



BARBADOS NATIONAL ENERGY POLICY

(2017 - 2037)





BARBADOS

LAND INDUSTRY

SMART ENERGY
BARBADOS

TABLE OF CONTENTS

LIST OF TABLES	vii
LIST OF FIGURES	vii
LIST OF ACRONYMS	viii
ACKNOWLEDGEMENTS	xii
EXECUTIVE SUMMARY	xiv
EXECUTIVE SUMMARY	xv
CORE VALUES	xvii
BNEP VISION STATEMENT	xviii
VISIONARY GOALS:	xix
OVERALL OBJECTIVES	xix
TARGET ENERGY MIX	xxi
SECTION 1: INTRODUCTION	1
1. INTRODUCTION	2
1.1 Purpose of the Barbados National Energy Policy (BNEP) (2017-2037)	2
What is the BNEP designed to achieve?	2
1.2 SECTION 1 Overview	2
1.3. Barbados Energy Sector- Brief Discussion	3
Electricity	3
Solar Water Heaters	3
Solar PV	3
Wind Energy	4
Bio Energy	4
Natural Gas for Domestic Cooking	4
Transportation	4
Energy Efficiency	4
BREA	5
Barbados Energy Roadmap- Produced by IRENA	5
1.4 Regional Energy Context and its Influence on Barbados	6
1.5. International Energy Context and its Influence on Barbados	7
1.5.1 Economy	7
Expected Future International Energy Market	8
1.5.2 Climate Change	10
1.5.3 Technology	11

1.6	Regulatory and Legislative Context	12
1.7	Barbados Energy Consumption and Demand - Summary Charts and Tables	13
1.7.1	National Energy Use	13
1.7.2	Electricity Generation	16
1.8	Multi-Criteria Approach (MCA)	19
SECTION 2: PRELIMINARY ENERGY MIX TARGETS		20
2. PRELIMINARY ENERGY MIX TARGETS		21
	Energy Efficiency Target	22
	Energy Storage	22
	The Natural Gas Factor	23
2.1	Policy Analysis Matrix (PAM) – The Analytical Tool	24
	Important Components of the PAM	24
	Tradable Inputs	25
	Domestic Factors	25
	Non-tradable Intermediate Inputs	25
	Transfers	25
	Domestic Resource Cost (DRC)	25
	Private Profits	25
	Economic Profits	25
SECTION 3: VISION, GOALS, AND OVERALL OBJECTIVES		26
3. VISION, GOALS, AND OVERALL OBJECTIVES		27
3.1	Structure	27
3.2	Core Values	29
3.3	Visionary Goals	31
3.4	Overall Objectives	33
SECTION 4: SECTOR SPECIFIC OBJECTIVES & MEASURES		35
4. SECTOR SPECIFIC OBJECTIVES AND MEASURES		36
4.1	Introduction	36
4.2	Energy Supply	37
	Natural Gas	37
4.2.1	Oil and Gas Supply Sector Objectives	37
	Policy Measures - Oil and Gas Supply	39
4.2.2	Renewable Energy Supply	40
	Renewable Energy Supply Sector Objectives	41
	Sector Objectives Specific to Solar Energy	43
	Sector Objectives Specific to Bioenergy	44

	Sector Objectives Specific to Wind Energy	44
	Energy Storage - Renewable Energy	45
	Policy Measures - Renewable Energy Sector and Storage	46
4.3	Energy Efficiency and Energy Conservation	47
	Energy Efficiency and Conservation Sector Specific Objectives	48
	Policy Measures - Energy Efficiency and Conservation	49
4.4	Electricity Sector	50
	Electricity Sector Specific Objectives	50
	Policy Measures - Electricity Supply	52
4.5	Energy and Transportation	53
	Transport Sector Specific Objectives	54
	Policy Measures - Transport Sector	55
4.6	Energy and the Environment	56
	Energy and Environment Sector Objectives	57
	Policy Measures - Energy and the Environment	57
	Climate Change	58
	Climate Change Sector Specific Objectives	58
	Policy Measures for Climate Change	59
4.7	Human Resources and Institutions - Capacity and Development	59
	Human Resource and Institutions - Capacity Specific Objectives	60
	Policy Measures for Human Resources Institutions - Capacity and Development	61
4.8	Energy and the Cross-Cutting Sectors	62
	Overview of Cross-Cutting Sectors	63
4.8.1	Agriculture	63
	Agriculture Sector Specific Objectives	63
4.8.2	Tourism	64
	Tourism Sector Specific Objectives	65
	Industry, Manufacturing and Construction	65
4.8.3	Manufacturing, Construction and Building Sector Specific Objectives	66
	Key Policy Measures for Manufacturing, Building and Construction Sector	66
4.8.4	Waste Management Sector Specific Objectives	66
	Water	67
	Water Sector Specific Objectives	67

4.8.5	Health and Safety	67
	Health and Safety and Environment Sector Specific Objectives	68
	Disaster Management	68
	Sector Specific Objectives - Disaster Management	68
	Key Policy Measures - Cross Cutting Areas	69
4.9	Trade in Goods and Services within the Energy Sector	70
	Trade in Energy Specific Objectives	70
	Policy Measures - Energy Trade	71
4.10	Energy Access and Infrastructure	71
	Energy Access and Infrastructure Specific Sector Objectives	72
	Policy Measures for Energy Access and Infrastructure	72
4.11	Energy Investment and Financing	72
	Investment and Financing Sector Objectives	73
	Policy Measures Energy Investment and Financing	73
4.12	Implementation, Governance and Regulatory Framework	73
	Governance and Regulatory Framework Sector Specific Objectives	74
	Policy Measures - Governance and Regulatory Framework	74
	SECTION 5: POLICY TARGETS & DEVELOPMENT OF IMPLEMENTATION PLAN	75
5.	POLICY TARGETS AND DEVELOPMENT OF IMPLEMENTATION PLAN	76
	SECTION 6: DEVELOPMENT OF INDICATORS & MONITORING SYSTEM	77
6.	DEVELOPMENT OF INDICATORS AND MONITORING SYSTEM	78
	REFERENCES	85

LIST OF TABLES

Table 1 - List of Main Indicators	xxiii
Table 2 - Total Fuel Consumption for Electricity Production 2015	16
Table 3 - Energy Mix Breakdown	22
Table 4 - Structure of the Policy Analysis Matrix	25
Table 5 - Main Indicators And Targets For the BNEP	76

LIST OF FIGURES

Figure 1 - Total Barrels of Oil Demand per Day	14
Figure 2 - Demand by Energy Source 2006 to 2015	15
Figure 3 - Fuel Inputs for Electricity Production 2015 Barbados	17
Figure 4 - Electricity Sales By Demand Group	17
Figure 5 - Share of Electricity Generated from Renewable Energy Technologies as a percentage of Total Consumption (Business as Usual and Sustainable Energy Scenarios)	18
Figure 6 - Policy Inverted Pyramid	28
Figure 7 - Summary Table of Vision Statement and Visionary Goals	32

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
BOE	Barrels of Oil Equivalent
BOPD	Barrels of Oil per Day
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
EV	Electric Vehicle
FCA	Fuel Clause Adjustment
FOB	Freight on Board
FTC	Fair Trading Commission
GDP	Gross Domestic Product
GWh	Gigawatt hours
IADB	Inter-American Development Bank
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
kt	Kilotonne
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
MUS	Millions of US Dollars
MWh	Megawatt hours
NDC	Nationally Determined Contributions
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

PRIME MINISTER'S MESSAGE

– RT. HON. FREUNDEL STUART



I am pleased to present the Barbados' National Energy Policy 2017-2037.

The policy seeks to make Barbados more economically viable and environmentally sounder while striving for more social balance in its energy sector and ensuring good governance in this area. The policy will move Barbados from a petroleum driven economy to one based largely on the use of indigenous renewable energy sources, thus saving on our usage of foreign exchange and reducing noxious emissions into the environment as we seek to achieve the aspirational goal of a 100% renewable energy island within the next 50 years of our independence.

We are painfully aware that fossil fuels currently dominate Barbados' energy mix; indeed over 90% of the energy used for electricity production in Barbados is derived from the use of imported fossil fuels and so constitutes a drain on the foreign exchange resources. In addition, the volatility in pricing of these products adversely impacts the competitiveness and economic resilience of the country. The Government has therefore begun the focused transition to sustainable energy within the overall framework of positioning Barbados to become an advanced Green Economy.

The Barbados National Energy Policy 2017-2037 fully embraces the Government's position in this regard since it has as its vision:

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

The intent of this policy is to bring about significant transformation to Barbados' production, distribution, and consumption of energy, as well as to enrich the socio-economic landscape of Barbados, while we advance towards a green economy paradigm.

The pragmatic nature of this policy recognises that a significant percentage of the world's energy consumption by 2050 will still be satisfied by fossil fuels. In this regard, the Barbados National Energy Policy has outlined a course of action to ensure the responsible exploration and production of fossil fuels that may be located in Barbados' offshore waters. These resources will be used to earn more foreign exchange and in the further development of the sustainable energy sector.

The policy projects a reduction in the importation of fossil fuels of 75% by 2037 and an increase in renewable energy by 75% by the same year with natural gas being used as a transitional fuel. As we make this transition, let us be ever mindful of the future that we want to leave to our children. My sincere hope is that we pass on a Barbados that continues to be ever resilient by transforming this fair land to one that is more energy independent with the use of indigenous energy resources.

The Barbados National Energy Policy presents to us a course of action that, once implemented, can result in a diverse energy sector where energy is reliably produced and efficiently consumed and makes a tangible contribution, however small, to climate mitigation.

This policy at its core is designed to ensure that energy is affordable to all while powering our society on the basis of collaboration. Our task is not simply to produce energy but to do so in a manner that allows the wealth of this nation to remain in this nation. This approach can be the catalyst for creating investment opportunities, as well as increasing employment for our youth and, as a consequence, positively impacting the quality of life of Barbadians. We must therefore strive together to make this policy work, recognising that its success or failure rest in the hands of all Barbadians.

I wish to express my profound gratitude to all the stakeholders who made sterling contributions to the development of this policy. The preparation of this document was a collaborative effort that benefitted substantially from consultation with a number of persons and organisations within the private and public sector and civil society who willingly gave of their time and intellect to ensure that this policy was capable of advancing Barbados' development for the next twenty (20) years.

In particular, I wish to express sincere thanks to Dr. David Ince, a local Consultant who was commissioned to prepare this policy as well as the Research Unit of the Division of Energy and Telecommunications who worked closely with Dr. Ince.

Let us be reminded that we are on the cusp of an energy revolution in this island that will enhance the lives of all Barbadians, the island and the wider earth.

ACKNOWLEDGEMENTS

The Division of Energy and Telecommunications is grateful to all the stakeholders who contributed to the preparation of the Barbados National Energy Policy 2017 to 2037. The development of this policy benefitted substantially from consultation with a number of persons within the sector who willingly gave of their time and intellect to ensure that this policy is capable of advancing Barbados' development for the next twenty (20) years. In particular, the Division of Energy and Telecommunication wishes to express its sincere gratitude to Dr. David Ince who was commissioned to prepare this policy and the Research and Planning Unit of the Division of Energy and Telecommunications, headed by Mr. Bryan Haynes, Chief Project Analyst, who was the focal point for this initiative.

The Division also conveys its deepest gratitude to the members of the National Task Force on Energy for their willingness to consult and deliberate on the content of this document. Indeed, their contribution to the policy has resulted in a course of action that can potentially reform the economic and social development of Barbados and positively impact many generations of Barbadians. The members of the National Task Force on Energy comprise the Barbados Light and Power Company; the Barbados Chamber of Commerce and Industry; the Barbados Manufacturers' Association; the Barbados Hotel and Tourism Association; the Barbados Small Business Association; the Barbados Renewable Energy Association; the Ministry of Finance and Economic Affairs; the Ministry of Agriculture, Food, Fisheries and Water Resources Management; the Ministry of International Business, Commerce and Small Business Development; the Ministry of Labour, Social Security and Human Resource Development; the Ministry of the Environment and Drainage; the Barbados National Oil Company Limited; the University of the West Indies; the Petroleum Dealers Association; the National Petroleum Corporation; and the representatives from the major oil companies.

In developing the Barbados National Energy Policy, the Division also consulted with other key stakeholders whose contributions added significant value and are therefore deserving of special mention. These entities are the Ministry of Education, Science, Technology and Innovation; The Ministry of Transport and Works; the Fair Trading Commission; representatives of the bio-diesel and bio-gas industries; the Cane Industry Revitalisation Project, the International Renewable Energy Association and the Commonwealth Secretariat.

Finally, the excellent work of the staff and resource persons in the Division of Energy and Telecommunications who made significant contributions to the policy's development is specially recognised, particularly the input of the staff of the Research and Planning, Natural Resources, Projects and Renewable Energy Units.

Division of Energy and Telecommunications

Prime Minister's Office

December 2017



DIVISION OF ENERGY
& TELECOMMUNICATIONS



CARIBBEAN CENTRE FOR RENEWABLE
ENERGY & ENERGY EFFICIENCY





EXECUTIVE SUMMARY:

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. It was developed using a collaborative approach, which included several rounds of interviews and consultations throughout Barbados’ energy sector in 2016 and 2017. The policy also benefitted from the consideration of research and documented accounts of regional and international jurisdictions that have experienced both challenges and opportunities.

The key approach used in developing the BNEP was a Multi-Criteria Approach (MCA), where the impacts of the policies chosen were taken 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, the natural environment, technology and social development were considered in a consolidated manner.

The BNEP spans all aspects of the energy sector, and 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 is still uncertain, but there is no doubt that increased sustainability due to greater dependence on renewable energy will boost Barbados’ economic and environmental future. The policy provides direction for managing the transition and ensuring viability from all points of view along the way.

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. Indeed, 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. The BNEP provides a basis for building on these successes while seeking to expand the use of these and other renewable energy technologies such as wind and biofuels.

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

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

Major sectors of the energy economy that were identified inter alia in completing the 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
- Other Cross-Cutting Sectors

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 Vision 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 and ecology, especially in connection with public health

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

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 - regulation).

OVERALL OBJECTIVES

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

- Overall Objective 1: Achieving stability and 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 diversity in the types of energy sources used in 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 in Barbados, with a view to increasing the number of shareholders and players in the various energy subsectors (related to Visionary Goal 6).
- Overall Objective 8: Promoting more local entrepreneurial activities in renewable energy and increasing fossil fuel energy development throughout the energy sub-sectors (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 sustainable by the local economy for various energy sources consumed in 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).

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 in the development of the Implementation Plan, which is expected to emerge as the next stage of the work after the completion of the 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 to develop targets in percentage mix for energy use in GWh. These targets were set more as a basis for discussion than as absolute goals. They generated much debate throughout the consultation process and are expected to be reviewed and modified if necessary within the timeframe.

Targets can be viewed as minimum levels to be obtained. However, if stakeholders are able to exceed the targets, this would be desirable, especially if they improve financial, environmental, economic or technological performance. At the moment, no decision has been taken as to whether targets should be mandatory, but this remains an option.

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 at \$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

Rather than fossil fuels, the reduction of *heavy* fossil fuel use is specified because in the transition to a more sustainable energy mix, the use of natural gas as a bridging fossil fuel (BFF) is being considered. Despite its reduced environmental impact, natural gas is still a fossil fuel source. However, in this instance, heavy fossil fuels refer to 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. The targets below 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% increase in renewable energy and BFFs by 2037

In this approach, natural gas scenarios, factors including 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

Name of Indicator (Units)	Baseline (2015)
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 ₂ Emissions/Final Consumption (kt/BOE)	0.0029
Total No. of Persons Employed in the Energy Sector (No.)	N/A
Electricity Generation Efficiency (%)	37
Percent Share of Renewable Energy Investment of Total GDP (%)	0.6

Establishing the appropriate indicators is critical in determining an effective system of monitoring that will allow the BNEP to be updated and revised on a timely basis for 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 of renewable energy development and energy efficiency, in developing appropriate standards and indicators. Other stakeholders likely to be involved will include The Barbados Light & Power Co. Ltd (BL&P), the Barbados National Oil Co. (BNOC), the Fair Trading Commission (FTC), various government ministries in energy and other cross-cutting sectors.

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







SECTION 1:

INTRODUCTION

1 INTRODUCTION

1.1 PURPOSE OF THE BARBADOS NATIONAL ENERGY POLICY (BNEP) (2017-2037)

The BNEP was developed to provide clear direction to the government in the short, medium and long term, for the development of renewable and non-renewable aspects of energy. Issues related to energy production, energy consumption and energy efficiency are considered and addressed.

WHAT IS BNEP THE DESIGNED TO ACHIEVE?

The BNEP is intended to provide a framework to guide decision making with regard to energy development in Barbados. At the outset, it defines a broad Vision Statement followed by Visionary Goals and Overall Objectives up to 2037. Later in the document, specific objectives under the various sub-sectors are identified. There are also some recommended measures that are expected to play a role in achieving the goals identified.

It is important to note that the BNEP is NOT designed to prescribe specific, detailed actions to be taken in any of the sub-sectors identified. It also does not determine specific targets within the various sub-sectors, strategies needed within the sector, or specific roles and responsibilities of individuals or agencies that are required to achieve its stated goals and objectives.

All these aspects are undeniably important if the 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, the 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.

The policy's 20-year planning horizon allows for the assessment of long-term scenarios and impacts, with frequent reviews of the document as circumstances change. It is recommended that a policy review be undertaken at least once every five years. Modifications to policy recommendations are not only possible, but expected.

1.2 SECTION 1 OVERVIEW

This first section discusses the Barbados energy sector, highlighting achievements, activities and challenges up to 2017. The section also provides an assessment of likely present and future influencing factors on the sector from a regional and international perspective. The legislative and regulatory framework that governs activities within the energy sector in Barbados is then presented within the context of information emerging from these factors.

Charts detailing the current energy mix and associated costs are presented, as is a description of the Multi-Criteria Approach (MCA), which is used as the underlying approach for developing the BNEP.

The section sets the context for the Objectives and Targets outlined later in the document

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 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, The 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 2028.

Given the planning horizon of the 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 structure of the industry. However, details on the electricity industry and opportunities for competition or new business models are outside the scope of the 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 now stands out like a beacon of 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. There are local companies that now export to the rest of the Caribbean and even further afield. Indeed, Barbados is one of the leading countries for solar water heaters per capita, both in the western hemisphere and the world.

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 success in developing other renewable energy technologies. However, while there have been some successes, there is still much more that can be done on the island to achieve the desired level of sustainability.

Solar PV

Recent efforts in securing a more sustainable energy mix provide reason for optimism. The establishment of photovoltaic projects throughout the island in the last five years has led to many new players either getting involved or expanding in the market.

The local utility has also played its part by establishing a 10 MW solar farm.

Wind Energy

While wind energy has not taken off significantly, there are plans to develop this technology to complement 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 light of a declining sugar cane industry on the island, there is increasing confidence in the agricultural sector that there can be greater 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 in building on this experience.

Natural Gas for Domestic Cooking

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

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

Transportation

Discussions with people 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. Greater reliance on renewable energy in the production of electricity in Barbados, coupled with the use of more electric vehicles (EVs), 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 to establish suitable infrastructure for increased use of EVs and other vehicles powered by alternative fuels, the local petroleum companies are open to facilitating the change as 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. Moreover, efforts are ongoing to establish and implement efficiency standards for buildings, refrigeration and air conditioners.

BREA

Interest in pursuing renewable energy development further has been such that a new NGO, the Barbados Renewable Energy Association (BREA), was established within the last five years. BREA was created to advocate for the use of renewable energy, facilitate the continued growth of the industry, and establish standards of performance and efficiency within this new sector of the economy.

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

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 through government's drilling and exploration exercises offshore. The possibility of a significant oil or gas find could potentially lead to 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 the sustainability of the entire energy sector.

The BNEP is therefore seen as a tool to provide some direction and balance to the sometimes conflicting priorities that can occur.

Barbados Energy Roadmap - Produced by IRENA

During the development of the 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 largely on the electricity sector and the possibilities for greater efficiency, as well as an increased use of renewable energy. That roadmap identified the following goals as part of the Barbados Government's 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 goals are consistent with many of the goals presented in the roadmap and provide a framework for further actions that can be developed from it.

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 generation to be produced from renewable sources by 2030.

The BNEP takes into consideration the path identified 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 sectors will impact other cross-cutting sectors within the energy space.

Although the BNEP attempts to give direction for the Implementation Plan and activities in the various sectors, there was need for a level of flexibility to allow for the assessment and evaluation of technologies not yet considered viable, but that may become major players in the next 30 years.

The 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 the BNEP will need to be considered in the context of broader economic policy documents in other sub-sectors of the Barbados Government. This will include policies such as the industrial policy, the trade policy, the transport policy and the disaster management policy.

It is also expected that the BNEP will help in giving further guidance and streamline existing processes.

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:

- “(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 the 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 affect attitudes to spending and investments. 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. During the last 8 to 10 years, the global economy 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 solar photovoltaic (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 the development and installation of PV and other renewable energy technologies. However, as oil prices have fallen, the BL&P's Fuel Clause Adjustment (FCA) 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 at times when oil prices are both high and low. There will also be a need 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. Consequently, several governments worldwide, as a means of reducing CO₂ 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.

Volatility in oil prices is expected to continue, thereby 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 long-run. However, international oil prices are expected to fluctuate between US\$20.00 to US\$52.00 in the short to medium terms, 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 its unemployment rate. This unemployment rate has hovered between 10% and 12%. The economic challenges that Barbados faced over the last ten years have been observed through 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 was 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 away significantly from fossil-based consumption on the other hand. One of the fundamental constraints to moving towards more renewable energy sources is government's heavy reliance on the revenue derived from fossil fuel consumption. Indeed, this is a paradox because fossil fuel consumption contributes significantly to the loss of the national resource. Therefore, if Barbados is to move towards significant reduction in fossil fuel use by 2037, the Government of Barbados must overcome its dependence on such sources for revenue. This will be one of the key issues to be addressed in determining the measures and strategies in the Implementation Plan which follows the BNEP and for the long-term energy development of Barbados.

1.5.2 CLIMATE CHANGE

In seeking to develop the 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 caused largely by carbon dioxide emissions related to the combustion of fossil fuels. The economic consequence of fossil fuel consumption in Barbados is that there is a loss of resources through foreign exchange, efficiency and environmental costs. Analysis 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.



Barbados is vulnerable to the impact of climate change

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 some 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 a 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. 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. Therefore, some traditional natural gas producers, such as Trinidad and Tobago, have lost market share in locations such as the US. Also, there has been greater incentive to look for markets in the Caribbean, including Barbados, to purchase this natural gas. The 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 sub-sector as an important element to reducing Barbados' dependence is warranted. 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. The 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 like 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 is discussed later when considering specific challenges to renewable energy development and associated targets.

1.6 REGULATORY AND LEGISLATIVE CONTEXT

In developing the 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 relevant to the fossil fuel sector and 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 established the *Offshore Petroleum Act* and the *Offshore Petroleum Taxation Act* in 2007. These Acts contain the rules governing the exploration and production of offshore oil in Barbados and consider the limits and optimum levels of production to 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 the 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 electric 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 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, incorporating revisions 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* (SEFB) 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, 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 shown 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 BL&P residential customers.
- **A/C Rebate Trade in Facility (BDS\$3 million):** A 50% rebate to residences and businesses, which replace older air conditioners with 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 in an attempt to build on many aspects of the *Draft Energy Policy* developed in 2007. The 2013 document emphasised the sustainable production and use of various energy resources. Efficient use of fossil fuel production and consumption, along with the development of renewable energy technologies, were the key areas of focus of this draft policy.

Further incentive for developing renewable energy technologies, was given through the establishment of the Renewable Energy Rider (RER) proposed by BL&P and approved by the FTC in 2010. The RER allowed 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 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 PV and \$0.315/kWh for wind energy, for systems up to 500 kW of installed capacity.

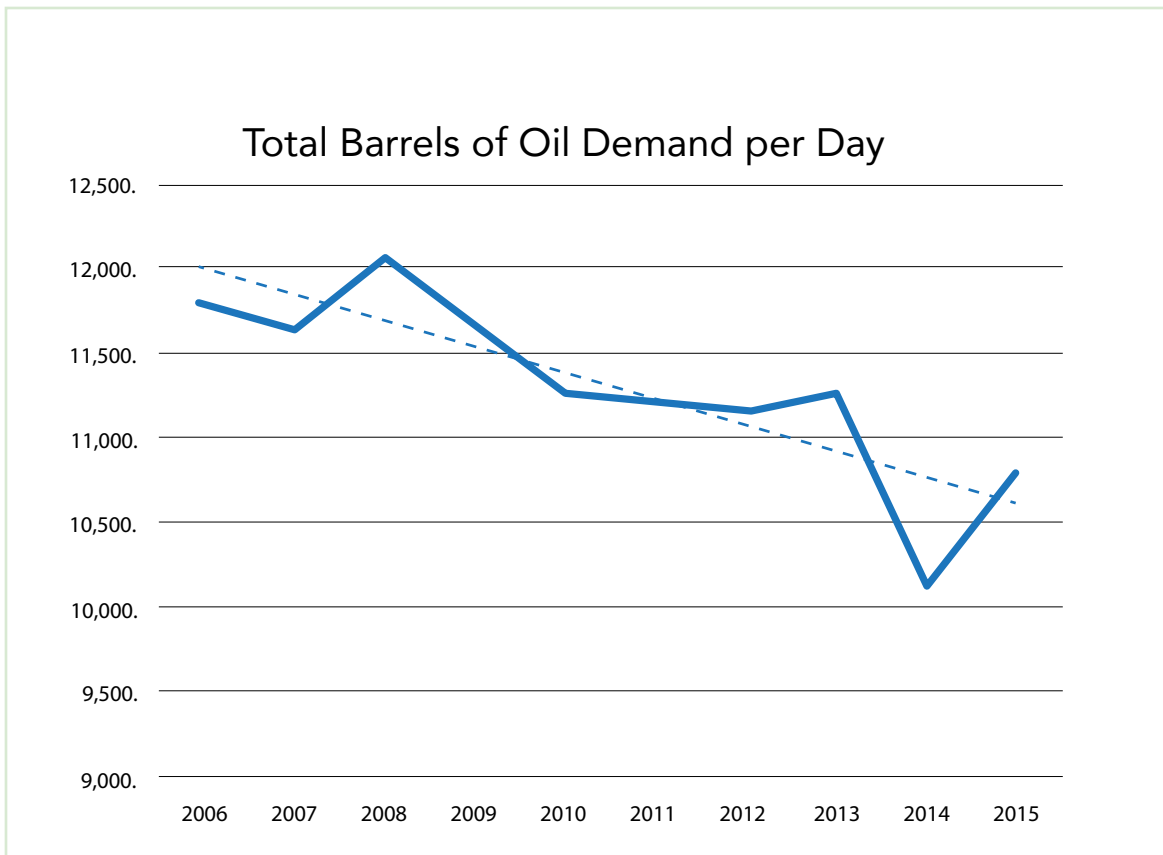
A list of the energy projects and programmes undertaken by the Division of Energy and Telecommunications during the period 2009 to 2017 is attached to this document.

The 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

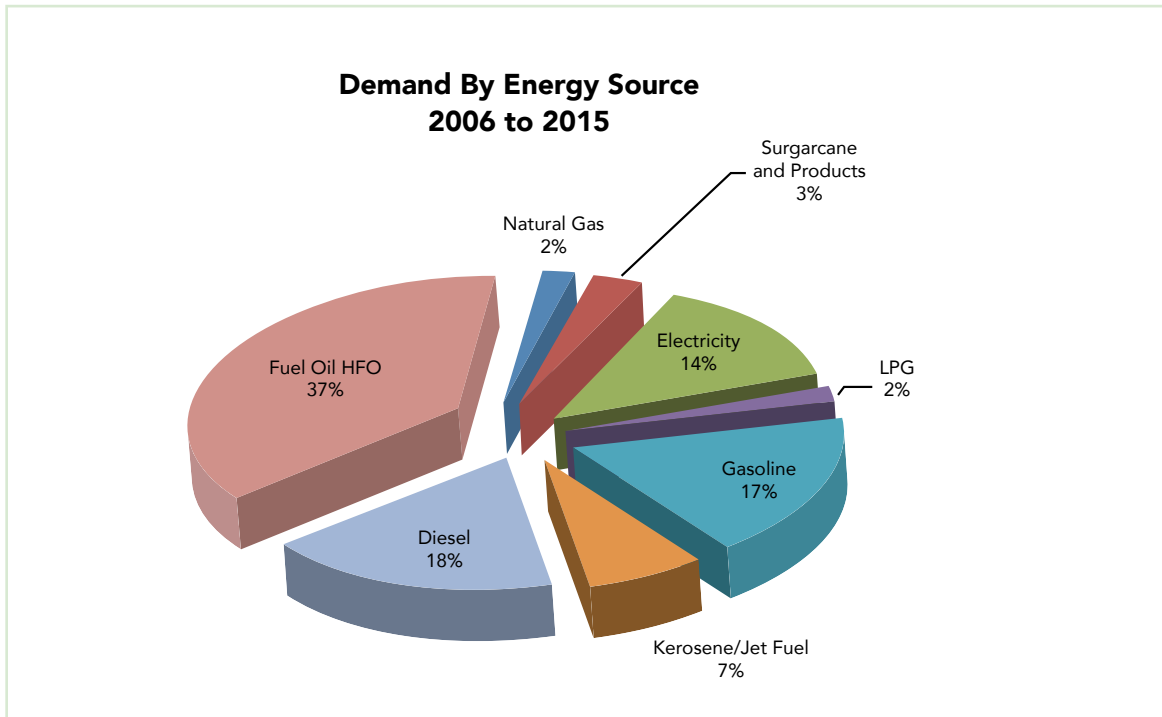
The demand for energy in Barbados over the last ten years is characterized by a declining trend. The average demand of primary and secondary energy was estimated at 11,297 BOE per day. Energy demand over the period declined, reflecting the economic challenges that Barbados has been facing. Barbados’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

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%
- - 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, adding only 2% to the energy mix. However, its widespread use in Barbados for (domestic) cooking, and various activities in the tourism and industrial sectors, has had a considerable social impact. The benefit of this fuel source is that it is less carbon intensive than other fossil fuels. This can also lead to stability in prices, as natural gas does not have the same level of price as heavy fuel oil. The use of natural gas in Barbados may well increase in the long term, due to current exploration for oil and gas offshore, as well as importation, stability in world pricing and improvements in technologies. However, 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 amounts for domestic consumption and sale on the international market.

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

Oil was discovered in Barbados as far back as the 18th century. Currently, oil that is produced on the island is sent to Trinidad for refining. The Barbados National Oil Company (BNOC) is a government-owned company that produces oil and gas onshore, 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 700 BOPD. Regarding natural gas, the equivalent of 500 BOPD are produced by BNOC under the operation of the National Petroleum Corporation (NPC). BNOC and the NPC are being merged into one entity.

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%



North Substation, Maynards, St Peter, Barbados

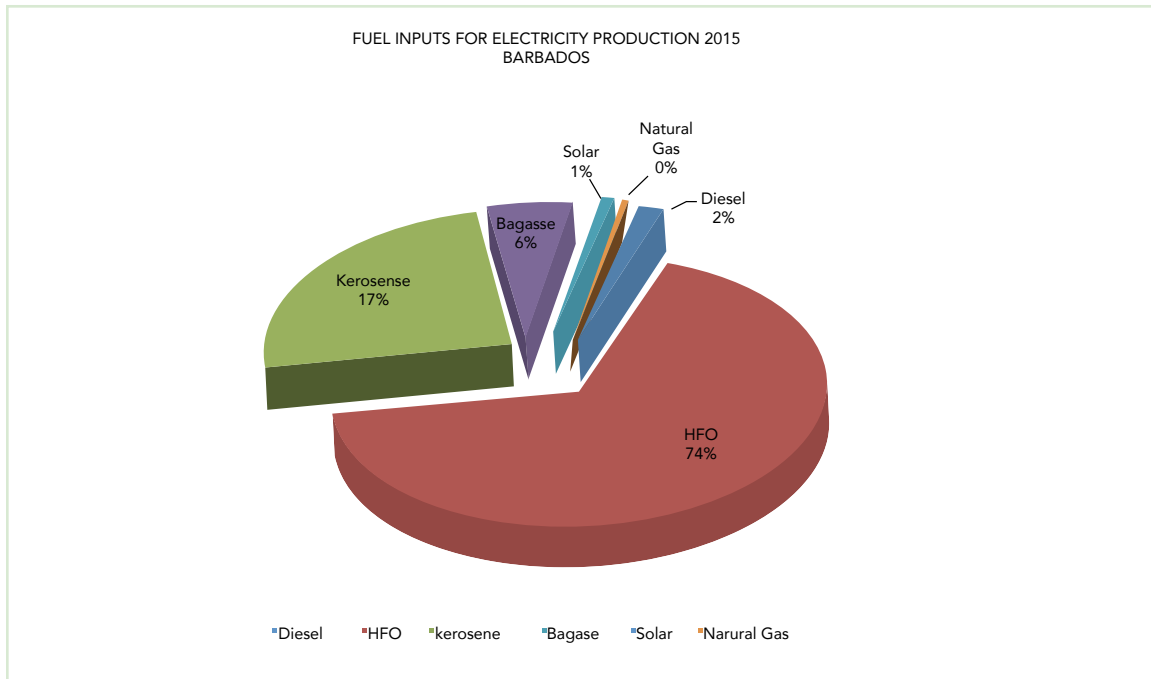
The configuration above demonstrates the high trade dependence required for Barbados to produce its electricity. However, in 2016, Barbados' production capacity for solar electricity increased from 10MW to over 22 MW, contributing an estimated 2.4% of the total electricity distributed. The table and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

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.

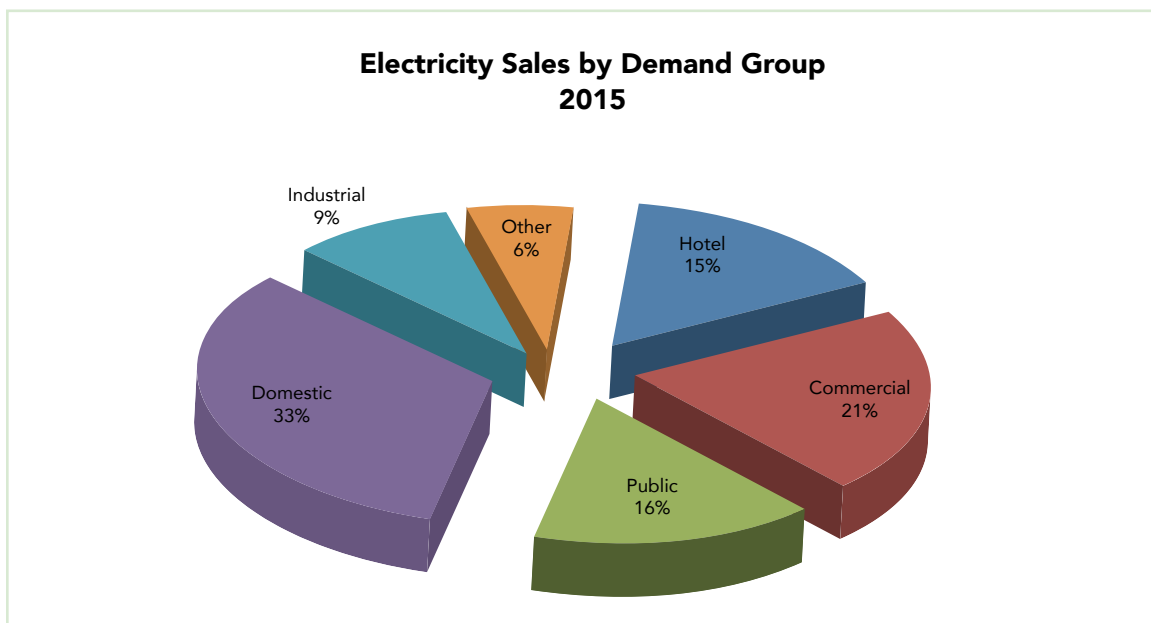
Figure 3 – Fuel Inputs for Electricity Production 2015 Barbados



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

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

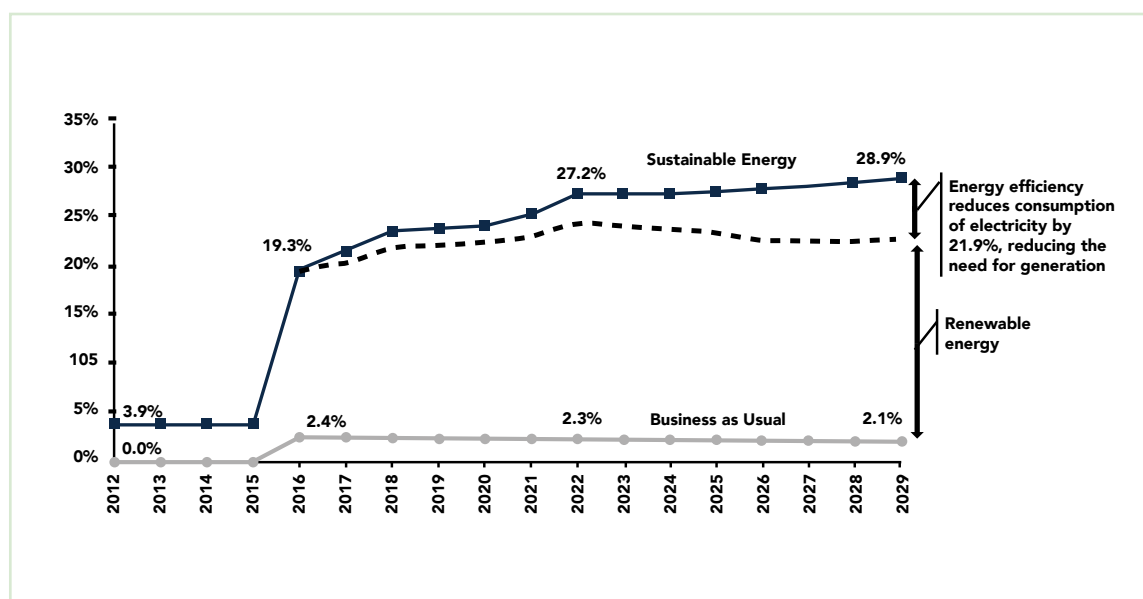
Figure 4 – Electricity Sales by Demand Group



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. 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, and the Barbados economy produced on average, BDS\$8.00 from every KWh produced and distributed. The BNEP seeks to build on the value that the electricity sector brings to Barbados by introducing the appropriate energy sources and ensuring that the highest level of efficiency in electricity generation 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 electricity producers.

Barbados hopes to steadily increase its share of renewable energy in the local market, widening 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. This is according to the *Draft National Sustainable Energy Policy for Barbados, 2013*, which 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 target could lead to high electricity prices if only solar PV installation is undertaken. 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 - a 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 2013 *Draft National Sustainable Energy Policy for Barbados*, as ways 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.

The BNEP further considers these issues as it seeks to provide strategies for overcoming some of the limitations to sustainable development in Barbados.

1.8 MULTI-CRITERIA APPROACH (MCA)

Given the previous discussions 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). The BNEP attempts to achieve sustainability in the energy sector by using a Multi-Criteria Approach.

In seeking to determine the ideal option or path of energy development, this policy will consider the broad economic, environmental and social impacts. This means that an option with a higher per kilowatt-hour cost may still be chosen if it is deemed to have a lower environmental impact or can provide wider social gains.

In all of the sub-sectors, various stakeholders are encouraged to consider 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 section were chosen. See Section 2 for further details on the specific model used to determine the targets.

Consideration was given to the use of rankings and weights for the model. However, at this stage, given the number of stakeholders to be considered, and the contextual precedence allotted to value or objective, these aspects were omitted. Nevertheless, it is possible that they will be considered while the Implementation Plan is being developed.



SECTION 2:

PRELIMINARY ENERGY MIX TARGETS

2. PRELIMINARY ENERGY MIX TARGETS

2. PRELIMINARY ENERGY MIX TARGETS

Using the MCA to determine the energy mix targets discussed below, some key factors were considered, including:

- 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
- 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 Barbados' competitiveness was not negatively impacted over the twenty-year planning horizon of the 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 greater 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.

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 is that in order for the country to make substantial progress towards a more sustainable energy mix, government will likely be required to provide further incentives.

The energy mix target in the BNEP consists of renewable energy, variable and intermittent technologies, as well as cleaner fossil fuels such as natural gas. The target proposed in the BNEP requires 75% reduction in total heavy fossil fuel (heavy fuel oil, diesel, gasoline, kerosene and LPG) consumption, and replacement with the following:

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

(These percentages refer to energy and NOT installed capacity)

This suggested mix is based only on current prices and predicted availability, and may change as further developments in renewable resources and technology occur, together with the exploration of natural gas over the next five to ten years.

Details on how these percentages were determined are given under section 2.1.

They translate into energy output and installed capacity as follows:

Table 3 - 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 ^{3**}
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 intended that the BNEP will allow for the targets to be modified by the DET in accordance with rules that they will define in consultation with stakeholders in the energy sector. The expectation is that under the BNEP, the DET will be able to adjust the targets by a maximum of 40MW for 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 11000 BOE/day to 5400 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 positions natural gas as a potential bridge to the eventual and complete removal of fossil fuels from Barbados' energy consumption pattern. 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 additional renewable energy sources to replace more intermediate and peaking plant continue.

Natural gas is not a renewable energy source, and the intention is not to characterise it as such in this document. However, in including it as a source that can take the mix away from more carbon intensive options such as diesel, jet fuel and heavy fuel oil, natural gas can play a role in developing a more sustainable energy mix.

Some of the natural gas being discussed is produced from renewable biogas sources. 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, the use of natural gas for electricity production could increase the cost of production if the volumes are not at significant levels to utilise 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 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 contribute significantly to sustainability in the energy and agricultural sectors in the medium to long term.

Biomass, which is expected to consist of bagasse, king grass and river tamarind, was allocated the largest portion of the mix among the renewables. Its production costs were among the lowest for renewables, at \$0.28 per kWh. Moreover, it could contribute effectively to base load energy production. However, 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. While 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 benefits discussed above, a reduction in the volume of heavy fossil fuels currently used in energy generation will have to occur by the following increments 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

Rather than discussing a reduction in fossil fuels, the 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 being considered. Despite its reduced environmental impact, natural gas is still a fossil fuel source. In this instance, heavy fossil fuels refer to 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. Targets are expressed below 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

2.1 POLICY ANALYSIS MATRIX (PAM) – THE ANALYTICAL TOOL

One of the principal tools used in the MCA was the Policy Analysis Matrix (PAM), which uses a partial equilibrium approach, and provides a convenient way of estimating divergence. This allows 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 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 4 below presents the basic structure of the PAM used for the purposes of this paper.

Table 4 - 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, and 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)

DRC is the value of domestic inputs at economic prices to the value-added at economic prices. Therefore, the interpretation of the 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 and domestic resources at private prices.

Economic Profit

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



SECTION 3:

VISION, GOALS, AND OVERALL OBJECTIVES

3. VISION, GOALS, AND OVERALL

3.1 STRUCTURE

The BNEP provides a broad policy framework, which has a Vision Statement, Visionary Goals, Overall Objectives, and Specific Objectives that are presented at different levels of abstraction. Higher levels of abstractions present statements that are more general and over-arching 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 viewed 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 the 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 is important to make sure that each level of abstraction flows directly 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 Vision Statement. This statement flows into 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 into 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 Vision 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 100 %.
- Overall Objective: Increasing diversity in the types of energy sources used in both the renewable and fossil fuels sectors.
- Specific Objective: A renewable energy sector that has a greater involvement of smaller investors in the system.
- * Measure: Establish a system to ensure protection of intellectual property and patents.

The Vision 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 the assessment of issues identified in previous policy documents prepared for Barbados and members of CARICOM. *The CARICOM Energy Policy* and the *Jamaica National Energy Policy* were 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 believed 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, regardless of 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 and ecology, especially in 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% (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



The following Overall Objectives were developed from the Visionary Goals. These objectives are not specific to any sector within the industry but are relevant to the general energy sector:

- Overall Objective 1:** Achieving stability and 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 diversity in the types of energy sources used in 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 in Barbados, with a view to increasing the number of shareholders and players in the various energy subsectors (related to Visionary Goal 6).
- Overall Objective 8:** Promoting more local entrepreneurial activities in renewable energy and increasing fossil fuel energy development throughout the energy sub-sectors (related to Visionary Goal 6).
- Overall Objective 9:** Increasing collaboration within the energy sub-sectors 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 sustainable by the local economy for various energy sources consumed in 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

DANGER
HIGH VOLTAGE
KEEP OUT

4. SECTOR SPECIFIC OBJECTIVES & MEASURES

4.1 INTRODUCTION

The following Sector Specific Objectives emerged from the Overall Objectives in Section 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 focuses on both the renewable and fossil fuel energy sectors. A critical part of the policy sets a path for the necessary transition from a fossil fuel economy to one based primarily on renewable energy. Cognisant that the transition will be gradual, Barbados has also turned its attention to exploring for hydrocarbon resources in its Exclusive Economic Zone. Indeed, the 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.

Meanwhile, it was felt that oil and gas discoveries in Barbados should be developed in a way that strengthens the overall economy and 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 that seek to increase natural gas use as a bridging fuel in the 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
- 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 Section 3. These objectives relate to the stability of supply, efficiency of operation, development of indigenous and 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 deep water oil and gas exploration, drilling and production. These advances have made deep water basins more economic to explore. Developments that improved efficiency have occurred in areas such as compression systems, pipeline technology and drilling equipment, making 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.



Steeply dipping beds in the Chalky Mount member, St Andrew, Barbados

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 diversity in the types of energy sources used in 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 will result in a sector that:

- Ensures the 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 the National Petroleum Corporation (NPC) and Barbados National Oil Company (BNOOC) as the implementing agencies for government policies in various energy areas.
- Maximises 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 the 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 processes 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 in Barbados' Exclusive Economic Zone, all relevant entities in Barbados shall work together to:

- 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 the 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.
- Formulate clear legislation governing environmental management in offshore 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 for employment in the emerging oil and gas offshore sector.
- Create an enabling environment that will empower local businesses to participate effectively in the supply of goods and services to the offshore oil and gas sector.
- Offer 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 used effectively.
- Develop an unambiguous system for determining whether a future gas find should be used for export or included as part of the domestic market.
- Produce legislation that identifies limits on the amount of oil and gas resources that can be exploited in the short term.
- Build a defence and security framework to protect the Exclusive Economic Zone.



Pumpjack extracting oil in Barbados

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 BL&P's Renewable Energy Rider. Despite these successes, there is still a lot that can be done to expand solar thermal and PV technologies to their full potential, and extend 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 increasing the use of solar water heaters as far as it is financially and economically feasible. 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. The potential for these and other innovations in renewable energy to be exported to other Caribbean markets, offering the opportunity for further entrepreneurship in Barbados, should also be considered. If such markets were developed, Barbados could establish a goal in the medium and long term to be a renewable energy hub for the Caribbean.

Similarly, there is also potential for research into improving efficiencies and designs of some of the existing solar and renewable energy technologies.

There is a need to identify overall strategies to increase the penetration of renewable energy technologies in the energy generation mix, while at the same time identifying the appropriate level of development of specific renewable energy technologies for Barbados. Proposed targets for renewable energy are outlined in Section 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 the 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 emerging renewable energy technologies that may become more feasible for development over the planning horizon of the 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 4.

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

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.

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.



Solar farm at Trents, St Lucy, Barbados

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

- Reduced importation and consumption of fossil fuels, which result in loss of foreign exchange
- More efficient energy producing technologies
- dependence on fossil fuel
- Preservation of Barbados' natural environment

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 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.
- Shows greater involvement of smaller investors in the system, playing an important role in sector decision making.
- Exhibits 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 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 optimum diversification of energy resources in 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.
- Demonstrates a clear understanding of roles and accountability for installation and maintenance of new renewable energy systems.
- Provides strong NGO representation, with the capacity to promote awareness and understanding of issues in the general community.
- Establishes clear measurements of indicators and standards for various renewable energy technologies.
- Maximises the amount of manufacturing or assembly of renewable energy products within the country that is financially and economically viable.
- Optimises training opportunities in the application of established and emerging renewable energy technologies;
- Offers appropriate tax incentives to motivate investment in new renewable energy technologies that are adjusted with the maturity of technology.
- Operates within a regulatory regime that incentivises investment.
- Shows an increased use of renewable energy in vehicles (e.g. biofuels and electric vehicles).

- Promotes 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).
- Offers a programme that allows for low income households to benefit from renewable energy installations such as solar water heaters, PV and wind.
- Shows a high level of transparency in the granting of licenses to players within the renewable energy sector.
- Encourages technicians highly skilled in the 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.
- Allows effective collaboration and coordination of players in the renewable energy industry.
- Incorporates a programme to stimulate job creation within the renewable energy sector
- Includes a clear system for end-of-life disposal of renewable energy equipment and associated technologies such as batteries.
- Places greater emphasis on the development of renewable energy technologies ideally suited to Barbados or Caribbean conditions.

Sector Objectives Specific to Solar Energy

A sector that:

- Encourages greater penetration of solar water heaters as far as is financially and economically feasible for residential customers.
- Supports greater 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.
- Demonstrates 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 greater integration of electric installation companies into the solar PV and other renewable energy grid connected technology industries.
- Makes use of economies of scale that can be gained through utility scale solar installations, to ensure viability and sustainability.

Sector Objectives Specific to Bio-energy

A sector that:

- Shows increased use of liquid fuels prepared from local crops on unused land (e.g. bio-diesel) to replace imported fossil fuel where feasible.
- Requires larger farms to install capacity on site for producing biogas for electricity production.
- Uses streamlined systems for waste management/separation to facilitate waste to energy projects.
- Allocates an adequate amount of agricultural land for development of bio-energy.
- Includes the production of bio-diesel for transportation.
- Optimises land used in the production of energy from bio-fuels.
- Supports a bio-methane industry based on fermentation technologies, and with clearly defined markets.
- Articulates clearly established standards for methane production from biogas.
- Provides several options to promote flexibility in energy supply.
- Provides specific regulations for the storage of bio-methane.
- Clearly regulates health, safety and the environment.
- Provides appropriate fiscal and financial support framework for the bio-methane industry.
- Accommodates strong systems to support research and development.



Biogas digester while under construction

Sector Objectives Specific to Wind Energy

A sector that:

- Provides 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 the 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.
- Encourages 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 storage 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 is expected to become more prominent.

Even with grid-connected renewable energy, there are limits for renewable energy penetration. *The Barbados Solar and Wind Integration 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 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. At the moment, however, there is no storage option that can lead to any of the intermittent renewable energy becoming a base load source. Furthermore, significant investment in research and development of energy storage technology will be required to help satisfy the long-term vision of attaining 100% of energy produced from renewable energy.

At this point in the process, there are no specific targets set for storage technologies. However, 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:

- Commands access to research detailing the potential for use of various energy storage technologies such as batteries, pumped storage, and compressed air.
- Articulates standards for energy storage technologies that are used in combination with renewable energy technologies.
- Provides 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 and Storage

In order to achieve a sustainable transition to a sector more strongly based on renewable energy, all relevant entities in Barbados shall work together to:

- Diversify and optimize the renewable energy mix that results in the maximisation 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 and 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 technically sound, and is financially, economically and environmentally viable.
- Establish a program of international financing and ‘in kind’ assistance that effectively supports the supply of renewable energy, and promotes Barbados’ economic growth and competitiveness.
- Increase staffing (secretariat) and human capacity to support local NGOs such as BREA.
- Develop 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.
- Provide regular and clear communication to the public on developments within the renewable energy industry.
- Institute efficiency standards for manufacturing 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.
- Create a system to ensure the protection of intellectual property and patents for renewable energy technologies.
- Define land areas for bio-energy and wind production in Barbados’ Physical Development Plan.
- Establish and support infrastructure for the collection, handling, and processing of organic material to produce energy.
- Provide fiscal and financial support for research and development in bio-energy technologies and methods.
- Develop standards of production for bio-methane from biogas.
- Create standards for electricity generation efficiency in the bio-energy, wind energy and other renewable energy sub sectors.

- Produce a legislative and regulatory framework for bio-energy production, distribution, storage, and plant decommissioning.
- Devise a strategy for expanding Barbados' renewable energy markets into the Caribbean.
- Establish a transparent decision protocol for choosing between energy storage measures.
- Create clear guidelines for integration of battery technology in PV systems.
- Implement proven storage technologies and systems that promote renewable energy and are economically, environmentally and financially viable.
- Establish 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 to provide more output for less input improves both the economic and environmental performance of any technology. Looking across the planning horizon of the BNEP, it is expected that the economy will experience growth, and potentially increase the demand for energy. In promoting energy efficiency and conservation, growth across 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.



Striving for an energy sector that focuses on sustainability and conservation

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

The 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 energy efficiency is further emphasised in Overall Objective 10.

Overall Objective 10: Improving the efficiency in the production and consumption of energy products within the various sub-sectors.

The importance of energy efficiency and its overarching role in improving sustainability throughout the sectors, make it sufficiently significant to merit its own policy or plan emerging from the BNEP. For this reason the development of an Energy Efficiency Plan is included among the recommended measures below. The Energy Efficiency Plan would have sub-sections to consider areas of energy management and planning, lighting and exterior energy efficiency activities.

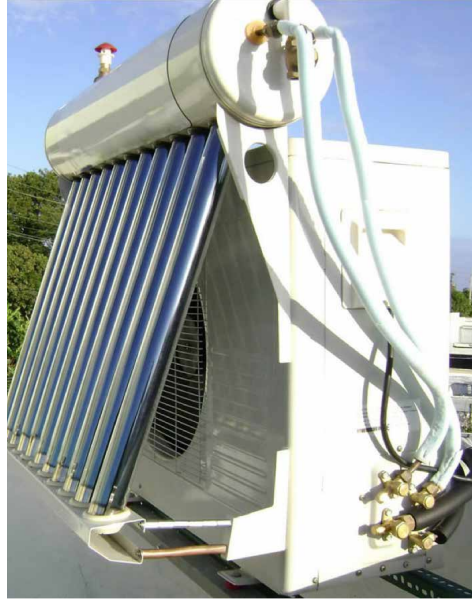
The BNEP seeks to address and promote energy efficiency activities through the following:

- 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
- Human resources development

Energy Efficiency and Conservation Sector Specific Objectives

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

- Establishes efficiency standards for manufacturing of local renewable energy products.
- Provides energy efficiency standards for importation of electrical and electronic equipment into Barbados.
- Creates an energy efficiency labelling protocol for electric and electronic equipment.
- Integrates energy efficiency activities with renewable energy, and views renewable energy as energy efficiency with zero cost.
- Establishes retrofits or energy efficiency where feasible; e.g. replacing florescent bulbs with LED lights.
- Considers energy efficiency alongside renewable energy development in an integrated approach to sustainability throughout the sector.



Solar air conditioning unit

Policy Measures - Energy Efficiency and Conservation

- To improve the efficiency of energy use in the country, all relevant entities in Barbados shall work together to:
- Establish efficiency standards governing electricity production for utility and distribution-scale operations.
- Develop a maximum useful life and cost/performance ratio of operations for generation equipment.
- Create legislation and regulations to govern movement towards greater energy efficiency in businesses and residences in Barbados.
- Craft an energy efficiency plan as a policy guideline document.
- Develop an energy conservation education and awareness programme that will promote lifestyle changes among Barbadians with regard to energy consumption.
- Promote energy efficiency in the productive and trading sectors.
- Develop sectoral energy efficiency and consumption standards for buildings, and encode them in the Town and Country Planning Act.
- Establish or adopt business standards for the design of energy efficient homes and offices.
- Create energy efficiency standards for appliances and equipment used for residential, commercial and industrial purposes.
- Provide equity for households that are unable to pay for energy efficiency retrofits and products.
- Develop a set of regulations in tandem with all government ministries involved in the energy sector, which identifies a clear and defined process for new applicants in energy efficiency projects.

- Produce a system of duties, taxes and economic incentives to promote greater use of high-efficiency energy technologies.
- Implement standards for insulation in buildings.
- Use Life Cycle Analysis to determine the best materials to be used 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 appropriately. The involvement of the utility is also important in promoting demand-side management and energy efficiency within various customer classes.

Given that 50% of energy used in Barbados is provided by the electricity utility, more renewable sources in the generation of electricity will go a long way towards reaching long-term targets. It is important that the electric utility is clear on government's long-term strategy to ensure that decisions regarding technological investments are made in support of the targets. The utility should also play a part in setting the targets and establishing plans for the transition towards a grid using more renewable energy and 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.



Half of all energy in Barbados is provided by the electricity utility.

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

Electricity Sector Specific Objectives

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

Overall Objective 1: Achieving stability and 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 the 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 with regard to licensing is important if the utility is 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 7.

Overall Objective 7: Encouraging local investment in energy projects and programmes in Barbados, with a view to increasing the number of shareholders and players in the various energy subsectors.

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

- Provides a reliable service, minimizing brownouts and blackouts.
- Offers 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%).
- Expresses 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 write-off of sunken assets by BL&P, NPC, BNOB and other electricity producing entities that may be regulated.
- Provides clear rules defining investments for firm capacity and intermittent capacity.
- Demarcates obligations for provision of universal service between the incumbent utility and potential new renewable energy players.
- Defines an optimum mix of technologies in renewable energy, i.e. percentage to be provided by wind, solar, biomass etc.
- Provides guidance on optimising the 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 fuels in electricity generation where financially and economically feasible.
- Maximises the potential in using storage technologies to improve the dispatch of supply.



Generating Plant, Spring Garden, St. Michael, Barbados

- Articulates clear rules on how utility planning should be undertaken; moving away from a least cost model to an MCA sustainable model.
- Demonstrates transparency in the roles of the utility, the government ministry and the regulator in establishing long-term planning and integration of IPPs in the new competitive market.
- Prioritises reduction of carbon emissions in line with climate change, and national and global targets.
- Increases the 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.
- Provides clear and transparent rules for dispatch of generation, with assigned roles and responsibilities.
- Offers streamlined and transparent rules determining the issue of licenses for IPPs (could be an auctioning or RFP process by an independent body).
- Establishes a market with the maximum participation of local entrepreneurs and international partners that can be accommodated.
- Develops an equitable and stable pricing regime that is consistent with social and environmental values.
- Provides financial incentives for investors that promote renewable or more sustainable energy sources.
- Creates tariff and pricing regimes for the utility that include consideration of the cost of storage technologies.
- Includes the integration of SMART grid technologies.
- Improves 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, all relevant entities in Barbados shall work together to:

- Establish electric market structures that reduce the effects of monopolistic operations where financially and economically feasible.
- Create a pricing mechanism for electricity from renewable energy suppliers.
- Devise protocols for interconnectivity between IPPs and the utility to supply electricity.
- Expand electricity regulation to include the wide ranging aspects of the market, generation, distribution, supply, dispatch, transmission, and electricity use within the electricity sector.
- Produce 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. Institute targets for limits on CO₂ emissions in the electricity sector.

- Promote the use of renewable and other clean sources of energy to produce electricity.
- Develop clear rules for determining roles and timelines for updating the Integrated Resource Plan.
- Use SMART meters as part of an advanced communication infrastructure for distribution management, to facilitate the use of more intermittent technologies and aid in demand-side management.



Aerial view of a solar energy farm at Trents, St Lucy, Barbados

4.5 ENERGY AND TRANSPORTATION

The transportation sector is a large consumer of fossil fuel and, therefore, a significant contributor to greenhouse gas emissions in Barbados. Transportation is responsible for about 33% of energy consumed on the local energy sector. Given 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 technological development and issues of management and organisation within the sector. There is also a need for focus on infrastructure 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 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.



The public transport system consumes a large amount of fossil fuels

Consequently, the 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
- 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, thereby giving rise to a sector that:

- Operates with a greater percentage of electric vehicles (EVs) and hybrid vehicles in the local fleet.
- Utilises a skilled workforce available to provide effective maintenance on EVs.
- Provides more information 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 and charging stations).
- Reduces the duties on the importation of EVs.
- Uses more batteries and other storage technology to facilitate the charging of vehicles 24 hours per day.
- Offers greater concessions in infrastructural cost to encourage more local automobile dealers to be involved in the EV market.
- Collects more detailed information on the number of EVs, hybrids and other alternative fuel vehicles in the country.
- Includes the use of EVs, biofuels, and other alternative fuels in public transport.
- Uses fewer vehicles per capita to reduce the level of traffic congestion in the country.
- Provides more convenient and attractive public transport options to consumers.

- Sensitises the public to the benefits of using mass public transit rather than private cars.
- Has created a disaggregated sector plan.
- Has defined a consistent transportation policy that makes investment in new technologies worthwhile.
- Supports a well maintained system of charging stations at strategic points in the country.
- Owns a fleet with a greater average performance efficiency of vehicles in Barbados.

Policy Measures Transport Sector

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

- Create biofuel standards for wholesale and retail supply of vehicles.
- Establish a transportation information system to provide data for transportation and energy policies, strategic planning, tracking of CO2 emissions, and environmental impacts.



Electric Vehicle (EV)

- 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 it with ethanol and bio-diesel.
- Promote linkages with the agriculture sector to encourage the production of agro-energy crops where financially and economically viable.

- Encourage energy efficiency in the transportation sector.
- Provide tax incentives to vehicle dealerships that train 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 and encourage a scheduled approach to increasing their use in the national transportation fleet, while at the same time, not harming government's revenue stream.
- Develop a road network that promotes energy efficiency.
- Establish the use of management technology in public transit, e.g. using smartphone apps to verify arrival times of buses.
- Create 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.
- Integrate charging stations with traditional gas stations.
- Construct more charging stations for EVs.
- Control and maintain CO2 emissions at levels consistent with local and global climate change targets.
- Establish a system that facilitates the change from traditional vehicles to those powered by renewable energy, taking transition costs into consideration.
- Implement standards for streetlight efficiency.
- Provide cost incentives that encourage investment in required infrastructure with charging stations etc.
- Acquire more details on the number of vehicles using each fuel type.
- Establish standards in charging and other renewable energy infrastructure related to fuelling.
- 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.



Solar Power panels on a beach facility in Silver Sands, Barbados

Given the focus on long-term health and environmental issues related to marine life, ground water and air quality, it is important to explore the impact of energy, the environment and associated costs. This pertains 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 13: Reducing the environmental impacts associated with the production and use of energy resources locally.

The 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
- 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 a strong flow of information on the environmental effects of various types of energy production technologies in the energy sector and the wider society.
- Provides infrastructure that allows the authorities responsible for environmental protection to assess and monitor environmental standards in 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.
- Requires (through 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.



Coastline of the Eastern side of Barbados

Policy Measures -Energy and the Environment

To ensure that environmental concerns and objectives are addressed fully, all relevant entities in Barbados shall work together to establish:

- Standards and protocols for the safe and effective disposal of equipment and devices in the energy sector.

- A sustainable environmental management framework for the upstream offshore petroleum sector.
- A decommissioning fund for the energy sector to facilitate the decommissioning and abandonment of energy operations and facilities.
- Standards and protocols for energy production in the petroleum and renewable energy sub-sectors that promote and encourage the goal of zero harm to the people and the environment.
- Information systems and infrastructure that promote the flow of information requiring environmental standards, best practices and legislation.
- Studies within the sector that assess the correlation between carbon dioxide emissions and health risks (e.g. cancer and 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 occurrences that could severely impact Barbados' economy and those of other SIDS.

It is therefore in Barbados and other small islands' interest to lead the way internationally in promoting the 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 reduction of CO₂ emissions by promoting the use of clean and renewable energy.
- Fosters collaboration and cooperation amongst all stakeholders to reduce CO₂ emissions.



View of coastal landscape at Pico Teneriffe in St Peter, Barbados

- Works with international investors and agencies to finance climate change mitigation initiatives.
- Establishes a baseline database for the level of greenhouse gases associated with economic and developmental activities in the various sectors.

Policy Measures for Climate Change

To achieve success in the reduction of CO₂ emissions within the energy sector, all relevant entities in Barbados shall work together to:

- Create a mechanism to cap and trade CO₂ emissions within the Barbados energy sector.
- Provide a trade facility that allows holders of CO₂ emissions permits to trade with other emitters of CO₂.
- Develop strong rules for capping CO₂ emissions.
- Establish a clear international agenda for the acquisition of climate change funding.



Demonstration home in Queen's Park, Barbados

4.7 HUMAN RESOURCES AND INSTITUTIONS: CAPACITY AND DEVELOPMENT

In order for the 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 11 and 12 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 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.

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.

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
- Capacity development and institutional strengthening



Solar panels installed on the roof of a school, Barbados

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.
- Maintains standards of qualification for all aspects of the energy sector, especially in renewable energy.
- Maximises information sharing between educational institutions and the energy sector in establishing school curricula, and degree and vocational programmes.
- Incorporates new skills relevant to emerging, conventional and renewable energy sectors into syllabi in tertiary institutions such as the Barbados Community College (BCC), the Samuel Jackman Prescod Polytechnic (SJPP), and the University of the West Indies (UWI).
- Offers an increased number of scholarships for persons interested in studying new areas related to renewable energy and aspects of sustainability in the oil and gas sector.
- Allows for the flow of energy information from regional institutions to the local environment, and from local industry to regional institutions.
- Uses more qualified persons in conducting energy audits.
- Emphasizes the concept of 'innovation' in energy-related curricula at various levels of education.
- Uses various media regularly to communicate with the general public about issues relevant to energy policy and sustainable energy development in the country.
- Maximises the commercialisation of new and renewable energy technologies in the country.

- Offers significant internship opportunities in energy technology development in the private sector.
- Provides significant opportunities for the private sector to sponsor local energy development projects.
- Facilitates financial contributions from the general public for the development of various projects.
- Makes greater use of international standards and best practices in the development of the energy sector.
- Encourages the pursuit of vocational skills that are important in building an effective renewable energy sector through support of institutions such as the Technical Vocational and Education Training (TVET) Council.
- Creates an environment that motivates personal entrepreneurship in areas of small business development in energy-related fields.
- Provides a community teaching programme in renewable energy.
- Offers clear levels of acceptable standards of service for various energy products, with the 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, all relevant entities in Barbados shall work together to:

- Develop energy studies curricula for secondary and tertiary institutions.
- Establish a knowledge base for the energy sector within an appropriate institutional framework.
- Develop an energy workbook that makes use of an integrated approach, including general concepts in math, science, etc.
- Formulate a partnership between stakeholders within the energy sector and the Ministry of Education.
- Create an information network between the energy and educational sectors to communicate requirements pertaining to skills and expertise.
- Mobilise funding for training and development of persons employed in the energy sector, and fields of disciplines that support it.
- 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 the timely supply of data and information to the Barbados National Energy Information System.
- Establish regional and international agendas to develop technical capacity.
- Implement guidelines for the adaptation, 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 the electricity and natural gas sub-sectors.
- Enable an effective system of knowledge transfer of higher order energy skills available in international institutions to local educational and vocational facilities.
- Establish an educational system that supports efforts for entrepreneurship in the energy sector.
- Introduce research programmes that illustrate the link between the development of the local energy sector and the economy.
- Create new jobs throughout the energy industry that increase overall employment opportunities in Barbados;
- Empower a working group, including members of educational institutions and the energy sector to ensure the on-going relevance of education in the changing energy environment.
- Institute demonstration projects that illustrate innovation and the 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, touching 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 will be impacted by energy production or consumption practices.

It is possible that along the planning horizon of the BNEP, other sectors will be added as they become more significant in terms of their impacts on the overall energy sector. During this time, the 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 ensure synchronicity and harmony in all policies relating to the Barbados economy.

The importance of the cross-cutting approach is summarised in Overall Objective 9.

Overall Objective 9: 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 bio-fuels. 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 its 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 to complement bagasse production from sugar cane.

More activity and discussions in these areas are expected. Sustainability in agriculture will help safeguard 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 agricultural sector that:

- Maximises the use of bagasse from the sugar cane industry and king grass to generate electricity that can be used within the industry and/or sold to the utility.
- Maintains efficient sugar production processes and supports products made from sugar cane.
- Optimises the use of waste heat produced in agriculture for cogeneration.
- Makes use of available land to maximise production using energy technologies to improve the yields and diversity of products.
- Has increased commercial viability of sugar cane and the overall agricultural industry through efficiency improvements.
- Incorporates biomass (possibly river tamarind) as an off-season fuel to complement bagasse fuel production.
- Uses a higher percentage of bio-gas, bio-fuels, bagasse and other biomass, such as king grass, to produce greater price stability.



Agricultural-Energy linkage is central to sustainable development in Barbados

- Uses more electricity in services such as cooking, in order to create additional applications for renewable energy.
- Includes the use of ethanol from sugar cane in the transportation sector to replace MTBE.



A field with king grass and sugarcane growing side by side

- Establishes a virtual museum to demonstrate various aspects of the sugar industry and linkages relating to energy and sustainability.
- Increases the use of biomass, while reducing reliance on fossil fuel in the manufacture of plastics.

4.8.2 TOURISM

The tourism sector is a major contributor to the Barbados economy. The success of the industry relies, in part, on maintaining the natural environment; specifically marine and coastal resources, and air and water quality. A programme that highlights the importance of protecting these resources for citizens and visitors to the island will be of great benefit. Energy conservation, efficiency and promotion of renewable energy are key elements in these activities relating to the Vision Statement and Visionary Goals of the BNEP.

Sustainable tourism is also a way for Barbados to market its tourism product more broadly, as a greater number of visitors are becoming aware of environmental issues, and are taking them into consideration when choosing a vacation destination.

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

Solar thermal energy for air conditioning is another potential area of growth if the appropriate incentives are implemented. International environmental standards, such as “Green Globe” or “EarthCheck,” could lead to a greater focus on renewable energy and energy efficiency standards across the sector.

Integrating hotel operations with activities in industries, such as the rental car business, can extend energy sustainability efforts in the area of transport, which is another key energy sector.

In addition, the expanding tourism sector is currently responsible for a considerable amount of the electricity demand on the island. Therefore, energy efficiency improvements in this sector, and the uptake of renewable energy, will enhance the energy sustainability potential of the country. In this regard, it would be useful to focus on areas such as refrigeration, air conditioning, lighting, industrial cleaning and cooking.

Tourism Sector Specific Objectives

A sector that:

- Integrates EVs and other renewable energy vehicles within into the rental car business and other tourism-related services.
- Develops an educational programme for hotel guests and tourists in Barbados, emphasizing the importance of energy efficiency and environmental conservation.
- Allows the electric utility to invest in the hotel sector in a way that will reduce the hotels’ overall energy costs and help 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 facilitate better cost-control planning and budgeting.
- Provides further incentives to promote the use of solar water heaters and solar cooling technology for air conditioning.
- Supports a programme to encourage hotels to achieve international energy efficiency and environmental standards such as “EarthCheck.”



Aerial view of Saint Peter, Barbados

Industry, Manufacturing and Construction

Over the last decade, the Barbados economy has expanded in the industrial sectors, with an increase in manufacturing. This expansion has resulted in 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 because of 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 prices at which goods are sold 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, as such, areas of sustainability and energy efficiency 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 the Waste Management 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 environmental impact of waste materials such as non-biodegradable plastics can also be significant and, with the development of an effective waste separation system, there is potential for more recycling efforts. Alternative ways of waste disposal, including incineration, have been considered in Barbados. Options such as these will have an impact on energy consumption, which will in turn affect the cost of waste management.

In addition to how waste management is impacted by 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. Various 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 garbage entering the landfill and increasing the use of indigenous energy resources in Barbados.

4.8.4 WASTE MANAGEMENT SECTOR SPECIFIC OBJECTIVES

A sector that:

- Maximises the use of waste resources in industrial processes for the generation of electricity within the industry and to the grid.
- Provides a clear assessment of the potential of identified waste products in generating electricity based on availability and energy calorific content.
- Minimises the impacts of wastewater production in generating electricity and other manufacturing processes.

Water

Protection and maintenance of a good quality supply of water has also become a source of concern. Barbados is supplied entirely by ground water aquifers, although there have been efforts to develop additional desalination plants. 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, the BWA has explored renewable energy options such as solar and wind energy for generating electricity on its premises.

It is important that within this policy, the link between water conservation 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 the BWA decides to pursue an energy source that is separate from the grid. The loss of the BWA as a customer to BL&P could result in increased tariffs for customers that stay on the grid. In this situation, BL&P 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 the 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.
- Includes the use of renewable energy technology to reduce the overall demand and environmental impact 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. Nitrous and sulphur oxides associated with burning fossil fuels for 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 the replacement of MTBE by ethanol or gasohol has been explored as an alternative. There are also safety considerations when it comes to interconnection of renewable energy technologies to the grid. For example, there is danger of electrocution to technicians on lines for distributed renewable energy generation flowing back to the centralized grid.



Barbados is susceptible to the impact of environmental factors

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 be 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:

- Supports health and safety, with clear standards and protocols for establishing and maintaining new renewable energy systems.
- Establishes studies that quantify the link between energy use and various health ailments observed in Barbados.
- 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 associated with climate change and other impacts that affect the environment.

Overall Objective 13: 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. The 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
- 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 the 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 capabilities and resources for rapid disaster management.

- 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 the location of generation plant consider 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, all relevant entities in Barbados shall work together to:

- Promote balanced land use for energy and food production.
- Encourage energy efficiency for irrigation and animal production.
- Support the use of fisheries and agricultural waste for bio-energy production.
- Promote energy efficiency within the industrial, agricultural and tourism sectors by employing internationally recognized efficiency standards.
- Bolster the use of waste from the industrial, agricultural and tourism sectors, along with other municipal sources to produce energy where feasible.
- Establish legislation and regulations to encourage the safe disposal of waste from the energy sector.
- Implement time-of-use rates for the manufacturing sector in order to improve overall efficiency.
- Develop programmes to highlight possible uses for 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;
- Formulate and implement a building code, focusing on aspects such as passive cooling, energy efficiency and general 'green building' solutions.
- Introduce standards to ensure the safety of renewable energy systems in the event of a natural disaster.
- Establish renewable energy resources that could provide relief in the wake of a natural disaster.
- Develop protocols for disaster management in service stations and charging stations with renewable energy infrastructure.
- Create an energy sector disaster response plan.
- Review legislation in the energy sector to enshrine the principle of zero harm.
- Offer economic incentives to give hotels the opportunity to provide more energy efficiency and renewable energy products.
- Introduce a pilot project to illustrate the impact of renewable energy and energy efficiency measures on the overall economy.

4.9 TRADE IN GOODS AND SERVICES WITHIN THE ENERGY SECTOR

The continued development of the energy sector necessitates an enabling environment that promotes the capacity of Barbadian companies to provide goods and services competitively. Although maximum growth in renewable and sustainable energy will depend largely 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.



An energy sector that encourages local and international investment

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

Overall Objective 7: Encouraging local investment in energy projects and programmes in Barbados, with a view to increasing the number of shareholders and players in the various energy sub-sectors.

Overall Objective 8: Promoting more local entrepreneurial activities in renewable energy and increasing fossil fuel energy development throughout the energy sub-sectors.

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

There are currently a number of local enterprises that are supplying renewable energy products and services in Barbados. The BNEP will provide for a course of action to promote the vigorous participation of local enterprises in all aspects of the energy sector. These include the development and implementation of an enabling environment that facilitates local content for:

- Exploration and production of oil and gas offshore in Barbados
- Renewable energy operations

Trade in Energy Specific Objectives

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

- Addresses the barriers restricting participation in emerging renewable energy markets.
- Offers financial terms to encourage small businesses to enter the renewable energy market.
- Provides local investors with 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.

- Maintains 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, all relevant entities in Barbados shall work together to:

- Strengthen networks between renewable energy businesses to foster greater collaboration.
- Develop a database of potential local projects in renewable and non-renewable energy, and the investment and skills needed.
- Minimise all barriers to entering the renewable energy market.
- Promote the enabling infrastructure that will encourage the establishment of financial mechanisms to fund renewable energy.
- Determine the needs and readiness of local firms and suppliers of goods and services to meet the standards of supply for the offshore oil and gas sector.
- Review and adjust government's regulatory and operational framework to allow an enabling environment for local companies to acquire the standards of supply.



Providing affordable energy to all citizens of Barbados

Establish legislation and regulations to govern the modes of supply for electricity from renewable energy sources.

4.10 ENERGY ACCESS AND INFRASTRUCTURE

Over the years, Barbados has 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 will become more difficult and expensive to acquire. The policy will tackle the 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:

- Guarantees that access to electricity is extended and maintained for all citizens of Barbados.
- Possesses a developed electricity and energy infrastructure 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, all relevant entities in Barbados shall work together to:

- Establish an energy mix that promotes affordable energy prices.
- Formulate legislative and regulatory requirements within the energy sector to contain excessive pricing.
- Promote market structures that encourage transparent, competitive and stable energy pricing.
- Introduce a lifeline rate for persons unable to afford the 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 that allows investment to flow. The 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



Investing in the renewable energy sector in Barbados

- Resource requirements for energy sector development
- Information mobilization and investment
- Investment scheduling

Investment and Financing Sector Objectives

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

- Maintains an optimum level of private and public sector investment for development of energy projects in Barbados.
- Operates with 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, all relevant entities in Barbados shall work together to:

- Establish rules to guide local and overseas developers on requirements for investing in Barbados' oil and gas sector.
- Create a local content programme for the upstream petroleum sector.
- Develop local investment and ownership within the renewable energy sub-sector where feasible.
- Promote foreign/local partnerships for investment within the energy sector.
- Build a business enabling framework that allows for timely and easy establishment of operations.
- Improve the flow of information within the energy sector to ensure access to all available sources of financing (equity, debt and grant).
- Ensure that 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 despite the technological 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 which provide for changes to be made 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 wider stakeholder group.

Moreover, when such powers of discretion exist for the minister, there should be a system of considerations in place to inform the decisions to the extent that it is possible.

In other instances, new legislation will be needed, but there are other situations where modifications might be required to facilitate the policy direction. Legislation exists in some areas, but additional legal instruments and procedural rules are needed to bring it to the point where it can be implemented.

Visionary Goal 8 and Overall Objective 3 point to the key issues of focus in establishing an effective system of governance, regulation and legislation.

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

Overall Objective 3: Establishing a consistent and comprehensive regulatory framework to govern activities in various energy sub-sectors.

In relation to the governance and regulatory framework, the 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 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.
- Develop regimes for the 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 business activities in both the renewable and oil and gas sectors in Barbados.
- Develops and identifies the specific agencies responsible for the governance of business activities in the renewable energy and oil and gas sectors.
- Promotes the use of multi-criteria analysis for decision makers responsible 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, all relevant entities in Barbados shall work together to:

- Undertake a project to establish procedural rules to support all of the existing legislation governing the renewable energy and oil and gas sectors.
- Conduct sensitisation 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 Section 4 and the sector targets given in Section 2, a number of associated targets are provided here.

The approach in designing the targets considered the overall impact of the measures on the economy, government and civil society. This technique of assessment is consistent with the Multi-Criteria Approach (MCA) discussed earlier.

In this approach, natural gas scenarios and 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 in the sectors, wherever possible, for the measures outlined in Section 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

Name of Indicator (Units)	Baseline (2015)	2022
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 ₂ Emissions/Final Consumption (kt/BOE)	0.0029	
Total No. of Persons Employed in the Energy Sector (No.)	N/A	
Electricity Generation Efficiency (%)	37	
Percent Share of Renewable Energy Investment of Total GDP (%)	0.6	



SECTION 6:

DEVELOPMENT OF INDICATORS & MONITORING SYSTEM

6. DEVELOPMENT OF INDICATORS AND MONITORING SYSTEM

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

The targets developed will need to be SMART.

Specific

Measurable

Achievable

Relevant

Time 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 monitoring system that will allow timely policy updates and revisions to ensure continuous improvement. A full list of indicators is included at the end of the section.

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

It is possible that the indicators identified will be used to established targets for the sector. These may ultimately be mandatory or voluntary. Decisions on whether to implement mandatory standards will be based on the resources needed to administer and enforce them, and whether they are likely to reduce innovation. 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 when forming any legislation to support the policy and the Implementation Plan. Even if the targets are not mandatory, the Government of Barbados will need to outline a plan of action should targets not be achieved.

ENERGY POLICY PERFORMANCE INDICATORS

PERFORMANCE OF ENERGY SECTOR

	Baseline 2015	2022	2027	2032	2037
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/Capita)	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				
RENEWABLE ENERGY					
Percentage Share Of The Renewable Energy Supply In The Total Energy Supply For Given Period (%)	2.00%				
Percentage Share Of The Solar Supply In The Total Energy Supply For Given Period (%)	0.30%				
Percentage 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 (%)					
Percentage Share Of The Electricity Generated From Renewable Supply In The Total Electricity Generated For Given Period (%)	14.00%				
Percentage Share Of The Electricity Generated For Solar Supply In The Total Electricity Generated For Given Period (%)	1.70%				
Percent Share Of The Electricity Generated For Biomass Supply In The Total Electricity Generated For 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				

	Baseline 2015	2022	2027	2032	2037
ELECTRICITY					
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					
	Baseline 2015	2022	2027	2032	2036
ENERGY AND TRANSPORTATION					
Percentage Share Of Biofuels Of The Total Energy Supply To The Transportation Sector (%)					
Percent Share Of Electricity Of The Total Energy Supply To The Transportation Sector (%)					
Percentage 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					
ENERGY EFFICIENCY AND ENERGY CONSERVATION					
Residential Sector					
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 (%)	37				

	Baseline 2015	2022	2027	2032	2037
ENERGY AND THE ENVIRONMENT					
CO2 Emissions / Final Consumption (Kt/BOE)	0.003				
CO2 Emissions Intensity (Gg/MUS\$) - CARBON DIOXIDE	0.001				
CO2 Industrial Emissions/Industrial Energy Consum. (Kt/BOE) - CARBON DIOXIDE	2.094				
CO2 Industrial Emissions/Industrial Energy Consum. (Kt/BOE) - HYDROCARBONS	0.001				
CO2 Transport Emissions/Transport Energy Consum. (Kt/BOE) - CARBON DIOXIDE	0.432				
CO2 Transport Emissions/Transport Energy Consum. (Kt/BOE) - HYDROCARBONS	0.000				
Per Capita total CO2 Emissions (Gg/khab) - CARBON DIOXIDE	29.450				
Per Capita Total CO2 Emissions (Gg/khab) - HYDROCARBONS	0.006				
Total Emissions Intensity With Respect To GDP (Ton/MUS\$) - HYDROCARBONS	0.408				
Percentage Increase In The Use Of Cleaner Technologies (%)					
ENERGY INVESTMENT AND FINANCING					
Percentage Share Of Energy Investment Of Total GDP (Current Prices)					
Percentage Share Of Energy Investment Of Total Investment					
Percentage Share Of Renewable Energy Investment Of Total Energy Investment					
Percentage 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)					
HUMAN RESOURCES DEVELOPMENT					
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					

	Baseline 2015	2022	2027	2032	2037
CROSS-CUTTING SECTOR					
Agriculture					
Total amount of Land Used To Produce Agro-energy Crops	0				
Total Amount Of Agricultural 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					
Manufacturing/Industrial					
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					
Water Management					
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					
Tourism					
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					
Waste Management					
Total Amount Of Waste Used In The Production Of Energy (MT)					

	Baseline 2015	2022	2027	2032	2037
CROSS-CUTTING SECTOR					
Agriculture					
Total amount of Land Used To Produce Agro-energy Crops	0				
Total Amount Of Agricultural 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					
Manufacturing/Industrial					
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					
Water Management					
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					
Tourism					
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					
Waste Management					
Total Amount Of Waste Used In The Production Of Energy (MT)					

	Baseline 2015	2022	2027	2032	2037
ECONOMIC CONTRIBUTION AND COST					
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				
Average Utility Rate - Independent Power Producer (\$/Kwh):					
Wind	\$0.315				
Solar Electric	\$0.416				
Biomass					
Biogas					
Waste to Energy					
Other					

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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



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