologies and aid in demand side management.

## 4.5 Energy and Transportation

The transportation sector is a large consumer of fossil fuel and therefore a significant contributor to green-house-gas emissions in Barbados. Transportation is responsible for about 33 % of energy consumed on the local energy sector. Giving the ever expanding fleet of vehicles on the roads, management within the transport sector will be vital in charting a sustainable path for energy development on the whole.

In addressing the transport sector, it is crucial to consider both the technology development and issues of management and organisation within the sector. There is also need for a focus on infra structure such as roads and refuelling systems.

The expansion of the local fleet of electric vehicles was identified as a principal area of development alongside other changes to alternative fuels or improvements in overall efficiency.

Enhancements in the Transport Sector will play a significant role in achieving the Visionary Goals and Overall Objectives, including the following:

**Visionary Goal 1:** An energy sector that offers a diversity of sustainable energy options with a trajectory towards 100%)

**Overall Objective 3:** Increasing the amount of renewable energy sources used in the energy mix to the extent that it can be accommodated from a technical and socio-economic perspective.

As a consequence, BNEP seeks to provide measures to address the following issues:

- Energy consumption and efficiency within the transportation sector;
- Conversion from fossil fuel use to electricity;
- Transportation Management;
- Fuel switching within the transportation sector; and
- Clean energy use and emissions control within the transportation sector.

### **Transport Sector Specific Objectives**

The transformation of the type of energy consumption within the transportation sector will be achieved giving rise to a sector that

- has a greater percentage of electric vehicles EVs and hybrid vehicles in the local fleet;
- has a skilled workforce available to provide effective maintenance on EVs;
- has greater information available to customers on comparative operating costs of running diesel, gasoline and EVs;
- has a greater number of renewable energy systems installed that can be used as charging stations for EVs; (carports, charging stations)
- reduces the levels of duties on the importation of EVs;
- has a greater use of batteries and other storage technology to facilitate charging of vehicles 24 hours per day;
- has greater concessions in infra structure cost to encourage more local automobile dealers to be involved in the EV market;
- collects more detailed information of number of EVs, hybrids and other alternative fuels vehicles in the country;
- includes the use of EVs, biofuels, and other alternative fuels in public transport;

- has fewer vehicles per capita to reduce the level of traffic congestion in the country;
- has a public transport sector that provides a more convenient and attractive option to consumers;
- has a more sensitized public to the benefits of using mass public transit rather than using private cars;
- has a disaggregated sector plan within transport;
- has a consistent transportation policy that makes investment in new technologies worthwhile;
- has a well maintained system of charging stations at strategic points in the country; and
- has a fleet with a greater average efficiency of performance of vehicles within Barbados.

### **Policy Measures Transport Sector**

In order to achieve the significant change in the consumption of energy to more efficient, clean and renewable energy, Barbados shall:

- establish biofuel standards for wholesale and retail supply of vehicles;
- establish a transportation information system to provide data for transportation and energy policies and strategic planning, as well as tracking of CO<sub>2</sub> emissions and environmental impacts;
- introduce more renewable energy and clean energy into the public transportation system;
- provide appropriate incentives to promote “green pumps” within service stations and on commercial properties;
- remove MTBE from gasoline and diesel and replace with ethanol and biodiesel;
- promote linkages with the agriculture sector to encourage the production of agro-energy crops where financially and economically viable;
- promote energy efficiency in the transportation sector;



- provide tax incentives to vehicle dealerships that have trained their mechanics to maintain and repair EVs;
- establish a programme for identifying appropriate international sources of funding to facilitate and assist the Government in transitioning from fossil fuels to EVs;
- remove duties and VAT from EVs in a phased manner to encourage a scheduled approach to increasing EVs in the national transportation fleet in a manner that will not harm government's revenue;
- develop a road network that promotes energy efficiency;
- establish the use of management technology in public transit e.g.: use of smartphone apps to verify arrival times of buses;
- establish a system that includes mobile charging stations for vehicles;
- Introduce ethanol rather than MTBE as an anti-knock agent.
- Implement more stringent regulations on vehicles exhausts and emissions;
- establish charging stations integrated with traditional gas stations;
- establish a greater number of charging stations for EVs;
- control the level of CO<sub>2</sub> in a manner that it can be maintained at levels consistent with local and global climate change targets;
- establish a system that facilitates the change from traditional to renewable energy vehicles by taking into consideration transition costs;
- develop standards for streetlight efficiency;
- establish cost incentives that encourage investment in required infrastructure with charging stations etc.;
- acquire more details on number of vehicles using each fuel type; ]
- establish standards in charging and other renewable energy infra structure related to fuelling; and
- develop a regulatory framework for the implementation of vehicle to grid storage and supply technology.

## 4.6 Energy and the Environment

It has long been observed that the production of energy has had an impact on our natural environment through the emission of various pollutants, and that such costs have for many years been externalized from the sector, and not seen as a cost to doing business.

Given the focus on long term health and environmental issues related to marine life, ground water and air quality; exploring the impact of energy and the environmental impact and associated costs is an important consideration. It relates to the Visionary Goals and Overall Objectives below.

**Visionary Goal 7:** An energy sector that minimizes the environmental impacts and contribution to global climate change. (environment)

**Overall Objective 12:** Reducing the environmental impacts associated with the production and consumption of energy resources locally.

BNEP will establish a course of action for the following issues:

- Energy's impact on the environment – such as air and ground water quality;
- Oil spill management;
- Information management and education;
- Establishment and enforcement of environmental standards;
- Clean energy; and
- Waste and Energy.

## **Energy and Environment Sector Objectives**

The achievement of a sustainable balance between energy production, transport and consumption, and protecting the environment will produce a sector that:

- has strong information flow within the energy sector and the wider society on the environmental effects of various types of energy production technologies;
- has infrastructure that allows the authorities responsible for environmental protection to assess and monitor environmental standards within the energy sector;
- possesses the information infrastructure that would allow for the dissemination of environmental best practices on the production, transportation and consumption of energy; and
- requires by legislation and regulation all participants to adhere to the principle of zero harm to people and the environment in pursuit of energy production, transportation and distribution;

## **Policy Measures -Energy and the Environment**

In order to ensure that environmental concerns and objectives are addressed fully, Barbados shall:

- establish standards and protocols for the safe and effective disposal of equipment and devices in the energy sector;
- establish a sustainable environmental management framework for the upstream offshore petroleum sector;
- establish a decommissioning fund for the energy sector to facilitate the decommissioning and abandonment of energy operations and facilities;
- establish standards and protocols that promote and encourage the goal of zero harm to the people and the environment in the

production of energy in the petroleum and renewable energy sub-sectors;

- Establish information systems and infrastructure that promotes the flow of information requiring environmental standards, best practices and legislation; and
- Establish studies within the sector that assess the correlation between carbon dioxide emissions and health risks (e.g. cancer, asthma).

## Climate Change

The statement in Visionary Goal 7 emphasises the importance of climate change among the environmental factors. Barbados and all SIDS are particularly vulnerable to climate change impacts.

Contamination of groundwater, damage to coral reefs, destruction of coastlines and more frequent extreme weather events are just a few of the impacts that could severely impact Barbados' economy and those of other SIDS.

It's therefore in Barbados and other small islands' interest to lead the way internationally in promoting mitigation of climate change.

BNEP speaks to the following:

- Climate Change Financing;
- Carbon Pricing and Trading;
- Moving the international energy sector towards a climate change neutrality;
- Information flow;
- Implementation of the nationally appropriate mitigation action;

## **Climate Change Sector Specific Objectives**

Climate Change mitigation will require a sector that:

- contributes to the CO<sub>2</sub> emission reduction by promoting the use of clean energy and renewable energy;
- fosters collaboration and cooperation amongst all stakeholders to reduce CO<sub>2</sub> emissions;
- works with international investors and agencies to finance climate change mitigation initiatives;
- establishes a baseline database for level of greenhouse gases associated with economic and developmental activities in various sectors.

## **Policy Measures for Climate Change**

To achieve success in the reduction of CO<sub>2</sub> emissions within the energy sector Barbados shall:

- establish a mechanism to cap and trade CO<sub>2</sub> emissions within the Barbados Energy Sector;
- establish a trade facility that allows holders of CO<sub>2</sub> emissions permits to trade with other emitters of CO<sub>2</sub>;
- establish strong rules for capping CO<sub>2</sub> emissions;
- establish a clear international agenda for the acquisition of climate change funding.

## **Human Resources and Institutions: Capacity and Development**

In order for BNEP to be effective, the institutions and human resources which service the energy sector must be honed and applied in a meaningful way. The move of the energy industry towards a greater reliance on renewable energy represents a paradigm change in energy production and consumption. It will be necessary to ensure that the workforce is adequately prepared for the new skills that are needed and for institutions to be restructured to regulate and manage activities within the new sector.

Of extreme importance in capacity building is the education system, especially the promotion of energy efficiency and renewable energy in the school curriculum at primary, secondary and tertiary institutions.

Visionary Goal 5 and Overall Objectives 10 and 11 specifically identify these key issues related to human resource development.

*Visionary Goal 5: An energy sector that offers opportunities for development of human capacity and collaboration.*

*Overall Objective 10: Improving the awareness and understanding of energy production and consumption, its impacts and the associated environmental and socio-economic consequences within all sections of the public.*

*Overall Objective 11: Increasing the number of persons locally with qualifications and skills relating to energy production and management of renewable and fossil fuel sources.*

This section addresses and anticipates these changes and developments needed in the area of human resources and institutional capacity.

The Specific Objectives for Human Capacity will address issues relating to:

- Research and Development;
- Education and skills development;
- Energy information management;
- Knowledge Development; and
- Capacity development and institutional strengthening.

## 4.7 Human Resource and Institutions Capacity Specific Objectives

The development of skills and knowledge in the energy sector will result in a sector that:

- has a skilled workforce able to fulfil the requirements of the new renewable energy sectors;
- has standards of qualification for all aspects of the energy sector especially in renewable energy;
- maximizes information sharing between educational institutions and the energy sector in establishing degree programmes, vocational programmes and school curricula;
- Incorporates new skills relevant to emerging conventional and renewable energy sectors in syllabuses in tertiary institutions such as the Barbados Community College (BCC), Samuel Jackman Prescod Polytechnic (SJPP), and University of West Indies (UWI) etc.;
- has an increased number of scholarships available for persons interested in studying new areas related to renewable energy and aspects of sustainability in the oil and gas sector;
- has a framework that allows for flow of energy information from regional institutions to local environment and also from local industry to regional institutions;
- has an increased number of qualified persons in conducting energy audits;
- emphasizes the concept of 'innovation' throughout curricula related to energy at various levels of education;
- has an effective use of various media on a regular basis to communicate to the general public important issues relevant to energy policy and sustainable energy development within the country;
- ensures that the commercialization of new and renewable energy technologies within the country is maximized;
- offers significant internship opportunities in energy technology development within the private sector;
- offers significant opportunities for the private sector to sponsor local energy development projects;

- facilitates financial contribution of the general public towards the development of various projects;
- has greater use of international standards and best practices in the development of the energy sector;
- encourages pursuit of vocational skills that are important in building an effective renewable energy sector through support of institutions such as Technical Vocational and Education Training (TVET) Council;
- has an environment that motivates personal entrepreneurship in areas of small business development in energy related fields;
- has a community teaching programme in renewable energy; and
- offers clear levels of acceptable standards of service for various energy products with possibility of recourse for consumers if standards are not met.

### **Policy Measures for Human Resources Institutions: Capacity and Development**

To achieve the objectives that will lead to a significant improvement in human resources and capacity development Barbados shall:

- develop and establish energy studies curricula for secondary and tertiary institutions;
- establish a Department of Energy Studies within the UWI;
- establish an Energy Workbook that makes use of an integrated approach including general concepts in maths, science etc.;
- establish a partnership between stakeholders within the energy sector and the Ministry of Education;
- establish an information network between the energy sector and the education sector to communicate skills and expertise requirements;
- mobilise funding for training and development of persons employed in the energy sector and fields of disciplines that support the energy sector;



- create, develop and promote institutional capabilities in the energy sector including:
  - Energy policy formulation, management, assessment and audit;
  - Legislative review and reform;
  - Energy sector planning
- support, promote and maintain timely supply of data and information to the Barbados National Energy Information System;
- establish regional and international agenda to develop technical capacity;
- establish guidelines for the adaption, diffusion, and transfer of energy technologies;
- promote cooperation in research and technological development within the energy sector;
- support research and development into smart grid technologies for electricity and natural gas sub-sectors;
- establish an effective system of knowledge transfer of higher order energy skills available in international institutions to local educational and vocational institutions;
- establish an educational system that supports efforts for entrepreneurship in the energy sector;
- establish research programmes that illustrate the link between the development of the local energy sector and the economic drivers throughout industry;
- establish new jobs throughout the energy industry that increase overall employment opportunities in Barbados;
- establish a Working Group including members of educational institutions and energy sector to ensure ongoing relevance of the education system in the changing energy context; and
- establish demonstration projects that illustrate innovation and commercialization of energy projects.

#### 4.8 Energy and the Cross-Cutting Sectors

The energy sector has a significant impact on all aspects of Barbados socio-economic life. It touches all the critical sectors of production and consumption. It is important that this policy harmonizes with identified goals and policy objectives of the other sectors stated below:

- Agriculture;
- Tourism;
- Industrial sector;
- Waste management;
- Water;
- Health and Safety

Using the Multi Criteria Approach (MCA), means that it will always be necessary to examine the impacts of any policy decision or strategy on the energy sector from as wide a perspective as possible. The sectors identified above emerged from various discussions within the sector. These sectors are expected to have a significant impact on energy production or consumption and/or be impacted by energy production or consumption practices.

It is possible that along the planning horizon of BNEP, other sectors will be added as they become more significant in terms of their impacts on the overall energy sector. In planning over the horizon, BNEP should be modified as necessary to remain consistent with policies in other sectors such as Transport, Tourism, Agriculture and Small Business. Considering these policies in a consolidated manner, will go a long way to ensuring synchronization and harmonization of policies across the Barbados economy.

The importance of the cross cutting approach is summarised in Overall Objective 8.

*Overall Objective 8: Increasing collaboration within the energy subsectors and among the cross cutting sectors that have an impact on energy supply or consumption.*



## Overview of Cross Cutting Sectors

### 4.8.1 Agriculture

Agriculture is critical because there are potential uses of land for crops to produce biofuels. Animal waste from farms can also be used for production of biogas. In addition, the agricultural sector is a major consumer of energy in the process of food cultivation and production.

Traditionally, the sugar cane industry in Barbados was one of the pillars of the Barbados' economy. However significant decline over the last twenty years has meant that much of the land which was formerly used in this productive sector, now lies idle. There is considerable interest in developing crops which can be used for energy production on this land. In recent years, there have been investigations into the viability of using river tamarind as a crop that could be used in this regard and compliment bagasse production from sugar cane.

More activity and discussions in these areas are expected. It is recognised that a sustainable agriculture sector will play a major role in safeguarding the sustainability of the entire energy sector in the long term.

#### *Agriculture Sector Specific Objectives*

To achieve sustainability and the Visionary Goals. Barbados seeks to develop an Agriculture sector that:

- maximises the use of bagasse from the sugar cane industry to generate electricity that can be used within the industry and/or sold to the utility;
- has efficient production of sugar and associated products obtained from sugar cane.
- maximises the use of waste heat produced in agriculture for cogeneration;

- makes use of available land to maximize production using energy technologies to improve the yields and diversity of products;
- has increased commercial viability of sugar cane and the overall agriculture industry through improving all round efficiencies in the sector;
- uses biomass (possibly river tamarind) as an off-season fuel to be used as a complement to the bagasse fuel production;
- has a higher percentage of use of biofuels, bagasse and biomass in order to produce greater price stability;
- has increased use of electricity for production in services such as cooking in order to create more applications for renewable energy;
- includes the use of ethanol from sugar cane for use in the transportation sector to replace MTBE;
- establish a museum to demonstrate the aspects of the sugar industry and various linkages relating to energy and sustainability; and
- increases the use of biomass in the manufacture of plastics to replace fossil fuel based plastics.

#### **4.8.2 Tourism**

The tourism sector is a major economic sector for Barbados. The success of the industry relies in part on the maintenance of the natural environment in terms of the marine and coastal resources, along with associated air and water quality management. A programme that highlights the importance of protection of these resources both from the perspective of citizens and visitors to the island will be beneficial. Energy conservation, efficiency and promotion of renewable energy are key elements in these activities relating to the Vision Statement and Visionary Goals of BNEP.

Sustainable tourism is also a way for Barbados to market its tourism product more broadly, as a greater number of visitors to the island

are becoming aware of environmental issues and using that as a factor to be considered when choosing a destination for a vacation.

Although hotels have become more aware of energy efficiency and renewable energy, there are areas where the actions taken can go further. One area is in the area of solar water heaters, where the growth in the sector in the domestic sector has not been mirrored within the hotel sector.

Solar thermal for use in hotels for air conditioning are also possible areas of growth if the appropriate incentives are implemented. International environmental Standards such as ‘Green Globe’ or Earth Check could lead to greater focus on renewable energy and energy efficiency standards across the sector.

Integrating activities in industries such as rental cars within the hotel industry, can extend sustainability efforts in the industry into the area of transport, which is another key energy sector.

Additionally, the expanding tourism sector at the moment is responsible for a considerable amount of the electricity demand on the island. Therefore, improvements within this sector in energy efficiency and the uptake of renewable energy will translate to overall improvements to the energy sustainability in the country. Areas such as refrigeration, air conditioning, industrial cleaning and cooking can be focused on in this regard.

### *Tourism Sector Specific Objectives*

A sector that

- Integrates EVs and other renewable energy vehicles within the rental car business and other tourism related services;
- develops an education programme for hotel guests and tourists in Barbados emphasizing the importance of energy efficiency and environmental conservation.

- Allows investment by the electric utility in the hotel sector in a manner that will reduce overall energy costs for hotels in order to make them more competitive.
- Allows the hotel sector to take advantage of fuel hedging programmes offered by the utility to help stabilize energy costs and to allow better cost control planning and budgeting.
- Has further incentives in place to promote use of solar water heaters and solar cooling technology for air conditioning.
- Has a programme to encourage hotels to achieve international energy efficiency and environmental standards such as “Earth Check”.

### *Industry, Manufacturing and Construction*

Over the last decade, the Barbados economy has expanded in the industrial sectors with an increase in manufacturing. The expansion in this sector has meant a concomitant increase in both peak demand for energy and total energy consumption. The price of energy for the industrial sector has often been higher than the cost of service, as the electricity tariffs for domestic customers are kept at a lower level, due to social considerations. The higher cost of energy for industrial users affects the cost of production for both manufactured goods and services. This means that the price that goods are sold at in wholesale and retail outlets are also higher. At times this high price affects the competitiveness of businesses from an international perspective; especially when compared to the neighbouring twin island state of Trinidad & Tobago, where the cost of fossil fuel based energy products is much lower. Energy policy and regulation will need to address the cost of such energy products for the industrial sectors, to ensure that businesses remain competitive and costs of services to consumers remain reasonable.

Barbados has also expanded its activities in the areas of Building and Construction. This is one of the more energy intensive sub sectors in the Barbados economy and accordingly areas of sustainability and

energy efficiency relating to construction and buildings are critical. The attainment of international energy efficiency standards such as Leadership in Energy and Environmental Design (LEED) can play a major part in ensuring that standards are maintained in the long term.

#### **4.8.3 Manufacturing, Construction and Building Sector Specific Objectives**

A sector that:

- maintains electricity tariffs at levels that encourage entrepreneurship and maintain competitiveness;
- makes use of renewable energy technologies available to improve overall sustainability.
- Encourages and educates the sector on potential options with respect to renewable energy and self generation.
- Provides standards for buildings and construction that are in line with international standards such as LEED

#### *Key Policy Measures for Manufacturing, Building and Construction Sector*

In small island states such as Barbados, the issue of waste management is also one that will need to be addressed, especially because the availability of land for use in landfills is limited. The impact of waste materials such as non- biodegradable plastics on the natural environment can also be significant. There is potential for more recycling of products, with the development of an effective waste separation system. Alternative ways of waste disposal have been considered in Barbados, including incineration. Options such as these will have an impact on energy consumption which will in turn affect the cost of waste management.

However, in addition to the impacts on waste management of consumption, there are opportunities for using various waste products as fuel sources. Bagasse obtained from the sugar cane industry is an example of a waste product that has been used to



generate electricity. Other options using gasification of other organic waste have been considered in recent times. These waste to energy options could represent solutions for reducing the amount of waste entering the landfill as well as in increasing the use of indigenous energy resources within Barbados.

#### **4.8.4 Waste Management Sector Specific Objectives**

A sector that:

- maximizes the use of waste resources in industrial process for generation of electricity with the industry and to the grid; and
- provides a clear assessment of the potential of identified waste products in generation of electricity based on availability and energy calorific content.
- minimizes the impacts of wastewater production in generation of electricity and other manufacturing processes.

Protection and maintenance of a good quality and supply of water has also become a source of concern recently. Barbados is supplied entirely by ground water aquifers, although there has been activity to develop additional desalination plants as well. The energy required to pump and distribute water across Barbados is significant, and the Barbados Water Authority (BWA) is the customer with the highest usage of electricity from BL&P in the country. As a result, BWA has explored renewable energy options such as solar and wind energy for generation of electricity within its premises.

It is important that within this policy, the link between water conservation and efficiency and energy efficiency is emphasized. There is also a need to consider specific renewable energy technologies that could be developed for the water sector. It should be noted that there may be a regulatory impact if BWA decides to pursue an energy source that is separate from the grid. The loss of BWA as a customer to BL&P could lead to the need for increased tariffs for customers that stay on the grid. BL&P in this situation would still be required to meet its cost of service obligations. Any future policy and regulatory measures should take this into account.

It could be beneficial for BWA and BL&P to work together to develop energy efficiency, renewable energy and storage projects that reduce the overall energy burden of the water system, and utilizes the BWA assets more effectively.

### *Water Sector Specific Objectives*

A sector that

- Uses an integrated management approach that promotes efficiency in the consumption and production of this resource to the greatest extent possible; and
- includes the use of renewable energy technology to reduce the overall demand and environmental impact of the sector in terms of energy use.

### **4.8.5 Health and Safety**

Apart from the environmental factors associated with emissions generated from fossil fuel energy production, there are impacts that these emissions can have on health as well. Nitrous and sulphur oxides associated with burning fossil fuels involved in generating electricity are linked to respiratory ailments. In addition, emissions from gasoline and diesel vehicles can have a similar impact. MTBE that is used in unleaded gasoline vehicles as an anti-knock agent is also carcinogenic. It is partially for this reason, that replacement of MTBE by ethanol or gasohol has been explored as an alternative. There are also impacts that need to be taken into consideration from a safety perspective, especially when it comes to interconnection of renewable energy technologies to the grid. For example, there are dangers of electrocution to technicians on lines for distributed renewable energy generation flowing back through to the centralized grid. For stand-alone systems, batteries that are not properly maintained and stored can create risks of explosion.

There are also safety concerns related to the development of the new offshore oil and gas exploration industry. It is important that safety standards are in line with international best practices for all activities on the rig.

Related to the issue of health and safety in the energy sector is that of Disaster Management. Objectives and Measures related to Disaster Management are also considered below.

### *Health and Safety and Environment Sector Specific Objectives*

A sector that:

- has a Health and Safety sector with clear standards and protocols for establishment and maintenance of new renewable energy systems;
- Establishes studies that quantify in a comprehensive manner the link between energy use and various health ailments observed in Barbados; and
- has safety standards for oil and gas exploration that are in line with international best practices.

### *Disaster Management:*

Barbados as an island state is susceptible to natural and man-made disasters, especially related to hurricanes and other extreme weather related events. Many of these are related to climate change but they also are connected to other impacts that affect the environment.

**Overall Objective 12:** Reducing the environmental impacts associated with the production and consumption of energy resources locally.

Consequently, disaster management and mitigation is a very important component of any plan of action within the energy sector. BNEP speaks to the following disaster management issues:

- Energy and Fuel reserves/stocks management;
- Renewable energy use as a mitigation tool of disaster management;
- Oil spill management and mitigation planning;
- Electricity restoration management;
- Petroleum fuel transport disaster mitigation; and
- Disaster management and natural gas distribution

### *Sector Specific Objectives Disaster Management*

The development of a disaster management programme will create an energy sector that:

- ensures safety of renewable energy systems in the event of a natural disaster;
- makes renewable energy resources available to contribute to relief in the wake of a natural disaster;
- develops the capabilities and resources to respond rapidly to manage disasters;
- requires by law that all participants adhere to the principle of zero harm to people and the environment in pursuit of energy production, transportation and distribution;
- Ensures that the regulations for location of generation plant takes into consideration vulnerability to natural disasters such as hurricanes, earthquakes and tsunamis.

### *Key Policy Measures: Cross Cutting Areas*

In order to achieve these multi-sector objectives, as well as ensure safety and mitigate against disaster Barbados shall:

- promote balanced land use for energy and food production;
- promote energy efficiency for irrigation and animal production;
- encourage the use of agricultural and fisheries waste as viable feedstock for bioenergy production;

- promote energy efficiency within the industrial, agricultural and tourism sectors by employing internationally recognized efficiency standards;
- promote the use of waste from industrial, agricultural and tourism sectors to produce energy where feasible;
- establish legislation and regulation to encourage the safe disposal of waste from the energy sector.
- establish time of use rates for the manufacturing sector in order to improve overall efficiency;
- establish programmes to highlight the possibilities of use of renewable energy technologies in the manufacturing and other industrial sectors (grid tied and off grid options);
- establish and implement standards of energy efficiency in manufacturing, building and construction;
- establish and implement a building code focusing on aspects such as passive cooling, energy efficiency and general 'green building' solutions.
- develop standards to ensure safety of renewable energy systems in the event of a natural disaster;
- establish renewable energy resources that can be a source of relief in the wake of a natural disaster;
- establish protocols to manage disaster incidents in service stations and charging stations with renewable energy infra structure;
- develop an energy sector disaster response plan;
- review legislation within the energy sector to enshrine the principle of zero harm;
- Introduce economic incentives to give hotels opportunity to introduce more energy efficiency and renewable energy products; and
- Establish a pilot project to illustrate the impact that introduction of renewable energy and energy efficiency measures can have on the overall economy.

## 4.9 Trade in Goods and Services within the Energy Sector

The continued development of the energy sector makes it necessary to develop an enabling environment that promotes the capacity of Barbadian companies to provide goods and services competitively. Although maximum growth in renewable energy and sustainable energy as a whole will depend to a large extent on the international funding available for the technology, there will also be a significant need for local investment and entrepreneurship. The importance of investment and entrepreneurship that relates to trade is encapsulated in Visionary Goal 6.

**Visionary Goal 6:** An energy sector that offers significant opportunities for local entrepreneurship and international investment.

**Overall Objective 6:** Encouraging local investment in energy projects and programmes within Barbados, with a view to increasing number of shareholders and players in the various energy subsectors.

**Overall Objective 7:** Promoting increased entrepreneurial activities locally in renewable energy and fossil fuel energy development throughout the energy subsectors.

To this extent, facilitation of business and trade within the local energy sector is a key component of BNEP. Local trade is also important in making sure that the industry has long term sustainability and that the economic benefits of development are also shared in the local business community.

At the moment, there are a number of local enterprises that are supplying renewable energy products and services in Barbados. BNEP will provide for the implementation of a course of action that will promote the active participation of local enterprises in all aspects of the energy sector, these include:

- Development and implementation of an enabling environment to facilitate local content for exploration and production of oil and gas offshore in Barbados; and
- Development and implementation of an enabling environment to facilitate local content for renewable energy operations.

### **Trade in Energy Specific Objectives**

The improvement of trade in energy goods and services requires a sector that:

- addresses the barriers to entry to participate in emerging renewable energy markets;
- offers financial terms to encourage small business entry in the renewable energy market;
- offers local investors opportunities to be involved in local oil and gas exploration projects;
- allows the flow of information to empower investment and the flow of financial resources; and
- has a strong local content supporting the exploration and production of oil and gas.

### **Policy Measures Energy Trade**

To accomplish an enabling environment that will lead to a more desirable trade environment Barbados shall:

- strengthen networks between businesses involved in renewable energy to foster greater collaboration;
- develop a database showing potential local projects in renewable and non-renewable energy and investment and skills needed;
- remove all barriers to entering the renewable energy market;
- promote the enabling infrastructure that will encourage the establishment of financial mechanisms to fund renewable energy;

- conduct a diagnosis of the suppliers of goods and services to identify the readiness and need of local firms to meet the standards of supply for the offshore oil and gas sector;
- review and adjust the regulatory and operational framework of government to allow the enabling environment for local companies to acquire the standards of supply; and
- establish legislation and regulation to govern the modes of supply for electricity from renewable energy sources.

#### **4.10 Energy Access and Infrastructure**

Barbados has over the years successfully ensured that its population has access to energy. However, over the next twenty years the challenge will be to provide affordable energy as traditional sources of energy will become more difficult and expensive to acquire. The policy will tackle following:

- affordable energy for all citizens;
- access to clean and renewable energy;

The Visionary Goal and Overall Objective that speaks to this are as follows:

*Visionary Goal 3: An energy sector that offers basic energy products and services that are affordable to local citizens.*

*Overall Objective 2: Achieving affordability and access to all classes of consumers in energy products and services.*

#### **Energy Access and infrastructure Specific Sector Objectives**

Barbados will ensure that accessibility to energy is maintained and enhanced by creating a sector that:

- ensures that access to electricity is extended and maintained for all citizens of Barbados; and



- has a developed electricity and energy infra structure that allows for a greater degree of distributed generation where financially and economically feasible.

### **Policy Measures for Energy Access and Infrastructure**

To accomplish an enabling environment through improved energy access and infrastructure Barbados shall:

- establish an energy mix that promotes affordable energy prices;
- establish legislative and regulatory requirements within the energy sector to contain excessive pricing;
- promote market structures that encourage transparent, competitive and stable energy pricing; and
- establish a lifeline rate for persons unable to afford cost of basic energy services.

### **4.11 Energy Investment and Financing**

Investment management will determine the success or failure achieved within the sector and its growth in the future. A policy that recognizes the magnitude of investment required will establish the enabling environment to allow investment to flow. BNEP considers a course of action to address the following:

- Investment Sources:
  - Private Sector Investment
  - Public Sector Investment
  - Foreign Direct Investment
- Investment Structure:
  - Debt
  - Equity
  - Grant
- Resource requirements for energy sector development;

- Information mobilization and investment; and
- Investment Scheduling.

### **Investment and Financing Sector Objectives**

Sound energy investment and financing will see the emergence of an energy sector that:

- has an optimum level of private and public sector investment for development of energy projects in Barbados; and
- has an optimum mix of foreign and local investment for development of energy projects in Barbados.

### **Policy Measures Energy Investment and Financing**

To encourage sound, practical and timely investment in the energy sector Barbados shall:

- establish rules to guide local and overseas developers on requirements for investing in Barbados' oil and gas sector;
- establish a local content programme for the upstream petroleum sector;
- establish local investment and ownership within the renewable energy sub-sector where feasible;
- promote foreign/local partnerships for investment within the energy sector;
- establish a business enabling framework that allows for timely and easy establishment of operations; a
- improve the flow of information within the energy sector to ensure access to all available source of financing ( equity, debt and grant); and
- ensures a process is in place for government to facilitate the acceptance of renewable energy proposals and the financing required to implement a project

## **4.12 Implementation, Governance and Regulatory Framework**

It is apparent that in spite of the technology developments and increase in business activities in new and traditional energy activities, there is a need for clearly defined regulatory frameworks.

Such certainty in regulation and decision making helps to give confidence to potential investors and reduce the risk for all the players involved.

In some cases legislation and regulations are in place but there are no clear rules or procedures to ensure implementation. In other cases there are contradictions in the provisions of the existing legislation and this creates a level of ambiguity in interpretation.

There are areas of current legislation where provisions to make changes are at the discretion of the Minister responsible. While, it can be useful for the government and the person in charge to have the flexibility to change the direction of policy, it can lead to instability if such changes are made without consideration of the multi criteria impact on the wide stakeholder group.

It is suggested that when such powers of discretion exist for the Minister, that there be a system of considerations in place to inform the decisions to the extent that this is possible.

In some cases there will need to be new legislation drafted, but there are other situations where there may need to be modifications in order to make the legislation more facilitative to the policy direction. In some places the legislation is in place but there need further legal instruments and procedural rules to make the legislation to the point where it can be implemented.

Visionary Goal 8 and Overall Objective 2 point to the key issues that need to be focused on in establishing a system of governance, regulation and legislation that is effective.

*Visionary Goal 8: An energy sector that is governed by sound management of energy resources, and a clear regulatory framework.*

*Overall Objective 2: Establishing a consistent and comprehensive regulatory framework to govern activities in various energy sub-sectors.*

In relation to the governance and regulatory framework BNEP shall speak to processes to:

- Amend existing legislation and regulation or promulgate new ones where necessary to ensure responsible market behaviour and industrial harmonization;
- Rationalise the number of existing acts governing the sector through the introduction of new modern industry legislation;
- Review on an ongoing basis the existing legal framework for performance, strengths, weaknesses and lessons learnt to formulate and implement programmes of legal reform; and
- Develop regimes for pricing of electricity and petroleum products that will balance requirements for competitiveness with the long-term viability of the sector.

## **Governance and Regulatory Framework Sector Specific Objectives**

The government of Barbados will seek to establish a sector that:

- establishes clarity in identifying the specific legislation governing the business activities in both the renewable and oil and gas sectors in Barbados; and
- establishes and identifies the specific agencies with responsibility for governance of the business activities in the renewable energy and oil and gas sectors
- Promotes the use of multi criteria analysis for decision makers charged with responsibility for establishing policy measures.

## **Policy Measures- Governance and Regulatory Framework**

To accomplish an enabling environment that will lead to a more desirable governance and regulatory framework Barbados shall:

- conduct a project to establish procedural rules to support all of the existing legislation governing the renewable energy and oil and gas sectors;
- conduct sensitization and awareness programmes for all agencies involved in the enforcement of legislation and governance of activities within the energy sector.

**SECTION 5:**  
**POLICY TARGETS**  
**& DEVELOPMENT**  
**OF**  
**IMPLEMENTATION**  
**PLAN**

## **5. Policy Targets and Development of Implementation Plan**

Given the objectives and measures identified in Chapter 4 and the sector targets given in Chapter 2, a number of associated targets are provided here.

The 'Annex' provides further details on the targets and discusses the overall impact on the economy, government and civil society of the measures. This technique of assessment is consistent with the Multi Criteria Approach (MCA) discussed earlier.

In this approach natural gas scenarios, factors such as economic deficits, level of taxation, GDP, oil prices and costs of tradeable and non-tradeable goods are considered.

The results of this assessment will form the basis for the "Implementation Plan" which will be developed based on the BNEP.

In the "Implementation Plan", targets will be assigned wherever possible for the Measures indicated in the sectors considered in Chapter 4.

These sector targets will then be discussed in order to determine the appropriate measures and strategies that will be required to achieve the targets. These will be broken down into smaller, five year time horizons.

Below are the suggested Overall Energy Sector targets based on the MCA used. These will form the basis of the Sector Specific Targets.

*Table 5 - Main Indicators And Targets For BNEP*

<b>Name of Indicator (Units)</b>	<b>Baseline (2015)</b>	<b>2022</b>
Aggregate Energy Intensity(BOE/MUS\$)	324	
Total Energy Consumption per Capita (BOE/Persons)	5.03	
Percent Share of Renewable Energy of Total Energy (%)	2	
CO <sub>2</sub> Emissions/Final Consumption (kt/BOE)	0.0029	
Total No. of Persons Employed in the Energy Sector (No.)		
Electricity Generation Efficiency (%)	37	
Percent Share of Renewable Energy Investment of Total GDP (%)		



**SECTION 6:**  
**DEVELOPMENT**  
**OF INDICATORS**  
**& MONITORING**  
**SYSTEM**

## 6. Development of Indicators and Monitoring System

An important next step following the development Specific Sector Targets, will be the implementation of an appropriate monitoring system and suitable indicators.

The Targets developed will need to be SMART.

**S**pecific  
**M**easurable  
**A**chievable  
**R**elevant  
**T**ime bound

It is expected that these indicators and targets will include economic indicators that assess the cost related to various policy measures. Indicators that relate to aspects of energy efficiency will also be included. For example changes in 'energy intensity' overall and within individual consumption sectors may be useful in assessing the success of current measures. Other indicators that relate to the natural environment and social development will also be considered in the short, medium and long term.

Establishing the appropriate indicators will be critical in determining an effective system of monitoring that will allow the policy to be updated and revised on a timely basis to ensure continuous improvement. At the end of the chapter, a full list of indicators is included.

It is important to note that the "Implementation Plan" will not only develop indicators and targets but will also identify more specific programmes, determine strategies and assigned the roles and responsibilities to various groups, organisations and agencies in achieving these. There will also be an assessment of resources needed for various actions and some suggestions of funding options that can be considered.

It is possible that the indicators identified will be used to establish targets for the sector. These may ultimately be mandatory or voluntary. Decisions on whether to implement mandatory standards will be made based both on the resources that will be needed to administer and enforce standards, as well as whether the mandatory standards are likely to reduce innovation or efforts or our ability to affect those set in law. The cultural issues related to the implementation of mandatory standards will also need to be assessed going forward.

The targets will also need to be considered in the formation of any emerging legislation to support the policy and the Implementation Plan. It is recognised that even if the targets are not mandatory, the government of Barbados will need to outline a plan of action to take should targets be not achieved.

ENERGY POLICY PERFORMANCE INDICATORS								
Performance of Energy Sector								
	Baseline 2015	2022	2027	2032	2037	Comment	Assessment	Adjustment in Policy Action
Aggregate Energy Intensity (boe/MUS\$)	324.454							
Energy intensity by economic sector								
Energy Intensity Agriculture (boe/M\$US)	370.506							
Energy Intensity Manufacturing/Industrial (boe/M\$US)	1169.034							
Energy Intensity Construction (boe/M\$US)	181.683							
Energy Intensity Transportation (boe/M\$US)	2048.693							
Energy Intensity Commercial, Services, Public (boe/M\$US)	1299.875							
Percentage of Energy From indigenous Sources (Primary Energy)	2.40%							
Ratio of energy imports to total imports	0.185							
Energy consumption dependency on energy imports								
Total energy consumption per capita (boe/hab)	5.027							
Share of renewable energy in the total energy supply (boe)	0.02							
Total emissions intensity with respect to GDP (Ton/M\$US)	79.908							
<b>RENEWABLE ENERGY</b>								
Percent Share of the renewable energy supply in the total energy supply for given period (%)	2.00%							
Percent Share of the solar supply in the total energy supply for given period (%)	0.30%							
Percent Share of the biomass supply in the total energy supply for given period (%)	2.10%							
Percentage Share of the bio-diesel supply in the total energy supply for given period								
Percent share of the electricity generated from renewable supply in the total electricity generated for a given period (%)	14.00%							
Percent share of the electricity generated for solar supply in the total electricity generated for a given period (%)	1.70%							
Percent share of the electricity generated for biomass supply in the total electricity generated for a given period (%)	12.30%							
RENEWABLE ENERGY intensity (boe/M\$US)	20.782							
Bio-diesel Intensity (boe/M\$US)								
SOLAR intensity (boe/M\$US)	2.501							
BIOMASS intensity (boe/M\$US)	18.282							
<b>ELECTRICITY</b>								
Total Electricity Intensity(boe/M\$US)	132.295							
Agriculture Electricity Intensity(boe/M\$US)	31.731							
Manufacturing/Industrial Electricity Intensity(boe/M\$US)	483.260							
Construction Electricity Intensity(boe/M\$US)	13.900							
Commercial, Services, Public Sector Electricity Intensity(boe/M\$US)	841.536							
Transportation Electricity Intensity(boe/M\$US)								
Households/Residential Electricity Intensity(boe/M\$US)	73.367							
Greenhouse gas emissions per unit of electricity generated								

ENERGY POLICY PERFORMANCE INDICATORS								
Performance of Energy Sector								
	Baseline 2015	2022	2027	2032	2037	Comment	Assessment	Adjustment in Policy Action
<b>CROSS-CUTTING SECTOR</b>								
<b>Agriculture</b>								
Total amount of Land used to produce Agro-energy Crops	0							
Total amount of Agricultural Used Land used in the production of Energy	0							
Total Energy Used in Agricultural Production (boe)	22,928.57							
Percentage of Energy from Renewables (%)	0							
Percentage of Energy from Bagasse								
Percentage of Energy from Bioenergy								
Percentage of Energy from Local Sources								
<b>Manufacturing/Industrial</b>								
Total Energy Used in the Manufacturing/Industrial Production (boe)	182,865.80							
Percentage of Renewable Energy Used in Manufacturing/Industrial Production								
Percentage of Cleaner Energy Technologies in Manufacturing/Industrial Production	2.27%							
Percentage Increase use of Renewable Energy								
Percentage Increase use of Cleaner Energy Technologies								
<b>Water Management</b>								
Total Energy Used in Water Production and Distribution								
Percentage of Renewable Energy Used in Water Production and Distribution								
Percentage of Cleaner Energy Technologies								
Percentage Increase use of Renewable Energy								
Percentage Increase use of Cleaner Energy Technologies								
<b>Tourism</b>								
Total Energy Used in Tourism								
Percentage of Renewable Energy Used in Tourism								
Percentage of Cleaner Energy Technologies								
Percentage Increase use of Renewable Energy								
Percentage Increase use of Cleaner Energy Technologies								
<b>Waste Management</b>								
Total Amount of Waste Used in the Production of Energy (MT)								
<b>ECONOMIC CONTRIBUTION AND COST</b>								
Energy Contribution Economic Output BDS\$								
Cost of Energy BDS\$ (\$/boe)	\$ 300.00							
Cost of Electricity BDS\$ (\$/kwh)	\$ 0.37							
Average Electricity Rate - Utility (\$/kwh)	\$ 0.43							
<b>Average Utility Rate - Independent Power Producer (\$/Kwh):</b>								
Wind	\$ 0.315							
Solar Electric	\$ 0.416							
Biomass								
Biogas								
Waste to Energy								
Other								

ENERGY POLICY PERFORMANCE INDICATORS								
Performance of Energy Sector								
	Baseline 2015	2022	2027	2032	2036	Comment	Assessment	Adjustment in Policy Action
<b>ENERGY AND TRANSPORTATION</b>								
Percent Share of the biofuels of the total energy supply to the Transportation Sector (%)								
Percent Share of the Electricity of the total energy supply to the Transportation Sector (%)								
Percent Share of hydrocarbon of the total energy supply to the Transportation Sector (%)								
The Amount of Energy Consumed by Transportation (KBOE)								
Greenhouse gas emissions per unit of energy consumed by the Transportation								
<b>ENERGY EFFICIENCY AND ENERGY CONSERVATION</b>								
<b>Residential Sector</b>								
Total Energy Consumption (BOE)	271,297.35							
Total Fuel Consumption (BOE)	499,491.12							
Energy consumption per Household (BOE)	3.44							
Electricity Consumption per Household (BOE)	2.53							
Fuel Consumption per Household (BOE)	6.33							
Energy consumption per Capita (BOE)	0.98							
Electricity Consumption per Capita (BOE)	0.72							
Energy Efficiency (Energy Consumed per Unit of Fuel Input)	0.38							
Greenhouse gas emissions per Household								
Electricity Generation Efficiency (%)	0.37							
<b>ENERGY AND THE ENVIRONMENT</b>								
CO2 emissions / Final consumption (Kt/BOE)	0.0029							
CO2 emissions intensity (Gg/MUS\$) - CARBON DIOXIDE	0.0009							
CO2 Industrial emissions/Industrial energy consum. (Kt/bep) - CARBON DIOXIDE	2.094							
CO2 Industrial emissions/Industrial energy consum. (Kt/bep) - HYDROCARBONS	0.0005							
CO2 transport emissions/transport energy cons. (Kt/bep) - CARBON DIOXIDE	0.4321							
CO2 transport emissions/transport energy cons. (Kt/bep) - HYDROCARBONS	0.0001							
Per capita total CO2 emissions (Gg/khab) - CARBON DIOXIDE	29.4504							
Per capita total CO2 emissions (Gg/khab) - HYDROCARBONS	0.0063							
Total emissions intensity with respect to GDP (Ton/MUS\$) - HYDROCARBONS	0.4083							
Percentage Increase in the Use of Cleaner Technologies								
<b>ENERGY INVESTMENT AND FINANCING</b>								
Percent Share of Energy Investment of Total GDP (Current Prices)								
Percent Share of Energy Investment of Total Investment								
Percent Share of Renewable Energy Investment of Total Energy Investment								
Percent Share of Renewable Energy Investment of Total GDP (Current Prices)								
Percentage Share of Hydrcarbon Investment of Total Energy Investment								
Percentage Share of Hydrcarbon Investment of Total GDP (Current Prices)								
<b>HUMAN RESOURCES DEVELOPMENT</b>								
Total No. of Persons Employed in the Energy Sector								
Total No. of Persons Employed in the Renewable Energy Sector								
Total No. of Persons Employed in the Energy Efficiency Sector								
Total No. of Persons with Certification in Renewable Energy								
Total No. of Institutions Offering Certified Training in Renewable Energy								
Total No. of Institutions Offering Certified Training in Energy Efficiency								

# REFERENCES

Alexander Ochs et al., (2015). *Caribbean Sustainable Energy Roadmap and Strategy (C-SERMS): Baseline Report and Assessment* (Washington, DC: Worldwatch Institute, presented to CARICOM).

Antilles Economics. (2016). *Investigations of Likely Reactions to Removal of Green Energy Incentives*.

Barbados Light & Power. (2014). *Integrated Resource Plan*.

CARICOM. (2013). *Caricom Energy Policy*.

CARICOM. (2016). *Caribbean Sustainable Energy Roadmap and Strategy*.

Department of Energy and Telecommunications. (2007). *Draft National Energy Policy*.

Department of Energy and Telecommunications. (2017). *Barbados National Energy Information System*.

GE Energy Management Energy Consulting. (2015). *Barbados Wind and Solar Integration Study* (Presented to Barbados Light & Power Co. Ltd).

Government of Barbados. (2013). *Barbados Medium Growth and Development Strategy 2013-2020*.

Government of Barbados. (2015). *Barbados Economic Report – Energy Chapter 2011- 2015*.

Government of Barbados. (2015). *Barbados Intended Nationally Determined Contribution* (Presented to the UNFCCC 2015).

Hohmeyer. O. (2015). *A 100% renewable Barbados and lower energy bills: A plan to change Barbados' power supply to 100% renewables and its possible benefits*. Centre for Sustainable Energy Systems. Flensburg. Retrieved from <https://www.uni-flensburg.de/fileadmin/content/abteilungen/industrial/dokumente>



/downloads/veroeffentlichungen/diskussionsbeitraege/znes-discussionspapers-005-barbados.pdf

Humpert. M. (2013). *Barbados' Energy Market*. IADB. Retrieved from <http://blogs.iadb.org/caribbean-dev-trends/2013/11/22/barbados-energy-market/>

IADB. (2010). *Sustainable Energy Framework for Barbados*.

IISD. (2014). *Summary of the Third International Conference on SIDS*. Retrieved from <http://www.iisd.ca/download/pdf/enb0857e.pdf>

Ince, Vredenburg & Liu. (2015). Drivers and Inhibitors of Renewable Energy: A qualitative and quantitative study of the Caribbean. *Energy Policy*, 98, 700-712

IRENA. (2017). *Barbados Renewable Energy Roadmap*

Ministry of Energy and Mining Jamaica. (2009). *Jamaica's National Energy Policy 2009-2030*

Monke E. A. and Pearson S. (1989). *The Policy Analysis Matrix for Agricultural Development*, Cornell University Press.

UNEP. (2014). *Emerging Issues for Small Island Developing States*. Retrieved from [http://www.unep.org/pdf/Emerging\\_issues\\_for\\_small\\_island\\_developing\\_states.pdf](http://www.unep.org/pdf/Emerging_issues_for_small_island_developing_states.pdf)

UNFCCC. (2015). COP Paris Agreement. Retrieved from <http://unfccc.int/files/home/application/pdf/decision1cp21.pdf>

U.S.E.I.A. (2016). *International Energy Outlook 2016*.

## **Acts and Legislation**

Electric Light & Power Act 2013

Electric Light & Power Act Amendment 2015

Electric Light & Power Act Fees and Regulations

Fair Trading Commission Act 2002

Offshore Petroleum Act 2007

Offshore Petroleum Act Amendment 2012

Offshore Petroleum Regulations

Offshore Petroleum Taxation Act (2007)

Petroleum Winnings Operations Act

Renewable Energy Rider Agreement\

Renewable Energy Rider- Requirements for Grid Connection

Storage of Petroleum Act

Sustainable Energy Framework for Barbados 2010

Utility Regulation Act 2002