Renewable Energy Technology and the Hotel Sector of Small Island Developing States (SIDS): Managing Sustainability Transitions on the Island of Barbados

By:
Martyn Henry de Boulay Forde

A thesis submitted in conformity with the requirements for the degree of a Master of Arts in Geography with a collaborative in Environmental Studies

The Graduate Department of Geography and Planning
University of Toronto

©Copyright by Martyn Henry de Boulay Forde (2014)
Abstract

Renewable Energy Technology and the Hotel Sector of Small Island Developing States (SIDS):
Managing Sustainability Transitions on the Island of Barbados

Martyn Henry de Boulay Forde

Master of Arts in Geography and Environmental Studies

Geography and Planning Department

University of Toronto

2014

This thesis examines the barriers to renewable energy technology within the hotel sector of Barbados. The topic is approached using the theoretical perspective of transition management. An economic analysis of renewable energy technologies applicable to Barbados is coupled with the insights of stakeholder interviews. Consequently, the space created for hotels to implement innovations in renewable energy technology is discussed. In particular, identified barriers are used to characterize the existing energy regime on the island. The categories of barriers identified are: institutional, market, economic, technical and socio-cultural. Despite favorable levelized costs of electricity for renewable energy technologies there must be new governance activities and market-based approaches to facilitate an energy transition within island hotels.
Acknowledgements

I want to begin by thanking my thesis committee for their assistance throughout my time at the University of Toronto. I wish to thank my supervisor, Dr. Danny Harvey for all of his support during my research and his trust in my abilities during my undergraduate and graduate years. I was inspired by his knowledge of renewable energy technologies and his passion for tackling climate change. I want to thank Dr. Virginia Maclaren for her patience, guidance and constant encouragement. Thank you to Dr. Joe Leydon for helping me find new ways of thinking about my research after my time away from school. Thank you to Dr. Rodney White and Dr. Michael Bunce for your valuable influences.

To all the people of my life in and outside of the department, my friends, colleagues and teammates, I could not have finished this without you. I want to especially thank Gaby Sauter for believing in me, being patient, challenging me, keeping me sane, and encouraging me to keep pushing forward! Thanks to Fidel Reijerse, Dr. Winz Casagrande, Dr. Leonard Nurse, and Dr. Peter Rychwalski for your mentorship. Thanks to Terrence Haynes and Kaie Warner for giving me an engineer’s perspective. Thanks to Mr. Charles Tibbits, Alan Warner, Allen and Tatanya Benjamin, Justin Jeffers, Justin Emtage, Sharisse Dukhu, Renee Campbell, Zack Chetrat, Serguei Bagrianski, Bobby Savulich, George Bovell, Tim Ross, Esther Lambert, Kevin Roy, Ulrike Rippke, Jacob Nigro, the Wolf Pack, Mary-Kay Bachour, Sharlene Fernandez, Nikki Hassell, Nicky Neckles, Brian Clarke, Aneeka Hopkin, Guisa Ahmed, Gete Berhe, Simone Walker, Ajahni Seale, Zahra Rosa, Susanne Clarke, Jamila Headley, Zahra Williams and Alana Brooks, Cheyoka Miranda, Melanie Watts, Machel Forde for your reassurances throughout my studies. Thanks to my coaches David Farmer, Byron Macdonald, Linda Kiefer, Mark Hill and Mike Bottom, Jay Fitzgerald, Jack Nelson, and Abdul Sheriff for teaching me the importance of perseverance. Thanks to my research participants and anyone who assisted me in this work.

Thanks to my extended family: the Pearlmutter family, Phillips family, Goodman family, the Zerpa/Riera family, the Hoytes, the Greaves, the Mannings, Aunty Sheila, the Lauries, the Allys, Mum Layne, and the Walker/King families, the Brennan Family, my brothers Nicholas and Patrick Forde, Aunty Monica, Mrs. Payne, Heather, Vivian, Rowe, Greenidge and Iris. Thank you to my godmother, Dame Patricia Symmonds for encouraging me to go further in my studies. Thank you to Aunt Olga for operating on three different levels and always providing the bigger picture. To Uncle John Manning, you are never forgotten and the commitment to issues of land-use in Barbados demonstrated in your book The Land Owners was inspirational for my work.

Above all, thanks be to God and my immediate family for their love and support throughout all of my life’s endeavors. I love you and can’t thank you enough. Mum and Dad you have always encouraged me to pursue my ambitions and selflessly offered guidance throughout my journey. To Uncle Roddy and my brother Ryan, you have both been the voices of rationality throughout this time. Grandpa, thank you for always exposing me to photographs or discussions of social issues concerning Barbados. I will always remember our conversations and when you showed me the train tracks that existed on the island. To Gran and Grandpa, may you rest in peace, thank you for your examples and my work is dedicated to you!
## Contents

**ABSTRACT** ............................................................................................................................. II

**ACKNOWLEDGEMENTS** ............................................................................................................ III

**CONTENTS** ................................................................................................................................ IV

**LIST OF TABLES** ...................................................................................................................... IX

**LIST OF FIGURES** .................................................................................................................... X

1. **INTRODUCTION** ...................................................................................................................... 1

   1.1 **RESEARCH PROBLEM** ..................................................................................................... 1

   1.2 **RESEARCH CONTEXT AND OBJECTIVES** ....................................................................... 2

   1.3 **RESEARCH CONTRIBUTION** .............................................................................................. 3

   1.4 **CHAPTER OUTLINE** .......................................................................................................... 3

2. **THEORETICAL PERSPECTIVES** ............................................................................................ 5

   2.1 **INTRODUCTION** ............................................................................................................... 5

   2.2 **DEVELOPMENT THEORY** .................................................................................................. 5

       2.2.1 **Rethinking Sustainable Development** ......................................................................... 6

   2.3 **TRANSITION MANAGEMENT** ........................................................................................... 7

       2.3.1 **Complexity and Adaptive Governance** ......................................................................... 7

       2.3.2 **The Multilevel Perspective (MLP)** ............................................................................... 8

           2.3.2.1 Niche-innovations (micro-level) .................................................................................. 8

           2.3.2.2 Socio-technical Regime (meso-level) ......................................................................... 8

           2.3.2.3 Socio-technical Landscape (macro-level) ................................................................... 9

           2.3.2.4 Multiple Actors ........................................................................................................... 9

           2.3.2.5 Windows of Opportunity and Action Space ................................................................10

       2.3.3 **Governance Activities** ................................................................................................11

       2.3.4 **Typologies of Transitions** .......................................................................................... 12

       2.3.5 **Criticisms and New Research Agendas of Transition Management** ............................ 14

           2.3.5.1 The importance of Agency and Power ......................................................................... 14

           2.3.5.2 The Need for Greater Conceptual Specification .......................................................... 15

           2.3.5.3 Focus Beyond Niche-Driven Change .......................................................................... 15

           2.3.5.4 The MLP as a Heuristic Device and Methodology .................................................... 16

           2.3.5.5 Greater attention to the landscape level ..................................................................... 16

           2.3.5.6 Space, Scale and the Geography of Transitions ......................................................... 16

           2.3.5.7 Transition in Practice .................................................................................................. 17

   2.4 **THE APPLICATION OF TRANSITION MANAGEMENT TO MY RESEARCH** ....................... 18

   2.5 **SUMMARY** .................................................................................................................... 21

3. **SUN, SAND, SEA AND FOSSIL FUELS- ENERGY AND TOURISM IN BARBADOS** .................. 23
3.1 INTRODUCTION .................................................................................................................. 23
3.2 ENERGY SUPPLY IN BARBADOS .................................................................................. 23
3.3 ELECTRICITY GENERATION AND DEMAND IN BARBADOS .......................................................... 26
  3.3.1 Electricity Use by Economic Sector ................................................................................ 29
  3.3.2 Energy use within hotels ................................................................................................. 31
3.4 THE COST OF FUEL AND ELECTRICITY PRICING ......................................................... 32
3.5 ELECTRICITY REGULATION AND ENERGY INCENTIVES IN BARBADOS ......................... 36
  3.5.1 Legislative framework .................................................................................................... 36
  3.5.2 Governmental Energy Incentives .................................................................................... 37
  3.1.1 Utility Energy Incentives ................................................................................................. 39
3.6 PLANNING FOR DEVELOPMENT ...................................................................................... 40
  3.6.1 From Sugar to Sand ........................................................................................................ 40
  3.6.2 Tourism Today ................................................................................................................ 44
  3.6.3 Agenda for Future Energy Use ........................................................................................ 45
3.7 SUMMARY .......................................................................................................................... 47

4 INTERVIEWS, STUDY DESIGN AND RESEARCH METHODS .................................................. 48
4.1 INTRODUCTION .................................................................................................................. 48
4.2 MIXED METHODS APPROACH .......................................................................................... 48
  4.2.1 Grounded Theory ........................................................................................................... 49
4.3 GAINING ACCESS AND RESPONDENT SAMPLE .................................................................. 52
4.4 DATA COLLECTION AND ANALYSIS ................................................................................ 54
  4.4.1 Semi-structured interviews ............................................................................................ 54
    4.4.1.1 Informed Consent, Recording and Transcription ....................................................... 54
    4.4.1.2 Coding and the use of Computer Assisted Qualitative Data Analysis Software ...... 55
  4.4.2 Secondary Data Sources ................................................................................................. 56
  4.4.3 Hotel Observation and Photography .............................................................................. 57
4.5 CONCERNS AND LIMITATIONS WHEN CONDUCTING RESEARCH ................................. 58
  4.5.1 Power and reflexivity ....................................................................................................... 58
  4.5.2 Rigour ................................................................................................................................ 59
  4.5.3 Access to Information ...................................................................................................... 60
4.6 SUMMARY .......................................................................................................................... 60

5 RESULTS: AN ECONOMIC ANALYSIS OF RENEWABLE ENERGY TECHNOLOGIES IN BARBADOS...... 61
5.1 INTRODUCTION .................................................................................................................. 61
5.2 LEVELIZED COST OF ELECTRICITY (LCOE) ..................................................................... 61
  5.2.1 Inputs and the Levelized Cost of Electricity Calculation ............................................... 62
6.4.4.1 Access to Information ........................................................................................................... 115
6.5 MARKET BARRIERS .......................................................................................................................... 115
6.5.1 Restructuring of the Electricity Market ...................................................................................... 116
6.5.2 Manufacturing and Establishing Economies of Scale ............................................................... 117
  6.5.2.1 Competition and Manufacturing Logistics ............................................................................. 118
6.5.3 Competition with Natural Gas, Low Fuel Prices and Energy Companies .............................. 120
6.5.4 Hotel Competition ..................................................................................................................... 121
6.5.5 The Market for Energy Efficiency ............................................................................................. 123
6.5.6 Research and Development ...................................................................................................... 124
6.6 ECONOMIC BARRIERS ....................................................................................................................... 124
6.6.1 The Recession and the Investment Climate ................................................................................. 125
  6.6.1.1 Credit Ratings Impacts .......................................................................................................... 125
  6.6.1.2 Labour and Hotel Seasonality ............................................................................................... 127
6.6.2 Upfront Cost of Systems and the Cost of Capital ...................................................................... 128
6.6.3 Funding Opportunities ............................................................................................................... 128
  6.6.3.1 Self-financing of RET Systems .............................................................................................. 128
  6.6.3.2 Debt-financing via Commercial Banks .................................................................................. 129
  6.6.3.3 Private Investors and development partners ......................................................................... 130
  6.6.3.4 Government Grants, the Central Bank and Development Banks ........................................ 130
6.7 TECHNICAL BARRIERS .................................................................................................................... 133
  6.7.1 Choosing the site for the technology ...................................................................................... 133
    6.7.1.1 Aesthetic Concerns ............................................................................................................ 134
  6.7.2 Climatic Conditions .................................................................................................................. 137
  6.7.3 Grid Characteristics .................................................................................................................. 138
6.8 SUMMARY ......................................................................................................................................... 139
7 ANALYSIS AND DISCUSSION ............................................................................................................. 141
7.1 INTRODUCTION ............................................................................................................................... 141
7.2 TRANSITION MANAGEMENT AND THE CHARACTERIZING THE ENERGY REGIME IN BARBADOS ............................................................................................................. 142
  7.2.1 Governance activities .............................................................................................................. 142
    7.2.1.1 Strategic ............................................................................................................................. 142
    7.2.1.2 Tactical ............................................................................................................................. 143
    7.2.1.3 Operational ....................................................................................................................... 143
    7.2.1.4 Reflexive Activities and Cycles of Learning ...................................................................... 144
  7.2.2 The Multi-Level Perspective, Selective Pressure, and Adaptation in Barbados .................. 144
    7.2.2.1 Landscape ......................................................................................................................... 144
    7.2.2.2 Regime ............................................................................................................................. 145
    7.2.2.3 Niche ................................................................................................................................. 148
7.2.2.4 Protective Space and Empowerment ................................................................. 149
7.2.2.5 Windows of Opportunity and Steering? ............................................................. 149
7.3 RECOMMENDATIONS............................................................................................... 150
7.3.1 Governmental Recommendations ......................................................................... 150
  7.3.1.1 Legislated Measures and Regulatory Reforms .................................................... 150
  7.3.1.2 Land-use/Environmental Reforms ..................................................................... 153
  7.3.1.3 Integration of RETs into Building Codes ............................................................ 154
  7.3.1.4 Tax Policy Reform: Operational Framework, Added Allowances and Workshops. ......................................................................................................................... 154
  7.3.1.2 Information Portals and Awareness Campaign..................................................... 155
7.3.2 Financial Institutions ............................................................................................. 155
7.3.3 Utility Recommendations ....................................................................................... 155
  7.3.3.1 Grid Penetration Study and Storage Options for RETs ....................................... 155
  7.3.3.2 Extend the Time of Use and Interruptible Service Rider Programs to Hotels .... 156
  7.3.3.3 Avoid Hydrocarbon Lock-In of Electricity Infrastructure .................................. 156
  7.3.3.4 On-bill Financing ............................................................................................. 156
  7.3.3.5 Wheeling .......................................................................................................... 157
7.3.4 Hotel Recommendations ....................................................................................... 158
  7.3.4.1 Community/Employee Coownership Models .................................................... 158
  7.3.4.2 Tourist owned energy and development of a Hotel Sector Renewable Energy Fund .......................................................... 159
  7.3.4.3 Collaboration with University of West Indies and Global Research Initiatives ... 160
  7.3.4.4 Energy for Villas and Small Hotels .................................................................. 160
7.3.5 Energy Service Companies Business Models ..................................................... 160
  7.3.5.1 Leasing of Technology....................................................................................... 160
  7.3.5.2 Integrated Energy Contracting ......................................................................... 161
7.4 LIMITATIONS AND FUTURE RESEARCH ............................................................... 161
7.5 CONCLUSION .......................................................................................................... 163
8 APPENDIXES .............................................................................................................. 164
  8.1 APPENDIX A: UTILITY INFORMATION ................................................................. 164
  8.2 APPENDIX B: METHODS MATERIALS ................................................................. 168
  8.3 APPENDIX C: ECONOMIC CALCULATION MATERIALS .................................... 169
  8.4 APPENDIX D: GOVERNANCE INFORMATION ....................................................... 173
9 REFERENCES ............................................................................................................. 182
List of Tables

Table 3-1: Characteristics of Barbados Light and Power Company Limited’s Power Generation Plant. (Source: BL&PC 2012; Castalia 2010). .................................................................................................................................................. 29

Table 4-1: Description of Respondents in Research Sample and Assigned Names ................................................................................................................. 53

Table 5-1: Inputs for Levelized Cost of Electricity for Fossil Fuel-Based Electricity Generation (BL&PC 2012a; BL&PC 2014; BSS 2013) ........................................................................................................................................... 67

Table 5-2: Contribution of Fuel Component to Electricity Costs ($/kWh) of Fossil Fuel Based Generation Technologies for the Three Forecast of Fuel Price Escalation (BL&PC 2012a). ........................................................................................................ 68

Table 5-3: Inputs for the Levelized Cost of Electricity Calculation for Renewable Energy Technologies .......................................................................... 75

Table 5-4: Cumulative Energy Output Extrapolation for Twenty and Twenty Five Years in kWh Given a Module Energy Output of 1652kWh/kWp, for the First Year and Module Degradation of 0.5 Percent ..................................................................................................................... 78

Table 5-5: Internal Rate of Return for Four Photovoltaic Systems Over 25 Years Under Different Scenarios of Electricity Price Escalation. ........................................................................................................................................... 79

Table 5-6: Installation Costs and Payback Period for Four Photovoltaic Systems ............................................................................................................. 80

Table 5-7: Total Number and Capacity of Grid-Tied Customers Utilizing the Renewable Energy Rider Incentive as of January 1st 2014 ........................................................................................................................................... 83

Table 5-8: Barrels of Oil and Tonnes of Carbon Emissions Avoided Using Various RET Technologies Over 20 Years. ........................................... 90

Table 5-9: Tonnes of Carbon Emitted by the Candidate Thermal Generation Systems (BL&PC 2012). .............................................................. 90

Table 5-10: Land and Water Requirements for Solar, Wind and Waste to Energy Technologies .................................................................................. 92

Table 5-11: Land and Water Requirements for Utility Scale Thermal Generation ............................................................................................. 92

Table 6-1: Identified Decision Makers Likely to Influence the Implementation of Renewable Energy Technologies in the Hotel Industry of Barbados ................................................................. 101

Table 6-2: Sources of Funding Geared Towards Hotel Sector and RETs in Barbados Since 2006 ............................................................ 132

Table 6-3: Summary of Identified Barriers to Renewable Energy in the Hotel Sector of Barbados ......................................................................... 140

Table 7-1: Windows of Opportunity Facilitating RET at the Niche Level Within Hotels ..................................................................................... 149

Table 7-2: The Advantages and Disadvantages of Feed-in Tariff Implementation ........................................................................................................ 153

Table 7-3: Advantages and Disadvantages of Environmental Legislation/Land Use/Planning Reform ........................................................................ 154

Table 7-4: Advantages and Disadvantages of Creating Transparent Tax Framework and Workshops ........................................................................ 155

Table 7-5: Advantages and Disadvantages of On-Bill Financing for Hotels in Barbados. ..................................................................................... 157

Table 7-6: The Advantages and Disadvantages of Hotels Wheeling Electricity Via Utility Infrastructure ........................................................................ 158

Table 7-7: Advantages and Disadvantages of Community/Employee Co-ownership of Technology at Hotels. (Berry 2013; Hicks & Ison 2011; Walker 2008) ........................................................................................................... 159

Table 7-8: Advantages and Disadvantages of Integrated Energy Contracting for Deploying RET in Hotels (IEA-RETD 2013; Hansen et al. 2009). ............................................................................................................. 161

Table 8-1: Breakdown of Economic Sector Categories Used to Demonstrate Electricity Demand ........................................................................... 164

Table 8-2: Historic Fuel Clause Adjustments (2009-2013) ................................................................................................................................. 165
TABLE 8-3: ELECTRICITY TARIFFS AVAILABLE IN BARBADOS AND INCENTIVES ................................................................. 167
TABLE 8-4: CALCULATED LCOE FOR SOLAR PV SYSTEMS AT DIFFERENT COMMERCIAL RATES ........................................... 171
TABLE 8-5: LCOE CALCULATED FOR WIND SYSTEMS AT DIFFERENT COMMERCIAL RATES ................................................ 171
TABLE 8-6: LCOE FOR WASTE-TO-ENERGY, BIOMASS COGENERATION AND LCOE COOLING FOR SOLAR WATER HEATERS AT DIFFERENT LENDING RATES .......................................................................................................................... 172
TABLE 8-7: LCOE OF OCEAN THERMAL ENERGY CONVERSION AT DIFFERENT LENDING RATES ........................................ 172
TABLE 8-8: INCENTIVES OFFERED TO HOTELS FOR ENERGY UNDER THE TOURISM DEVELOPMENT ACT ...................................... 173
TABLE 8-9: INCENTIVES UNDER THE INCOME TAX ACT 2002 AND THE AMENDMENT 2013 .......................................................................................................................... 174
TABLE 8-10: BUDGETARY ANNOUNCEMENTS 2006-2013 .................................................................................................... 178
TABLE 8-11: ECONOMIC INDICATORS FOR BARBADOS AS OF APRIL 2014 (CENTRAL BANK OF BARBADOS 2014) .............. 181

List of Figures

FIGURE 2-1: THE MULTI-LEVEL PERSPECTIVE ON TRANSITIONS ................................................................................................. 11
FIGURE 2-2: BREAKDOWN OF TRANSITION MANAGEMENT FRAMEWORK .......................................................................................... 22
FIGURE 3-3: PRIMARY FOSSIL FUEL ENERGY PRODUCTION AND CONSUMPTION IN BARBADOS, PROVED RESERVES AND REFINERY CAPACITY 1980-2012 .................................................................................................................... 25
FIGURE 3-4: PERCENTAGE BREAKDOWN OF TOTAL ISLAND FOSSIL FUEL IMPORT COSTS FOR 2012 ........................................ 26
FIGURE 3-5: TOTAL ANNUAL PETAJOULES OF ELECTRICAL ENERGY GENERATED SEPARATED BY HYDROCARBON-BASED SOURCES FOR ALL UTILITY GENERATION IN BARBADOS (2008-2012) ........................................................................................................ 27
FIGURE 3-6: MINIMUM AND MAXIMUM ELECTRICITY DEMAND IN BARBADOS (2008-2013) .......................................................... 28
FIGURE 3-7: GIGAWATT-HOURS (GWH) OF ELECTRICITY CONSUMED PER YEAR BY ECONOMIC SECTORS IN BARBADOS (1998-2013) .... 30
FIGURE 3-8: BREAKDOWN OF TOURISM SECTOR ELECTRICITY CONSUMPTION FOR 2013 (GWH) .................................................. 31
FIGURE 3-9: ELECTRICITY END-USE IN HOTELS IN BARBADOS ........................................................................................................... 32
FIGURE 3-10: THE BARBADOS LIGHT AND POWER COMPANY LIMITED’S AVERAGE FUEL COSTS ($/kWh) FOR 2008-2012 .......... 33
FIGURE 3-11: COST PER MEGAJOULE OF FUEL SOURCE UTILIZED FOR ELECTRICITY GENERATION FROM 2008-2012 .......... 33
FIGURE 3-12: AVERAGE YEARLY ELECTRICITY COSTS BY CUSTOMER CATEGORY AND FUEL CLAUSE ADJUSTMENT (BD$/kWh) ON THE ISLAND VERSUS THE VARIANCE IN WORLD SPOT PRICE FOR CRUDE OIL ($/MJ) 2008-2013 .......................................................... 35
FIGURE 3-13: TARIFF SURVEY FOR CARILEC MEMBERS SHOWING COST OF USING 100 kWh FOR MONTH TO RESIDENTIAL CUSTOMERS IN SEPTEMBER IN 2010 VERSUS 2012 .................................................................................. 36
FIGURE 3-14: MAP ILLUSTRATING THE ELECTRICITY DISTRIBUTION NETWORK OF THE BARBADOS LIGHT AND POWER COMPANY LIMITED RELATIVE TO HOTEL LOCATIONS. (LSD 2013; BL&PC 2014) ................................................................. 42
FIGURE 3-15: MAP SHOWING THE HOTELS, GENERATION STATIONS, AND SUBSTATIONS RELATIVE TO THE URBAN LANDSCAPE OF BARBADOS (LSD 2013; BL&PC 2014) ................................................................. 43
FIGURE 3-16: TOTAL ELECTRICITY GENERATION VERSUS POPULATION GROWTH, LONG STAY TOURIST ARRIVALS AND CRUISE SHIP TOURIST ARRIVALS 1960-2013 .................................................................................................................................................45

FIGURE 4-1: STEPS INVOLVED IN THE QUALITATIVE INQUIRY ..................................................................................................................................................................................51

FIGURE 4-2 BREAKDOWN OF AREAS OF EXPERTISE RESPONDENT SAMPLE ...........................................................................................................................................................................54

FIGURE 5-1: THREE SCENARIOS OF PRICE ESCALATION FOR FUEL FOR HEAVY FUEL OIL, JET A1, DIESEL AND NATURAL GAS UNTIL 2036 .........................................................64

FIGURE 5-2: THREE ELECTRICITY PRICE ESCALATION FORECASTS BASED ON THREE SCENARIOS OF PER ANNUM GROWTH FOR SECONDARY VOLTAGE POWER (SVP) CUSTOMERS: EXPECTED (0.8%), HIGH (2.7%) AND LOW (-0.3%).................................................................................................................................................64

FIGURE 5-3 LEVELIZED COST OF ELECTRICITY ($/kWh) FOR UTILITY GENERATION USING HFO AND DIESEL FUELED GENERATORS VERSUS NATURAL GAS GENERATORS ........................................................................................................................................69

FIGURE 5-4: LEVELIZED COST OF ELECTRICITY ($/kWh) FOR PRIVATE ELECTRICAL GENERATOR SETS (GENSETS) IN BARBADOS WITH AN ANNUAL CAPACITY FACTOR OF 0.25 (A UTILIZATION OF 25 PERCENT) ........................................................................................................................................................................................70

FIGURE 5-5: LEVELIZED COST OF ELECTRICITY ($/kWh) FOR PRIVATE ELECTRICAL GENERATOR SETS (GENSETS) IN BARBADOS WITH UTILIZATION OF 240 HOURS OR 2.7 PERCENT UNDER ISR ...............................................................................................................................................70

FIGURE 5-6: LEVELIZED COST OF ELECTRICITY AND HEAT FROM SOLAR WATER HEATERS ($/kWh) FOR DISTRIBUTED AND UTILITY-SCALE RENEWABLE ENERGY TECHNOLOGIES IN BARBADOS ..........................................................................................................................................................................................74

FIGURE 5-7: LCOE FOR FOUR PHOTOVOLTAIC SYSTEMS IN BARBADOS AT DIFFERENT COMMERCIAL LENDING RATES VERSUS AVERAGE PRICE OF ELECTRICITY ($/kWh) FOR THE PERIOD 2009-2012 .........................................................................................................................................................77

FIGURE 5-8: CASH FLOW OF 160kW SYSTEM UNDER THREE SCENARIOS OF ELECTRICITY PRICE GROWTH PER ANNUM: EXPECTED (0.8%), HIGH (2.7%) AND LOW (-3%) .....................................................................................................................................................79

FIGURE 5-9: TIMELINE OF LICENSED CUSTOMERS AND CAPACITY INSTALLED UNDER THE RENEWABLE ENERGY RIDER BY JANUARY 1ST 2014 .................................................................................................................................................................................................82

FIGURE 5-10: CUSTOMER-GENERATOR REIMBURSEMENT FOR ELECTRICITY PRODUCED USING A 160kW PHOTOVOLTAIC SYSTEM FOR 2012 .........................................................................................................................................................................................83

FIGURE 5-11: MEGAWATT HOURS PER MONTH OF ELECTRICITY CONSUMPTION FOR HOTELS A, B, AND C FROM JANUARY 2009 UNTIL AUGUST 2010 .........................................................................................................................................................................................85

FIGURE 5-12: MEGAWATT HOURS PER YEAR OF ELECTRICITY FROM DISTRIBUTED ENERGY TECHNOLOGIES AVAILABLE FOR HOTELS COMPARED TO ANNUAL CONSUMPTION OF DIFFERENTLY Sized HOTELS (NUMBER OF ROOMS) IN BARBADOS ..................................................................................................................86

FIGURE 5-13: THE IMPACT OF A 30 PERCENT REDUCTION IN MEGAWATT HOURS PER YEAR ELECTRICITY CONSUMPTION OF HOTELS OF VARIOUS SIZES IN BARBADOS ...............................................................................................................................................................................87

FIGURE 5-14: SAVINGS ON FUEL IMPORTS OVER THE LIFETIME OF UTILITY SCALE RETs .................................................................................................................................................................................88

FIGURE 5-15: SAVINGS ON FUEL IMPORTATION OVER THE LIFETIME OF DISTRIBUTED SCALE RETs .................................................................................................................................................89

FIGURE 6-1: PHOTOGRAPHS ILLUSTRATING THE USE OF HOTEL SPACE, HOTEL SIZE AND THE PROXIMITY OF HOTELS RELATIVE TO OTHER INFRASTRUCTURE ................................................................................................................................................................................135

FIGURE 6-2: PHOTOGRAPHS DEMONSTRATING A HOTEL’S ATTEMPT TO CONCEAL VARIOUS TECHNOLOGIES ON THE ROOF OR BEHIND FOLIAGE, WALLS OR FENCES .................................................................................................................................................................................136

FIGURE 8-1: LCOE FOR FOUR PHOTOVOLTAIC SYSTEMS AT DIFFERENT COMMERCIAL LENDING RATES AND LIFESPANS .................169
FIGURE 8-2: SAMPLE OF THE INSTALLATION COSTS FOR FOUR PHOTOVOLTAIC SYSTEMS IN BARBADOS PROVIDED BY AN INSTALLATION COMPANY. .................................................................170

FIGURE 8-3: GOVERNANCE FRAMEWORK OF BARBADOS AS IDENTIFIED BY RESPONDENTS .................................................................175

FIGURE 21: NOTE ON THE STEPS NECESSARY TO CREATE LEGISLATION IN BARBADOS .................................................................180
1. Introduction

1.1 Research Problem

Many countries around the world have been challenged with managing energy and their natural resources. The lack of diversity within the economies of many small islands has placed these states with a particular dilemma in today’s global economy. In 1992, islands with shared sustainable development challenges were categorized as Small Island Developing States (SIDS) at the United Nations Conference on Environment and Development (UN 1994). Tourism is recognized as one of the world’s largest industries and is one of few development options for small island states intent on creating a comparative advantage (BPOA 1994, Hall & Page 2006). Since the 1950s, many Caribbean islands have relied on their natural resources and beauty to construct their tourism product. Increased economic growth, however, has come at a cost; the increase of visitors creates an increased demand for hotel space, energy, water, food and waste management. Islands have relied heavily on the competitiveness of the tourism industry and the importation of commodities to supply local and visitor populations. Such reliance reduces foreign exchange earnings stocked by the same tourism product that has been embedded within island ecologies.

Electricity demand on many islands has been predominantly met through fossil fuel based generation. Consequently, the Caribbean has faced some of the highest electricity tariffs in the world within vertically integrated energy markets (CARILEC 2010; MCG 2013). Electricity prices are subject to fluctuations in global fossil fuel markets. The Barbados Program of Action (BPOA) is a policy document proposed by the United Nations (BPOA 1994). In this document renewable energy has been proposed as a potential solution for islands to create energy security and save foreign exchange. However, new renewable energy technologies (RETs) face a variety of barriers within an establish socio-technical context. My research attempts to investigate energy solutions to the challenges facing small island hotel industries as they attempt to transition to renewable energy electricity generation.

---

1 The BPOA addresses fourteen areas of concern for SIDS: “climate change and sea-level rise, natural and environmental disasters, management of wastes, coastal and marine resources, freshwater resources, land resources, energy resources, tourism resources, biodiversity resources, national institutions and administrative capacity, regional institutions and technical cooperation, transport and communication, science and technology, human resource development” (SIDSnets 2013)
1.2 Research Context and Objectives

Barbados is a democratic small island found in the Caribbean Sea and Atlantic Oceans with coordinates at 13.1°N 59.5°W. It is the eastern most island of the Caribbean archipelago. The relatively flat landscape is approximately 430 square kilometers and consists of a predominately karst topography (Innis 2008).2 After independence from British rule on November 30th 1966 the island modeled its parliamentary system on that of the former colonizers and became part of the British Commonwealth (Innis 1991). There are two main political parties: the Barbados Labor Party (BLP) and the incumbent Democratic Labor Party (DLP).

Tourism is the largest earner of foreign exchange in Barbados, with burgeoning hotel plant development since the 1950s. Since 1899, the Barbados Light and Power Company Ltd (BL&PC) has had a non-exclusive license for the generation, transmission and distribution of electricity in Barbados. In 2010, electricity generation was 100 percent fossil fuel based, with the island spending 7.1 percent of gross domestic product (GDP) on the import of fossil fuel (BSS 2013). The Government of Barbados (GOB) has played a prime role in the development of both the hotel product and the regulation of the energy sector. The hotel industry in Barbados consists of a full spectrum of formal accommodations, from small guest houses to large-scale luxury resorts (Jönnson & Devonish 2009). Hotel infrastructure has expanded along with electrification of the island and accounts for 15 percent of the island’s electricity consumption (BL&PC 2013). The GOB has committed to two voluntary national objectives: 1) to achieve 29 percent renewable energy (RE) capacity in addition to 22 percent reduction in absolute energy consumption by 2029, compared to 2010 and 2) to restructure and rejuvenate the tourism industry through green growth by 2021 (AOSIS 2012; GOB 2012).

Given such a context, Barbados presents an opportunity to explore the potential space for RETs in hotels. My fieldwork began in September 2010 when I attended the first Barbadian conference exclusively focused on renewable energy - *Alternative Energy Pathway to a Sustainable Future in Barbados*. The fieldwork of this research uses a series of in-person interviews with governmental, market and civil society actors in Barbados. In addition, I obtained cost data to determine the levelized cost of electricity (LCOE) of RETs in Barbados. These methods have been designed to achieve two objectives:

---

2 Karst landscapes consist of predominately limestone and coral. Barbados is one of the few Caribbean islands that is not volcanic. (Day 2010)
1. Identify the barriers to the hotel sector of Barbados becoming a niche for the deployment of renewable energy technologies.

2. Provide recommendations for potential experiments with renewable energy technologies, given the identified barriers and the island’s socio-technical characteristics.

1.3 Research Contribution

This exploratory study may provide insight into the potential for creating protected spaces within island economies to influence the diffusion of renewable energy innovations. In particular, synergies between the accommodation industry and energy policy will be identified. I hope my work may contribute to understanding the resource challenges that are characteristic of SIDS. The size of islands has been considered a limitation towards economic development; however, my work attempts to illustrate the opportunities for islands to create energy security and new industry. Energy regulation is evolving within the Caribbean and I hope my work may contribute to the discussion of energy reform in Barbados. Furthermore, I hope to add to the literature on socio-technical transitions by providing a discussion of energy transitions outside of the European context.

1.4 Chapter Outline

This thesis consists of six chapters: 1) Introduction, 2) theoretical perspectives, 3) a background on hotel and energy infrastructure in Barbados, 4) study design and research methods, 5) results and 6) Discussion and recommendations.

Chapter 2 introduces Transition Management (TM) as my theoretical approach to understand the socio-technical context of Barbados. This pragmatic approach developed in Europe in the 1990s and promotes the use of adaptive governance to guide societies in the transition toward new technological regimes. Socio-technical change is said to occur at three levels: the niche, regime and landscape. In addition, actors are categorized into three categories: market actors, governmental actors and civil society actors.

In chapter 3, I introduce the characteristics of energy use and supply at a national scale and the hotel scale. In addition, I introduce the regulatory framework and a brief history of tourism and electricity planning. Finally, I introduce agendas/visions for the future of energy on the island and tourism.

Chapter 4 explains the design of my study and the use of mixed qualitative and quantitative methods. I explain my procedures for conducting interviews, the development of my samples and the use of grounded theory as a method of qualitative inquiry. In addition, I explain the limitations to my methods.
In chapter 5, I present the results of my economic analysis calculations. I provide the levelized cost of electricity for utility and distributed scale technologies and discuss the potential economic benefits to the island and to the hotel industry. These results are followed by chapter 6, where I discuss/present the barriers identified by my sample of respondents.

In chapter 7, I discuss my results in reference to my theoretical perspectives and provide recommendations for niche-innovation experiments to deploy renewable energy.
2 Theoretical Perspectives

2.1 Introduction

At the turn of the millennium, criticism of the efficacy of sustainable development has called for a new approach to sustainability. Development theory has shaped the governance of the tourism and energy industries of the world. This research thesis focuses on the barriers to using the hotel sector of Barbados as sites for renewable energy technologies (RETs). This chapter provides a discussion of the theoretical perspectives and literature involved in my study. I begin this chapter with a description of development theory as it has evolved since the 1950s toward the post-development critique of sustainable development. Secondly, I introduce transition management (TM) as a new approach of adaptive governance designed to direct sustainability transitions. The theoretical underpinnings of this model of environmental governance are explained. Thirdly, I explain the criticisms of transition management. Finally, I discuss the application of these perspectives to the research agenda along with the potential contribution to the theoretical debate of sustainability transitions. In particular, I discuss the importance of the exploration and development of practical knowledge for the transition to renewable energy on islands.

2.2 Development Theory

‘Development’ is an ambiguous term that has been used to describe the economic and social advancement of sovereign countries toward desirable future states (Sharpley 2003). The term has evolved as a theory with many paradigms. Since the 1950s, there have been four paradigms of development thinking: modernization theory, dependency theory, neoliberalism and post-development (Sharpley 2000; Telfer 2003).

Modernization theorists contend that nations follow a linear path of growth to become industrialized states. Much of this paradigm was pioneered by thinkers such as Walt Rostow in the 1950s and 60s. He proposed that there are five stages of growth a country must go through: traditional society, preconditions for takeoff, take-off, an age of high mass consumption and beyond consumption (Rostow 1960). The idea of a linear progression towards modernity became axiomatic with national planning strategies around the world (Weaver 2006).

Dependency theory emerged in the 1950s as a criticism of modernization and the linear stages of growth (Nash 1989). Dependency theorists contend that wealthy core countries exploit the natural resources of peripheral countries through their power and influence in global markets (Cardosa & Falleto 1979). Developing countries remain dependent on the core developed countries because of embedded internal and external political, institutional and economic structures (Telfer 2003; Britton 1991).
‘Structuralism’ emerged as a solution to this dependency and holds that to escape such dependency requires significant action at the state level through control of domestic markets, import substitution, social reform, and protectionism (Telfer 2003).

Economic neoliberalism gained momentum in the aftermath of the 1973 oil crisis and promoted minimalist intervention by the state in economic affairs. Neoliberals believe in a one-world-system where neoliberal principals of economic development are transferable to all countries. Structural adjustment, laissez-faire economics, privatization, supply side macroeconomics and unadulterated free market competition were characteristic of this paradigm (Allen et al 2000). Structural adjustment became the mechanism to enhance growth in developing countries during the 1980s. Consequently, neoliberals considered tourism a vital export for the countries of the Caribbean to create comparative advantages in the global marketplace (Klak & Conway 1998; Van der Hoeven 1995). However, critics lament the potential impacts of expansive capitalistic growth such as ecological mismanagement and increased social inequity (Gössling 2003; Van der Hoeven 1995).

The post-development critique arose in the 1990s by thinkers such as Esteva (1985), Sachs (1992) Escobar (1995) and centres on issues of gender, equity, sustainability, community participation and social empowerment (Telfer 2003; Sharpley 2000). This paradigm shift represents the first time development was “singled out as an object of academic scrutiny in its own right” (Azacarté 2006). It was during this paradigm that much attention was placed on the concept of ‘sustainable development’ and its doctrine that environments can be managed to “meet the needs of the present generation without compromising the ability of future generations to meet their own needs” (WCED 1987: 43; Telfer 2003). As a result, scholars have advocated new approaches to sustainability to address the natural resource management challenges that countries may face.

2.2.1 Rethinking Sustainable Development

The post-development paradigm has called for a rethinking of the governance and the planning of sustainable development in one of the largest industries in the world – Tourism (Butler 1999; Gössling 2003). Butler (1999) questions the ontology of ‘sustainable development’ and states that it is indefinable and obscure; it has become “all things to all interested parties” (Butler 1999:11). Consequently, a hotel may operate sustainably in isolation and implement practices that increase profits or public relations (Gössling et al. 2012; Lane 2009; Weaver 2009). However, the impact of hotel activities on resources at the community or national scale may not be sustainable to the environment or the persons living at the

3 Structural adjustment refers to a variety of neoliberal instruments such as financial liberalization, trade liberalization, removal of price controls, privatization (Allen et al 2000).
locale (Hall 2008). In addition, sustainable development has been misconstrued as an illusionary yet proverbial end point despite the reality that sustainability issues will continue inevitably into the future. Accordingly, managing sustainability is a continuous process as the goals and values of society change (Meadowcroft 2009).

Gössling et al. (2012) insist that tourism research requires a systems-level analysis with a focus on significant structural change. Transition management (TM) has emerged in the last fifteen years as one such systems-level model for assessing sustainability transitions (Kemp 2007).

2.3 Transition Management

Transition management (TM) is a multilevel model of environmental governance that attempts to address the complexity of sustainable development. It is based on complex adaptive systems theory or “systems thinking” and relies on collective visions, experiments and cycles of learning and adaptation (Kemp et al 2007; Loorbach 2010). The visions of actors within a society influence collective action and the trajectory of a socio-technical transition. These trajectories are evaluated through experiments and when executed have the potential to cause structural changes to the institutional fabric of a society (Foxon et al. 2009). Small groups of actors come together in a form of participatory policy and create “transition arenas” where the social learning can occur (Foxon et al. 2009:3). Proponents of TM hold that:

[Sustainable Development] is a never-ending process of progressive social change. It involves multiple transitions or system innovations. Each transition is made up of processes of co-evolution involving changes in needs, wants, institutions, culture and practices...requires radical changes in functional systems and changes not only in government policy but also in current systems of governance...different types of governance are needed: more open, adaptive and oriented towards learning and experimenting. (Kemp et al. 2007)

Socio-technical transitions are major transformations of various subsystems within a society resulting in the fundamental alteration of the societal system (Loorbach 2007). These transformations are driven by behavioural change as the society adopts technological innovations.

2.3.1 Complexity and Adaptive Governance

‘Systems thinking’ is influenced by the work of two sociologists: Anthony Giddens (1984) and Niklas Lulmann (1984). As seen in Gidden’s ‘structuration theory’, systems’ thinking is concerned with the influence of individual and institutional action (agency) on the production of societal change (Loorbach
Lullman (1984) focused on how communication determines meaning and norms within a system and ultimately how such communication can reinforce or deteriorate the system. TM recognizes the complexity of society itself, the problems facing society and the need to use effective governance to deal with such complexity (Loorbach 2010). In TM, societies are seen as groups of complex systems that coevolve and adapt to challenges to their structure (i.e. selective pressures).

“Governance is the structures and processes by which people in societies make decisions and share power” (Folke et al. 2005:444; Lebel et al. 2006). ‘Governance’ does not necessarily involve a coercive state power. However, the purpose of the government is to be an agent of governance. The state is indispensable as an instrument of collective action towards environmental change (Paavola 2007). The energy industry and tourism industry both have their own structures of governance that include, but are not limited to, governmental agents (Foxon et al 2010; Gössling 2003). The complexity of sustainable development requires a governance model that accounts for the scope and activities of actors involved at various levels. The ability of a governance system to adapt to various selective pressures, maintain its form, and enact control is an indication of system resilience (Lebel et al. 2006).

2.3.2 The Multilevel Perspective (MLP)

Transition Management employs a multi-level perspective as a heuristic analytical framework to understand socio-technical transitions (Geels & Schot 2009; Geels 2002; Rip & Kemp 1998). This approach is distinguished by three interconnected empirical levels of analysis: 1) niche-innovation (micro-level), 2) socio-technical regime (meso-level) and, 3) the socio-technical landscape (macro-level):

2.3.2.1 Niche-innovations (micro-level)

This refers to an area where radical innovations and experimentation take place. These spaces may be nurtured and are “partially insulated from normal market selection in the regime, for example, specialized sectors or market locations” (Foxon et al. 2009:3). This insulation may be the result of intentional policy regulations and incentives designed to foster alternative to the established socio-technical regime (Smith 2007; Fouquet & Pearson 2012).

2.3.2.2 Socio-technical Regime (meso-level)

This level refers to the predominant shared regulations, practices, standards, technologies, and routines within an engineering community that create or reinforce a particular technological system (Foxon

---

4 Agency within sociology is the capacity for an entity (individual agent) to take action resulting in an impact in the world whereas structures are manifested from the repetition of these acts and represent factors that enable or limit the capacity of the agent e.g. religion, legislative frameworks (Gregory et al 2009:347; Giddens 1984)
et al. 2009). These practices occur within established institutional and infrastructural structures. Conventional technologies may become ‘locked-in’, thus challenging the emergence of new competing green technological innovations, such as RETs (STRN 2010; Smith et al 2005; Walker 2000). The power to influence regime change is dependent on “regime membership, the distribution of resources and expectations” (Smith et al 2005:1491).

2.3.2.3 Socio-technical Landscape (macro-level)

The macro, or landscape level “represents the broader political, social and cultural values and institutions that form the deep structural relationships of a society and can only change slowly” (Foxon et al 2009: 2). In addition, the socio-technical landscape refers to the macro-economic and macro-political pressures on the regime. Changes in the landscape create tensions within and between regimes; it is during this time that “new technologies and practices can diffuse into existing regimes” and reshape them (Grünewald et al 2012:450). Examples of selective pressures at the landscape level may include: demographic shifts, an increase in the culture of consumerism, societal attitude, neoliberalism and globalization, anthropogenic global warming, climate change and global financial crises (Gössling et al 2012).

2.3.2.4 Multiple Actors

There are three groups of actors that exist at the niche, regime and landscape level:

1) Government or state actors: Ministerial departments of government such as advisory committees, legislative and regulatory bodies, planning departments.

2) Market-led actors: vertically-integrated supply companies and private market based companies e.g. hotels, renewable energy installers and private consultants

3) Civil-society actors: non-governmental organizations (NGOs), trade unions, and end users of products supplied by market.

The MLP attempts to focus on catalysts for innovation from all three groups of actors and is inclusive of a broad range of coalitions of actors that constitute dynamic supply and demand networks. Actors can be international institutions, such as development banks, local government ministries or even local residents. Scholarship evaluating the efficacy of environmental governance through multiple actors has found great importance in non-state actors providing alternative, experimental and innovative approaches to sustainability (Newell et al. 2012; Bramwell & Lane 2011). Market-driven governance arrangements have considerable effects on changing the competitive structure of technological systems (Newell et al. 2012). Identifying the roles of actors may illuminate the relationships and alliances formed between
different types of actors. However, it is inevitable that actors are not static and may have multiple roles or engagements within a regime (Jørgensen 2012).

2.3.2.5 **Windows of Opportunity and Action Space**

Regime change is a function of the shifting selection pressures created in the interaction of actors at the niche, regime and landscape levels. A regime’s adaptation to these pressures depends on the coordination of internal and external resources. As technological innovation at the niche level builds momentum, pressures at the landscape level may create “windows of opportunity” for novel technologies to become dominant (Geels 2011:28). In addition, actors’ interactions create broadly defined “action spaces” in which the regimes are embedded (Foxon et al. 2009: 8). The dynamics of such action space is contingent upon the power of actors, the expectations and perspectives of actors, the availability resources, and the complexity of relationships within the regime. Market-led actors expect a level playing field through governmental regulation as well as compliant consumers of their products (Foxon et al 2009). Governmental actors are afforded regulatory compliance by market-led actors and political legitimacy by the civil society when decisions are considered equitable (Foxon et al. 2009). As such, innovation is given space to grow.

Figure 2-1: The multi-level perspective on transitions

(Source: Geels 2011:28; After Geels 2002, Copyright Elsevier), demonstrates how innovations introduced at the niche level become increasingly structured, thus destabilizing and reconfiguring the socio-technical regime over time. This reconfiguration influences activities at all levels of analysis.
2.3.3 Governance Activities

The coordination of four types of governance activities is required in transition management: 1) strategic, 2) tactical, 3) operational and 4) reflexive (STRN 2010; Loorbach 2010; Kemp et al. 2007). Strategic activities focus on the discourse of the overall transition and include vision development, long-term goal and norms formulation, problem structuring and strategic discussion (Kemp et al 2007). It also includes the establishment of a transition arena where change is fostered (Loorbach 2010). The time horizon for such strategic activities is a generation in length (i.e. at least a thirty year cycle) (Loorbach 2010). Tactical activities address changes in institutional structures and the rules and regulations of regimes. Tactical activities have a time horizon of ten to fifteen years and include agenda building, negotiating, networking and coalition building (Kemp et al. 2007). Operational activities refer to short time horizon experiments with innovation as well as the introduction of “new structure, cultures, routines or actors” (Loorbach 2010:170). Operational activities involve the mobilization of actors, and experiments (Loorbach 2010). Finally, reflexive activities utilize information networks to monitor ongoing changes in society and policy. This constant cycle of governance activities is integral to the evaluation and success of the transition management approach.
2.3.4 Typologies of Transitions

Socio-technical transitions are characterized by a regime’s resource endowments and the degree of coordination of activities in response to selective pressures (Geels & Schot 2007; Berkhout et al. 2004). Berkhout et al. (2004) state that “relating the context of transformation to transformation processes must become a starting point for analysis” (Berkhout et al. 2004:67). There are four types of transition contexts: 1) endogenous renewal, 2) purposive transitions, 3) reorientation of trajectories and 4) emergent transformation.

‘Endogenous renewal’ and ‘purposive transition’ require a high degree of coordination of actors and governance activities (Gössling 2012). In endogenous renewal, the established regime utilizes internal resources to respond to perceived pressures resulting in incremental changes (Berkhout et al. 2004; Smith et al. 2005). In purposive transitions, coordinated processes emerge from outside of the existing regime (Gössling 2012). An example of a purposive transition is the global shift away from nuclear energy due to global anti-nuclear attitudes and the resultant attention to renewable energy deployment (Berkhout 2004).

‘Emergent transformations’ and ‘reorientation of trajectories’ both have minimal coordination of actors and governance activities. Emergent transformation mobilize external resources in response to pressures from outside the established regime i.e. new firms (Geels & Schot 2007). ‘Reorientation of trajectories’ mobilizes internal resources in response to internal or external shocks. In addition, there is no clear vision or consensus within the ‘reorientation of trajectories’ context.

Teleological (goal-oriented) contexts like ‘endogenous renewal’ and ‘purposive transition’ demonstrate that, in practice, TM requires policy decisions driven by strategic collective visions (Gössling 2012). It is a misconception, however, to think that actors plan transitions from the outset. Instead, transitions are the result of a convergence of processes and visions. They “become coordinated at some point through the alignment of visions and activities of different groups” (Geels & Schot 2007:402). Furthermore, transition pathways are not deterministic; thus, the creation of a new socio-technical regime cannot be guaranteed (Geels & Schot 2007).

In an attempt to refine the transition contexts introduced by Berkhout et al. (2004), Geels & Schot (2007) explain that more importance must be placed to firstly, the timing of interactions and secondly, to the nature of these interactions. They argue that the stage of maturity of the niche innovation and the time it is introduced may determine the impact of the niche-innovation in restructuring the incumbent regime. Disruptive or reinforcing relationships between niche, landscape and regime determine the nature of the transition pathway.
Geels & Schot (2007) articulate four primary types of transition pathways with varying disruptive and/or reinforcing pressure: 1) ‘transformation path,’ 2) ‘de-alignment and re-alignment’, 3) ‘technological substitution’ 4) reconfiguration pathway. In addition, there is the ‘reproductive pathway’ where there is no change, and another pathway consisting of a combination of changes (sequence of transitions).

In the ‘transformative path’ there is moderate disruptive change at the landscape level. However, the niche innovation is not developed enough to utilize the window of opportunity. Incumbent regime actors are the cause of any changes to the regime and this leads to incremental reorientations of the regime. ‘De-alignment and re-alignment’ of the regime may occur when there is sudden and large disruptive change (avalanche change) at the landscape level coupled with large internal problems in the regime. In this scenario, there is no dominant niche innovation and competition ensues. Eventually a new innovation is successful and the regime re-aligns (Geels & Schot 2007; Suarez & Oliva 2005).

‘Technological substitution’ and ‘reconfiguration pathways’ both involve niche-innovations that are more mature and competitive. In ‘technological substitution’ there are specific shocks and large disruptive change in the landscape. The relatively stable regime attempts to defend itself and adjust through investment and policy. Eventually, pressure from the niche-innovation level leads to a substitution of the regime (Geels & Schot 2007). In the reconfiguration pathway, innovations are symbiotic with the objectives of regime actors and are adopted to solve problems created by gradually increasing landscape pressure. This adoption stimulates “further adjustment in the basic architecture of the regime” Geels & Schot 2007:411).

To illustrate this interaction and timing of transition pathways, consider the ‘de-alignment and re-alignment’ pathway. At the landscape level there is a large, sudden divergent pressure (avalanche) that occurs. This may be in the form of large structural shifts due to a loss of faith in the regime. Geels & Schot (2007) provide the example of early twentieth century, horse-drawn urban transport responding to the avalanche pressures of automobile development, concerns with hygiene and animal waste, increased urban expansion over vast distances, and the high operating costs of horse tram stables (Geels & Schot 2007). These landscape changes lead to a window of opportunity for new transportation services and competition amongst niche innovations such as electric trams, bicycles and automobiles. There was rapid diffusion of electric tram which became the dominant technology until it was replaced by the new niche actor the Model-T automobile; hence there was a de-alignment leading to a further re-alignment (Geels & Schot 2007).
2.3.5 Criticisms and New Research Agendas of Transition Management

Critics of the transition management (TM) perspective have attempted to strengthen its theoretical underpinnings (Smith et al. 2005, Shove & Walker 2007, Genus & Coles 2008, Kern & Smith 2008, Smith et al. 2010, and Jørgensen 2012). These criticisms reveal opportunities for new research agendas. The main criticisms of TM are: 1) the lack of attention to the interplay of power and agency, 2) the need for clear specification of concepts, 3) a broader focus beyond niche-driven change, 4) the heuristic attributes of the MLP and the TM methodology, 5) a need for more attention to landscape pressures and; 6) the importance of scale, space and the geography of transitions, and 7) the practicality of managing transitions.

2.3.5.1 The importance of Agency and Power

Critics have argued that TM must have a stronger focus on agency and power (Smith 2005; Genus & Coles 2008). According to Smith (2005), the MLP necessitates a greater analysis of the role of agency and more attention to power and politics. Geels (2011) defends the MLP and states that agency is addressed by understanding the routines, visions and activities of actors. He agrees that there is room for a focus on certain types of agency that are “less developed e.g. rational choice, power struggles, cultural discursive activities” (Geels 2011:30). It is impossible to achieve pathways without conducive political conditions; therefore, institutional change requires consideration of the power, agency and perspectives of incumbent actors (Nilsson et al. 2011).

Grin et al. (2010) explain that different types of power exist at the niche, regime and landscape levels. This power may change throughout a transition and researchers must be cognizant of these dynamics. Power is relational at the experimental or niche level where focus is placed on the achievement of interacting agents and the difference in agent ability (Grin 2010). At the regime level, power is dispositional and the focus is on resources, the rules and the position of agents (Grin et al 2010; Geels 2011). At the landscape level power is structural and the focus is directed to the changing signification or legitimation of governance activities. Meadowcroft (2009) explains that power is always unevenly distributed within a system and energy transitions may be “messy, conflicted [sic] and highly disjointed” (Meadowcroft 2009:323). Thus, understanding where power exists within a transition is key to the success of niche experiments, especially since decisions may have long-term positive or negative consequences for the society under analysis (Mackard et al. 2012; Meadowcroft 2009).

Genus & Coles (2008) warn that MLP may undervalue the importance of agency and politics if it does not recognize that ‘transition managers’ themselves are part of the milieu. Conceptualizing transition managers as separate to the regime limits the agency of their politics. In the same vein, (Jørgensen 2012) contends that research analysts using the MLP must be recognized as part of the research field.
2.3.5.2 The Need for Greater Conceptual Specification

When using the TM approach, the conceptual levels of analysis and the systems under investigation must be clearly demarcated i.e. actors, niche, regime, landscape and systems (Berkhout et al. 2004; Geels & Schot 2007). Systems can be defined at different aggregations depending on a researcher’s focus (Smith 2005; Foxon 2010). The system could be defined as only primary energy (i.e. gas and oil), or it could be aggregated to include secondary uses like electricity production (Geels 2011). In addition, Genus & Coles (2008) also call for clarity when conceptualizing the difference between regime and systems. In response to this criticism, Geels (2011:31) makes the distinction:

*System refers to the tangible and measurable elements (such as artefacts, market shares, infrastructure, regulations, consumption patterns, public opinions), whereas regimes refer to intangible deep structures (such as engineering beliefs, heuristics, rules of thumb, routines, standardized ways of doing things, policy paradigms, visions, promises, social expectations and norms)* So regime is interpretive analytical concept that invites analyst to investigate what lies underneath activities of actors who reproduce system elements

Another criticism is that TM tends to analyze one regime at a time and new research agendas must consider multi-regime interaction (Raven & Verbong 2007). Conceptual specification allows analysts to identify the processes that impact both regimes within a system.

Another conceptual criticism of the MLP concerns the ontology of the three levels. Jørgensen (2012) argues that the analyst must recognize not only conflict that occurs between actors as a condition for change, but that actors engage at all levels within society instead of hierarchical relationships within the three levels of the MLP (Geels 2011). He proposes the notion of “arenas of development” (AOD). This approach downplays the rules and mechanisms of regime tensions and focuses on actor interaction and level of engagement in sense-making dynamics (Jørgensen 2012) “Arenas are temporary constructs and their boundaries may expand or shrink, depending on actor performances. Actors are not restricted to a single arena, and arenas can overlap, be coupled, and conflict, leading to social tensions and the process of reconfiguration” (Markard et al 2012:963) Despite using the MLP to demarcate distinction between actors, the focus of my research is directed at the degree of engagement of the actors.

2.3.5.3 Focus Beyond Niche-Driven Change

The MLP was originally criticised for focusing on bottom-up models of change. Berkhout et al. (2004) claimed that this ignored the importance of potential top-down change from the landscape and regime. The transition pathways developed by Geels & Schot (2007) address this criticism and go beyond the basic bottom-up model by illustrating the importance of timing of innovation and the type of selective
pressure (Geels 2011). These pathways proposed by Geels & Schot (2007) were previously discussed in section 2.3.4.

2.3.5.4 The MLP as a Heuristic Device and Methodology

Heuristic devices act as frameworks to explain phenomenon and processes. The MLP has been criticized as being at most a heuristic device or framework that privileges the choice of the analyst (Genus & Coles 2008). In addition, TM has been criticized for its heavy focus on secondary data sources such as written historical accounts (Genus & Coles 2008). Smith et al. (2010) warn that the MLP “must not become counter-productively simplistic in its abstraction” (Smith et al 2010:442; Sayer 1992). Geels (2011) welcomes these criticisms, explaining that an interpretive approach is valuable. He contends that the open framework provided by MLP guides the analyst’s attention to relevant questions of processes and the timing of activities. The objective of an open framework like the MLP is to “help the analyst to better think through the problem” (Porter 1991; as cited in Geels 2011:34).

Geels (2007) explains that TM is not a grand theory but a middle-range theory. As such, the MLP may be used to engage with other theories or perspectives and emphasizes interaction with other forms of empirical research to identify recurring patterns and generalizable lessons (Geels 2011:26). In chapter 4, I discuss the use of TM as an addition to my qualitative analysis.

2.3.5.5 Greater attention to the landscape level

The landscape level is under-theorized and analysts must understand how different frequencies of shocks affect a society (STRN 2010; Genus & Coles 2008). Jørgensen (2012) explain that TM literature has a tendency to treat the landscape as an exogenous space to delegate factors that cannot be influenced at the regime level. He argues that these processes influence all actors’ perceptions and levels of engagement, and thus require closer attention and greater inclusion in theorizing transitions. Turnheim & Geels (2012) advocate that landscape crises such as climate change and oil shocks, have the ability to erode the legitimacy of regime policies (Turnheim & Geels 2012; Geels 2013). The impact of the 2009 global recession on attitudes towards climate change, finance and governance was predominantly negative with a global reduction in investments and feed-in-tariff deployment (Geels 2013).

2.3.5.6 Space, Scale and the Geography of Transitions

Despite its focus on the societal functions, the subject of spatial scale has not been fully explored along with its complexities (Smith et al. 2010, Lawhon & Murphy 2011). A major shortcoming of transition literature is the failure to explain uneven spatial realities of transitions (STRN 2010). In
particular, the spatial distribution of power may be observed with a geographical approach to TM (Lawhon & Murphy 2011).

Transition literature itself is primarily engaged in a Eurocentric focus with a shift towards regional studies and the creation of transition regions (Truffer & Coenen 2012). Some authors have applied the TM lens towards the USA (Sovacool 2009); however, there is room for research of transitions in non-OECD countries (STRN 2010). Smith et al. (2010) explain that much of the discussion with regard to energy transitions has equated ‘regime’ to mean interactions at the state level. Consideration must be made for processes beyond the national jurisdiction (Smith et al. 2010). National policies of the state are themselves in competition with other external international influences. International corporate structures of multinational companies (MNCs) and international trade alliances are examples of influence beyond the scale of the nation-state.

Meadowcroft (2002) maintains that it is almost impossible to harmonize coordination at temporal, community, national and international scales. He points out that adaptation of governance to environmental concerns takes time, and this temporal scaling may prove to be a barrier; windows of opportunity are lost. Such a view correlates with the discussion postulated by Geel & Schot (2007) on the importance of timing in transitions.

The scale of transitions has the ability to expand or contract. TM literature traditionally refers to the “region” as the sub-national level (Cooke 2011). Spӓth & Rohracher (2010) examine the idea of creating energy regions where the mobilization of social actors is at a regional scale. Truffer & Coenen (2012) explain that solar civic initiatives for photovoltaic technologies in Germany began in the 1990s by mobilized citizens operating in various regions of the country. These initiatives spread to the federal scale and the private sector with market formation being the result of catalytic and novel regional development. The message here is that these promotional activities were initially focused at the local level or at a community scale. Such innovation was embedded and resulted in promoting larger policy instruments like feed-in-tariffs (FITs) (Truffer & Coenen 2012; Jacobsson & Lauber 2006).

2.3.5.7 Transition in Practice

Some critics ask if transitions can really be managed. In practice, policy and corporate players are the key actors “even if involvement of other groups and interests is vital” (Shove & Walker (2007:7). The use of MLP as a heuristic device is acknowledged; however, Shove & Walker (2007) argue that there is no reference to the ways of living necessary and the demand-side patterns needed for socio-technical transitions.

In their critique of the application of TM in the energy policy of the Netherlands, Kern & Smith (2008) found that despite collective long-term visions of the energy system trajectory, funding limitations
become a short-term hindrance. Kern & Smith (2008) ask analysts not to underestimate the fact that overarching structural change is politically difficult. They hold that TM’s concept of keeping technology options open for the most sustainable to be selected and prevent lock-in, is not realistic because of actors’ perceived risks. They suggest to focus on short-term goals since such goals encourage momentum and gain political legitimacy among elite actors. An explanation for this discrepancy between long and short term is that limited institutionalized space is provided for regular policy because of the short time frame between elections i.e. political cycles (Loorbach 2010).

The Sustainability Transitions Research Network (STRN 2010) explains that research into private industry and firms may give feedback on the roadblocks to sustainable agendas and policy. They contend that with new innovations, first movers may be hesitant and delaying action may rationally protect firm interests in light of uncertainties (i.e. vague legislative frameworks and incentives). It is argued that new technologies “cannot immediately compete on the market against established technologies” (Schot and Geels 2008: 537). Thus it is advantageous to identify the strategies of industry players. Berkhout et al. (2004) believe the TM model is too optimistic about cohesive acceptance of collective vision and concur that there is a need for a more explicit focus on diverging interests. Späth and Rochracher (2010) explain that despite the potential for diverging visions, such ambivalence provides avenues for the implantation of innovation through the use of discursive strategies within niche experiments.

2.4 The Application of Transition Management to My Research

My work explores the potential for socio-technical transitions within energy and tourism subsystems of Small Island Developing States (SIDS). SIDS have received much scholarly attention since the beginning of the post-development paradigm (Wilkinson 1987; Albuquerque & McElroy1995; Gӧssling 2003; Belle & Bramwell 2005; Bunce 2008). In particular, the Caribbean region has become a “useful point of entry for discussing development and the environment” (Lloyd Evans et al. 1998:3). My research investigates energy transitions on the island of Barbados. My research objective is to identify the barriers to establishing the hotel sector of Barbados as a niche area for renewable energy innovations. Such an experiment represents an operational governance activity (Section 2.3.3). However, feasibility of such an activity is assessed through exploration of the processes, practices, and policies that impact the energy and hotel industries. Such an understanding of the transition arena may prove insightful as the island moves away from hydrocarbon-based electricity generation. I use the insights of actors in Barbados to understand the island’s socio-technical context. Thus, TM is used as a heuristic device to discuss the themes

---

5 STRN was inaugurated in June 2009 at the first European Conference for Sustainability Transitions and is composed of a steering group of leading researchers in the field of transitions (STRN 2010).
expounded in my research. Bramwell and Lane (2011) maintain that the significance of critical research in tourism is not only its affront on conceptualizations of sustainability, but the space created for innovation. Researchers can “engage with theoretical frameworks from other social science fields, and this permeability across research domains provides new insights into tourism governance” (Bramwell & Lane 2011: 414; Tribe 2007).

Scholarship concerning the impact of attitudes on the social acceptance of renewable energy is not new, as seen in the research of Bell et al. (2005) and West et al. (2010). The work of Dalton, Lockington and Baldock explores the attitudes of tourism operators, tourists and hotel employees towards the deployment of RETs in Australian hotels. Their work found that tourism operators preferred conventional fossil fuel based electricity supplies, whereas tourists had a high acceptance of the RET innovations (Dalton et al. 2007: 2008). These studies were followed with feasibility studies of renewable energy options for hotels (Dalton et al. 2008b; 2009). I consider the investigation of attitudes coupled with a feasibility analysis to be an effective way to illustrate the dynamics of renewable energy integration in hotels. However, I believe a transition management approach allows the inclusion of a broad spectrum of actors whose opinions allow me to characterize the established action spaces for an energy transition.

The three main steps required in the application of the multi-level perspective (MLP) to energy research are: “1) Characterize the existing energy regime, its internal tensions and landscape pressure on it; 2) Identify dynamic processes at the niche level; and, 3) Specify interactions giving rise to or strongly influencing transition pathways” (Foxon et al. 2010:4). To address conceptual specification, the system under investigation is characterized as the primary and secondary energy used to supply the hotel industry. Thus, I investigate renewables not only at the hotel scale, but I consider the broader implications for the national grid and national fossil fuel demand. Addressing the barriers of renewable energy supply to the hotel industry, inherently considers the implications of hotel governance structures. This means that my work addresses multi-regime interactions and explores the broader implications for Barbados’s transition. In addition to assessing the feasibility of developing a niche experiment, I believe the TM approach will allow me to illustrate power struggles amongst civil-society, market-led, and governmental actors.

My work addresses issues of space and scale by taking TM away from its Eurocentric focus and into the relatively new domain of Caribbean tourism. In addition, this study considers barriers to innovations from the bottom-up and the top-down. I illustrate the effectiveness of government and market driven policies towards RETs. The Caribbean has a history of attempting to function as a region through island integration (e.g. CARICOM). Tourism may be considered regional in some circles with influential regional governance structures and networks such as the Caribbean Tourism Organization. In the advent of new energy infrastructure, the Caribbean itself may come to function as an energy region. I hope to
influence future research on energy transitions in the broader Caribbean. Nevertheless, the potential opportunities for diffusion to other sectors of the Barbadian economy may be elucidated at the local scale.

Small islands provide a petri-dish to study economies that are considered particularly vulnerable to external shocks in the landscape, such as climate change and the financial crisis (Simpson et al 2011, AOSIS 2012). Geels (2013) assesses the impact of the 2009 global recession on attitudes towards climate change, finance and governance in the UK. He concludes that the impact was predominantly negative with regards to public opinion of climate change and governance; furthermore, he notes global reduction in investments and feed-in-tariff deployment (Geels 2013). My research engaged actors in the year directly following the recession and may provide insight into the adaptability of hotels and energy infrastructure to such shocks in Barbados.

Identification of the potential avenues for social acceptance is another contribution of the research. Information and misinformation guides the acceptance of RETs across all actors. Sovacool (2009) explains that various actors have conceptions of the limits of technologies that may undervalue RETs. Conventional technologies are therefore locked-in, due in part to consumer and utility immobility. Insights into the perception of various actors may indicate market inaccuracies, conventional training practices, or split incentives, amongst other variables (Sovacool 2009). A consequence of the TM approach is that a focus on the individual insights of multiple actors may reduce a tendency of policy makers to make broad categorizations of the actors within society (West et al. 2010). In addition, actors as individuals exist within different categories making perspectives fluid e.g. an employee of the utility, can be a member of a particular community that is situated near hotel or RET installation. Consequently, the spatial aspect of perception is manifested.

Snapshots in time of public debate on energy and tourism in Barbados illustrate the socio-technical complexities of the island. Discourse, as a “cultural lens through which the world is viewed by an individual at a point in time can thus inform responses to environmental problems and requires greater exploration to help guide policy development” (West et al. 2010: 5740). Exploration of actor perspectives is necessary to not only identify impediments to RET experiments in the hotel sector, but to understand the collective visions for future sustainability opportunities and agendas.
2.5 Summary

Post-development critiques have called for a rethinking of sustainable development in light of patterns of natural resource consumption. Scholars have advocated the need for transitions to more sustainable forms of electricity generation worldwide. Transition Management is a form of adaptive governance proposed to address the complexity of sustainability issues. Figure 2-2 below provides a breakdown of the empirical levels of the MLP analysis, the types of actors, the forms of governance activities and the types of transition pathways found in the TM model. My objective is to evaluate the potential for establishing the hotel industry of Barbados as a niche experiment for renewable energy innovations. Such an operational governance activity requires an assessment of the attitudes towards renewable energy technologies on the island. I believe the identification of processes at the various empirical levels of analysis and the relationships between actors are essential to my research objectives. Therefore, I believe the TM model is an appropriate heuristic device to discuss the barriers to renewable energy identified by the civil-society, the market-led, and governmental actors in my study.
### Empirical Level

<table>
<thead>
<tr>
<th>Categorical Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>niche-innovation</td>
</tr>
<tr>
<td>partially insulated space for experiments with innovation</td>
</tr>
<tr>
<td>socio-technical regime</td>
</tr>
<tr>
<td>the predominant shared regulations, practices, standards, technologies</td>
</tr>
<tr>
<td>socio-technical landscape</td>
</tr>
<tr>
<td>political, social and cultural values, macro-economic and political pressures</td>
</tr>
</tbody>
</table>

### Actors

<table>
<thead>
<tr>
<th>Roles of Actors</th>
</tr>
</thead>
<tbody>
<tr>
<td>civil-society</td>
</tr>
<tr>
<td>NGOs, trade unions and end users of system products</td>
</tr>
<tr>
<td>market-led</td>
</tr>
<tr>
<td>vertically-integrated supply companies, private companies, hotels, banks</td>
</tr>
<tr>
<td>governmental</td>
</tr>
<tr>
<td>governmental departments, advisory committees, regulators, planners</td>
</tr>
</tbody>
</table>

### Governance Activity

<table>
<thead>
<tr>
<th>Time Horizon</th>
<th>Type of Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>strategic</td>
<td>vision development, long term goals, and strategic discussion</td>
</tr>
<tr>
<td>tactical</td>
<td>agenda building, negotiating, coalition building, networks</td>
</tr>
<tr>
<td>operational</td>
<td>experiments and project building, protection of niche</td>
</tr>
<tr>
<td>reflexive</td>
<td>monitoring, learning and evaluation</td>
</tr>
</tbody>
</table>

### Transition Type

<table>
<thead>
<tr>
<th>level of activity coordination</th>
<th>Resources mobilized and selection pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>endogenous</td>
<td>high</td>
</tr>
<tr>
<td>purposive</td>
<td>high</td>
</tr>
<tr>
<td>reorientation of trajectories</td>
<td>low</td>
</tr>
<tr>
<td>emergent transformation</td>
<td>low</td>
</tr>
</tbody>
</table>

### Transition Pathway

<table>
<thead>
<tr>
<th>Landscape pressure</th>
<th>niche development</th>
<th>effect on regime</th>
<th>perception of the regime</th>
</tr>
</thead>
<tbody>
<tr>
<td>reproductive</td>
<td>none</td>
<td>low</td>
<td>stable</td>
</tr>
<tr>
<td>transformation</td>
<td>moderate</td>
<td>insufficient</td>
<td>internal reorientation</td>
</tr>
<tr>
<td>de-alignment and re-alignment</td>
<td>large and sudden</td>
<td>competition for dominant innovation</td>
<td>erosion of the regime</td>
</tr>
<tr>
<td>technological substitution</td>
<td>specific shocks, avalanche change, and disruptive shocks increasing pressure reinforces pathway</td>
<td>niche is sufficiently developed to pressure regime</td>
<td>regime is relatively stable</td>
</tr>
<tr>
<td>reconfiguration</td>
<td>slowly increasing and disruptive</td>
<td>regime is relatively stable</td>
<td>changes the architecture of regime</td>
</tr>
<tr>
<td>sequence of transitions</td>
<td>slowly increasing and disruptive</td>
<td>regime is relatively stable</td>
<td>interactions vary along with adaptability and level of tension</td>
</tr>
</tbody>
</table>

**Figure 2-2: Breakdown of Transition Management Framework**

(Source: Geels & Schot 2007; Berkhout et al 2004; Foxon et al. 2009; Geels 2011)
3 Sun, Sand, Sea and Fossil Fuels- Energy and Tourism in Barbados

3.1 Introduction

To postulate a transition to renewable energy technologies (RETs) in the hotel sector of Barbados requires a contextual introduction of the established energy and tourism infrastructure. Firstly, I present an overview of energy use on the island. The primary energy consumption is provided followed by electricity use on the island and within hotels. The costs of importing fuel and generating electricity are introduced. Secondly, I discuss the electricity regulation and the various energy incentives available on the island. Thirdly, I provide a brief history of physical development planning in Barbados and the role of electricity and the economic importance of tourism since Independence in 1966. Finally, I introduce future agendas of the Government of Barbados (GOB) as they relate to tourism, energy use, and climate change resilience.

3.2 Energy Supply in Barbados

A country’s energy chain refers to the “sequential use of energy in the production of goods and services” (Labatt & White 2007:27). Energy found in nature that has not been subjected to human conversions and processes is known as primary energy. Secondary energy has been transformed once, and includes petroleum products, heat and electricity. The energy intensity of a country is the aggregate primary energy required per dollar of gross domestic product (GDP). Energy intensity indicates the efficiency of utilizing energy to generate economic growth, and the mix of goods and services in a country; thus, it is affected by the expansion of infrastructure and the purchasing behavior of a population (Harvey 2010). The carbon intensity of a country represents the mass of carbon emitted per unit of energy used (Harvey 2010).

Figure 3-1 and Figure 3-2 compare the energy intensity and carbon intensity, respectively, of Barbados and the world (EIA 2014). Barbados has a much lower energy intensity and a slightly higher carbon intensity than the world average. The country has improved its ability to convert energy to GDP since the recession of 1991 (EPC 2006). Despite an improving trend in the island’s energy intensity, the technology type and source of fuel for energy generation impacts the carbon released along the energy chain. Some countries generate electricity using a greater mix of hydrocarbon and non-hydrocarbon based fuels (e.g. hydro and nuclear in Canada). Barbados’s fuel mix is predominantly hydrocarbon based.

---

6 GDP has traditionally been used as an economic indicator of a country’s development. The World Energy Council created the Energy Sustainability Index to include a multitude of indicators e.g. energy security, equity, environmental sustainability, political and societal strength. Barbados in 2013 ranked 50th and was the highest in the Caribbean (WEC 2013).
7 Trinidad 0.17 percent of the world’s total emissions; all other Caribbean countries contribute 0.01 percent or less of global emissions (Sanders 2014).
8 Information was provided in 2005 US dollars and was adjusted to 2014 Barbados dollars to create these graphs.
Today, the Barbados National Oil Company Limited (BNOCL) and the National Petroleum Corporation (NPC) are the state owned suppliers of oil and natural gas respectively (BNOCL 2013). The Energy Division (ED) is the unit of the Government of Barbados responsible for oil and gas, alternative energy and energy conservation. In addition, the ED monitors primary energy prices and is responsible for
the development of energy policy (ED 2014). Barbados’s history with fossil fuels began in 1896 and exploration continued over the following century with a peak in production in 1998 (Energy Division 2013; Central Bank 2013; BSS 2013). Since 1998, fossil fuel produced in Barbados is transported to Trinidad for refining and returned to the island.

The import of fossil fuel began as the island expanded beyond the export of sugar into tourism and manufacturing in the 1960s (Mitchell 2006; Cox 1980). Barbados is a price taker in the global energy market, with the local demand for primary energy exceeding local supply, as illustrated in Figure 3-3. Proven reserves have dwindled since the early 1990s. The natural gas is solely produced and consumed locally. In 2010, BDS $604 million (7.1 percent of GDP) were spent on the import of hydrocarbon fuels and increased to BDS $824 million or 11 % of GDP in 2013 (IMF 2013; Central Bank 2013; BSS 2013). Consequently, fossil fuels accounted for over 20 percent of total island imports (IMF 2013). Figure 3-4 reveals the breakdown of money spent on the import of hydrocarbon based fuels by fuel type in 2012. The majority of imports consist of bunker ‘C’ fuel oil, jet fuel, and non-vehicular diesel used for power generation.

Figure 3-3: Primary fossil fuel energy production and consumption in Barbados, proved reserves and refinery capacity 1980-2012

(Source: EIA 2014).

---

9 The ED consists of an “Administrative Unit, the Legal & Regulatory Unit, the Natural Resources Department, the Renewable Energy & Energy Conservation Unit and the Research & Planning Unit” (ED 2014).

10 The West Indian Petroleum Company was formed in 1896 and was the first oil company on the island.

11 50 percent of imported fossil fuel is estimated for electricity generation and 33 percent for transportation (Castalia 2010a).
3.3 Electricity Generation and Demand in Barbados

The Barbados Light and Power Company Limited (BL&PC), as renamed in 1955, is the only electric utility in Barbados and is responsible for the generation and distribution of electricity across the island.\(^\text{12}\) BL&PC is investor owned with Emera, a Canadian utility company, owning 79.7 percent of shares. On average, 11.4 petajoules of energy are used yearly from hydrocarbon based fuel sources in the generation of approximately 1054 gigawatt-hours (GWh) of electricity per year in Barbados.\(^\text{13}\) Figure 3-5 illustrates the total petajoules of energy used for electricity production from 2008 until 2012. Since 2008, the thermal mix of generation fuel inputs consists of heavy fuel oil (72-78 percent), diesel fuel (12-20 percent), heavy vacuum fuel oil (0.5-1.5 percent), jet A1 fuel (4-11 percent) and natural gas (<1 percent) (BL&PC 2014). The BL&PC does not have utility-scale renewable energy generation. The BL&PC has obtained approval to develop a 10MW wind farm in the north of the island; however, the project has not yet materialized due to land acquisition issues (Madden 2011). Bagasse has been utilized on-site to generate electricity at sugar factories; nevertheless, this contribution is not a utility-scale supply (Gischler and Janson 2011).\(^\text{14}\)

---

\(^\text{12}\) The electric utility plant was known as the Barbados Electric Supply Corporation (BESC) formed in 1909 (BL&PC 2014).

\(^\text{13}\) A petajoule is 1 x 10\(^{15}\) joules.

\(^\text{14}\) Bagasse is a fibrous residue that remains after sugar cane processing and can be used in cogeneration.
Figure 3-5: Total annual petajoules of electrical energy generated separated by hydrocarbon-based sources for all utility generation in Barbados (2008-2012).

(Source: BL&PC 2013).

Figure 3-6 illustrates the minimum demand (Baseload) and maximum demand (peak-load) for electricity in Barbados. Since 2010, this peak-load has declined on the island from 165.7 MW to 156.7 MW. Reducing the size of the peak creates a more efficient plant and makes better use of existing assets. The utility has a reserve capacity margin which can be calculated as the difference between generation capacity and peak capacity, divided by peak demand. This percentage was approximately 50 percent in 2009 and declined to 46 percent in 2013. A standard of minimum reserve capacity ensures that the largest units of generating plant are backed up in the event of an emergency: approximately 30MW or 18 percent reserve capacity is needed by the BL&PC (Castalia 2010a). The advantage of such a reserve capacity is the ability to dispatch electricity at a short notice. However, energy security is challenged since the fuel sources employed for base-load and peak-load depend on imported fossil fuels. Table 3-1 provides a breakdown of the steam, diesel and gas turbines used for power generation by the BL&PC. Base-load supply is dependent upon heavy fuel oil (HFO) whereas peak is met through a combination of diesel and jet fuel. In addition, approximately 103 MW of generation plant are scheduled to be retired between 2014 and 2020, starting with the two largest generators-the 20MW steam turbines. The HFO fueled turbines are the largest emitters of carbon per year.
Figure 3-6: Minimum and maximum electricity demand in Barbados (2008-2013).

(Source BL&PC 2014)
<table>
<thead>
<tr>
<th>Power plant type and operational name</th>
<th>Installed Capacity (MW)</th>
<th>Fuel Type</th>
<th>Role of generator</th>
<th>Annual Production (GWh)</th>
<th>Emissions Factor (tC/GWh)</th>
<th>Tonnes of carbon (tC) per year</th>
<th>Retirement Date (month/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam turbine 1</td>
<td>20</td>
<td>HFO</td>
<td>Baseload</td>
<td>107</td>
<td>379</td>
<td>40660</td>
<td>12/2015</td>
</tr>
<tr>
<td>Steam turbine 2</td>
<td>20</td>
<td>HFO</td>
<td>Baseload</td>
<td>107</td>
<td>379</td>
<td>40660</td>
<td>12/2015</td>
</tr>
<tr>
<td>Low Speed Diesel (D10)</td>
<td>12.5</td>
<td>HFO</td>
<td>Baseload</td>
<td>75</td>
<td>188</td>
<td>14083</td>
<td>12/2018</td>
</tr>
<tr>
<td>Low Speed Diesel (D11)</td>
<td>12.5</td>
<td>HFO</td>
<td>Baseload</td>
<td>75</td>
<td>188</td>
<td>14083</td>
<td>12/2018</td>
</tr>
<tr>
<td>Low Speed Diesel (D12)</td>
<td>12.5</td>
<td>HFO</td>
<td>Baseload</td>
<td>75</td>
<td>188</td>
<td>14083</td>
<td>12/2018</td>
</tr>
<tr>
<td>Low Speed Diesel (D13)</td>
<td>12.5</td>
<td>HFO</td>
<td>Baseload</td>
<td>75</td>
<td>188</td>
<td>14083</td>
<td>12/2018</td>
</tr>
<tr>
<td>Low Speed Diesel (D14)</td>
<td>29.7</td>
<td>HFO</td>
<td>Baseload</td>
<td>178</td>
<td>188</td>
<td>33460</td>
<td>12/2035</td>
</tr>
<tr>
<td>Low Speed Diesel (D15)</td>
<td>29.7</td>
<td>HFO</td>
<td>Baseload</td>
<td>178</td>
<td>188</td>
<td>33460</td>
<td>12/2035</td>
</tr>
<tr>
<td>Gas Turbine (GT02)</td>
<td>13</td>
<td>Diesel</td>
<td>Peak-load</td>
<td>24</td>
<td>259</td>
<td>6104</td>
<td>12/2016</td>
</tr>
<tr>
<td>Gas Turbine (GT03)</td>
<td>13</td>
<td>Diesel</td>
<td>Peak-load</td>
<td>24</td>
<td>259</td>
<td>6104</td>
<td>12/2021</td>
</tr>
<tr>
<td>Gas Turbine (GT04)</td>
<td>20</td>
<td>Diesel</td>
<td>Peak-load</td>
<td>36</td>
<td>259</td>
<td>9391</td>
<td>12/2024</td>
</tr>
<tr>
<td>Gas Turbine (GT05)</td>
<td>20</td>
<td>JetA1</td>
<td>Peak-load</td>
<td>36</td>
<td>259</td>
<td>9391</td>
<td>12/2026</td>
</tr>
<tr>
<td>Gas Turbine (GT06)</td>
<td>20</td>
<td>Diesel</td>
<td>Peak-load</td>
<td>36</td>
<td>259</td>
<td>9391</td>
<td>12/2027</td>
</tr>
<tr>
<td>Waste Heat Recovery 1</td>
<td>1.5</td>
<td>On site</td>
<td></td>
<td>188</td>
<td></td>
<td></td>
<td>12/2018</td>
</tr>
<tr>
<td>Waste Heat Recovery 2</td>
<td>2.2</td>
<td>On site</td>
<td></td>
<td>188</td>
<td></td>
<td></td>
<td>12/2035</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>239.1</strong></td>
<td><strong>1024</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>244952</strong></td>
<td></td>
</tr>
</tbody>
</table>

Table 3-1: Characteristics of Barbados Light and Power Company Limited's power generation plant.\(^{15}\) (Source: BL&PC 2012; Castalia 2010).

3.3.1 **Electricity Use by Economic Sector**

Figure 3-7 provides the trend in electricity consumption by economic sector in Barbados from 1998 until 2013. Tourism-related activity is the second largest category of electricity demand in Barbados. The largest sector is the commercial sector and this category includes retail and department stores that indirectly benefit from the tourism sector. The entertainment sector also indirectly relies on the business of tourists. Accordingly, Figure 3-7 demonstrates the broad impact of tourism activities on electricity demand in Barbados. Figure 3-8 further categorizes the tourism sector electricity demand by activity for 2013. Hotel

\(^{15}\) Generation data based on sales data provided for 2012 and emissions data calculated using emissions factors provided by the Sustainable Energy Framework for Barbados study (BL&PC 2012; Castalia 2010). Waste heat from the low speed diesel is recovered and used for cogeneration purposes. D10-13 represent waste heat 1 and D14 and D15 represent waste heat 2.
accommodation represented the majority of demand (66%), followed by guest houses (11%) and attractions (9%).

Figure 3-7: Gigawatt-hours (GWh) of electricity consumed per year by economic sectors in Barbados (1998-2013)

(Source: BL&PC 2014).\textsuperscript{16}

\textsuperscript{16} A breakdown of the various categories represented can be found in Table 8-1 of Appendix A: Utility Information and represents the Standard Industrial Classifications (SIC) of various activities on the island. Local apartments relate to non-tourism related accommodation and large houses. The residential sector is not represented here in this breakdown.
3.3.2 Energy use within hotels

The Caribbean Hotel Energy Efficiency Action Program (CHENACT) was piloted in 2009 to increase hotel competitiveness through the provision of detailed energy audits for small to medium-scale Caribbean hotels (CHENACT 2013). This was made possible through financing from local and international actors such as development banks and various associations and programs. In addition to energy efficiency (EE), the program assessed the potential for achieving a clean development mechanism (CDM) Program of Activity (PoA) using energy efficiency, renewable energy and the reduction of ozone depleting substances in hotels (Castalia 2010a). Before CHENACT, there had been attempts to assess the carrying capacity of the island and visitor impact; however, these studies have focused on beach

---

17 Hotels according to the Barbados Tourism Development Act 2002 refer to “any building containing not less than 10 bedrooms each of which is valued at not less than $175 000; or any group of buildings, whether cottages, bungalows or otherwise, situate within the same precincts, served by common maid service and together containing not less than 10 bedrooms each of which is valued at not less than $175 000, for the accommodation of guests for reward and available for letting for at least 9 months in each year” (TDA 2002: 6). A guest house or villa refers to a building that “has at least 3 bedrooms and is valued at not less than $525 000; is managed by a company or real estate agent, and employs no less than 3 persons; is registered with the Barbados Tourism Authority; and is available for the accommodation of guests for reward for at least 9 months in every year” (TDA 2002: 8).

18 Small to medium scale according to CHENACT is less than or equal to four hundred guest rooms. No hotel in Barbados exceeds this number of rooms. This project conducted detailed audits and walkthroughs of 30 hotels in Barbados, 18 hotels in the Organization of Eastern Caribbean States (OECS) and detailed audits in 5 hotels in the Greater Caribbean Region (CCCCC 2013). The Inter-American Development Bank (IDB), German Technical Cooperation (GTZ), Caribbean Hotel & Tourism Association (CHTA), the Caribbean Alliance for Sustainable Tourism (CAST), Center for Development Enterprise (CDE), United Nations Environmental Program (UNEP) the Barbados Light & Power (BL&P), the Barbados Hotel & Tourism Association (BHTA) and the Government of Barbados (GOB).

20 Under a PoA it is possible to coordinate policy goals and the achievement of credits for emissions reductions. The PoA benefit developing countries because of the reduction in transaction costs, investment risks and faster registration and processing. (CDM 2013).
management (Moses & Cumberbatch 1982, Moses & Cumberbatch 2011). Electricity consumption of tourists has only recently become a large part of the debate. Electricity consumption of the Barbados-based hotels in the CHENACT study ranged from approximately 207000 to 14700000 kWh of electricity per year at an average occupancy rate across all hotels of 57 percent (CHENACT 2012). The number of rooms in these hotels in Barbados ranges from 10 to 400. Figure 3-9 demonstrates that the most significant end-use of electricity identified within Barbados hotels is air conditioning (48.2%) and next is lighting (11.5%).

![Figure 3-9: Electricity end-use in hotels in Barbados.](Source: CHENACT 2012)

### 3.4 The Cost of Fuel and Electricity Pricing

The four components of all electricity bills in Barbados are: 1) the base rate, 2) the demand charge, 3) the customer charge and 4) the fuel charge. Base rate covers the general cost of the utility’s business operation and is the product of the customer’s present usage and the base energy rate. The demand charge is the product of customer’s billing demand or power requirement and the set tariff rate. Customer charge is a fixed monthly charge based on customer’s tariff category. The most variable component of electricity billing on the island is the fuel surcharge based on the product of a customer’s usage and the fuel clause adjustment (FCA) (BL&PC 2014). Due to the reliance on fossil fuel imports for electricity generation by Caribbean utilities, FCAs are common energy risk management features designed to allow utilities to hedge and recover the incurred costs of generation (MCG 2013; Graves et al 2007). The FCA has a direct correlation with the world market spot price for oil and allows any variance in fuel costs to be accounted for. Until October 11<sup>th</sup> 2013, the calculation of the FCA was based on the utility’s projected fuel costs; however, to increase transparency in electricity pricing, the national regulator ruled all calculations to be based on historical data (i.e. the data from the previous month). The equation can be found in the Appendix A: Utility Information along with electricity rates and historic FCAs. Fuel costs account for 68 to 72 percent

---

21 Base rate covers the general cost of the utility’s business operation and is the product of the customer’s present usage and the base energy rate. The demand charge is the product of customer’s billing demand or power requirement and the set tariff rate. Customer charge is a fixed monthly charge based on customer’s tariff category.  
22 An adjustment clause is a provision made in a utility tariff that allows for periodic change in charges or credits to customers “this is due to increase or decrease costs over or under those included in the base rate (EEI 2005:2).
of the BL&PC’s operating expenses. On occasion, these fuel costs have reached as high as BDS$ 409 million dollars per year. Figure 3-10 illustrates that most of the money is spent on heavy fuel oil. Nevertheless it is the cheapest of the fuels per megajoule of output, as seen in Figure 3-11.

Figure 3-10: The Barbados Light and Power Company Limited’s average fuel costs ($/kWh) for 2008-2012.

(Source: BL&PC2013)

Figure 3-11: Cost per megajoule of fuel source utilized for electricity generation from 2008-2012.

(Source: BL&PC 2013).
Hotel customers of the BL&PC fall within two tariff categories: Large Power (LP) or Secondary Voltage Power (SVP). Figure 3-12 demonstrates the increase in the average cost of electricity to residential, SVP and LP customers as the FCA has varied. The FCA has risen constantly since 2009, going from BDS13.54¢ in January 2009 to as high as 49.35¢ in April 2012 and hovering in the 40¢ range since then. This is an increase in FCA by a factor of approximately 3.5. Hotel customers have had electricity costs increase from approximately $0.40 per kilowatt hour at the end of 2009 to above $0.60 per kilowatt hour in 2011 until present.

For most of 2008, the Government of Barbados (GOB) implemented a BDS $36 million dollar subsidy to protect the electric utility company and the Barbadian economy from rising fuel costs. The FCA was held at BDSS0.23 dollars in December 2007 until the price of oil eased and the FCA fell below the subsidized level in November 2008 (Mascoll 2011). In addition, BDSS15 million in governmental support was extended to the hotel sector with the development of the Tourism Industry Relief Fund (TIRF) designed to support job retention in eligible tourism accommodation and ancillary services. This fund was implemented again in 2012 to assist hotels with the escalating energy prices.

Fossil fuel dependency, geopolitics and diseconomies of scale have impacted the entire Caribbean. The Caribbean Electricity Services Corporation (CARILEC) is the region’s association of electric utilities responsible for shaping best practice, training, and technical publications. Figure 3-13 demonstrates the high costs of electricity for domestic customers in most of the Caribbean (CARILEC 2010; CARILEC 2012). Trinidad and Suriname are the most fossil fuel-endowed nations and exhibit relatively low costs of generation. Bermuda demonstrates astronomically high costs of generation as a result of the high cost of living, leading to high labour and infrastructural costs, along with high dividends for shareholders of the private utility (Young 2014; Royal Gazette 2012). Barbados has a lower cost of electricity relative to most of the other Caribbean islands.

---

23 A kilo volt-ampere (kVA) is a unit of electrical power representing power dissipated when a current of 1 ampere is produced with 1 volt. SVP customers have a billing demand of no less than 5 kVA whereas LP customers have a billing demand of no less than 50 kVA (BL&P 2013b).

24 Figure 3-12 maintains the fluctuation in FCA without demonstrating the period when the FCA was held at 23 cents from December 2007 until November 2008.

25 Available to establishments registered with the Barbados Hotel and Tourism Association (BHTA) with no outstanding national insurance debt. Registrants must have generated at least BDSS1.5 million in any of the three years prior to the recession (2006-2008) (EGFL 2009).
Figure 3-12: Average yearly electricity costs by customer category and fuel clause adjustment (BDS$/kWh) on the island versus the variance in world spot price for crude oil ($/MJ) 2008-2013.

Source: (BL&PC 2013; FTC 2013).
Figure 3-13: Tariff Survey for CARILEC members showing cost of using 100 kWh for month to residential customers in September in 2010 versus 2012.\textsuperscript{26}

(Source: CARILEC 2010; CARILEC 2012)

3.5 Electricity Regulation and Energy Incentives in Barbados

3.5.1 Legislative framework

The legislative framework for electricity in Barbados is structured on four regulatory Acts or statutes: the Electric Light and Power Act (ELPA), the Fair Trading Commission Act (FTCA), the Utilities Regulation Act (URA) and the Electricity Act. Before 2013, the BL&PC had the non-exclusive license to generate, transmit, and distribute electricity on the island. To sell power to the utility or other customers, Independent Power Producers (IPPs) required an approval from the Minster of Energy coupled with an Act of Parliament. In 2013, the Parliament of Barbados repealed the ELPA (1899) and enacted new legislation. The ELPA (2013) allows licensed IPPs to generate electricity from renewable energy sources

\textsuperscript{26} 2010 data was not provided by some of the utilities for both years. Survey occurs for one set month of the year. Recent surveys are not available on the CARILEC website.
and requires the BL&PC to offer power purchase agreements (PPAs) to such producers for all energy supplied to the public grid (ELPB 2013). The terms of these contracts are negotiable between the utility, the customer and an advisory committee.27 The total installed capacity, permitted per site, is fixed at 5kWp for residential purposes and 100kWp for non-residential. Applicants interested in generation capacity greater than 100kWp and up to 1MW must provide public notice over a period of three months to allow any representation or objections to be made to the Minister of Energy (ELPA 2013).

The Electricity Act (1936) was established to ensure that all grid connections are in accordance with the requirements of the ELPA (Castalia 2010). The Government Electrical Engineering Department (GEED) is the agency responsible for inspection of all grid connections. IPPs are not facilitated without obtaining a license of approval from the GEED. In addition, self-generators must also have their systems approved despite not being connected to the grid as an IPP.28

The Utilities Regulation Act (2000) was established to lay the framework for all utility regulation on the island: natural gas, sewerage, water, telecommunications, and electricity. In addition, the Fair Trading Commission (FTC) was established as an autonomous agency, to enforce utility regulation under the Fair Trading Commission Act (2000). The FTC’s explicit purpose is to:

...safeguard the interest of consumers, to regulate utility services supplied by service providers, to monitor and investigate the conduct of service providers and business enterprises, to promote and maintain effective competition in the economy, and for related matters.

(FTCA 2001:5)

To date, the FTC deals primarily with the regulation of electricity and telecommunications industries. These sectors consist of private companies, whereas water, natural gas, and sewerage are substantially under governmental ownership and operation.

### 3.5.2 Governmental Energy Incentives

The Government of Barbados has utilized fiscal incentives for energy initiatives. Barbados has been successful in developing an indigenous solar water heater (SWH) industry. The Fiscal Incentive Act of 1974 provided import benefits and tax exemptions for materials used in the construction of SWHs. Concurrently, a thirty percent consumption tax on electric water heaters was levied (Perlack & Hinds 2003). This was a strategic move to promote growth of the nascent SWH industry following the 1973 oil crisis. The Home Owner Tax Benefit was implemented from 1980 until 1992, allowing the deduction of

---

27 The 2013 Electric Light & Power Act (ELPA) amendment states that ultimate power to provide a license for interconnection rests with the Minister responsible for energy under consultation of an advisory committee. This committee consists of the Permanent Secretary of Energy, the Chief Energy Conservation Officer; the Chief Electrical Officer, the Chief Town Planner. In addition the Minister may appoint five persons that are qualified in accounting, law or engineering to the committee (ELPA 2013).

28 Independent Power Producers (IPPs) are commercial entities that generate and transmit electricity to the national grid for profit (FTC 2010).
the full costs of SWHs from taxable income. After the 1989 global recession, this policy was discontinued as part of the fiscal policy for structural reform of the economy. In 1996, the benefits were reinstated allowing system owners to deduct BDS$3500 dollar per year (Perlack & Hinds 2003).

Incentives for electricity generation technologies followed a decade later with the waiver of the import duty and environmental levy for photovoltaic systems. Components such as panels and inverters were allowed to enter the island without any added costs (Rogers et al. 2011). The Income Tax (Amendment) Act 2013 amendment provides tax holidays and concessions to eligible businesses and investors interested in development of renewable energy. Firstly, tax holidays are given to homeowners on income generated from RET. A ten year tax holiday is given for the establishment of new RET businesses (i.e. installers, developers and manufacturers). Secondly, eligible businesses constructing or upgrading a facility to supply renewable energy may deduct 150 percent of the amount paid on a loan for such purpose. Such businesses may also deduct 150 percent of the expenditure spent on training of staff in renewable energy generation, sales and installation of renewable energy and energy efficiency products. In addition, this deduction applies to expenditure on product development, research, and marketing. Thirdly, exemptions from corporation tax for up to ten years for venture capitalist are allowed; the venture capital contributions may be deducted from the investor’s taxable income. Shareholders in RET companies are exempt from Withholding Tax on dividends over the same ten year period. Finally, financial intermediaries that finance the development, manufacturing and installation of renewable energy and energy efficiency products are exempt from tax payment on interest earned.

The Government of Barbados has provided the hotel industry with incentives and guidelines for the development of hotel infrastructure under the Tourism Development Act 2002 and the Special Development Areas Act 2002. These tax incentives aim to increase the industry’s competitiveness. Hotel developers are eligible for investment tax credits, deductions on refurbishments, deductions on interest on loans, deductions for environmental certifications, and reduced customs duty on energy saving technologies and hotel equipment.

In Barbados, value-added tax (VAT) presently is charged at 17.5 percent, after an increase from 15 percent in 2012 (Nationnews 2012b). However with respect to RET development, VAT is zero-rated in conjunction with the previously mentioned fiscal incentives (Rawlins-Bentham 2013). Hotels have also been allowed to reduce their VAT on sales to 7.5 percent in the hopes of reducing visitor costs and consequently increasing competitiveness of the tourism industry. The hotel industry has been granted

---

29 In Barbados all goods imported are subject to “four kinds of import tax: import duty (0-20 percent); environmental levy (1 percent); excise tax (only for vehicles, tobacco products, alcoholic Beverages, and petroleum products); value added tax (15 percent)” (Rogers et al. 2011: 288).
more incentives than any other sector of the economy, having regard to its potential to earn revenue and particularly foreign exchange (Central Bank 2013).

The GOB has also invited the private sector to provide funding for the development of the renewable energy sector.

3.1.1 Utility Energy Incentives

In May 2009, the BL&PC submitted an application to the FTC to increase electricity rates to cover incurred utility expenses, attract capital for new plant, and to satisfy financial intermediaries and shareholders (Carter et al. 2012; Camfield et al. 2008). In addition to the rate increase, the utility requested the approval of three pilot incentive programs to be evaluated over a three year period: namely the Time of Use tariff (TOU), the Interruptible Service Rider (ISR), and the Renewable Energy Rider (RER) (FTC 2009).

The TOU tariff divides the day into various sections or blocks and is available to thirty Large Power customers. Electricity rates are higher at times of greater demand, with the highest rates during on-peak time (10 am to 9 pm). The benefit to the customers is achieved if they switch their operation to off-peak periods when electricity costs are cheaper. The utility company benefits from improved load factors and efficiencies and a reduced need for infrastructural expansion to satisfy peak customers.

The ISR is available to twenty manufacturers on the island with the ability to self-generate electricity using non-renewable sources such as diesel generation (FTC 2009). A total capacity of 10000 kVA and no more than 240 hours of interruptible service per customer is allowed (FTC 2009). Eligible customers are contracted to voluntarily reduce their load to a firm demand level (FDL) within thirty minutes (FTC 2009). This mechanism allows the utility to reduce its peak and the customers are provided with credit for their avoided demand. Eligible customers cannot be already compensated under the TOU tariff (FTC 2009).

The RER offers a potential incentive for customers in all tariff classes on the island who look to generate electricity through wind or photovoltaic energy. An interconnection agreement, with the utility, guarantees approved customers a reimbursement for the avoided cost of fuel. Customers in the Domestic

---

30 Riders are temporary credits or charges that have been approved by the regulator and are initiated to adjust for factors that have not been anticipated (Yukon Energy 2014).
31 Load factor refers to “the ratio between average net generation load over the year and peak demand” (Castalia 2010a:2-10).
32 Customers are only eligible if they have a billing demand above 300kVA and a monthly interruptible demand (MID) of not less than 100kVA. MID is calculated by taking the difference between the Monthly Average Demand (MAD) and the Firm Demand Level (FDL). If a customer agrees to be interrupted between 8 a.m. and 9 p.m. on any day they will be reimbursed at BDS$12 per kVA of MID for Monday to Friday; if customer agrees to be interrupted between 8 and 4:30 pm they will receive BDS$9 per kVA (FTC 2009). This agreement must last at least twelve months and the customer must give this same time period of notice if they wish to discontinue (FTC 2009).
Service (DS), Employee (EMP) and General Service (GS) classes are limited to a capacity of 5kWp. Initially, SVP and LP customers were limited to a 50kWp capacity; however, this was expanded to 150kWp. Initially, customer-generators were reimbursed at a rate of 1.8 times the FCA per kWh produced or 31 cents per kWh produced, whichever is higher. After reviewing the RER pilot program in July 2013, the FTC changed the reimbursement to 1.6 times the FCA (FTC 2013). The maximum capacity for RE is capped at 7MW of distributed RE totaled across the island. Systems with capacities beyond 1.5 times the customer-generator’s current usage will be credited at the FCA per kilowatt hour beyond the 1.5 limit. The customer-generator is also responsible for maintaining liability insurance and must purchase yearly coverage of BDS$100000 for systems 5 kW or less and BDS$500000 for systems greater than 5kW (BL&P 2010). Under the RER, the energy produced by customer generators is sold to the utility and the energy consumed is bought from the utility (FTC 2014). Details of all incentives on the island may be found in the Appendix D: Governance Information.

3.6 Planning for development

3.6.1 From Sugar to Sand

Soon after settlement of the island in 1627, the sugar industry was the main developmental tool for the island and contributed significantly to economic and social growth. This industry depended to a large extent on renewable energy in the form of windmills to grind sugar mechanically. Until the 1960s, national development plans focused primarily on the sugar industry and had limited policy addressing tourism (Marshall 1978).

After independence in 1966, leaders recognized the potential to compete with other Caribbean islands and to diversify the economy with tourism. “The smooth transition from sugar to sand was paramount to the development of 20th and 21st Century Barbados” (Greenidge 2004:118). Tourism revenues were second to agriculture and growing at 15% per annum by the end of the 1960s (T&CP 1970). Manufacturing was a meager industry and competitiveness in the sugar market had begun to wane.

---

33 Employee class refers to persons who work for the BL&PC.
34 AC or alternating current is an “electrical current that changes amplitude continuously and periodically changes polarity” (Thompson 2006: 137). AC reverses its direction at a regularly occurring interval or frequency which is 50 times per second in Barbados (BL&P 2013) Single Phase is a cycle of voltage that operates in the same time phase i.e. all the voltages are in unison. “Single phase service is where a facility has two energized wires coming into it. Typically serves smaller needs of 120V/240V and requires simpler equipment and infrastructure to support (less expensive)” (EEI 2005).
35 Windmills differ from wind turbines in that they use mechanical energy to pump water, grind mill or sugar cane. Wind turbines use the kinetic energy in the wind to drive a generator and create electrical energy.
Electrification was considered necessary for the socio-political advancement of the Barbadian society post-independence. The campaign of the country’s first Prime Minister, Errol Barrow promised that “all people living in the country subject to the same taxation should have the benefit of the utilities” (Carter 2012:13). This resulted in an aggressive policy of street lighting, rural electrification and increased grid capacity to drive economic diversification (Carter 2012).

Planning processes remain highly centralized in the vision of the national government of Barbados (Bunce 2008; Pugh & Potter 2000). For many English speaking Caribbean islands such as Barbados, land-use planning is based on the British Town and Country Planning Act (1947) resulting in planning units positioned within a hierarchical institutional structure (Pugh & Potter 2000). Environmental legislation is not legislated and environmental impact assessment (EIA) is conducted case by case basis. Land acquisition policies are heavily guided by the economic ambitions of the GOB and consequently focus on projects of the highest monetary value juxtaposed against a fragmented environmental policy framework (Bunce 2008; Pugh 2005; Kahn & Alleyne 1996). The 1970 Physical Development Plan for Barbados prepared by the Barbados Town & Country Planning Office (T&CP) with assistance from the United Nations clearly outlined the preferential considerations made with regard to the expansion of hotels and tourism amenities

Tourist accommodation will fall on whatever land is available that is contiguous with or adjacent to good safe bathing beaches... the regions of the South Coast and West Coasts of the island. Competition between permanent residents and tourists for these areas of high amenity has been resolved in favor of the dollar with the highest value. Other areas suitable for tourist development: rugged coast lines, and great old plantation houses and yards have yet to be exploited. (T&CP 1970:9):

The 1970 development plan envisioned future electrification of the island and conceded the establishment of electrical utility plant along the coasts as the most economically feasible locations despite the belief that such an allocation was an “unsatisfactory use of land in an area which has a high potential tourist development value” (T&CP 1970: 30). Figure 3-14 and Figure 3-15 demonstrate how such infrastructural planning has placed hotels along the coastlines. In addition, the expansion of the grid coincided with coastal commercial development. Today, electricity infrastructure is still considered vital to economic growth (Lorde 2010).
Figure 3-14: Map illustrating the electricity distribution network of the Barbados Light and Power Company Limited relative to hotel locations. (LSD 2013; BL&PC 2014).
Figure 3-15: Map showing the hotels, generation stations, and substations relative to the urban landscape of Barbados (LSD 2013; BL&PC 2014).
3.6.2 Tourism Today

Today the “Caribbean is the most tourism dependent region in the world with few options to develop alternative economic sectors” (GOB 2012: v). In Barbados, tourism is the most important industry on the island. The total share of GDP attributed to tourism was 43.7 percent in 2012 and this fell to 36.2 in 2013 (WTTC 2012; WTTC 2014). The accommodation sector of the industry directly employs 10 percent of the working population and has contributed an average of approximately BDS$1 billion per year in foreign exchange since 1999 (BSS 2013). In the last forty years, tourist arrivals have increased to over one million per year, with half of these arrivals being long-stay tourists.\textsuperscript{36} The total number of visitors to the island per year exceed the local population, with the average length of stay per visitor averaging eight to ten days (BSS 2013). The largest tourism markets have traditionally been the United Kingdom and Canada.

Barbadian economists have stated that foreign reserves are the “lifeblood of the economy” (Gill & Campbell 2005:32). The island is marketed as an area for foreign direct investment (FDI) by offering a variety of incentives to develop infrastructure and establish the island as an international financial services center (Barbados Advocate 2010). In 1986, FDI counted for 25 percent ownership of hotels in Barbados (Gill & Campbell 2005).

Today, approximately 30 percent of hotels are foreign owned, and approximately 20 percent have a combination of local and foreign ownership. In addition, approximately 20 percent of registered apartments and 15 percent of registered guest houses (villas) are owned or partially owned by foreigners (BTA 2013). In recent years there has also been a trend of an increasing number of annual hotel closures, with approximately 12 hotels, 13 guest houses and 19 apartments closing since 2007 (BTA 2013). This is an indication of the volatility and competitiveness of the tourism industry.

The bar graph in Figure 3-16 demonstrates the growth in electricity demand for domestic and non-domestic customers since 1960 in relation to the number of tourist arrivals and local citizens. The greatest increase in growth came between 1960 and 1980 for electricity generation and for tourist arrivals (BSS 2013). As the economy has expanded, non-residential electricity consumption increased at a greater rate than residential. The line graphs illustrate the total long-stay visitors and cruise ship visitors to the island, and national population growth. Since 2007, long stay-tourist arrivals have dwindled with a slight recovery in 2011. In 2013, the long stay visitors to the island were the lowest tally since 2002. The expansion of the economy and infrastructure was enough to for the utility company to recover their costs, secure an adequate rate base and maintain electricity rates from 1983 until the recession of 2008 and oil price shocks of 2007.

\textsuperscript{36} Long-stay arrivals refer to tourists on the island for longer than 24 hours that have not arrived by cruise ship.
Figure 3-16: Total electricity generation versus population growth, long stay tourist arrivals and cruise ship tourist arrivals 1960-2013

Source: (CBB 2014; BHTA 2013; BSS 2013)

3.6.3 Agenda for Future Energy Use

The Sustainable Energy Framework for Barbados (SEFB) and the Tourism Master Plan are two policy directives of the Government of Barbados relevant to the hotel sector. In his 2008 Budget Speech the late Prime Minister of Barbados, David Thompson placed emphasis on the need for restructuring of the tourism sector to adapt to international shocks since tourism is the country’s “main economic engine”(Thompson 2008:52). The creation of a Tourism Master Plan (TMP) by the Ministry of Tourism was proposed to address land-use policy, marketing, carrying capacity, and citizens’ livelihood (Thompson 2008). In particular, energy use within the tourism sector was considered integral to such a plan. Under the SEFB, energy scenarios have been developed to assess the potential future energy mix for the island along with the development of an Energy Smart Fund (ESF) facilitated by the Enterprise Growth Fund Limited (EGFL). The ESF was established through the Inter-American Development Bank (IDB) and provides financing to business for RETs and energy efficiency projects at low interest rates. An interest

37 According to the Energy Division of the Government of Barbados the main objectives of the SEFB are: “1)To help the Government of Barbados (GOB) develop a Sustainable Energy Framework (SEF) for Barbados, and achieve institutional strengthening in the areas of RE and EE; 2) To help the GOB promote EE in the country’s key sectors, and to implement energy efficiency pilot projects;3)To help the GOB identify and promote the most effective alternatives for RE generation, and to implement renewable energy pilot projects;4)To ensure wide dissemination of all project activities and results, thus contributing to improving information on sustainable energy practices in Barbados” (ED 2014).

38 The Enterprise Growth Fund Limited (EGFL) is a private sector led institution that facilitates venture capital loans for Small and Medium Enterprises (SMEs).
rate of 3.75% is offered for a loan with a maximum limit of BDS$1.5 Million dollars. The objective of the ESF is to capitalize BDS$20 million for renewable energy and energy efficiency projects through low cost funding and grants. The SEFB maintains that the national target for renewable energy is 29 percent by 2029 coupled with a 22 percent reduction in energy use (BL&PC 2012a).

In 2012, the BL&PC piloted an Integrated Resource Plan (IRP) to evaluate the potential mix of renewable and non-renewable generating technologies to meet national demand for the next twenty to thirty years. This IRP was based on local statistical data, the SEFB study, and global fuel price projections of the US Energy Information Administration (EIA) (EIA 2012; Castalia 2010a; Castalia 2010b). The BL&PC has proposed three scenarios of incremental electricity price escalation per annum: the base case (0.8%), the low case (-0.3%), and the high scenario (2.7%). In collaboration with the GOB and company shareholders, the utility is using these scenarios to secure and replace adequate generation plant. The utility company is considering the use of natural gas-based generation plant in place of existing diesel/HFO to cut costs and reduce CO₂ and other emissions (BL&PC 2012a; Guardian 2012; Gleaner 2012).

As part of the Alliance of Small Island States (AOSIS), the Caribbean Community (CARICOM) emphasizes the urgency to mitigate and adapt to climate change. AOSIS denounces the prospects of the “climate divide” whereby islands that contribute the least to global emissions levels face the most immediate challenges of climate change impacts namely: loss of coral reefs, biodiversity, sea level rise, and increased intensity of climatic events (Whalley & Walsh 2009). Climate change’s potential impacts and the consequential costs of adaptation are expected to be devastating to the tourism industry. In addition to adaptation, AOSIS calls for the UN member states to ensure financing to support renewable energy and energy efficiency as the “essential pillars of future mitigation actions by all countries, taking into account national circumstances” (AOSIS 2009:3). In 2012, The Barbados Declaration on Achieving Sustainable Energy for All in Small Island Developing States (SIDS) was signed by AOSIS member states committing to sustainable energy as the way forward for islands (AOSIS 2012). This declaration hoped to reaffirm the Barbados Program of Action (BPOA), a policy document focused on the sustainable development of islands based on their economic, social and environmental contexts. It was first envisioned at the 1992 Rio Earth Summit, and implemented in 1994 at the Global Conference on the Sustainable Development of Small Island States (AOSIS 2012; UN 1994).

At the national and the international scales the Government of Barbados has advocated its commitment to the use of renewable energy technologies. The justifications have been in light of burgeoning public debt, reduced credit ratings, reduced competitiveness in the tourism industry and the volatility of fossil fuel prices. Nevertheless, there has been a cry for more aggressive and transparent renewable energy policy as the country moves forward (Rogers 2013).
3.7 Summary

This chapter highlights the challenges that Barbados now faces. Barbados is reliant on the tourism industry to maintain the economy; however, the revenues have been used to service public debt and to import fossil fuels, primarily for electricity generation. Land-use planning decisions remain centralized in an island with infrastructure that relies heavily on the import of fossil fuel. The island is vulnerable to fluctuations in world commodity prices. After the beginning of the oil price shocks in 2007, long-stay visitor numbers fell and the island has not fully recovered from the global recession of 2008. Despite success in solar water heating (SWH), current renewable energy deployment has not achieved significant levels at a time when aging electricity infrastructure necessitates replacement. Hotels on the island benefit from a variety of incentives due to the island’s economic dependence on foreign reserves in the form of tourism receipts and foreign direct investment. Renewable energy technologies are considered potential solutions to the country’s foreign reserve deficits, potential fossil fuel price escalation and climate change.
4 Interviews, Study Design and Research Methods

4.1 Introduction

The objective of this thesis is to identify the barriers to renewable energy in the hotel sector of Barbados. Consequently, to determine these barriers my research involved in-person interviews with market-led, civil-society and governmental actors from the tourism, energy, academic and financial sectors of Barbados. The interview transcripts were evaluated using a grounded-theory approach to identify recurring themes amongst the comments of the study participants. Computer Assisted Data Analysis Software (CAQDAS) was used to sort these themes into categories or codes and to analyze patterns within the data. Secondary sources of information such as newspapers, journals, climatic data, and national economic statistics were gathered to validate or dispel the perceptions of the study participants. In addition, my study involves a quantitative element. I use cost information, national statistics and an electricity price forecast to illustrate the economics of renewable energy technologies (RETs), at the distributed and the utility scales.

In this chapter I introduce the mixed methods approach, whereby qualitative methods such as grounded theory are combined with quantitative analysis in the hope of creating pragmatic knowledge. Secondly, I discuss gaining access to informants and the use of purposive and snowball sampling techniques; I also describe the sample of respondents in my study. Thirdly, I describe the data collection and analysis processes. Finally, I discuss concerns and potential limitations of the research.

4.2 Mixed Methods Approach

This research subscribes to the ‘pragmatist’ paradigm. “Pragmatism” holds that knowledge is measured by its expediency within society especially through “engagement in public discourse, ethics and policy” (Hepple 2008:1539; Gregory 2009; Creswell 2003). The identification of perceived barriers to RETs may illuminate the potential avenues for policy makers and hoteliers to address energy use in Barbados. Although initially a qualitative inquiry, this research attempts to combine qualitative methods with a quantitative assessment of prospective renewable energy technologies for the island. Since all data have inherent limitations, the triangulation of information allows the data sources to complement each other (Hoggart et al. 2002).39

39 Triangulation refers to the use of more than one source of data to study social phenomenon and ensure that results are cross checked.
Quantitative methods address the study of social phenomena with the use of systematic empirical research in the form of numerical data, statistics, and calculations. Qualitative methods are concerned with “how the world is viewed, experienced and constructed by social actors; they provide access to motives, aspirations and power relationships that account for how places, people, and events are made and represented” (Johnston et al. 2004:660). Such methods may be inductive, constructionist or interpretive and emphasis is placed upon words and the recognition of meta-physical knowledge as opposed to quantification. There is a multiplicity of techniques for conducting qualitative research; however, I chose to use grounded theory to identify themes in my interviews.

4.2.1 Grounded Theory

Grounded theory was first proposed in 1967 by two sociologists: Barney Glaser and Anslem Strauss. Grounded Theory refers to a systematic method of social inquiry used to analyze and interpret qualitative data. The goal is to produce explanations (theories) of processes and interactions using the perspectives of a group of participants (Creswell 2007; Wuest 2007; Goulding 1999; Glaser & Stauss 1967). The aim is to not only to develop an understanding of an area under investigation but to provide courses of action in that same area (Heath & Cowley 2004). Grounded theory is an appropriate pragmatic method when the goal is “a framework or theory that explains human behavior in context” and especially behavior related to “developmental transitions and situational challenges” (Wuest 2007:230; Glaser & Strauss 1967; Glaser 1978). Barbados faces the challenges of transitioning the electrical infrastructure of the island and maintaining a competitive edge within the tourism market. The perception of actors in Barbados may determine the course of action taken to address the island’s challenges.

The approach to Grounded Theory has changed over the years. Glaser focused on induction and believed that grounded theory occurs when the researcher begins his or her inquiry with no prior knowledge of the literature or phenomena (Glaser 2004). However, Strauss and Corbin (1990) pursue an inductive and deductive approach whereby looking for and verifying data through literature and other sources is necessary (Heath & Cowley 2004; Straus & Corbin 1990). Nevertheless, the goal is to let themes emerge from the data without the imposition of preconceived notions found in the literature. I chose to use the Strauss and Corbin approach and I engaged with literature on renewable energy and tourism development when designing my interviews. During the analysis of my respondents’ opinions, I let my themes emerge

---

40 Induction is a form of knowledge and reasoning that moves from specific instances to a generalization or creation of laws. It is contrasted with deduction whereby reasoning takes what is known or given as the general form of knowledge and deduces the consequences of a particular circumstance. (Gregory 2009). Constructivism sees knowledge as the result of the perceptions of individuals or groups within a social context as opposed to there being an independent material world. Interpretivism is “an epistemological position that requires the social scientist to grasp the subjective meaning of social action” (Bryman 2004: 540).
from what was said and made constant reference to the literature for verification. It is the process of constant comparison and review that is said to create theories ‘grounded’ in data.

In chapter 2, I proposed transition management (TM) as my theoretical perspective for this research. However, TM was not chosen before my data were gathered and coded using a grounded-theory approach. Heath and Cowley (2004) suggest that novice researchers “select the method that best suits their cognitive style and develop analytical skill through doing the research” (Heath & Cowley 2004:141). It was after the analysis of my codes that I found TM to be a suitable heuristic device to further explain the findings.\(^4\) I believe that my use of interviews and grounded theory may be beneficial since critics of TM state that much of TM is based on secondary sources as opposed to primary research (Genus & Coles 2008).

Thomas and James (2006) warn that the method of grounded theory may be too prescriptive, thus causing researchers to lose objectivity. Techniques to address this concern are: the use of verification by subsequent respondents, and the use of field notes and secondary data throughout the data collection phases. These issues are further discussed throughout section 4.5. The stages involved in the qualitative portion of this thesis are summarized in Figure 4-1. The research question is formulated and the research site and sample respondents are chosen. The interviews are conducted and a process of review and refinement of questions occurs with every subsequent interview. After codes are identified, I returned to the previous interview transcript and literature to compare codes and comments. This reiteration continued for all interviews until no new concepts or relationships were identified in the text, leading to research grounded in data.

---

\(^4\) Heuristic devices are meant to explain phenomenon and processes and act as frameworks.
Figure 4-1: Steps involved in the qualitative inquiry

Source: (Adapted from Bryman 2004:269)
4.3 Gaining Access and Respondent Sample

Formal and informal gatekeepers were used to gain access to respondents on the island. A limitation of using gatekeepers is that their own fears, politics and alliances may influence the recommended informants (Bryman 2004). To address this limitation, three gatekeepers were identified from different areas of expertise: academia, the hotel industry and the energy industry. Kearns (2005) recommends that when conducting research a researcher should present a ‘known role’ to those being interviewed. This facilitates greater access to information. Gatekeepers and respondents were made aware of the objectives of my study and my status as a graduate student of the University of Toronto.

Purposive and snowball sampling techniques were used to develop a sample of respondents. Gatekeepers suggested that attending the September 2010 Alternative Energy Pathway to a Sustainable Barbados Conference would be the perfect place to initially engage respondents. At this conference, respondents from six categories of expertise were purposively chosen: 1) governmental departments, 2) the electric utility, 3) the financial sector, 4) hotel and private investor groups, 5) the renewable energy industry, and 6) local interest groups/NGOs. The justifications for choosing these groups are that they potentially hold a wide range of perspectives and such a sample encompasses market-led, governmental and civil society actors (Patton 2002). The remaining sample of respondents was further expanded using snowball sampling.

Mason (2010) found that amongst five hundred and sixty PhD theses, the mean sample size for interview respondents was thirty one. Sampling occurs until “the collection of new data does not shed any further light on the issue under investigation” (Mason 2010:2). Although not indicative of such saturation, my sample consisted of thirty one respondents. This size was limited by the duration of my fieldwork from September until November 2010.

Table 4-1 demonstrates that the sample consisted of 7 civil society actors, 8 governmental actors and 16 market-led actors. All respondents indicated a familiarity with renewable energy through job experience, mass media, or home ownership of renewable energy systems. Figure 4-2 demonstrates that most respondents worked in energy and regulation (19%). Financiers were the second largest group (16%). Tourism consulting and energy consulting followed with an equally represented percentage of respondents.

---

42 Formal gatekeepers are individuals who have some form of authority and control access to potential respondents and supplementary information, whereas informal gatekeepers do not have authority within the same network but may possess moral suasion amongst various actors (Siedman 2013).

43 Purposive sampling requires the selection of respondents that are considered “relevant to the research question” (Bryman 2004).

44 Snowball sampling is when a respondent suggests the next potential respondent based on the area under investigation.
The utility, academics, and hotel operators were the fourth largest group (9%) and NGOs and homeowners were the smallest set of respondents (6%).

<table>
<thead>
<tr>
<th>Respondent</th>
<th>Occupation</th>
<th>years of experience</th>
<th>Actor Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 : R07 Susan</td>
<td>non-governmental</td>
<td>5-10</td>
<td>civil society</td>
</tr>
<tr>
<td>8 : R08 Charlie</td>
<td>RE home system owner</td>
<td>15-20</td>
<td>civil society</td>
</tr>
<tr>
<td>12 : R12 Ian</td>
<td>RE home system owner</td>
<td>20-25</td>
<td>civil society</td>
</tr>
<tr>
<td>26 : R26 Fred</td>
<td>non-governmental</td>
<td>15-20</td>
<td>civil society</td>
</tr>
<tr>
<td>15 : R15 Chester</td>
<td>academic</td>
<td>30-35</td>
<td>Civil society</td>
</tr>
<tr>
<td>17 : R17 Arthur</td>
<td>Academic</td>
<td>5-10</td>
<td>Civil Society</td>
</tr>
<tr>
<td>18 : R18 Cliff</td>
<td>Academic</td>
<td>5-10</td>
<td>Civil Society</td>
</tr>
<tr>
<td>9 : R09 Jason</td>
<td>Tourism policy</td>
<td>25-30</td>
<td>Government Actor</td>
</tr>
<tr>
<td>23 : R23 Kate</td>
<td>Energy &amp; regulation</td>
<td>5-10yrs</td>
<td>Government Actor</td>
</tr>
<tr>
<td>27 : R27 Carl</td>
<td>Energy finance</td>
<td>15-20</td>
<td>Government Actor</td>
</tr>
<tr>
<td>28 : R28 Douglas</td>
<td>Planning regulation</td>
<td>25-30</td>
<td>Government Actor</td>
</tr>
<tr>
<td>29 : R29 Bradley</td>
<td>Energy &amp; regulation</td>
<td>15-20</td>
<td>Government Actor</td>
</tr>
<tr>
<td>1 : R01 Bobby</td>
<td>utility</td>
<td>30-35</td>
<td>Market Based Actor</td>
</tr>
<tr>
<td>2 : R02 Jeff</td>
<td>utility</td>
<td>20-25</td>
<td>Market Based Actor</td>
</tr>
<tr>
<td>3 : R03 Carol</td>
<td>tourism consultant</td>
<td>15-20</td>
<td>Market Based Actor</td>
</tr>
<tr>
<td>4 : R04 Elizabeth</td>
<td>finance</td>
<td>15-20</td>
<td>Market Based Actor</td>
</tr>
<tr>
<td>5 : R5 Gavin</td>
<td>energy consultant</td>
<td>25-30</td>
<td>Market Based Actor</td>
</tr>
<tr>
<td>6 : R06 Rachel</td>
<td>Tourism consultant</td>
<td>5-10</td>
<td>Market Based Actor</td>
</tr>
<tr>
<td>10 : R10 George</td>
<td>architectural consultant</td>
<td>10-15</td>
<td>Market Based Actor</td>
</tr>
<tr>
<td>13 : R13 Mike</td>
<td>hotel operations</td>
<td>15-20</td>
<td>Market Based Actor</td>
</tr>
<tr>
<td>14 : R14 Maria</td>
<td>hotel operations</td>
<td>5-10</td>
<td>Market Based Actor</td>
</tr>
<tr>
<td>16 : R16 Dale</td>
<td>hotel operations</td>
<td>5-10</td>
<td>Market Based Actor</td>
</tr>
<tr>
<td>19 : R19 Gerald</td>
<td>RE installer</td>
<td>10-15</td>
<td>Market Based Actor</td>
</tr>
<tr>
<td>21 : R21 Frank</td>
<td>finance</td>
<td>&gt;40</td>
<td>Market Based Actor</td>
</tr>
<tr>
<td>22 : R22 Rick</td>
<td>finance</td>
<td>&gt;40</td>
<td>Market Based Actor</td>
</tr>
<tr>
<td>24 : R24 John</td>
<td>utility</td>
<td>15-20</td>
<td>Market Based Actor</td>
</tr>
<tr>
<td>30 : R30 Rebecca</td>
<td>Tourism consultant</td>
<td>5-10</td>
<td>Market Based Actor</td>
</tr>
<tr>
<td>31 : R31 Alexander</td>
<td>finance</td>
<td>10-15</td>
<td>Market Based Actor</td>
</tr>
</tbody>
</table>

Table 4-1: Description of Respondents in Research Sample and Assigned Names
4.4 Data Collection and Analysis

Three sources of data collection were used: 1) Interviews, 2) secondary data sources in the form of literature, and quantitative data obtained from hotels, government, banks and the utility company 3) hotel site visits, photography, and energy use observation.

4.4.1 Semi-structured interviews

Semi-structured interviews were considered the best option for conducting this research since they facilitate the collection of “facts, opinions, attitudes, experiences, processes, behaviors or prediction” (Rowley 2012:261; Hoggart et al. 2002). In addition, such interviews provide greater flexibility in questioning and are adaptable to the responses of the interviewee (Bryman 2004). Therefore, questions do not follow a particular order and allow the respondents to guide the conversation at his or her pace. The respondents may be as detailed as they want, thus resulting in greater context. The interviews dealt with the following areas or themes: 1) the impact of tourism on the island’s development, 2) fuel prices 3) awareness of climate change 4) opinions of any current initiatives with regards to energy and tourism, and 5) future deployment of RETs. The interview protocol was approved by the Office of Research Ethics at the University of Toronto in May 2010. Appendix B: Methods Materials provides examples of the questions used throughout the interviews.

4.4.1.1 Informed Consent, Recording and Transcription

Contracts of informed consent were used as a method of respondent elicitation. Contracts offer respondents transparency in the use of their opinions and the information provided. In addition, the
provision of a contract develops trust and acts as legal protection to the parties involved in the interview (Corti et al. 2000). Information on the purpose of the study was provided during the first contact and interviews were scheduled once the candidate agreed to participate. I personally witnessed candidates read the contractual agreement outlining the use of information. I answered any questions before the contracts were signed. Candidates were guaranteed that the thesis was to be used solely for academic purposes and that upon completion of the research I could use the information for publishing in journals, conferences and presentations. Candidates were given the options to: 1) keep their name confidential or use it in the publication of the thesis, 2) not answer questions or ask for clarification, 3) withdraw statements or the entire interview at any time during the fieldwork period, 4) request a copy of the recording and transcript of the interview, and 5) donate transcripts to school archives and obtain a copy of the final thesis submission 6) allow or disallow the use of photography and utility information when hotel walkthroughs were conducted.

Although many respondents chose for their names to be used, I chose to provide anonymity to the respondents. As in Bringer et al. (2006), pseudonyms were assigned in the hope of reducing reader bias. Any real names used in the study may be traced to quotations of secondary sources.

Interviews were recorded and I immediately transcribed the conversations upon completion of the interviews. The respondents’ opinions influenced the content of the subsequent interviews. This reiterative process allowed for the building of concepts and themes. Shortcomings of transcription are that the process is lengthy and expensive if hiring assistance (Creswell 2009). The transcription process lasted three months. However, the benefit was that the combination of audio-recordings and written transcripts assists with remembering the context of the respondent’s speech (Seidman 2006; Vygotsky 1987; Heritage 1984). More importantly, transparency is created, since information is readily available for scrutiny.

4.4.1.2 Coding and the use of Computer Assisted Qualitative Data Analysis Software

In qualitative research, coding refers to the categorizing of data into assigned themes (Bryman 2004). A combination of open coding and selective coding was used to expound the themes necessary for analysis. Open coding refers to the “process of breaking down, examining, comparing, conceptualizing and categorizing data” and facilitates the building of theories (Strauss & Corbin 1990:61). These types of codes come directly from the data and represent the concerns of the sample respondents. Selective coding varies in that it is very specific and requires “emphasizing the most common codes and those that are seen as the most revealing about the data” (Bryman 2004:402; Charmaz 2004). This type of coding depends on the objective of the research. Transcriptions of the interview recordings were broken down into themes that emerged in the dialogue. Cope (2005) explains that coding is an iterative process and requires various
stages of revision. My coding consisted of two parts: the initial coding to develop a coding frame and the complete coding of all interviews.45

The data can be coded in many ways and the initial process leads to the generation of many codes. In reviewing the codes, categories are refined. As recommended by Bryman (2004), transcriptions were read through without notes being taken. However the second reading included the initial open codes. These codes were very basic or ‘NVivo’ codes meaning codes that represent the actual words of the interviewee. For example if a respondent were to claim: “Priority should be given to the vistas of seascape, our ‘windows to the sea,’ before we consider renewable energy”, the NVivo code can be created as the theme ‘windows to the sea’. The selective coding occurs later in the process as analytical relationships are realized in the data (Cope 2005). Using the same example, vistas are related to selective codes such as ‘siting and space’ for RETs. The data was further assessed by classifying respondents as government, civil society and private led actors. This allowed comparison of attitudes and opinions amongst different groups.

Computer Assisted Qualitative Data Analysis Software (CAQDAS) was used to analyze the interview transcripts and sort identified themes. The software program NVivo 10 designed by Qualitative Solutions and Research (QSR) was utilized for this task. The efficacy of CAQDAS as a research tool has been debated by many scholars (Richards 1999, Fielding & Lee 1998; Bryman 2004). Critics argue that such programs decontextualize data by reducing complex material into fragmented texts and codes (Fielding & Lee 1998; Baxter & Eyles 1997). Also, it is a common misconception that this software can analyze data on its own. Contrary to this belief, the researcher must still conduct the coding line by line. Nevertheless, the benefits were judged to outweigh the limitations and such software “creates possibilities for previously unimaginable analytical scope” (Lu & Stuart 2008:106; Richards & Richards 1991). CAQDAS are advantageous since the software may expedite the coding process when large samples of transcript are involved. Furthermore, the software organizes the data and automatically creates an audit trail to track the researcher’s interaction with the data. Moreover, NVivo 10 allows secondary sources to be imported, thus allowing the researcher to verify facts stated by respondents.

4.4.2 Secondary Data Sources

Secondary data sources took on various forms: journals, newspapers, internet, architectural information, annual reports and climatic data. A majority of the literature and economic data used in this research for illustrations and documentation were sourced from the management teams of the Barbados Light & Power Company (BL&PC), the Fair Trading Commission (FTC), and the measurements done by

45 A coding frame is a list of themes or categories used in the analysis of the qualitative data and especially important in analyzing the responses to open questions (Bryman 2004).
the various hotels. Furthermore, statistical data was provided by the Central Bank of Barbados (CBB), the Barbados Statistical Service (BSS), the Barbados Tourism Authority (BTA), and the Caribbean Tourism Organization (CTO). The advantage of secondary analysis is that it assists with credibility through the use of high quality data, and has the potential to save time and money (Bryman 2004). Furthermore, this form of data collection may be relatively “unobtrusive” and accessible freely on the World Wide Web (Lee 2000). The use of newspapers allows for a longitudinal aspect to my research. This is of particular importance given that time has elapsed since the initial fieldwork in 2010.

Mapping and roof area data of hotels in Barbados were provided by the Land and Survey Department of Barbados (LSDB). The purpose of obtaining these data was to obtain an estimation of available hotel roof-space for solar photovoltaic electricity generation. The data were obtained under the agreement that it is to be used for academic purposes. In order to obtain hotel roof area data, I visited the LSDB and manually identified hotel space on a GIS map. The resulting shape file was then given to me without the names of the hotels provided in the sample. This data visually represents hotel space relative to electrical infrastructure and other land uses on the island.

Climatic data were provided by the Caribbean Institute of Meteorology and Hydrology (CIMH) in Husbands, St. James, Barbados. Data on rainfall, cloud cover, atmospheric pressure, solar irradiance and wind speed and direction were provided for two locations on the island. These data were compared to data found in journal articles and NASA data.

Data on the energy output and costs of photovoltaic systems were provided by installers on the island. This information was compiled with international energy statistics and the other secondary sources previously mentioned. A cost analysis was done based on this information and may be found in chapter 5.

4.4.3 Hotel Observation and Photography

During the study, I had the opportunity to tour and observe three hotel sites on the island. These sites were selected randomly and exhibited different energy densities. The use of photography was approved by hotel operators. In two of the three tours, I was accompanied by an engineer to guide me through mechanical rooms and explain the facility. In the third case, I was given a preliminary tour and then provided a pass to walk around the facility and document my tour using notes and my camera. The tours allowed me to explore the roofs of the hotels as well as to document the use of that space. Hotel management provided energy use information from January 2009 until September 2010 for all three hotels.
In order to not affect the everyday business of the hotels, I was only allowed to enter empty rooms and spaces. The objective of such observation was to not only document how hotel space is used but also to identify the potential space for RETs at the hotel site.

In addition, I had the privilege of taking a helicopter tour of the island along the entire coastline. This flight was taken at solar noon in October 2010. This provided me with a bird’s-eye view of the hotel plant on the island and facilitated photography of coastal hotel infrastructure.

4.5 Concerns and limitations when conducting research

There are various limitations when conducting research. Firstly, power dynamics and research bias must be consciously mitigated through reflexivity. Secondly, researchers must take steps to address rigour. Finally, research is limited by access to data, costs, and time.

4.5.1 Power and reflexivity

As time working in the field elapses, researchers must recognize their own position relative to their study participants (Mullings 1999). It is the researcher’s responsibility to manage personal bias and recognize the power dynamics embedded in social interactions. The politics of the research context and the duration of time spent in the field impact the interactions researchers share with their participants (Campbell & Grey 2006). Elwood and Martin (2000) explain, “the interview site itself embodies and constitutes multiple scales of spatial relations and meaning, which construct the power and ‘positionality’ of participants in relation to the people, places, and interactions discussed in the interview” (Elwood & Martin 2000: 649).

Participant perception of the researcher influences the type of information divulged and the quantity (Seibert et al. 2002). In my study, the point of contact with potential respondents was always through formal introduction or within the context of the respondents’ working environments. Some respondents, all of them civil servants, asked me to accompany them to their residence to speak. In these instances I dressed formally and the interviews occurred within the house owners’ home offices. Although my Barbadian citizenship allowed me access to information, I had to be cognizant of the nature of the political milieu. Some respondents probed my motives, my lineage and my political beliefs before and after recordings began. Furthermore, after hearing my motivations for research, some respondents rejected my

---

46 Reflexivity is “reflection upon the conditions through which research is produced, disseminated and received” (Gregory et al 2009: 627). This term from used in social research recognizes the position of the researcher relative to his or her surrounding environment. Political influence, upbringing, gender all play a role in the interpretation and reception of researcher and subjects.

47 Positionality is a social science term and refers to the fact that a researcher’s cultural, social, psychological backgrounds influence the questions asked, how they are framed and interpretations. The power relationship between researcher and respondent is in itself a social construct. It is the recognition of potential impacts of scholarly distance and relationships on the objectivity of field work and creation of knowledge (Gregory et al. 2009).
request to conduct an interview. These actors were mostly market based actors from the hotel industry and the renewable energy industry. However, these omissions were not detrimental to my study. I cannot infer their justifications for not participating. I am, however, cognizant that I am viewed as an actor from the same society and subsequently my access is dependent on respondent acceptance. I acknowledge that my interest in the subject has developed over time from my childhood on the island, observing the tourism industry’s impact on the culture, and my educational background in environmental studies, political science and international relations. In interacting with my respondents I made a conscious decision not to engage in opinionated speech and in some instances let respondents carry the conversation with minimal prompting. I believed that if the respondents felt control of the discourse, they would be more amicable.

Memos are notes written to catalogue thought process along the way of the research and were utilized to manage reflexivity. Memos can be used to add to the understanding of nodes when coding (Bringer et al 2006). This creates a starting point from where the researcher left off or provides definitions of concepts or codes used in the data. It is essential for researchers to explicitly communicate the terms of the research process and the rationale(s) for “respondent selection, key changes in research direction and analytical procedures” (Baxter & Eyles 1997: 521). NVivo 10 allows researchers to create these memos and provides insight into the development of thoughts. More importantly, they assist researchers in reflexivity; the iterative process of coding allows the researcher to question bias, and their position relative to the research and allows criticism and transparency (Bryman 2004).

4.5.2 Rigour

Establishing rigour in qualitative research requires the evaluation of four criteria: ‘transferability’, ‘credibility’, ‘dependability’ and ‘confirmability’ (Baxter & Eyles 1997). To validate these four criteria I systematically evaluate my data using techniques such as: “reflexive management, constant comparison and the use of archives for data” (Bailey & White 1999b: 182). Critically assessing the data requires triangulation with secondary sources such as newspapers, journals and statistical data. As previously mentioned, the use of mechanical recording and peer examination enhances rigour. Statements made in the interviews were verified with other study participants as the field work continued. Such methods have been prescribed to address dependability by Baxter and Eyles (1997). Credibility has been considered by using purposive sampling amongst actors within the industry who work within the energy and tourism sectors. Secondly, I have persistently documented developments on the island since the beginning of my research. The subjective nature of qualitative data is said to make transferability or replication difficult (Baxter & Eyles 1997; Bryman 2004). Nonetheless, the systematic process of coding from the data may be replicated.
4.5.3 Access to Information

In my opinion, the most prominent limitation to my research was my lack of full access to information. Some data to be used in illustrations were either not shared or required lengthy procedures to obtain. The time spent in the field may have limited the quantity of information gathered. Furthermore, some information was not archived for public access without purchasing. Hotels were not willing to provide occupancy rate data or details of corporate structures, and some renewable energy firms were unwilling to share cost data. Some respondents did not return my phone calls or email attempts to contact them. Some actors, upon reading my statement of purpose, exercised their right to turn down my request. I was also offered explanations that with the island being small, disclosing insider information and methodologies may put actors at competitive disadvantage. Nevertheless, this provided insight into the Barbadian political and socio-technical milieu.

4.6 Summary

One of the objectives of my study is to identify the barriers to renewable energy within the hotel industry of Barbados through qualitative and quantitative methods of research and analysis. I used a grounded theory to analyze interviews with civil society, market-led, and governmental actors in Barbados. Themes were expounded using Computer Assisted Qualitative Data Analysis Software. And the relationships of themes were used to illustrate the socio-technical context of Barbados. These insights were combined with the use of literature, photography, and cost calculations. Each method used in the study has inherent weaknesses and strengths. The quality of the research was enhanced through the use of triangulation, respondent verification and the careful consideration of bias, power dynamics, reflexivity, and rigor.
5 Results: An Economic Analysis of Renewable Energy Technologies in Barbados

5.1 Introduction

This chapter presents a cost analysis of renewable energy technologies (RETs) applicable to Barbados. I introduce the levelized cost of electricity (LCOE) for a range of utility and distributed-scale thermal and renewable energy technologies. Results are given in Barbados dollars per kilowatt hour.\(^48\) The analysis considers scenarios of fuel and electricity price escalation presented by the Barbados Light and Power Company’s (BLPC) Integrated Resource Plan (BLPC 2012). I continue with an analysis of four photovoltaic systems operating in Barbados and determine the internal rate of return (IRR) for these investments. In addition, I discuss tax incentives and the utility’s credit system for self-generators known as the Renewable Energy Rider (RER). Finally I present a discussion of the impact of RET on foreign exchange savings and the negative externalities of conventional electricity production such as carbon emissions, and water scarcity.

5.2 Levelized Cost of Electricity (LCOE)

The levelized cost of electricity (LCOE) is the average price per kilowatt hour ($/kWh) at which energy must be sold to recover all costs, including interest charges, over the lifetime of an energy project (Harvey 2010b). It is computed as:

\[
C_{\text{electricity}} = \frac{(CRF + INS) \times CC + OM_{\text{fixed}}}{8760 \times CF_{AC}} + OM_{\text{variable}} + \frac{C_{\text{fuel}} \times 0.0036}{\eta}
\]

where

\[
CRF = \frac{i}{1-(1+i)^{-n}}
\]

As seen in equation 5.1, the required inputs when calculating the LCOE of an energy system include:

1. The initial investment or capital costs (CC) of the energy system.
2. The cost recovery factor (CRF) or annual fixed fraction of the capital costs to be paid against a loan (principle). As seen in equation 5.2, the CRF is dependent on the real interest rate per year expressed as a fraction (i) and the lifetime of the energy system in years (n).\(^49\)
3. The annual insurance costs as a fraction of the capital cost (INS).

\(^{48}\)The exchange rate is US$1.00 = BDS $2.00

\(^{49}\)Using the real interest rate thus accounts for inflation and is the difference between the quoted interest rate (nominal rate) and the rate of inflation.
4. The fixed operation and maintenance costs ($OM_{fixed}$).

5. The per annum energy output of an energy generation system. The average electrical output as a fraction of peak output is called the capacity factor ($CF_{AC}$). $CF_{AC}$ times the number of hours in a year (8760) gives the number of kWh generated per year per kW of capacity.\(^{50}\)

6. The variable operations and maintenance costs ($OM_{variable}$);

7. The cost of fuel ($C_{fuel}$) in $/GJ$, divided by the efficiency ($\eta$) of the energy system in converting that fuel to energy. The factor 0.0036 is the number of kWh in 1 GJ, where 1 kWh is 3.6 MJ.

Equivalently, the LCOE can be determined by using the quotient of all the costs involved in establishing an energy generating system discounted to the present time and the total energy output of that system over its lifetime discounted to the present.

### 5.2.1 Inputs and the Levelized Cost of Electricity Calculation

The LCOE calculation is very sensitive to the inputs, so a range of inputs is used here to address potential errors (Darling et al 2011; IRENA 2012). My study utilizes the most recent accessible cost inputs to calculate the LCOE for renewable energy technologies in Barbados (REN21 2013; BL&PC 2012; Castalia 2010a, 2010b; IRENA 2012a, 2012b, 2012c; EIA 2013). In addition, I use cost data provided by a renewable energy company in Barbados for four photovoltaic systems of varying capacity operating on the island. All costs are up to the point of interconnection to the grid. Therefore, the costs of transmission infrastructure and storage are not calculated.

#### 5.2.1.1 Weighted Average Cost of Capital

Large commercial banks are the main source of debt financing in the Caribbean with many of these financial intermediaries operating in Barbados (MCG 2013).\(^{51}\) Prime interest rates are the lending rates offered by commercial banks to the most credit worthy commercial clients. The weighted average cost of capital (WACC) refers to the cost of financing from debt and equity with each component equally weighted according to its use (Donavan& Nuñes 2012).\(^{52}\) Hotels can use equity to finance projects if they have the necessary reserved capital. Equity financing is more dependent on internal resources in the form of funds

---

\(^{50}\) AC or alternating current is an “electrical current that changes amplitude continuously and periodically changes polarity” (Thompson 2006: 137). AC reverses its direction at a regularly occurring interval or frequency which is 50 times per second in Barbados (BL&P 2013)

\(^{51}\) Barbados National Bank, Butterfield Bank, Bank of Nova Scotia, CIBC First Caribbean International, RBC Royal Bank of Canada, Royal Bank of Trinidad & Tobago

\(^{52}\) WACC=$[\text{Cost of Equity}(\text{Equity/Equity + Debt})]+[\text{Cost of Debt}(\text{Debt/(Equity + Debt)})]$ (Donavan & Nuñes 2012)
from investors. Investors require higher returns on their investment than debt financing. Many businesses use a combination of debt and equity. In this analysis, it is assumed that hotels will finance RET projects through debt. Therefore, the average upper and lower prime interest rates of commercial banks are used as the baseline for the WACC. According to the Central Bank of Barbados, the average prime rates ranged from 7.65-8.70 percent (CBB 2014). Consequently, I assume 9 percent as the interest rate to conservatively compare technologies. These rates are high compared to Canada and the USA where rates were 3 percent and 3.3 percent respectively in 2013 (WBG 2014).

5.2.1.2 Lifetime of Systems

The lifetimes of technologies vary with rate of degradation and environmental factors (Branker et al. 2011; IRENA 2012). In this study, I assume that the lifetime of technologies to be 20 years for the renewable energy projects. For solar PV, this is a very cautious assumption, as PV systems are now expected to last 25 years or longer (IRENA 2012). The waste-to-energy (W2E) and biomass cogeneration projects are 30 year projects. For conventional thermal plant, the low-speed generators have a lifetime of 30 years whereas combustion turbines have a 25 year lifetime.

5.2.1.3 Fuel and Electricity Price Escalation

Three scenarios of fuel and electricity price escalation are implemented to account for the uncertainty of energy prices in the BL&PC’s Integrated Resource Plan (IRP) (BL&PC 2012). As seen in Figure 5-1, natural gas is considered the cheapest option for the country. The high scenario of natural gas fuel price gives lower price estimates than the low scenarios of all the other fuel types. In addition, three scenarios of utility electricity price escalation per annum were proposed: an expected increase of 0.8 percent, a high scenario of 2.7 percent, and a low scenario of -0.3 percent. Figure 5-2 illustrates forecasts of electricity price increase until 2036, beginning with the average price for secondary voltage power (SVP) customers of 65 cents. These three scenarios are used to assess the economics of RETs versus conventional electricity generation.
Figure 5-1: Three scenarios of price escalation for fuel for heavy fuel oil, jetA1, diesel and natural gas until 2036
(Source: BL&PC2012).

Figure 5-2: Three electricity price escalation forecasts based on three scenarios of per annum growth for secondary voltage power (SVP) customers: expected (0.8%), high (2.7%) and low (-0.3%)
(Source: BL&PC 2012; EIA 2012).
5.2.2 Analysis of Levelized Costs

5.2.2.1 Levelized Costs of Fossil Fuel Based Electricity Generation Systems

The current national electrical supply provided by the BL&PC consists of a series of aging low-speed generators, steam generators and combustion turbines. The utility has proposed replacing the existing infrastructure with natural gas based generators (BL&PC 2012). This proposition assumes the availability of liquid natural gas (LNG) or compressed gas via shipping and underwater pipelines to Barbados (BL&PC 2014; BL&PC 2012a).

Table 5-1 illustrates the inputs for the levelized cost of electricity for fossil fuel based electricity generation (BL&PC 2012a; BL&PC 2014; BSS 2013). Combustion turbines have the lowest capital costs ($/kW) compared to the low-speed generators and combined-cycle generators. However, combustion turbines exhibit the highest variable costs ($0.08/kWh) and fuel costs ($0.21-$0.60/kWh) per kilowatt hour of electricity produced (Table 5-2). The use of diesel as the source of combustion for these generators drives the costs up. In addition, combined cycle turbines (CCTs) and low-speed diesel generators (LSD) are relatively more efficient at creating electricity than diesel and gas combustion turbines. This means the ratio of electrical output to heat energy is higher. Ultimately, the capital costs may be higher for CCTs; however, they run more efficient service with smaller fuel and variable costs.

Figure 5-3 illustrates the potential differences in costs per kilowatt hour using natural gas for low-speed generators (LSD), combustion turbines (CT), and combined cycle turbines (CCT). HFO and diesel supplied generators incur higher costs than natural gas supplied generators of the same capacity. Diesel-based generation is the most costly. Combined cycle power-plants are the least expensive and most efficient fossil fuel power-plants but are only economical at sizes between 25-50 MW and larger (Harvey 2010a).

The utilization of natural gas as the fuel source reduces the cost per kilowatt hour of electricity by 50 to 60 percent for the LSD, CTs and CCGTs. Nevertheless, consideration must be given to renewable energy generation where there is little to no fuel costs involved. Increased fuel prices may negate the

---

53 Low-speed engines are reciprocating engines whereby fuel is converted to mechanical energy and using pistons that rotate a crank shaft. This energy compresses air in the cylinders and combustion occurs. The power from this process is used by an alternator to create electricity through magnetic induction. “Low-speed” refers to the revolutions per minute of the pistons relative to other engines e.g. gas engines. In a combustion turbine air is brought in through a compressor and pressurized. It then is sent to combustor where fuel and air area mixed and ignited creating hot air that expands and turns the generator shaft (Harvey 2010a). Some of this power created is used in the compressor again and the remainder is used for electrical energy. Combined cycle engines can be a mix of diesel and natural gas or steam and natural gas.
projected lower LCOE for these fossil fuel-based generators relative to RETs. Such uncertainty has justified the diversification of utility portfolios to include a mix of renewable energy sources (EIA 2013).

Hotels may utilize small-scale diesel and natural gas generators (Gensets) as backup generation at times of emergency or brown outs. Such systems are sized based on the needs of the customer and may include additional fuel tanks and battery systems. These systems require constant maintenance and are heavily influenced by the cost of imported fuel. The expected, high and low costs per gigajoule of fuel used for diesel and natural gas Gensets can be observed in Table 5-1. Table 5-2 illustrates the high contribution of the fuel costs involved to the cost of electricity when using a Genset. Figure 5-3 demonstrates that the natural gas options for Gensets have lower levelized costs. The efficiency of these systems can decrease after ten years and they are best suited as backup or in combination with intermittent sources like RETs (Agajelu 2013).

As mentioned in chapter 3, some manufacturers on the island have utilized these technologies to benefit from the Interruptible Service Rider (ISR). As of 2013, four industrial users, one supermarket and a port have utilized the ISR. However, this option has not been utilized by hotels on the island and private generators are limited in capacity. Since such systems are used as backup sources of electricity, the assumed capacity factor (0.25) indicates the limited use of these systems during the year. However, the ISR is limited to 240 hours per customer or only a limited capacity factor of 2.7 percent. As seen in Figure 5-5, in a scenario with high future fuel costs, the costs per kilowatt hour increase from $1.48 to as high as $6.91/kWh for a 500kW diesel generator. The ISR may prove risky for a hotel that has to guarantee service to tourists. A credit of $12 per kW of interrupted demand is a small incentive. Thus utilization as a backup in case of emergency is suitable. Nevertheless, a generator offers a dispatchable source of electricity and hotels value maintaining services to clientele. RETs remove the fuel cost concern; however, the intermittent nature of RETs does not guarantee the hotel can maintain electrical services for tourists.

---

The ISR is available to twenty manufacturers on the island with the ability to self-generate electricity using non-renewable sources such as diesel generation (FTC 2009). A volt amp (VA) is a unit of power roughly equal to a watt (W). A total capacity of 10000 kVA and no more than 240 hours of interruptible service per customer are allowed (FTC 2009). Eligible customers are contracted to voluntarily reduce their load to a firm demand level (FDL) within thirty minutes (FTC 2009). This mechanism allows the utility to reduce its peak and the customers are provided with a credit for their avoided demand. If a customer agrees to be interrupted between 8 a.m. and 9 p.m. on any day they will be reimbursed at BDS$12 per kVA of monthly interruptible demand (MID) for Monday to Friday; if customer agrees to be interrupted between 8 and 4:30 pm they will receive BDS$9 per kVA (FTC 2009). A lump sum is provided at the end of each month. If MID is less than 100kVA then no credit is given. This agreement must last at least twelve months and the customer must give 12 months of notice if they wish to discontinue (FTC 2009).
<table>
<thead>
<tr>
<th>Technology</th>
<th>Fuel</th>
<th>Size (MW)</th>
<th>Scale</th>
<th>lifetime (years)</th>
<th>Efficiency</th>
<th>capacity factor</th>
<th>capital cost (BD$/kW)</th>
<th>Fuel Cost ($/GJ)</th>
<th>O&amp;M ($/kW/yr.)</th>
<th>variable costs ($/kwh)</th>
<th>LCOE ($/kwh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fossil Fuel Generation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-speed diesel generators</td>
<td>HFO</td>
<td>30-40</td>
<td>utility</td>
<td>30</td>
<td>0.47</td>
<td>0.87</td>
<td>$2,853</td>
<td>$19.35</td>
<td>$110</td>
<td>$0.012</td>
<td>$0.37</td>
</tr>
<tr>
<td>Low-speed diesel generators</td>
<td>natural gas</td>
<td>30-40</td>
<td>utility</td>
<td>30</td>
<td>0.47</td>
<td>0.9</td>
<td>$3,261</td>
<td>$10.42</td>
<td>$110</td>
<td>$0.012</td>
<td>$0.17</td>
</tr>
<tr>
<td>Diesel combustion turbine</td>
<td>diesel</td>
<td>30-40</td>
<td>utility</td>
<td>25</td>
<td>0.36</td>
<td>0.9</td>
<td>$1,829</td>
<td>$28.83</td>
<td>$26</td>
<td>$0.080</td>
<td>$0.62</td>
</tr>
<tr>
<td>Gas combustion turbine</td>
<td>natural gas</td>
<td>30-40</td>
<td>utility</td>
<td>25</td>
<td>0.36</td>
<td>0.9</td>
<td>$1,786</td>
<td>$10.28</td>
<td>$11</td>
<td>$0.080</td>
<td>$0.23</td>
</tr>
<tr>
<td>combined cycle turbine</td>
<td>diesel</td>
<td>30-40</td>
<td>utility</td>
<td>25</td>
<td>0.49</td>
<td>0.9</td>
<td>$3,698</td>
<td>$28.83</td>
<td>$110</td>
<td>$0.010</td>
<td>$0.46</td>
</tr>
<tr>
<td>combined cycle gas turbine</td>
<td>natural gas</td>
<td>30-40</td>
<td>utility</td>
<td>25</td>
<td>0.49</td>
<td>0.9</td>
<td>$3,129</td>
<td>$10.28</td>
<td>$110</td>
<td>$0.010</td>
<td>$0.16</td>
</tr>
<tr>
<td>Hotel Private Fossil Fuel Backup Generators</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>electric generator set</td>
<td>diesel</td>
<td>0.06</td>
<td>distributed</td>
<td>20</td>
<td>0.33</td>
<td>0.25</td>
<td>$250</td>
<td>$26.3</td>
<td>$163</td>
<td>$0.010</td>
<td>$0.69</td>
</tr>
<tr>
<td>electric generator set</td>
<td>diesel</td>
<td>0.3</td>
<td>distributed</td>
<td>20</td>
<td>0.33</td>
<td>0.25</td>
<td>$150</td>
<td>$26.3</td>
<td>$480</td>
<td>$0.010</td>
<td>$0.83</td>
</tr>
<tr>
<td>electric generator set</td>
<td>diesel</td>
<td>0.5</td>
<td>distributed</td>
<td>20</td>
<td>0.33</td>
<td>0.25</td>
<td>$250</td>
<td>$26.3</td>
<td>$1,379</td>
<td>$0.010</td>
<td>$1.25</td>
</tr>
<tr>
<td>electric generator set</td>
<td>natural gas</td>
<td>0.05</td>
<td>distributed</td>
<td>20</td>
<td>0.33</td>
<td>0.25</td>
<td>$270</td>
<td>$10.04</td>
<td>$141</td>
<td>$0.010</td>
<td>$0.23</td>
</tr>
<tr>
<td>electric generator set</td>
<td>natural gas</td>
<td>0.15</td>
<td>distributed</td>
<td>20</td>
<td>0.33</td>
<td>0.25</td>
<td>$120</td>
<td>$10.04</td>
<td>$194</td>
<td>$0.010</td>
<td>$0.25</td>
</tr>
</tbody>
</table>

Table 5-1: Inputs for levelized cost of electricity for fossil fuel-based electricity generation (BL&PC 2012a; BL&PC 2014; BSS 2013)

Size and interconnection specifications for diesel and natural gas generator sets of varying sizes were obtained from manufacturers (Cummins 2014; CAT 2014). The value per kilogram of generator mass imported to Barbados for 2013 was obtained from the Barbados Statistical Service. Multiplying the generator sizes in kilograms by the value per kilogram per year ($/kg/yr.) of imported generators to the island provided an estimate of the capital cost of gensets. The fuel cost for the systems involved are calculated using the forecast price per gigajoule of diesel and natural gas ($/GJ) in the BL&PC’s IRP. Configurations of gensets vary considerably and may include ancillary components such as cages.
<table>
<thead>
<tr>
<th>Generator Type</th>
<th>Capacity and fuel type</th>
<th>Contribution of Fuel Cost to electricity cost ($/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Expected</td>
</tr>
<tr>
<td>Low-Speed Generators</td>
<td>30 MW Heavy Fuel Oil</td>
<td>$0.34</td>
</tr>
<tr>
<td></td>
<td>40 MW Heavy Fuel Oil</td>
<td>$0.33</td>
</tr>
<tr>
<td></td>
<td>30 MW Natural Gas</td>
<td>$0.10</td>
</tr>
<tr>
<td></td>
<td>40 MW Natural Gas</td>
<td>$0.10</td>
</tr>
<tr>
<td>Diesel and Gas Combustion Turbines</td>
<td>30 MW Diesel</td>
<td>$0.56</td>
</tr>
<tr>
<td></td>
<td>40 MW Diesel</td>
<td>$0.58</td>
</tr>
<tr>
<td></td>
<td>30 MW Natural Gas</td>
<td>$0.13</td>
</tr>
<tr>
<td></td>
<td>40 MW Natural Gas</td>
<td>$0.13</td>
</tr>
<tr>
<td>Combined Cycle Turbines</td>
<td>30MW Diesel</td>
<td>$0.43</td>
</tr>
<tr>
<td></td>
<td>40 MW Diesel</td>
<td>$0.41</td>
</tr>
<tr>
<td></td>
<td>30 MW Natural Gas</td>
<td>$0.10</td>
</tr>
<tr>
<td></td>
<td>40MW Natural Gas</td>
<td>$0.10</td>
</tr>
<tr>
<td>Private GENSETs</td>
<td>Diesel (60-500kW)</td>
<td>$0.66</td>
</tr>
<tr>
<td></td>
<td>Natural Gas (50-150kW)</td>
<td>$0.15</td>
</tr>
</tbody>
</table>

Table 5-2: Contribution of fuel component to electricity costs ($/kWh) of fossil fuel based generation technologies for the three forecast of fuel price escalation (BL&PC 2012a).56

and backup batteries. However the landed value of the generator alone was used. Genset system availability is much lower when compared to utility-scale dedicated generators.

56 Fuel costs were calculated using the cost per GJ escalations predicted by the BL&PC (2012a) and the fuel costs ($/GJ) seen in Table 5-1. The energy output of systems was extrapolated over the lifetime of the system. Degradation (loss of efficiency) was not used as a factor in calculating the contribution of fuel costs to the final cost of electricity.
Figure 5-3 Levelized Cost of Electricity ($/kWh) for utility generation using HFO and diesel fueled generators versus natural gas generators.

The nomenclature used describes the generator type/capacity in megawatts/fuel type used e.g. a low-speed generator with 30 MW capacity run on heavy fuel oil = LSD30HFO. GT=gas turbine, CCGT=combined cycle gas turbine, NG=natural gas, D=diesel.
Figure 5-4: Levelized cost of electricity ($/kWh) for private electrical generator sets (Gensets) in Barbados with an annual capacity factor of 0.25 (a utilization of 25 percent).

Figure 5-5: Levelized cost of electricity ($/kWh) for private electrical generator sets (Gensets) in Barbados with utilization of 240 hours or 2.7 percent under ISR.

5.2.2.2 Levelized Costs of Renewable Energy Technologies

Grid parity refers to when electricity can be generated at a LCOE that is lower than the price of electricity bought from the grid. The average price of electricity on the island for hotel customers in 2013 was BDS$0.65/kWh. Figure 5-6 demonstrates the range of levelized costs for utility and distributed scale
RETs. All of the technologies achieve grid parity. Appendix C: Economic Calculation Materials contains charts illustrating LCOE for RETs at different rates of interest.

5.2.2.1 Utility-scale technologies

Fossil fuel supplied utility scale technologies are ‘dispatchable’; thus, the technology can be trusted to provide firm capacity upon request. Many RETs represent non-firm supplies of power due to the intermittency of the energy sources (e.g. sunny days are not available on request or at night). Nevertheless, some technologies can be counted as firm capacity e.g. ocean thermal energy conversion (OTEC), biomass cogeneration, and waste-to-energy (W2E).58

As seen in Figure 5-6, onshore wind energy is the most cost-effective utility scale RET option, followed by offshore wind at capacities of 3.5 MW and above. Utility-scale photovoltaic generation shows potential at $.36/kWh. At the same 25 MW capacity, biomass cogeneration is slightly cheaper than the utility-scale photovoltaic plant by 0.04 cents/kWh. The Government of Barbados in collaboration with the BL&PC is considering this dispatchable resource in the hope to increase the competitiveness of the sugar industry. This initiative known as The Barbados Fuel Cane Project, was announced in 2002; however, it has not yet come to fruition (Albert Thenet 2006). Bagasse from the sugar industry is considered the feedstock for biomass cogeneration.

Waste-to-energy is at grid parity with a cost of $0.45/kWh. W2E has the potential for mitigating national waste disposal concerns by diverting landfill materials (Castalia 2010b). The SEFB indicates that the presence of an existing landfill in Barbados means building landfill capacity is not necessary thus the technology has the potential for net savings (Castalia 2010b).

Sea water air conditioning (SWAC) and ocean thermal energy conversion (OTEC) were proposed to the Government of Barbados as potential options for the hotel sector (Castalia 2010b). As noted in chapter 3, 48 percent of hotel energy use is for air-conditioning purposes. SWAC produces chilled water for air conditioning. However, the advantage of an OTEC plant is that it produces chilled water, and generates electricity using the thermal difference between the surface and the deep waters to drive a turbine. This technology can be used to displace baseload capacity at the national scale since the energy from the ocean’s thermocline is always available. The passive use of heat differences requires only electrical energy

58 OTEC systems use difference in temperature between surface water and deep water to generate electricity; it is done by vaporizing and condensing ammonia to drive an electrical turbine. Sea water air conditioning (SWAC) on the other hand requires the use of cool water around 5 degrees Celsius found at least ten kilometers off the coast; the cold water passes through heat exchangers that transfer the cold temperature to chill fresh water filled pipelines (HSAC 2013).
to pump water. As seen in Figure 5-6, OTEC is the utility scale technology with the largest variance of costs. However, economies of scale exist and the cost of deep sea technology decreases with increasing capacity (Elsafty & Saied 2009).

In Barbados, the hotel sector is located mostly along the south and west coasts of the island one kilometer off shore, the continental shelf can reach depths of 1000m with temperatures ranging from 28°C at the surface to 4°C at the bottom (Castalia 2010a). Although such a steep shift in continental shelf is a barrier to the development of offshore wind farms, such conditions were considered ideal for OTEC.

OTEC demonstrates levelized costs at approximately $0.48 per kWh for a 20MW plant. The GOB considers these technologies technically viable; however, the initial investment costs are a concern given the novelty of the technology (OTECNEWS 2014) along with substantial uncertainty concerning its long term performance. SWAC and OTEC are capital intensive technologies that have not reached the stage of commercialization seen with other capital intensive technologies like biomass cogeneration and waste to energy (Surroop & Abhishekanand 2013; Elsafty & Saeid 2009; Castalia 2010b). The seawater piping and the sea water pumping system represent this greatest share of the upfront capital costs at 28 and 26 percent respectively (Elsafty & Saied 2009).

As seen in Table 5-3, the operation and maintenance (O&M) costs are high for waste-to-energy, biomass and ocean technologies compared to the 25 MW utility-scale solar. Most of the cost for photovoltaics and wind occurs with the initial implementation. The technologies with firm supply have a greater amount of effort to maintain. Nevertheless, the GOB signed an agreement with Cahill Energy of the island of Guernsey to develop a BDS$240 million Plasma-gasification waste-to-energy plant that is estimated to divert 650 tonnes of waste per day and generate 25 percent of the islands energy requirements (WMW 2014). The proposed benefits are significant divergence of the island’s waste stream and the production of byproducts such as syngas, fertilizers (Cahill Energy 2014).

5.2.2.1.2 Distributed Scale Technologies

Distributed generation refers to small grid-tied generation situated near to a load that functions as self-generation and as a backup for utility energy sources (EEI 2005). These technologies have a capacity of less than one megawatt and include: solar photovoltaics (PV), solar water heating (SWH), small scale wind turbines. Residential and commercial solar water heating (SWH) have the lowest levelized cost at 26 - 27 cents/kWh. SWH technologies do not generate electricity; however, they offer savings on electricity that would be used to heat water in an electric heater. Market penetration of STWH has been predominantly in the residential sector as opposed to the hotel sector (Perlack & Hinds 2003). Nevertheless, according to
the Earth Policy Institute (2013), Barbados was the leading Caribbean island in 2008 and fifth in the world with 82000 m² of solar water heating (SWH) installation (i.e. 0.32 m² per capita).

Industrial sized photovoltaic systems (500kWp) are the cheapest distributed electricity generation option with a cost of 35 cents/kWh. At 48 cents/kWh, residential PV is more expensive than commercial and industrial scale PV. This demonstrates that economies of scale exist with PV systems.

Small-scale wind turbines can be horizontal axis wind turbines (HAWT) or vertical axis wind turbines (VAWT). Bishop and Amaratunga (2008) compared the potential of the island wide implementation of distributed small-scale wind versus the 10 MW farm proposed by the BL&PC. Bishop and Amaratunga (2008) found that utility scale farms are slightly more cost effective than HAWT set up. VAWTs on the other hand had relatively high costs. Bishop and Amaratunga (2008) conclude that there is great potential for small wind once the systems become more cost competitive with utility-scale wind. As seen in Figure 5-6, small wind costs approximately 30 to 55 cents/kWh compared to 14 to 17 cents/kWh for on shore utility scale wind. As seen in Table 5-3, small wind turbines with their moving parts have higher O&M costs per year compared to solar technologies like solar water heating and photovoltaics.

The wide range in costs shown in Figure 5-6 illustrated by OTEC can be attributed to the fact that such technology is in the research and design phase with high technological risks (IRENA 2013). Wind and solar are established commercial technologies and have lower technological risks involved (IRENA 2013; Couture et al 2010). This is important when securing financing for RET projects. It is the policy of the Government of Barbados and the BL&PC to utilize least cost options for technologies (BL&PC 2012). The LCOE can vary within different markets and is not a guarantee of a technology’s efficacy. However, these costs allow for a broad comparison of the options available. In addition, the levelized costs can also be used by policy makers to design a Feed-in Tariff scheme by incorporating a targeted return within the levelized costs (Couture et al. 2010; Mendonca 2007).
Figure 5-6: Levelized cost of electricity and heat from solar water heaters ($/kWh) for distributed and utility-scale renewable energy technologies in Barbados.\textsuperscript{59}

\textsuperscript{59} These LCOE assume a commercial interest rate of 9\%, insurance rate of 2 \%, and O&M cost of 2\% of the installation cost. The capital cost inputs for PV and wind are taken from REN21 (2013). The SWH capital costs is from SEFB study (Castalia 2010a; 2010b). The BL&PC 2012a provides capital cost inputs for waste-to-energy, ocean thermal energy conversion (OTEC) and biomass cogeneration. Harvey (2010b) and IRENA (2012a; 2012b) provide ranges of variable costs for the wind and photovoltaic sources.
<table>
<thead>
<tr>
<th>Technology</th>
<th>Fuel</th>
<th>Size (MW)</th>
<th>Scale</th>
<th>lifetime (years)</th>
<th>capacity factor</th>
<th>capital cost (BD$/kW)</th>
<th>O&amp;M ($/kW/yr.)</th>
<th>variable costs ($/kWh)</th>
<th>fuel costs contribution to electricity ($/kWh)</th>
<th>LCOE ($/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Renewable Energy Technologies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>photovoltaic</td>
<td>solar</td>
<td>0.005</td>
<td>distributed</td>
<td>20</td>
<td>0.2</td>
<td>$4,550</td>
<td>$6,600</td>
<td>66</td>
<td>n/a</td>
<td>$0.48</td>
</tr>
<tr>
<td>photovoltaic</td>
<td>solar</td>
<td>0.1</td>
<td>distributed</td>
<td>20</td>
<td>0.2</td>
<td>$5,000</td>
<td>$6,014</td>
<td>60</td>
<td>n/a</td>
<td>$0.47</td>
</tr>
<tr>
<td>photovoltaic</td>
<td>solar</td>
<td>0.5</td>
<td>distributed</td>
<td>20</td>
<td>0.2</td>
<td>$3,000</td>
<td>$5,200</td>
<td>52</td>
<td>n/a</td>
<td>$0.35</td>
</tr>
<tr>
<td>photovoltaic</td>
<td>solar</td>
<td>25</td>
<td>utility</td>
<td>20</td>
<td>0.2</td>
<td>$3,600</td>
<td>$4,000</td>
<td>45</td>
<td>n/a</td>
<td>$0.36</td>
</tr>
<tr>
<td>solar water heater</td>
<td>solar</td>
<td>0.002</td>
<td>distributed</td>
<td>20</td>
<td>0.2</td>
<td>$1,500</td>
<td>$2,200</td>
<td>22</td>
<td>$0.090</td>
<td>$0.26</td>
</tr>
<tr>
<td>solar water heater</td>
<td>solar</td>
<td>0.07</td>
<td>distributed</td>
<td>20</td>
<td>0.2</td>
<td>$1,800</td>
<td>$2,000</td>
<td>20</td>
<td>$0.090</td>
<td>$0.28</td>
</tr>
<tr>
<td>onshore wind</td>
<td>wind</td>
<td>3.5</td>
<td>both</td>
<td>20</td>
<td>0.4</td>
<td>$1,450</td>
<td>$1,770</td>
<td>35</td>
<td>$0.007</td>
<td>$0.15</td>
</tr>
<tr>
<td>offshore wind</td>
<td>wind</td>
<td>7.5</td>
<td>utility</td>
<td>20</td>
<td>0.45</td>
<td>$3,000</td>
<td>$4,500</td>
<td>90</td>
<td>$0.021</td>
<td>$0.33</td>
</tr>
<tr>
<td>small wind turbines</td>
<td>wind</td>
<td>0.1</td>
<td>distributed</td>
<td>20</td>
<td>0.5</td>
<td>$3,000</td>
<td>$6,000</td>
<td>120</td>
<td>$0.050</td>
<td>$0.41</td>
</tr>
<tr>
<td>Waste-to-Energy</td>
<td>solid waste</td>
<td>13.5</td>
<td>utility</td>
<td>30</td>
<td>0.85</td>
<td>$18,000</td>
<td>$25,000</td>
<td>$500</td>
<td>$0.020</td>
<td>$0.54</td>
</tr>
<tr>
<td>*Biomass cogeneration</td>
<td>biomass</td>
<td>25</td>
<td>utility</td>
<td>30</td>
<td>0.9</td>
<td>$7,500</td>
<td>$8,180</td>
<td>300</td>
<td>0.15</td>
<td>$0.33</td>
</tr>
<tr>
<td>Ocean Thermal Energy Conversion</td>
<td>ocean temperatures</td>
<td>20</td>
<td>utility</td>
<td>20</td>
<td>0.9</td>
<td>$7,000</td>
<td>$15,000</td>
<td>300</td>
<td>0.020</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Table 5-3: Inputs for the levelized cost of electricity calculation for renewable energy technologies.\(^60\)

\(^60\) The solar water heating capacity is measured in terms of megawatts of thermal energy and the SWAC is measured in terms of megawatts of cooling load. * Biomass has fuel costs ($/GJ) of $8.83 (expected), $10.59 (high), and $7.07 (low).
5.3 Levelized Costs of Four Photovoltaic Systems

This section demonstrates the commercial viability of four photovoltaic systems as an investment for a hotel. To do this I consider the implications of a hotel qualifying for financing from the Energy Smart Fund (ESF) at an interest rate of 3.75% versus the lower and upper prime lending rates of 7.65-8.70 percent discussed in Section 5.2.1.1. Prime rates are used as the weighted average cost of capital (WACC) and it is assumed that the systems are financed through debt. The LCOE for four systems currently operating in Barbados was calculated using cost data and energy output data provided by a solar installation company in Barbados. Details of these costs are found in Figure 8-2 of Appendix C: Economic Calculation Materials. Modules and inverters are the most expensive components of the PV system installations. The four grid-tied systems are 5kW_pDC, 55kW_pDC, 75kW_pDC and 160kW_pDC. Polycrystalline Trina TSM Solar PA05-250 modules and Sunny Boy inverters are used in all four systems. These systems represent the maximum limitation of capacity allowed by the utility incentive known as the renewable energy rider (RER) before the Electric Light and Power Act 2013. Under the RER, these systems are credited at 1.6 times the fuel clause adjustment for the energy produced.

Figure 5-7 illustrates that all systems are at grid parity in 2013 when financed at an interest rate of 12 percent. The 160 kW system is the cheapest to finance demonstrating economies of scale. Since 2009 the systems have become increasingly cheaper relative to the cost of utility-supplied electricity for SVP customers. The average cost of grid electricity increases from 42 to 67 cents/kWh. Financing at lower interest rates is advantageous to the deployment of the systems. Borrowers qualifying for the ESF financing are at an advantage with a 160 kW system having a LCOE of .34 cents/kWh versus a cost of grid electricity of .67 cents/kWh. In 2010 at the time of my interviews with respondents and before the development of the ESF, a hotel borrowing at the upper prime lending rate was slightly above 2010 grid parity for a residential 5kW system. At this time, larger systems met parity with financing at a WACC of 11 percent. Figure 8-1 of appendix C demonstrates the LCOEs for various WACC.
5.4 Payback of Four Photovoltaic Systems

This section demonstrates the profitability of the four photovoltaic systems discussed in the previous section, accounting for the pretax cash flows over twenty five years. The initial costs of the systems are used as the first cash flow. As recommended by experts on the island, I assume that the operations and maintenance cost increase by 2.5 percent per year and that insurance costs rise by 0.5 percent per year. It is assumed that the energy output per system is 1652 kWh/kW during the first year.\(^{61}\) Module degradation of crystalline solar cells is in the range of 0.2-0.5 percent per annum and system energy output is extrapolated over a using a conservative module degradation rate of 0.5 percent (Branker et al 2011). Table 5-4 illustrates the electrical output in kilowatt hours calculated for the four solar PV systems after 20 and 25 years.

---

\(^{61}\) Historically, solar radiation on the island of Barbados has been approximately 5.7 kWh/m\(^2\) per day (Rogers et al. 2011:1477). Using the assumed 250W panels, 2059.2 kilowatt hours per kilowatt peak (kWh/ kWp) of solar capacity can be calculated using this 5.7 kWh/m\(^2\) of radiation. A conservative derate factor of 80 percent to account for system losses such as temperature leaves an energy output of approximately 1647.36 kWh/kWp. This output is further justified by the 1624kWh/kW estimated for high efficiency polycrystalline modules by the Sustainable Energy Framework for Barbados study (Castalia 2010b).
### Table 5-4: Cumulative energy output extrapolation for twenty and twenty five years in kWh given a module energy output of 1652kWh/kWp /during the first year and module degradation of 0.5 percent.

<table>
<thead>
<tr>
<th>year(n)</th>
<th>5 KW</th>
<th>55kW</th>
<th>75kW</th>
<th>160kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 years</td>
<td>157578</td>
<td>173336</td>
<td>236367</td>
<td>504250</td>
</tr>
<tr>
<td>25 years</td>
<td>194566</td>
<td>214022</td>
<td>291848</td>
<td>622610</td>
</tr>
</tbody>
</table>

#### 5.4.1.1 Internal Rate of Return

The purchasing power of money changes with time and cash flows that occur in the future must consider the time value of money. The present value \( P \) of a single future savings \( F \) occurring \( n \) years in the future discounted at an interest rate \( i \) can be determined as:

\[
P = \frac{F}{(1+i)^n}
\]  

(5.3)

The present value (NPV) of a string of \( N \) annual savings of magnitude \( F \) is given by

\[
NPV = F \times F_{NPV}
\]  

(5.4)

\[
F_{NPV} = \frac{(1+i)^N-1}{(1+i)^Ni}
\]  

(5.5)

where \( F_{NPV} \) is a net present value factor. NPV is the amount of money that must be invested today at an interest rate \( i \) to have an equal amount of money in the future ‘\( n \)’ years ahead (Harvey 2010b). Multiplying \( F_{NPV} \) by the number of years is the same as taking the sum of a string of annual net present values over the lifetime of the RET system.

Hotel businesses must consider how to budget their capital and may rely on the internal rate of return (IRR) as an indicator of an investment’s profitability. The IRR is the discount rate or “the interest rate that has to be used in calculating the NPV of all future savings such that the NPV is zero” (Harvey 2010b: 531). The discounted economic benefits generated from a renewable energy technology will equal the initial investment costs at the rate determined by the IRR (Capehart et al. 2011; Harvey 2010b). There is no formula for IRR, so it is determined through multiple iterations. The IRR is found when the NPVs of the savings from the system over its lifetime is equal to the initial cost of the system. The investment with the highest IRR is considered desirable.
Table 5-5 provides the IRRs calculated for the four systems under three scenarios of electricity price escalation. Larger PV system capacities have greater internal rates of return. In addition, the higher the escalation of electricity prices, the more beneficial the system as seen for the 160kW_{PDC} system. A small system like a 5kW_{PDC} has the least profitable outlook. The acceptance of these systems, however, can be determined by many factors. Businesses like hotels must consider their minimum accepted rate of return (MARR) when making decisions on investments in tangible assets. The MARR varies between hotels and is dependent on the capital structure, the cost of capital, and the risks of conducting business at that point in time. In addition, an IRR enables the PV systems to be compared to other fixed assets (long-lived or short) that hotel investors may wish to consider.

<table>
<thead>
<tr>
<th>Electricity Price Escalation Scenario</th>
<th>5kW</th>
<th>55kW</th>
<th>75kW</th>
<th>160kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected (0.8%/year)</td>
<td>7.74%</td>
<td>14.54%</td>
<td>14.92%</td>
<td>15.63%</td>
</tr>
<tr>
<td>High (2.7%/year)</td>
<td>11.12%</td>
<td>16.96%</td>
<td>17.31%</td>
<td>18.01%</td>
</tr>
<tr>
<td>Low(-0.3%/year)</td>
<td>5.43%</td>
<td>13.08%</td>
<td>13.47%</td>
<td>14.20%</td>
</tr>
</tbody>
</table>

Table 5-5: Internal Rate of Return for four photovoltaic systems over 25 years under different scenarios of electricity price escalation.

Figure 5-8 illustrates the time it takes for a 160 kW system to pay for itself at three scenarios of electricity rate escalation without considering the discount rate. By the 6th year (end of the 5th annualized period) the system has covered the initial capital outlay under the expected and high scenarios. The system pays for itself by the 7th year in the low scenario, in which electricity prices decrease slightly in the future. Table 5-6 gives the payback period for all four systems under the three scenarios. The greater the output of energy per system the faster the payback.

Figure 5-8: Cash flow of 160kW system under three scenarios of electricity price growth per annum: Expected (0.8%), High (2.7%) and Low (-.3%).
<table>
<thead>
<tr>
<th>Size of System</th>
<th>Installed Costs</th>
<th>$/W_{pDC}</th>
<th>Years until payback under scenarios of electricity escalation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Expected</td>
</tr>
<tr>
<td>5kW_{pDC}</td>
<td>$33,723</td>
<td>$6.74</td>
<td>9</td>
</tr>
<tr>
<td>55 kW_{pDC}</td>
<td>$335,679</td>
<td>$6.10</td>
<td>7</td>
</tr>
<tr>
<td>75 kW_{pDC}</td>
<td>$450,732</td>
<td>$6.01</td>
<td>7</td>
</tr>
<tr>
<td>160 kW_{pDC}</td>
<td>$933,668</td>
<td>$5.84</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 5-6: Installation costs and payback period for four photovoltaic systems

5.4.1.2 Tax Allowances

To be conservative, the IRR is calculated without consideration of taxes or the depreciation recovery of the renewable energy assets. As mentioned in chapter 3, the new *Income Tax (Amendment) Act 2013* legislates tax holidays and concessions to eligible businesses and investors interested in the development of renewable energy. To claim most types of tax allowances in the first year, a business must be profitable. Despite these allowances, there is still the need for elaboration of this tax framework. These new incentives may not benefit the hotel industry since hotels must first acquire tax benefits under the Tourism Development Act. These allowances include duty-free import and deductibles on the expenditure on new assets/equipment coupled with extended tax write offs. Ultimately, the streamlining and clarification of the tax incentives available to the hotel sector from using RETs may increase the internal rate of return on investments.

In calculating allowances, The Barbados Revenue Authority (BRA) must first take unrelieved capital expenditure of hotel development under the Tourism Development Act (TDA). Consequently, profitable hotels are unlikely to have taxable profits remaining after the relief of expenditures. However, the TDA grants eligible hotels duty-free importation of building materials and goods such as light fittings, water heaters, building management systems (BMS), energy efficient light bulbs and electronics that increase the energy efficiency of the hotel. Section 21 of the TDA allows hotel owners a 150 percent reduction on interest paid for a loan to refurbish the plant and deductions on expenditure towards environmental certifications and linkages with other sectors of the economy. In addition, the duration of tax write offs can last from fifteen to twenty years. Appendix D: Governance Information illustrates the

---

62 Figure 8-2 demonstrates the breakdown of initial costs for the systems involved. Payback periods are calculated using 05% increase in insurance costs and a 2.5% annual increase in O&M costs.

63 ‘Depreciation recovery’ refers to when a business owns a tangible asset, such as a photovoltaic system, and this investment is recovered for tax purposes over a specified time period through annual deductions (SEIA 2014). A simple straight-line method of depreciation is used for businesses on the island where the initial allowance is 20 percent and there are annual allowances of 20 percent per year until the cost of the system has been recovered. Thus the first year has a recovery fraction of ‘0.4’ and the subsequent years have ‘0.2’. If the business is not profitable, allowances for depreciation can be deferred to the following year. However, the initial allowance of 20 percent must be forfeited.
incentives for the two legislations and their limitations when applied to the hotel sector. Many of the new Income Tax Act (2013) incentives does not offer many applicable differences.

At present, the method of depreciation recovery on a tangible asset such as RETs has not been clearly outlined by the Barbados Revenue Authority. However, income earned through generation of renewable energy is non-taxable and represent an economic savings (i.e. a cost no longer incurred by hotels). The GOB intends to implement a tax of nil (i.e. “zero-rated tax”) on the extra income earned by renewable energy generators that produce more electricity than they consume. In addition, for every year over five years, a person carrying on a registered business may deduct 150 percent of expenditure (not exceeding BDS$25000) on a system used to produce renewable energy (Income Tax (amendment) Act 37H(7) 2011).

The legislation that offers the greatest potential as a RET incentive to hotels is the Land Tax Act 2011. The land tax rate is 0.65% on the improved value of the hotel or villa property (BRRA 2014). Part III 6 Section 2(C) of the Land Tax Act 2011 allows eligible hotels and villas reductions of 50 percent and 25 percent on the land tax demanded. The Government of Barbados in this same act provides a 50 percent rebate on the land tax demanded for commercial businesses engaged in the production/manufacture of solar energy regardless of the business’s profitability (KPMG 2011). It is at the confluence of these two fiscal incentives that uncertainty exists. Firstly, it is not clear, whether the rebate for the production of renewable energy occurs annually or only in the first year of solar operation. The time period for the rebate is not defined (i.e. is it the lifetime of the system or first five years). Secondly, it is not clear whether an eligible hotel installing a system will qualify for the 50 percent rebate on an already reduced 50 percent due to its status as a registered hotel (Tibbits 2014). Thirdly, capacity of the system is not defined or limited (Goddard 2013). Furthermore, the term ‘solar energy’ is not defined and may potentially include solar water heating. Moreover, there is scope to expand beyond the bias of ‘solar’ technologies to other renewables or technologies.

5.5 The Renewable Energy Rider

As seen in Figure 5-9, the BL&PC’s Renewable Energy Rider incentive began in March 2010 and implemented 3.02 MW of renewable energy capacity by January 2014. Most of this installation occurred in 2013 with almost one megawatt of capacity installed in the last six months of 2013. This increase occurred after the February 2013 Parliamentary Budget. The GOB announced plans to amend the Electric

---

64 The role of the Barbados Revenue Authority is to “administer the specified enactments and in particular, to assess, collect and enforce the payment of taxes, duties, interest, penalties, fees and other sums payable under the specified enactments; advise the Government and other public authorities on matters relating to this Act and the specified enactments and generally, to taxation; represent Barbados in respect of matters relating to taxation” (BRAA 2014:9).

65 Eligible hotels are approved by the Barbados Tourism Authority under section 2 of the Tourism Development Act 2002.
Light and Power Act and facilitate RETs. As seen in Table 5-7, a total of 378 customers obtained approval to generate electricity by 2014. Only 51kW of this total was spread between four hotels, despite the favorable LCOE for PV on the island. (BL&PC 2014). The RER is predominantly utilized by the residential sector. Despite the RER being open to wind and solar, only 1.2 kW of wind energy is installed as part of a 5kW hybrid small wind/photovoltaic residential system (BL&PC 2014). Wind generation on the island is predominantly off-grid with the utilization of batteries as storage (BL&PC 2014). Solar PV is the distributed source of choice.

There were various methods of reimbursement proposed for the RER since its initiation in 2010. Initially, customer-generators were credited for the sale of excess at a rate of 1.8 times the FCA per kWh produced or 31 cents per kWh produced, whichever is higher. After reviewing the RER pilot program in July 2013, the FTC changed the reimbursement to 1.6 times the FCA (FTC 2013). A buy-all/sell-all scenario is the option for crediting solar systems that hotels can utilize since most hotels use more energy than the 160kWp system can produce.

<table>
<thead>
<tr>
<th>Licensee</th>
<th>Residential</th>
<th>Hotel or Villa</th>
<th>Other Tourism entity</th>
<th>Manufacturing/ Repair/Service</th>
<th>Office/ Retail/ Commercial</th>
<th>Industrial</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number systems</td>
<td>344</td>
<td>4</td>
<td>1</td>
<td>13</td>
<td>12</td>
<td>4</td>
<td>378</td>
</tr>
<tr>
<td>Capacity (kW)</td>
<td>1422.4</td>
<td>51</td>
<td>3.8</td>
<td>497.4</td>
<td>497.2</td>
<td>558</td>
<td>3030</td>
</tr>
</tbody>
</table>

Table 5-7: Total number and capacity of grid-tied customers utilizing the Renewable Energy Rider incentive as of January 1st 2014.

(Source: BL&PC 2014).

Figure 5-10 illustrates how the three reimbursements compare using a buy-all/sell-all scenario at three different multipliers for credit in 2012. In addition, the graph demonstrates the change in FCA versus the 31 cent cap. When the FCA was its highest at 49 cents per kWh in April 2012, the credit was BDS$19 941 dollars at 1.8 times the FCA. Today this credit would be less at $17 725 dollars under the 1.6 scenario. The original RER was based on 2009 numbers and up until April 2010, the FCA had never gone above 31 cents. This, however, changed significantly and since 2010 the FCA has never dropped below 33 cents, making the cap redundant. It is a precaution set in place for customer generators in case fuel prices fall in the future. The utility passes the costs of providing the credit to licensed generators onto the customer base (Rogers & Chmutina 2013).

\[\text{Credit ($)} = \begin{cases} 
(1.8 \text{ times FCA}) \times \text{FCA ($/kWh)} \times \text{times kWh} \\
(1.6 \text{ times the FCA}) \times \text{times kWh} \\
$.31 \text{ times kWhs} \\
\text{Fuel Clause Adjustments} \\
31 \text{ cent baseline}
\end{cases}\]

Figure 5-10: Customer-generator reimbursement for electricity produced using a 160kWp<sub>dc</sub> photovoltaic system for 2012 versus the Fuel Clause Adjustment.

\[66 \text{ 2012 was is used in this illustration because it is the year that has shown the highest average monthly fuel clause adjustments in recent history.}\]
5.6 Hotel Energy Profiles

Hotels differ in their area, size, layout, occupancy density per building and energy consumption. The energy profile of an individual hotel impacts the efficacy of distributed generation systems despite favorable internal rates of return or utility incentives. The incorporation of RETs into a hotel’s investment portfolio must consider how consumption of energy compares to renewable energy production. There are 96 hotels in Barbados, with the average of rooms of 64 rooms per hotel (CHENACT 2012). Three hotels were observed in this study. Hotel A and B are SVP customers with electricity demands of less than 50kW and 50 to 500kW respectively. Hotel A is representative of villa type accommodation. Hotel C is a large power customer with a demand higher than 500 kW. Under the RER, systems are limited at 150kW_{PAC} to receive reimbursement for the avoided costs to the utility. Some hotels may be able to make substantial savings on their electricity using such a system, whereas, larger hotels may invest their capital into other projects if the savings impact is considered negligible. At the end of 2013, legislation has allowed a business to expand system sizes beyond this 150kW_{PAC} capacity. However, the terms of reimbursement are not standardized and are negotiated in the form of power purchase agreements (PPA) between the utility and the customer generator (ELPA 2013). The impact in 2014 is yet to be seen.

Figure 5-11 illustrates the monthly difference in energy consumption between the three hotels from January 2009 until August 2010. The peak tourist seasons on the island are from November to February and again in the summer May until August. Electricity consumption at the three hotels correlates with the peak tourism seasons. The peak of consumption occurs in January and August 2009 for hotel A. Hotel B has a peak in August 2009 and 2010. Hotel C has peaks in November 2009 and July 2010. Hotel A demonstrated reduced energy consumption from 2009 until 2010 whereas hotels B and C demonstrate an increase in electricity consumption. In 2009, hotel occupancy rates were at a low across the island due to the global economic crisis (BSS 2013).

Figure 5-12 demonstrates the megawatt hours per year of electricity from distributed energy technologies available for hotels compared to annual consumption of differently sized hotels (number of rooms) in Barbados (CHENACT 2012). Smaller hotels have electricity consumption that is close to the yearly output of the distributed sources. Commercial (100kW) and industrial (500kW) size solar PV can make a significant contribution to hotels with less than 50 rooms and villas such as hotel A. Small wind and Industrial PV can produce more electricity per year than is consumed by these hotels on average and may contribute significantly to all hotels with 100 rooms or less. Industrial sized solar PV may be suitable for larger hotels. Diesel generators can provide a significant output of electricity but rely on fossil fuel.
All of these systems may have varying impacts on a hotel’s bottom line. However, with gains in efficiency, the impact of RETs may be more significant. Hotels may benefit from an increase in demand side management efforts to increase electrical efficiency. CHENACT study found all hotels had the potential for at least a 30 percent reduction in electricity consumption. These measures include retrofitting of all light bulbs with LEDs, implementing building management software to control room temperatures, changing of outdoor lighting and replacement of chillers (CHENACT 2012). Figure 5-13 illustrates the impact of reducing energy consumption in the hotels by thirty percent. The study indicated investment costs at BDSS400 000 to $1.1 million dollars per hotel with an average payback of 2.5 years (Duffy-Mayers 2012). Furthermore, behavioral changes such as switching some operations like laundry to off-peak times may help the utility manage the peak demand. Energy efficiency first followed by RET is an investment strategy that can greatly impact the contribution to the hotel, the utility and the country.

![Figure 5-11: Megawatt hours per month of electricity consumption for Hotels A, B, and C from January 2009 until August 2010.](image-url)
Figure 5-12: Megawatt hours per year of electricity from distributed energy technologies available for hotels compared to annual consumption of differently sized hotels (number of rooms) in Barbados.

(Source: CHENACT 2012).
Figure 5-13: The impact of a 30 percent reduction in megawatt hours per year electricity consumption of hotels of various sizes in Barbados

(Source: CHENACT 2012; BL&PC 2012a).
## 5.7 Benefits beyond the Hotel

### 5.7.1 Reduced Fuel Importation

The amount of energy produced by the utility and distributed scale systems offers fuel savings and allows the Government of Barbados to conserve foreign exchange. The projections of crude oil price in the expected, high and low scenarios of the BL&PC’s IRP are used to calculate the savings in money spent on fuel. The energy produced in a year for the technologies is extrapolated over the lifetime of the systems and is converted to barrels of oil equivalent (BOE).

Figure 5-14 illustrates that OTEC has the potential to save the most fuel over its lifetime once in operation. Solar-PV at 25MW capacity saves more money than wind and offshore wind with capacities of 3.5 and 7.5 MW respectively. A scaling up of wind technology capacity may offer a greater reduction in fuel imports. The BL&PC intends to place an 11 MW wind farm in the north of the island but this has not come to fruition.

At the distributed scale, the impact on fuel importation over the lifetime of the technologies is not as significant as the dedicated utility scale technologies. However, Figure 5-15 demonstrates the potential contribution to Barbados’s economy of a hotel investing in these systems. The impact of residential PV systems is also illustrated. Regardless of the RER incentive, the implementation of RETs can have significant savings to the economy.

<table>
<thead>
<tr>
<th>Technology</th>
<th>Expected Scenario</th>
<th>High Scenario</th>
<th>Low Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utility PV (25MW)</td>
<td>$167,791,500</td>
<td>$46,981,620</td>
<td>$113,259,262</td>
</tr>
<tr>
<td>Onshore wind (3.5 MW)</td>
<td>$242,944,466</td>
<td>$68,024,451</td>
<td>$163,987,515</td>
</tr>
<tr>
<td>Offshore wind (7.5 MW)</td>
<td>$79,392,544</td>
<td>$22,229,912</td>
<td>$53,589,967</td>
</tr>
<tr>
<td>Waste to Energy (13.5 MW)</td>
<td>$385,081,492</td>
<td>$557,557,550</td>
<td>$182,205,888</td>
</tr>
<tr>
<td>OTEC (20 MW)</td>
<td>$604,049,399</td>
<td>$874,600,079</td>
<td>$285,813,158</td>
</tr>
</tbody>
</table>

**Figure 5-14: Savings on fuel imports over the lifetime of utility scale RETs.**
Figu

5-15: Savings on fuel importation over the lifetime of distributed scale RETs.

5.7.2 Climate Change Mitigation

The value of RETs is not only monetary. As seen in chapter 3, the BL&PC currently emits approximately 244952 tonnes of carbon a year. This is approximately 4899040 tonnes of carbon over 20 years. The Caribbean Hotel Energy Efficiency Action Program (CHENACT), hopes to achieve credits for carbon emissions reductions through a clean development mechanism (CDM) Program of Activity for hotels on the island (CHENACT 2012).

Table 5-8 demonstrates the potential total tonnes of carbon avoided over twenty years for the RETs assessed in this study.\(^{67}\) The reduction of emissions is the added benefit of using RETs that do not consume fossil fuel as an input. The PV emissions avoided for systems ranging from 5kW to 500kW are dwarfed compared to utility scale solar at 25 MW. Nevertheless, the cumulative impact of these systems across the island must be considered. As of January 2014 the utility has 3028.8 kW of solar capacity installed in the RER (BL&PC 2014). This capacity accounts for approximately 265 tonnes of carbon (tC) or 3064 Barrels of crude oil equivalent (BOE) per year.\(^{68}\)

Table 5-9 demonstrates the impact of conventional thermal plant proposed for the island.\(^{69}\) A comparison of Table 5-8 and Table 5-9 illustrates that the emission per year of thermal generation systems

\(^{67}\) It is assumed there are 1628.2 kilowatt hours of electricity and 317 kilograms of carbon dioxide in one barrel of oil (BOE). The total generation of the RET is divided by the 1628.2 kWh to determine the BOE. This number is then multiplied by 317 kgCO\(_2\). To determine the carbon the kgCO\(_2\) is multiplied by .273 (molecular ratio of Carbon in a CO\(_2\) atom).

\(^{68}\) Assuming an output of 1647.36 kWh/ kWp/year the RER generates 4990 MWh/year and saves 3064 barrels of crude oil equivalent or 265 tC per year.

\(^{69}\) It is carbon positive thus a net release of carbon emissions to the atmosphere.
is greater than the lifetime emissions of the RETs. The RETs displacement may be small compared to thermal plant output. Nevertheless, they reduce the load on the national grid.

<table>
<thead>
<tr>
<th>Capacity and Technology</th>
<th>Megawatt hours of electricity produced (MWh)</th>
<th>Fuel Type</th>
<th>Barrels of Oil Avoided (BOE)</th>
<th>Tonnes of Carbon avoided (tC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5kW solar PV</td>
<td>158</td>
<td>solar</td>
<td>97</td>
<td>8</td>
</tr>
<tr>
<td>55kW solar PV</td>
<td>1733</td>
<td>solar</td>
<td>1065</td>
<td>92</td>
</tr>
<tr>
<td>75kW solar PV</td>
<td>2364</td>
<td>solar</td>
<td>1452</td>
<td>126</td>
</tr>
<tr>
<td>100 kW solar PV</td>
<td>3504</td>
<td>solar</td>
<td>2152</td>
<td>186</td>
</tr>
<tr>
<td>160kW solar PV</td>
<td>5043</td>
<td>solar</td>
<td>3097</td>
<td>268</td>
</tr>
<tr>
<td>500 kW solar PV</td>
<td>17520</td>
<td>solar</td>
<td>10760</td>
<td>931</td>
</tr>
<tr>
<td>25 MW solar PV</td>
<td>876000</td>
<td>solar</td>
<td>538017</td>
<td>46561</td>
</tr>
<tr>
<td>2kW residential SWH</td>
<td>60</td>
<td>solar</td>
<td>37</td>
<td>3</td>
</tr>
<tr>
<td>70 kW commercial SWH</td>
<td>2085</td>
<td>solar</td>
<td>1280</td>
<td>111</td>
</tr>
<tr>
<td>3.5 MW Onshore wind</td>
<td>245280</td>
<td>wind</td>
<td>150645</td>
<td>13037</td>
</tr>
<tr>
<td>7.5 MW Offshore wind</td>
<td>591300</td>
<td>wind</td>
<td>363162</td>
<td>31428</td>
</tr>
<tr>
<td>100 kW Small Wind</td>
<td>8760</td>
<td>wind</td>
<td>5380</td>
<td>466</td>
</tr>
<tr>
<td>13.5 MW Waste to Energy**</td>
<td>2010420</td>
<td>solid waste</td>
<td>1852125</td>
<td>160285</td>
</tr>
<tr>
<td>93MW SWAC</td>
<td>5376888</td>
<td>Ocean thermocline</td>
<td>3302351</td>
<td>285789</td>
</tr>
<tr>
<td>20MW OTEC</td>
<td>3153600</td>
<td>Ocean thermocline</td>
<td>1936863</td>
<td>167618</td>
</tr>
</tbody>
</table>

Table 5-8: Barrels of Oil and Tonnes of Carbon emissions avoided using various RET technologies over 20 years.

<table>
<thead>
<tr>
<th>Thermal Plant</th>
<th>Fuel type</th>
<th>Electricity Generation (MWh/year)</th>
<th>emissions factor (tC/MWh)</th>
<th>Tonnes of Carbon per year (tC/year)</th>
<th>Lifetime emissions (tC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSD30HFO</td>
<td>HFO</td>
<td>228636</td>
<td>0.200</td>
<td>45840</td>
<td>1375185</td>
</tr>
<tr>
<td>LSD40HFO</td>
<td>HFO</td>
<td>304848</td>
<td>0.200</td>
<td>61119</td>
<td>1833580</td>
</tr>
<tr>
<td>LSD30NG</td>
<td>Natural Gas</td>
<td>236520</td>
<td>0.151</td>
<td>35630</td>
<td>1068991</td>
</tr>
<tr>
<td>LSD30NG</td>
<td>Natural Gas</td>
<td>315360</td>
<td>0.151</td>
<td>47506</td>
<td>1425188</td>
</tr>
<tr>
<td>GT30D</td>
<td>Diesel</td>
<td>236520</td>
<td>0.157</td>
<td>37141</td>
<td>742813</td>
</tr>
<tr>
<td>GT30D</td>
<td>Diesel</td>
<td>315360</td>
<td>0.157</td>
<td>49521</td>
<td>990417</td>
</tr>
<tr>
<td>GT30NG</td>
<td>Natural Gas</td>
<td>236520</td>
<td>0.103</td>
<td>24324</td>
<td>486470</td>
</tr>
<tr>
<td>GT40NG</td>
<td>Natural Gas</td>
<td>315360</td>
<td>0.103</td>
<td>32431</td>
<td>648627</td>
</tr>
<tr>
<td>CGGT30D</td>
<td>Diesel</td>
<td>236520</td>
<td>0.161</td>
<td>38161</td>
<td>763217</td>
</tr>
<tr>
<td>CGGT40D</td>
<td>Diesel</td>
<td>315360</td>
<td>0.161</td>
<td>50881</td>
<td>1017623</td>
</tr>
<tr>
<td>CGGT30NG</td>
<td>Natural Gas</td>
<td>236520</td>
<td>0.106</td>
<td>25008</td>
<td>500159</td>
</tr>
<tr>
<td>CGGT40NG</td>
<td>Natural Gas</td>
<td>315360</td>
<td>0.106</td>
<td>33344</td>
<td>666879</td>
</tr>
</tbody>
</table>

Table 5-9: Tonnes of carbon emitted by the candidate thermal generation systems (BL&PC 2012).70

---

70 Emissions factors were provided in kg of CO2 per MWh and this was converted to tonnes of carbon by multiplying the kgCO2 by the ratio of carbon in a CO2 molecule and then dividing by 1000 to convert kg to tonnes (kgCO2 times .273 times 0.001 is equal to the tC).
5.7.3 Space and Water Requirements

The environmental externalities such as the impact of RETs on land and water resources must be included in investment decisions. The availability of space and land are considerations that affect the RET investment decisions of hotels and utilities. In addition, water is required in the operation of some technologies. Table 5-10 and Table 5-11 demonstrate the land and water requirements for RETs and thermal generators. The acquisition of space may be a factor in determining the cost of implementation of utility-scale technology. The time taken for environmental assessment and planning of RETs represent potential opportunity costs. The utility must lease or purchase land for the implementation of utility scale projects. Wind energy is the most land intensive investment per megawatt of output. However, it does not require water for operations. Solar requires water for the periodic washing of modules to maintain optimal operation.

Hotel size impacts economic decisions. Utilizing 10 percent of hotel rooftop space in Barbados would result in approximately 3.6 MWs of capacity (LSD 2013). This is larger than the grid-tied capacity already installed island wide. In this study, the total roof areas of hotels A, B and C were 1082m², 1692m², and 5500 m² respectively. The amount of quality roof area available for the implementation of PV panels is a potential barrier to RE deployment. Assuming all roof areas are flat, Hotel A is limited to systems under 160kW whereas hotel B can utilize the 160kW system. Only hotel C can expand beyond this and accommodate a 500kW system. In addition to the costs of roof rehabilitation, hotels in the study already utilized roof space for storage, and ventilation.

Barbados is one of the most water-scarce countries in the world (Cashman & Moore 2012). According to the World Resource Institute, Barbados has the highest water stress ranking of 5, placing it top ten in the world (Reig et al. 2013). As different electricity sources have different water requirements, the choice of electricity generation thus has an economic impact on the provision of water services to hotels and the entire island. Table 5-10 and Table 5-11 demonstrate that despite small land use impacts, dedicated utility generation requires significant contributions of water. The requirement for thermal plant per year exceeds the requirement over the lifetime of RETs.

---

71 According to data from the Land and Survey Department (2013) the total roof area for 10% of hotel roofs over 400m2 in Barbados is 244600m2. This gives approximately 14388 modules or 3.60 MW, assuming the roof is flat and 250Wp modules are installed with an area of 1.7m² each.

72 Assuming the roof area is flat and the same 250W panel for the LCOE is utilized.
## Table 5-10: Land and water requirements for solar, wind and waste to energy technologies

(Source: BL&PC 2012).

<table>
<thead>
<tr>
<th>Technology</th>
<th>Capacity MW</th>
<th>Land Requirement (m²/MW)</th>
<th>Total Required Area (m²)</th>
<th>Total Generation (MWh)</th>
<th>Liters of water per megawatt hour</th>
<th>Total Water Use (litres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar PV</td>
<td>0.005</td>
<td>6784.15</td>
<td>33.92</td>
<td>158</td>
<td>7.57</td>
<td>1193</td>
</tr>
<tr>
<td>Solar PV</td>
<td>0.055</td>
<td>6784.15</td>
<td>373.13</td>
<td>1733</td>
<td>7.57</td>
<td>13123</td>
</tr>
<tr>
<td>Solar PV</td>
<td>0.075</td>
<td>6784.15</td>
<td>508.81</td>
<td>2364</td>
<td>7.57</td>
<td>17895</td>
</tr>
<tr>
<td>Solar PV</td>
<td>0.1</td>
<td>6784.15</td>
<td>678.42</td>
<td>3504</td>
<td>7.57</td>
<td>26528</td>
</tr>
<tr>
<td>Solar PV</td>
<td>0.16</td>
<td>6784.15</td>
<td>1085.46</td>
<td>5043</td>
<td>7.57</td>
<td>38176</td>
</tr>
<tr>
<td>Solar PV</td>
<td>0.5</td>
<td>6784.15</td>
<td>3392.08</td>
<td>17520</td>
<td>7.57</td>
<td>132641</td>
</tr>
<tr>
<td>Solar PV</td>
<td>0.16</td>
<td>6784.15</td>
<td>1085.46</td>
<td>5043</td>
<td>7.57</td>
<td>38176</td>
</tr>
<tr>
<td>Solar PV</td>
<td>0.5</td>
<td>6784.15</td>
<td>3392.08</td>
<td>17520</td>
<td>7.57</td>
<td>132641</td>
</tr>
<tr>
<td>Wind</td>
<td>3.5</td>
<td>37004.46</td>
<td>129515.59</td>
<td>876000</td>
<td>7.57</td>
<td>6632038</td>
</tr>
<tr>
<td>Waste to Energy</td>
<td>13.5</td>
<td>14801.78</td>
<td>199824.06</td>
<td>2010420</td>
<td>2093.33</td>
<td>4208475977</td>
</tr>
</tbody>
</table>

## Table 5-11: Land and water requirements for utility scale thermal generation

(Source: BL&PC 2012).

<table>
<thead>
<tr>
<th>Capacity (MW)</th>
<th>Thermal Plant</th>
<th>Fuel Type</th>
<th>Generation MWh/year</th>
<th>Land Requirement (m²/MW)</th>
<th>Total Required Land Area (m²)</th>
<th>Liters of water per Megawatt hour</th>
<th>Total Water Consumption (litres/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>Low-Speed Generator</td>
<td>HFO</td>
<td>228636</td>
<td>74.0</td>
<td>2220</td>
<td>37.9</td>
<td>8654810</td>
</tr>
<tr>
<td>40</td>
<td>Low-Speed Generator</td>
<td>HFO</td>
<td>304848</td>
<td>74.0</td>
<td>2960</td>
<td>37.9</td>
<td>11539747</td>
</tr>
<tr>
<td>30</td>
<td>Low-Speed Generator</td>
<td>Natural Gas</td>
<td>236520</td>
<td>74.0</td>
<td>2220</td>
<td>37.9</td>
<td>8953252</td>
</tr>
<tr>
<td>40</td>
<td>Low-Speed Generator</td>
<td>Natural Gas</td>
<td>315360</td>
<td>74.0</td>
<td>2960</td>
<td>37.9</td>
<td>11937669</td>
</tr>
<tr>
<td>30</td>
<td>Combustion Turbine</td>
<td>Diesel</td>
<td>236520</td>
<td>37.0</td>
<td>1110</td>
<td>3.8</td>
<td>895325</td>
</tr>
<tr>
<td>40</td>
<td>Combustion Turbine</td>
<td>Diesel</td>
<td>315360</td>
<td>37.0</td>
<td>1480</td>
<td>3.8</td>
<td>1193767</td>
</tr>
<tr>
<td>30</td>
<td>Combustion Turbine</td>
<td>Natural Gas</td>
<td>236520</td>
<td>37.0</td>
<td>1110</td>
<td>3.8</td>
<td>895325</td>
</tr>
<tr>
<td>40</td>
<td>Combustion Turbine</td>
<td>Natural Gas</td>
<td>315360</td>
<td>37.0</td>
<td>1480</td>
<td>3.8</td>
<td>1193767</td>
</tr>
<tr>
<td>30</td>
<td>CCT</td>
<td>Diesel</td>
<td>236520</td>
<td>61.7</td>
<td>1850</td>
<td>749.5</td>
<td>177274384</td>
</tr>
<tr>
<td>40</td>
<td>CCT</td>
<td>Diesel</td>
<td>315360</td>
<td>61.7</td>
<td>2467</td>
<td>749.5</td>
<td>236365846</td>
</tr>
<tr>
<td>30</td>
<td>CCGT</td>
<td>Natural Gas</td>
<td>236520</td>
<td>61.7</td>
<td>1850</td>
<td>749.5</td>
<td>177274384</td>
</tr>
<tr>
<td>40</td>
<td>CCGT</td>
<td>Natural Gas</td>
<td>315360</td>
<td>61.7</td>
<td>2467</td>
<td>749.5</td>
<td>236365846</td>
</tr>
</tbody>
</table>
5.8 Summary

Combined cycle gas turbines (CCGTs) supplied by natural gas are cheaper and more efficient than the current diesel and heavy fuel oil based generation in Barbados. Nevertheless, fuel costs dictate the profitability of all generation technologies. The levelized costs of most RETs are at grid parity with the current average cost of electricity at 65 cents/kWh for commercial customers such as hotels. Utility scale firm capacity can be supplied by technologies such as waste-to-energy and biomass cogeneration. Similarly, OTEC and SWAC offer firm supply and savings in baseload electricity. However, these technologies are not as commercially established. Wind energy is the cheapest non-firm technology with offshore wind and utility scale solar at the same range of costs. Photovoltaics, solar water heating and small wind are distributed scale technologies beneficial to hotels and there is potential for further penetration in the hotel industry. In addition, small-scale on-site generation using Gensets is beneficial for backup and emergency services.

The utility incentive known as the Renewable Energy Rider has not been effectively utilized by the hotel industry despite cost parity and favorable rates of return on investment for PV systems allowed on the grid. The tax incentives offered through the Income Tax Amendment Act (2013) do not offer hotels fiscal allowances much different to the already established Tourism Development Act. The most beneficial fiscal incentive offered to hotels is an allowance on tax demanded under the Land Tax Act (2011). However, the facilitation of this tax mechanism needs further clarification and streamlining.

Ultimately, a hotel’s decision to implement RETs is dependent upon the electricity consumption patterns, the size of the hotel property, the ability to service debt, minimum accepted rate of return (MARR), cash flow and the type of investments within the investment portfolio. Hotels with higher electricity consumption may need greater incentives than those offered by the RER and the ISR. Investing in energy efficiency first is recommended before considering renewable energy. Consideration must be given to the environmental externalities of RE investments when evaluating the options for either island wide generation or hotel generation. RETs have the potential economic benefits of reducing foreign exchange spent on the importation of fossil fuel. In addition the social benefit of reduced carbon emissions and water use compared to fossil fuel based generation.

This economic analysis demonstrates that there is a framework amicable to renewable energy deployment. This is further enhanced by commercial lending at low interest rates. An understanding of actor perception of technologies and the barriers is required given the economic context thus far. This is essential to expounding the barriers to niche development within the hotel sector.
6 Results: Actor Insights and the Barriers to Renewable Energy

6.1 Introduction

This chapter begins with an introduction to the opinions concerning sustainability and the tourism industry expressed by my respondents. The technologies identified by my sample of respondents are introduced along with the identified drivers/motivations for an energy transition at the national scale and opinions concerning energy consumption awareness and behaviour. Secondly, I provide a summary of the identified agencies/actors that can influence governance decisions within the energy and hotel sectors of Barbados. Finally, I discuss categories of barriers to the implementation of renewable energy technology (RET) in the hotel sector of Barbados classified as: 1) institutional, 2) market 3) economic, 4) technical.

6.2 Fostering Visions of Sustainability for the Hotel Industry

This section provides a behavioural context of my respondents’ understanding of sustainability and their awareness of renewable energy technologies. In particular, their motivations and perceptions of the need for a change in the hotel sector are presented. Actors varied in their opinion of what “sustainability” meant. Most respondents mentioned the necessity of environmental stewardship for future generations of Barbadians. In addition, emphasis was placed on the importance of social equity and education in shaping a Caribbean vision of sustainable development.

*It seems as though the people who talk about sustainable development in the developed world, speak about it from a capitalistic point of view rather than a socialist point of view.*

Rick, finance

*Sustainable development is development that is affordable, minimizes damage to the environment and can be sustained over the long term with the available resources. We have to be looking at life cycle of issues associated with that development.*

Harry, Public Utilities Regulation

*[Sustainability] is more than just environmental resources, you have a lot of human resources, you have cultural heritage, all of these fall into sustainable development. But I think we tend to focus too much on the environment and forget the rest, whereas everything is supposed to be linking in. So that all your central policies for instance need to link together to achieve this idea.*

Bradley, Energy Regulation

Most respondents agreed that a re-evaluation of the Barbados tourism model is necessary. In particular, future hotel development should be more controlled with greater consideration for the island’s landscape and natural resources.
6.2.1 Awareness and Choice of Technology

The term ‘renewable energy’ is becoming more popular in Barbados and RETs have a greater appeal than demand side management and energy efficiency. The most mentioned RETs were solar photovoltaic (PV) followed by solar thermal water heating (STWH). Wind energy was the most contested choice. Despite some familiarity with RETs, fostering greater awareness within the general public and hotel industry was considered essential to influencing energy transition.

It seems like [renewable energy] is becoming a buzz word in Barbados and people are getting very interested in it...at least those who have the knowledge. Susan, NGO

There has always been a positive perception towards solar energy and that perception transitions now to a positive perception about photovoltaics. Barbados is a leader in hot water at the residential level but not necessarily through the hotel sector...There is a general lack of knowledge about things which are energy efficient...energy efficient technologies do not have the same kind of pizzazz, if I can use that word as solar energy.

Gavin, Energy Consultant.

A lot of the hotel owners that I have spoken to, they don’t really know what PV is in the first place. They know what solar panels are but they only know about the solar thermal panels for hot water heating.

Arthur, Academic.

I think there is scope but there is a lot of work to be done in terms of building that awareness in the industry. And convincing them with actual facts.

Rachel, Tourism Consultant

Technologies such as waste-to-energy, biomass cogeneration, sea water air conditioning (SWAC), ocean thermal energy conversion (OTEC) and desalination of salt water were mentioned by very few respondents. The ocean technologies were the least considered of all renewables due to the perception of that they were not at a commercial stage. However, some respondents believe there is potential for future utility-scale application. SWAC and OTEC are technologies that would require infrastructural expansion and raise potential environmental concerns with regards to the ocean. Biomass was considered potentially problematic due to the opportunity costs of producing food on land earmarked for fuel crops.

For the energies associated with the sea, those technologies are not off the shelf, and to some extent they may not be financially viable, so if you were buying technologies and you had a hundred dollars to spend, you would probably spend forty dollars on wind, forty dollars on solar, maybe fifteen dollars on biofuels or a different mix but only five dollars on [the ocean] because it is not really something that you want to bet your money on in the Barbados context.

Eric, Government

Deep sea water for cooling air conditioning of coastal and not too far inland buildings and hotels and the like. There again although the capital outlay is likely to be quite large by our standards, the economies of scale make it a technology to serve as well.

Chester, Academic.
No one has taken on biofuels seriously because of the scarcity of food and that connection.

Fred, NGO

We have the land out there, sitting down under sugarcane, losing a fortune. Grow food on the damn thing! I mean we could be growing enough to feed this country.

Carol, Tourism Consultant

6.2.2 Motivations for Renewable Energy

The majority of respondents (29), expressed optimism that RETs would be implemented in the hotel industry in the future. Actors identified a variety of drivers for the implementation of RETs at the national scale and within the hotel industry; however, economic crises were considered the catalysts for serious consideration/implementation of RETs. In particular, rapidly escalating fossil fuel prices and their impact on the various sectors of the economy including the hotel sector. Two thirds of respondents acknowledged that fossil fuels are a finite resource and demonstrated concern with the island’s fossil fuel dependence and limited energy security.

The unfortunate thing is that change takes place when there is a real crisis, a real need for the change.

Jeff, Utility

If there is a crisis that will force a change because crisis do that! I am not going that road of speaking of a major crisis but I think that there are pressures like increasing costs of fuel

Frank, Energy Finance

What happened in 2005 is that [oil] hit seventy. So this is Hurricane Katrina, so look at that, it doubled! In about six months! Boom. And that is when you start to panic because it’s no longer in our comfort zone! So there is our comfort zone and then this is the panic zone. That is when you say: “Is renewable energy for me?”

Eric, Government

In Barbados, the discovery and production rates of oil are falling and gas is diminishing. We now have to turn to external sources and with production of 1000 Barrels a day, we use about 5000 Barrels in the island a day. That is just an example of what is happening worldwide. We have very little diversification and we are very exposed to all the things that come with the advent of peak oil.

Bobby, Utility

It’s going to be more expensive to operate [hotels] so obviously the [new] costs have been passed over to the guest that is the consumer.

Dale, Hotel Operator

Like any other business, the price of inputs go up. It affects the viability of the hotel. The hotel has to increase its rates and so on. Then the market may or may not be able to bare those increases in rates. As it turns out the tourism industry is the single largest industry on the face of the planet so therefore if there are things that stop people from travelling maybe economic crisis and military crisis... but of course if the hoteliers did install renewable energy systems, the price risking part will be mitigated.

Gavin, Energy Consultant
Climate change (that is, ongoing and future anthropogenic global warming) was considered a potential driver for RET implementation that required collective action at the national scale. However, it was not considered the prime motivation for a shift to RET and half of the respondents labelled anthropogenic global warming as a theory. Nevertheless, most respondents expressed concern that the coastal hotel infrastructure is vulnerable to potential impacts of climate change such as sea level rise and flooding. It was found that for the nation to address climate change challenges, requires collective action and greater awareness of the risks of inaction.

What I will be doing effectively is disadvantaging myself by paying extra to do other things, but if I felt that what I was doing could make a difference because I am part of an overall thrust then that is a totally different thing. A collective thing! So if individually you can’t do it but collectively you think you can do it that would be a motivational factor.

Jeff, Utility

Yes our contribution in global terms is minute, but any small step we can take to even reduce it more, I think could be good. Again back to the public awareness, it really needs to increase.

Rebecca, Tourism Consultant

I believe this is one of the issues where the risk is so great that even if you were uncertain as to whether it is taking place you better take some steps to mitigate it because the consequences of not doing so are so great.

Bobby, Utility

That is one of the areas where there is a short fall...Not only across the public service, but also across the private sector in Barbados. We have to do a lot more public education programs so that we tackle climate change.

Douglas, Planner

That is a theory! Nobody knows if that is really true! But we will see given the predictions. In ten, twenty years we should expect some more of the polar caps to melt so we should see it...if there really is a global warming phenomenon.

Carl, Government Finance

6.2.3 Electricity Consumption Patterns

Respondents explain that electricity consumer behaviour impacts the need for RETs. As seen in chapter 3, the tourism industry is the second largest consumer of electricity in Barbados after the commercial sector. There is the opportunity for electricity savings through changing the consumptive behaviours of individuals at the hotel such as employees or tourists. If energy is used more conservatively then the size of renewable energy capacity needed at the hotel is reduced. Conversely, if energy is being wasted, systems may be oversized and more costly for hotels, and thus a deterrent to RET implementation due to the perceived high upfront costs. To address such an issue, it was suggested that fostering awareness of energy use behaviours is a priority. Rachel explains that the tourism industry can be an effective driver of such knowledge transfer due to clientele expectations and behaviours.
Electricity consumption in Barbados is extremely high in general and I think Bajans and tourists don’t consider energy consumption as something that they should try not to abuse. It’s like ‘Oh you have the money to pay for it, use it!’

Susan, NGO.

When you see these tourists leave a room they are accustomed to people turning off the lights. If their mindset is like that then we need to think of this from their point of view...why don’t we pursue these things here? When they come down here, what impression are they going to get of our destination? Rachel, Tourism Consultant.

Employees and tourists must make the connection between energy costs, their personal energy use, and the demand for fossil fuel. In addition to electricity consumption, Harry explains that people do not recognize the connection between water use and electricity. The Barbados Water Authority (BWA) is the islands water utility and the largest customer of the BL&PC due to the use of electric pumps for water extraction (BL&PC 2014). Therefore, hotels that monitor and mitigate excessive water-use contribute to national electricity use.

[The BWA] electricity bill has been between 20 and 40 million Barbados dollars a year. It is a substantial cost! [People] know, at least they should know that when the electricity goes off the water goes off as well. But when you hear the comments made sometimes you realize that connection is not too clear...Even when you explain the electricity is off so you could not pump water, people still quarrel with you saying you should have the supply.

Harry, Public Utilities Regulation.

Respondents advise that operational thinking is needed when developing hotels or businesses on the island. It was recommended that energy use should be considered throughout the design, site development, construction, commissioning, operation and decommissioning (i.e. the asset’s life-cycle). Jeff believes this type of thinking is not a norm in the island.

I said I really think that there is a lot that can be done here to save energy. The fellow told me ‘you see this? This design is finished! We aren’t making any changes because all of this has been approved and any changes are going to delay the implementation and it is going to cost us a lot more’...Now the hotel went ahead complaining about the costs of the operations on a day-to-day basis, wondering how it is costing them so much money. All of this could have been avoided if it had been designed properly but the reason that it was not designed properly is that the people who were designing it were not thinking operationally.

Jeff, Utility

6.3 Governance Actors/Decision Makers

Respondents were asked to identify the agencies or persons most likely to influence transitions towards renewable energy in the hotel sector of Barbados. Respondents identified actors that influence decision making in the energy sector and the hotel sector. The structure of energy and tourism governance in Barbados consists of a network of governmental, civil-society, market and supranational

73 Bajan is a local term for the Barbadian nationality.
actors/agencies. The identified actors/agencies and their roles are presented in Table 6-1. The Government of Barbados was identified as the most likely to influence the implementation of RETs within the hotel industry.

A majority of respondents proclaimed that demonstrative leadership at the national and hotel scales is essential to RET implementation. All respondents indicate a need for greater awareness, education and strategies for going green within the hotel industry. Bobby explains the island needs someone “who takes the lead and sets the example then others will follow….At the national level [a change in perception] requires a champion”.
<table>
<thead>
<tr>
<th>Actor Type</th>
<th>Actors</th>
<th>Roles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Governmental (Agencies/Actors)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Division</td>
<td>Governmental (Agencies/Actors)</td>
<td>Agency that monitors energy prices, responsible for oil and gas, energy conservation, and alternative energy. Liaise with supranational agencies (e.g., CARICOM, OLADE, and CARILEC). Monitors the BNOCL and NPC.</td>
</tr>
<tr>
<td>Minister of Energy</td>
<td></td>
<td>Responsible for national interest with regards to energy-supply and use and power to approve energy projects on island</td>
</tr>
<tr>
<td>Ministry of Finance and Economic Affairs</td>
<td></td>
<td>The management of government finances, economic policies, and financial regulations, fiscal policies</td>
</tr>
<tr>
<td>National Petroleum Corporation (NPC)</td>
<td></td>
<td>A state owned corporation responsible for the distribution of gas</td>
</tr>
<tr>
<td>Barbados National Oil Company Ltd (BNOCL)</td>
<td></td>
<td>Responsible for exploration, production and procurement of oil and gas</td>
</tr>
<tr>
<td>Fair Trading Commission (FTC)</td>
<td></td>
<td>Regulator responsible for maintaining consumer/utility interests by ensuring fair pricing</td>
</tr>
<tr>
<td>Town and Country Planning</td>
<td></td>
<td>Planning approvals for RETs and physical development (rural and urban land use)</td>
</tr>
<tr>
<td>Central Bank of Barbados (CBB)</td>
<td></td>
<td>In charge of monetary policy in Barbados</td>
</tr>
<tr>
<td>National Insurance Board (NIB)</td>
<td></td>
<td>Establish a system of national insurance and social security. A shareholder of the BL&amp;PC (20.3%)</td>
</tr>
<tr>
<td>Barbados Tourism Authority (RTA)</td>
<td></td>
<td>Agency responsible for the promotion of the tourism product, through marketing, licensing, regulation, registering services</td>
</tr>
<tr>
<td>Minister of Tourism</td>
<td></td>
<td>To protect national interest with regards to tourism and the power to grant project approvals</td>
</tr>
<tr>
<td>Barbados Investment and Development Corporation (BIDC)</td>
<td></td>
<td>Agency responsible for the development/promotion of products for export and expanding sustainable development and business enterprise in the small business, manufacturing and industrial sectors.</td>
</tr>
<tr>
<td>Government Electrical Engineering Department (GEED)</td>
<td></td>
<td>Department in charge of inspection and approval of electrical connections to the national grid.</td>
</tr>
<tr>
<td>Ministry of Tourism and International Transport</td>
<td></td>
<td>To lead in the sustainable development of the tourism industry through tourism policy, tourism research, the development of industry standards and facilitation of projects</td>
</tr>
<tr>
<td>Tourism Investment Company (BTI)</td>
<td></td>
<td>Agency responsible for attracting and engaging local and foreign investment in the tourism product</td>
</tr>
<tr>
<td>Barbados Hotel and Tourism Association (BHTA)</td>
<td></td>
<td>A non-profit trade association comprising of 280 tourism/non-tourism entities from Barbados and the world</td>
</tr>
<tr>
<td>Hotel businesses/developer</td>
<td></td>
<td>To make decisions regarding individual hotel plant and investment</td>
</tr>
<tr>
<td>Barbados Light &amp; Power Company Ltd (BL&amp;PC)</td>
<td></td>
<td>National utility responsible for generation/transmission and distribution of electricity</td>
</tr>
<tr>
<td>Light and Power Holdings (LPH)</td>
<td></td>
<td>Investment company responsible for investment in electricity and infrastructure</td>
</tr>
<tr>
<td>Emera Incorporated</td>
<td></td>
<td>Major shareholder of the BL&amp;PC (79.7%)</td>
</tr>
<tr>
<td>commercial banks and credit unions</td>
<td></td>
<td>Financial lenders for RET projects and other hotel ventures</td>
</tr>
<tr>
<td>Barbados Chamber of Commerce (BCC)</td>
<td></td>
<td>Responsible for growth of industrial and commercial business and act as a channel between government, public and private sectors</td>
</tr>
<tr>
<td>Supranational Actors/ networks</td>
<td>Caribbean Electric Utility Service Corporation (CARILEC)</td>
<td>Trade association of Caribbean utilities providing technical assistance, consultation and best practice services</td>
</tr>
<tr>
<td>------------------------------</td>
<td>---------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Caribbean Community (CARICOM)</td>
<td>To design regional energy policy and integration through Caribbean single market economy (CSME) and the Caribbean Renewable Energy Development Program (CREDP). CREDP is an initiative to improve the political, legal and regulatory framework conditions for RETs and energy efficiency in the Caribbean.</td>
</tr>
<tr>
<td></td>
<td>Caribbean Tourism Organization (CTO)</td>
<td>To provides services and information for sustainable development of tourism for the Caribbean</td>
</tr>
<tr>
<td></td>
<td>Caribbean Hotel and Tourism Association (CHTA)</td>
<td>A regional development partner and association of 36 national tourism associations</td>
</tr>
<tr>
<td></td>
<td>Caribbean Tourism Development Company (CTDC)</td>
<td>A regional marketing and development unit for the Caribbean</td>
</tr>
<tr>
<td></td>
<td>Inter-American Development Bank (IDB)</td>
<td>A development bank responsible for development funds in support of energy and the tourism sector(e.g. energy smart fund, CHENACT)</td>
</tr>
<tr>
<td></td>
<td>World Bank Group (WBG)</td>
<td>A financial institution responsible for development funds in support of energy (e.g. energy smart fund, CHENACT)</td>
</tr>
<tr>
<td></td>
<td>European Investment Bank (EIB)</td>
<td>A financial institution responsible for international development funds</td>
</tr>
<tr>
<td></td>
<td>Latin American Energy Organization (OLADE)</td>
<td>An organization responsible for integration, sustainable development and energy security in Latin America and the Caribbean</td>
</tr>
<tr>
<td></td>
<td>United Nations Development Program (UNDP)</td>
<td>To assist in institutional strengthening and development goals including energy, tourism.</td>
</tr>
<tr>
<td>Civil Society</td>
<td>Barbados Renewable Energy Association (BREA)</td>
<td>NGO advocating the interest of renewable energy and consumer, manufacturer and installers</td>
</tr>
<tr>
<td></td>
<td>The citizens of Barbados</td>
<td>The electorate that determines political incumbency</td>
</tr>
</tbody>
</table>

Table 6-1: Identified decision makers likely to influence the implementation of renewable energy technologies in the hotel industry of Barbados.
6.4 Institutional Barriers

Institutional barriers refer to policies, procedures, patterns of organization and inertia that occur within the governance structures of a society. Institutional barriers are the result of the decisions, norms and behavior of societal actors with the agency to influence governance and policy directives; once entrenched, institutional barriers limit renewable energy development (Krupa & Burch 2011; WBG 2010). Such barriers can be attributed to the immobility of state apparatus but are not limited to the action of government.

6.4.1 The Need for Clear Realistic Policy Targets and Legislative Framework

A primary concern is the need for agreement on clear, realistic policy targets for RETs. It was found that target capacities for RETs were historically lax and needed to be reassessed. Market and civil-society actors are the most critical of policy design in Barbados and suggest the need for legislated commitments towards target capacities.

_There are targets that have been talked about. There have been targets that have been published, there was a draft energy document but there is no legislated or agreed target at the moment. There have been documents prepared or produced that have suggested some targets. Some of them have been reasonable and some of them have been a little outlandish in terms of the amount of time._

_Bobby, Utility_

In 2005, the GOB released the National Strategic Plan for Barbados (GOB 2005). To strengthen the physical infrastructure and preserve the environment of the island was stated as objective four. The GOB indicated the need to expand the renewable energy and natural gas supplies to the island. The GOB set a target of 40 percent RET capacity by 2025 with 50 MW from wind energy (GOB 2005). At the time of the interviews in 2010, the GOB’s predominant document informing national energy policy was the 2006 Draft National Energy Policy (DNEP) (EPC 2006). The target set for RET capacity was 10 percent by 2012 and 20 percent by 2026 of the total grid-tied capacity. In addition, the policy recommended the creation of the Hotel Energy Fund designed for retrofits and valued at BDSS10 million.

Most actors from the private sector agreed that ambivalent targets were not enough to motivate systemic action and suggested the remedial implementation of concrete energy legislation. Total renewable grid-tied capacity on the island was 3.03MW or 1.27 percent of island capacity as of January 2014. This falls short of the targets outlined in the 2006 DNEP.

---

74 Off-grid capacity and savings though solar water heating are not accounted for in this estimate.
As much as respondents were critical of energy policy, an equal number empathized with policy developers that policy design is a lengthy exercise requiring extensive research efforts and coordination. They explained that consideration must be given to the novelty of large-scale distributed renewable energy in Barbados and the time needed to create, diffuse or adopt new standards.

*It is not as easy as one might think, to get all the legislation in place and to get the finances in place!*

*Chester, Academic*

*We only just got an energy policy...seems pretty good, taken a long time to get it up and running and its taking even longer to get it out into society but at least we have an energy policy.*

*Ian, RET System Homeowner*

The technologies are developing faster than policy can keep up...it is a small country, and policy takes time to develop. Certainly legislation takes time to enact...We are not driven by or use internal policies or internal standards and internal legislation requirements to set the standard. [We] look and see what is being adopted internationally...Any new change of technology introduced, people have fears and concerns.

*Bobby, Utility*

As demonstrated in Figure 21 of Appendix D: Governance Information, the creation of legislation using governmental policy directives requires many stages from conception to legislation. Traditionally, the annual Parliamentary Budget is used by the incumbent government to present its political vision. The impression is given that these visions are translated directly into legislation. On the contrary, this is not firm policy and it is the responsibility of legally qualified civil servants to begin the process of legislative drafting. Table 8-10 of appendix D list budget announcements addressing the hotel sector and energy initiatives in Barbados from 2006 until 2013. In 2006, a target of 30 percent renewable energy by 2012 was announced. This target is another example of an unrealistic vision. Many respondents believe that energy policy is used within budgets for political posturing at times of crisis.

*I think government has made some announcements. You can consult the Budget speech for 2008. That had a lot of policy utterances on the use of renewable energy and it is a lot about assisting the hotel industry with solar and assisting businesses in general with renewable energy.*

*Edward, Government*

*Energy policy in Barbados and many other Caribbean countries is often times only defined in the minds of decision makers and in their utterances rather than being defined concretely on paper.*

*Gavin, Energy Consultant*

*Along came 2006, seventy dollars a barrel...you will notice that in that budget speech quite a lot of things were being looked at. Then in 2008 the following Prime Minister also wrote some renewable policy but then again that is the zone that we are in...we have some fiscal policies that we will roll out and they started at the time of the panic zone in terms of energy prices...unrenowned to the average Barbadian and many government officials, the budgetary and financial statements made by the successive Prime Ministers is not law.*

*Eric, Government*
The Sustainable Energy Framework for Barbados (SEFB) was heralded as a necessary step forward for the island by critics and proponents of energy policy. This initiative recommended national targets for RET capacity of 29 percent by 2029 and energy efficiency targets of 22 percent below 2010 levels of electricity consumption (Castalia 2010a). The SEFB is an overarching policy guide to inform government decisions, especially as political incumbency changes. This document presents these cases as “indicative targets to guide policy and not fixed targets to be achieved at any cost” (Castalia 2010a: iii). The justification of such a caveat is to give policy makers flexibility and space to utilize least cost commercial technologies (Castalia 2010a). However, this same caveat can provide the space to move away from a RET commitment.

The targets outlined in the SEFB are held as voluntary commitments to the United Nations Barbados Declaration for Small Island Developing States 2012 (AOSIS 2012). Such a commitment allows the GOB to receive development assistance for RET implementation from the UNDP and development partners which include Australia, Denmark, the United Kingdom, Norway and New Zealand. In addition the national targets have been adopted by the utility company in development of their Integrated Resource Plan.

6.4.2 Policy Direction

Policies can be a barrier to the deployment of RETs in the hotel sector. Actors may not have consensus or feel included in the policy debate. Policy is driven directly and indirectly by different agents and a sense of exclusion may be perceived as a potential risk by likely RET developer/investors. Furthermore, such perceptions provide an indication of where power lies within the socio-technical regime.

6.4.2.1 Regional Energy Policy

Regional energy policies and agreements are said to influence policies at the national scale. CARICOM on 1st March 2013 established the Caribbean Community Energy Policy. Agreements between regional entities were said to influence the direction of governmental initiatives. Supranational alliances influence the policy direction. In the region Barbados, Montserrat and St. Lucia are the only islands that do not have preferential trade agreements for fossil fuels with Venezuela under PetroCaribe initiative (CARICOM 2013). Regionally, all island are continuing to develop policies to reduce dependence on fossil fuels, use least costs approaches to technology transitions, address climate change, establish further coalitions, and cross border electricity trading. Such novel policies demonstrate potential however they take a significant level of coordination and time. Most of the current action on energy occurs at the national level.
6.4.2.2 Government-led Policies

There was a general indication by respondents that energy policy and RET planning in Barbados are directed from the “top down”. The majority of market and civil-society actors expressed the necessity for greater collaboration between the public and the private sector in policy development. A few respondents believed that policy development can be strengthened by the private industry’s understanding of the dynamics of the energy and hotel sectors. In addition, a few actors proclaimed the importance of consumer opinions in shaping policy i.e. that civil society must be included in the process.

…the government has a very wrong approach when it comes to renewable energy policy! You were never consulted on the draft, nothing was sent to your sector or any sector; they just come up with a draft policy. They call you to a meeting and the unwritten expectancy is to sort of rubber stamp it. But in a marriage if you have an issue you have to sit down, you have to talk to your spouse and communicate and you have to do that in a caring and loving way. That is absent with government, whether it is the past government or the present government, that is just how government goes.

Gerald, RET Industry

That is another problem here; nobody talks to anybody else about anything...I work in a non-profit industry so we are grassroots bottom-up. We can do as much as we can from this end to encourage government to invest in renewable energy but really the policy is from the top down. We can encourage the policy as much as we can but we can’t necessarily write it because we are not the government. So it is the Ministry of Energy that is definitely in control.

Susan, NGO

I think there are two sets of people who can influence [RE development]. The government number one with their policies and number two the people, because you have enshrined interests....Don’t let the planning happen haphazardly so that you have people pushed aside and then they feel they are disenfranchised.

Charlie, RET System Homeowner

Barbados has a bipartisan parliamentary system and consequently policies are subject to change as new governments come to power. There is the potential of lateral pressure on the policy process as newly elected incumbents continue with, enhance, or dispel the policy initiatives of the former party in power. Consequently, there is the potential for delay in effective policy and increased opportunity costs.

When you have a change in government, some of the previous government’s policies continue to move toward law and some may be held up. Even if they don’t change in government there may be a policy that rationalizes that what the Prime minister has announced, we will have to hold on that or change it. So, there is no guarantee.

Eric, Government

Now problem with this [SEFB] is when the governments change, you know the usual story. The new government may have a different vision so it is left to be seen how far that will go in terms of continuity. That is always an issue once you have governments whose policy or thinking changes.

Rachel, Tourism Consultant
Issues may become politicized by party politics in the proverbial agreement to disagree. Despite the potential for political polarization, renewable energy has remained on the agenda since 2006. Two general elections have occurred since 2006 when the Draft Energy Policy was created. RE and electricity reform remained issues of concern within the House of Parliament after the government changed in 2008.

The country has to have the industry process led politically. Now thanks to 2006 Katrina, both sides of the political divide support renewable energy. Then it has to be economically viable but apart from it being economically viable it has to have mass appeal and then finally technical viability. Eric, Government

6.4.2.2.1 Political Will

The true motivation of government to move towards RET has been questioned by some actors. The visions of individuals within the state apparatus may only focus on political cycles and not focus on long-term objectives. There was a clear division in opinions across civil society, market and government actors. Critics believe that the space is not created for constructive feedback from the bottom-up and that the promotion of RETs is used as political capital in the public arena.

Even coloured by nostalgia, so many things about this island are worse than they were when I was young. I can only hope that the political will to think long-term appears somewhere because we are not talking about the five year cycle of governments. We are talking about what this island will be like in twenty, thirty forty years’ time.

Chester, Academic

I don’t know about the political will, I think they do [have it] but the only issue is I don’t see the level of enthusiasm that I would like to see from it. In other words, it is good public relations (PR) but are you really trying to make the change but are you trying to use it as sort of a buffer when somebody talks about, sustainable energy ‘oh yea we got this project going on!’” or is it really a transformation of how we think? ...What was the outcome of what you did? It’s not the activity that is important, it is the result.

Jeff, Utility

We are trying to do public participation in the government system. We have been taught that we don’t belong in the political world so just leave it alone...The NGOs, the community are trying, at least the people that care, are trying to tell the government what they want and it doesn’t feel like they are listening. It doesn’t feel like they care at all! In Barbados, you can say whatever you want but the government is going to do whatever they want. And it is very sad because that is not really the way a democracy is supposed to work!

Susan, NGO

Supporters of government’s efforts came from actors within the hotel industry. Proponents recognize the Caribbean Hotel Energy Efficiency Action Program (CHENACT) as a step in the right direction and a sign of serious commitment toward change.

Yes, especially right now! I can’t speak to how it has been in the past but right now there is a lot of press. I am trying to educate people on sustainable energy. There are
a lot of lectures and seminars and free conferences and training sessions and we have participated in 90 percent of them to show our support towards their [GOB] cause and to educate ourselves as much as we can on getting any savings that we can.

Maria, Hotel Operator

I am pleased to see that the government has started. I am pleased to see that it has come from the Government and just not one of those entities saying “look at what I am doing!”

Rebecca, Tourism Consultant

The government will encourage these hotels to the degree that it can to take action that would help them manage their energy utilization and their efficiency of utilization. We do that via projects like the CHENACT project where we try to get resources. So if the government can do anything to try to encourage better use, more efficient use, more appropriate use, I think that would influence decisions but ultimately the decision has to be made by the hotel itself based on its profitability!

Jason, Government

6.4.2.3 Hotel-Driven Policy

In addition to state directed policies, the corporate vision of hotel/operators may influence RE policy. Hotels on the island are locally and foreign owned; thus, the marketing/branding agendas can vary. The priority of hotel management thus dictates the pursuit of renewable energy:

And you will find in some of those places... there are covenants on the properties barring the ability to put up a wind turbine or even solar panels on a roof. It doesn’t fit in with the expectations I suppose of their clientele, so they are looking to put in water heating systems like boilers and chillers.

John, Utility

Hotel policy is largely market driven and influenced by pressures from outside the island. International standards of service are said to dictate the direction of hotel policy and marketing. The potential access to the green tourism market is considered an advantage of increasing RE covenants. Brand standards such as Green Globe Certification (GGC), ISO 14000, or Leadership in Energy and Environmental Design (LEED) are considered valuable to hotel marketing strategies and present voluntary policy instruments. Currently, ten hotels on the island have GGC (BHTA 2014). The marketability of such green certifications is a potential asset to hotel operators. The added value of the certification sometimes outweighs the arguments based on the greater upfront costs of RETs or energy efficiency.

Nowadays that argument is becoming, it has been diminished a little because a number of guests are asking the question; are you Green Globe certified?

Edward, Government

---

75 Green Globe Certification is a process where members are subjected to on site evaluations against 40 sustainability criteria that have been defined and accepted globally (Green Globe 2013). To maintain certification, the site must be audited every year by an independent party. There must be an “improvement of 3% every year in accordance with the previous audit results” (Green Globe 2013). A criterion is made under section D.1.3 Energy Consumption promotion of energy conservation and monitoring is recommended along with the incorporation of RETs in hotels (Green Globe 2013b). The standard D.2.1 Greenhouse Gas encourages monitoring and offsetting of greenhouse gases through energy management planning.
If you don’t have the Green Globe certain clients [are] not going to come to you. That is the impetus for some people to change because they think “I can’t allow myself to get locked out of this market so I have to update my system!” In fact I actually worked with a hotel, trying to get them Green Globe Certified because they were told by one company who they traded with that they were not going to send more clients until they do that.

Fred, NGO

The GOB has recognized the influence that external standards have on the marketability of the island as a destination and has incentivized such environmental certifications in section 12.E.10 of the *Income Tax Act*. Hotels that have incurred expenditure for such certifications may deduct an amount equal to 150 percent of the amount spent in that year (BIDC 2012). RETs and energy efficiency help hotels qualify for the GGC (Green Globe 2013b).

The 2012 CHENACT study calls for the development of the Barbados Hotel Clean Energy Policy with the goal to “improve the competitiveness and viability of the Barbados hotel sector through increased energy efficiency and low GHG emissions economic development” (CHENACT 2012:33). It is recommended that the BHCEP is incorporated into the SEFB, the Tourism Development Act and the Tourism Master Plan. CHENACT calls for a greater focus on hotel energy and the development of financing and incentives for RETs in the hotel sector (CHENACT 2012).

### 6.4.3 Regulatory Enforcement

Accountability for policy compliance is established through the use of regulation. Most opinions of the enforcement of policy on the island were negative. According to most respondents, there is a need for stronger regulatory measures to foster a culture of environmental best practice and energy management. Respondents recommended an all-encompassing regulatory framework that considers sustainability problems beyond energy. Suggested policy instruments included: a user tax for pollution from hotel emissions and utility emissions, 2) waste separation and recycling requirements, 3) vehicular emissions regulations for hotel taxis, 4) more stringent building codes, and 5) increased incentives for RETs, energy efficiency and water conservation.

*Government policies usually manifest themselves in terms of regulation. Policies tend to have a relatively weak influence at this point in time because they are just policies and perhaps not regulations. Certainly in terms of the environmental management of the sector, now depends on whether those regulations are being enforced or policed. Or whether or not the government has the resources to enforce and police those regulations!*

Gavin, Energy Consultant

---

76 The costs not including consultation and auditing range from US$750 for small establishments with up to 19 rooms, to US$5000 for accommodations with at least 250 rooms (Green Globe 2013b). This voluntary initiative is a small price to pay for a hotel operating in good financial times. However this option is evaluated in terms of costs and benefits since costs must include the upgrade and constant investment into the hotel plant.
We just have to back up the policy with action, the government needs to put their ideas and so on into action. Of course that brings to mind that we have anti-litter legislation but it is not enforced. So there is no point having big energy policy, unless it is enforced.

*Ian, RET System Owner*

I began to understand that people don’t do anything unless there is a regulation. If there was provision in the building code that required that a certain percentage of your energy must be generated from renewables...you have to support the Green Economy...[Government] has to create the incentive and they have to create the legislation in order for us to follow it.

*Susan, NGO*

Electricity regulation on the island is the responsibility of the Fair Trading Commission (FTC). The FTC exerts authority if a hotel wants to generate and sell electricity back to the grid. It does not challenge a hotel or any private person that wants to utilize all of their renewable energy for their own use i.e. an off-grid system. One respondent suggested that the FTC and the GOB consider implementing emissions standards as an indirect driver for the uptake of RETs.

We need to tax usage of the offenders. In Barbados there is absolutely no regulation for people generating power. We have no restrictions...there is no Barbadian regulation that says that coming out of your stack, you can only have so much particles. When you have got all these self-generators generating power with their own diesel generators there is absolutely no environmental control. I mean some of them could even be on the water table and we don’t even know.

*Jeff, Utility*

### 6.4.3.1 Concerns with Utility Directed Policies and the Renewable Energy Rider

Most respondents were supportive of credit systems, such as feed-in tariffs (FITs) and power purchase agreements (PPAs), to reimburse independent power producers (IPP) for the renewable energy generated. However, respondents shared mixed opinions of the utility company’s credit incentive known as the Renewable Energy Rider because it is directed from a utility with a natural monopoly on electricity. As a member of the RET industry, Gerald questioned the equity of the RER initiative without the protection of legislation. Gavin explained that the RER incentive is designed in the utility’s best interest and unlike a FIT, the RER is not legislated.

*I am not really interested in that [RER]. For the primary reason that legislation has to be put in place through the FTC and the Government with the private utility which is the BL&PC. At that point in time where all the three players bring the legislation into a reality, then I will get involved. I question if the buyback price per kWh is really beneficial ...it is questionable if the BL&PC’s price is a fair price for the consumer to receive his credit.*

*Gerald, Market Actor, RE industry*

---

77 The FTC is responsible for determining electricity rates, standards of service and the fairness of electricity pricing on the island.

78 Feed-in tariffs (FITs) are legislated pricing agreements whereby independent power producers (IPP) are paid rates that provide profitability for their investment in RET (Mendonca 2007).
The philosophy behind the precedent in Barbados is different to the precedent in Germany and in Ontario... It was the government policy and regulators who were proactive in Germany and Ontario while in Barbados we do not have that proactivity from regulators. The initiative came from the BL&PC so there is no surprise that they would make recommendation on a feed-in tariff that is based on their avoided costs and not the needs of the customer such as decent feedback and certainly not the needs of any potential manufacturers who might want to create a local market here in Barbados giving high FITs.

Gavin, Energy Consultant

The RER was acknowledged as a step in the right direction; however, critical suggestions were that the technologies accepted for the RER should expand beyond solar and wind. In addition, separate rates should be provided for each technology with compensation at least equal to the selling price since technology choice dictates the availability of the energy. Solar is available in the middle of the day at peak demand times whereas wind is potentially available at any time during the day. Peak-load generation costs the utility more than baseload generation and the RER awards customer-generators compensation for the avoided fuel cost of generation.

Net metering is a good option because you haven’t got to outlay that cost in batteries...if you are the hotel, ideally you would like to get near enough to the same as what they are selling it to you as!

George, Architect

There is one tariff and it represents an average of the costs for those two technologies. It means in my view that the solar energy technologies will be undercompensated and the wind technologies will be over compensated. The sun is only out for X hours during a day. The wind could be blowing at any time during the day.

Gavin Energy Consultant

A few respondents believe that the RER should represent more than the avoided cost to further incentivize the public. The fuel clause adjustment (FCA) was around 30 cents at the time of the interviews and was considered not enough of an incentive by a few respondents. However, the fuel adjustment has increased significantly since 2010, reaching as high as 48.4 cents/kWh in May 2011 and was at 44.5 cents/kWh as of July 2014 (BL&PC 2014).

When the sun is shining the BL&PC is also experiencing its peak demand so there is a day time peak in Barbados. The marginal cost of production get relatively high in Barbados and according to [BL&PC] data, more than a dollar per kWh. Now at today’s oil prices the fuel adjustment clause is about 30 cents and if you multiply 30 by 1.8 it comes to about 54 cents so in this month right now in Barbados as of September 2010 anyone who has installed a photovoltaic or small wind energy system and is feeding that electricity produced back into the grid under that program will be compensated at about 54 cents per kWh. Now at night when the person comes home, they now have to buy electricity from the national grid and they will be buying that electricity at the traditional tariff of the BL&PC which would be slightly more than 54 cents. So the situation is that the customer would never win.

Gavin, Energy Consultant
Eric explains that the utility is a private company with its own corporate interests to satisfy. The utility has invested in the traditional infrastructure and must account for the sunk costs and the operating costs. These costs are reflected in customers’ electricity bills with the variable component (fuel) being the most significant cost that customers must pay. Eric expresses the opinion that the BL&PC has too great an investment in fossil fuel based infrastructure to bring RETs in too rapidly. He is of the opinion that the utility’s potential loss of profits is a deterrent.

> Once we start removing the energy or the fuel by renewable energy then your equation goes haywire. So you have 100 percent renewable energy, it would mean that you have no fuel dollars at the top and the same amount of kilowatt hours at the bottom of the equation, which means that your fuel surcharge would be zero. So then all the utility would be getting is the money for the balance! That is a bit of a challenge for them!

Eric, Government

The utility avoiding RETs contradicts the national objective to reduce fossil fuel consumption. As previously discussed in chapter 5, the levelized cost of electricity (LCOE) from industrial solar PV (500kW) ranges between 26-44 cents/kWh. Since 2011, the fuel clause adjustment (FCA) has averaged at $0.43/kWh/year. This makes PV cheaper than the fuel component alone; therefore, the economic benefits are to the country and the utility. The utility still has the base rate, demand charge and customer charges covered for operations and distribution of the electricity. The cheaper distributed commercial solar from hotels reduces the fuel component for all customers. This contradicts Eric’s argument.

Generally, the GOB is accountable for the interests of all parties involved in energy supply and demand, regulating the import of fossil fuels for electricity production and protecting the interests of the public at large in balance with private commercial interests.

The justifications for the 2010 electricity rate increase were to cover utility expenses, attract capital for new plant, and to satisfy financial intermediaries and shareholders (Carter et al. 2012; Camfield et al. 2008). The RER was piloted during the rate increase to reduce the import of fuel and to experiment with RETs on the national grid. A few actors believed that the RER would bring hidden costs that fall upon customers who do not own systems of their own. A fear articulated was that residential customers who do not own systems of their own. A fear articulated was that residential customers who do not own systems of their own.

---

79 The components of bills in Barbados are: 1) the base rate or base energy charge - The base rate of an electricity bill refers to the portion of a bill that covers the general cost of business operation. This is the product of the customer’s present usage in kilowatt hours (kWh) and the base energy rate. 2) The demand charge - this is the product of the customer’s billing demand (kVA), and the demand rate for the tariff class in question. Billing demand varies between hotel establishments. 3) The customer charge - is a fixed monthly charge depending in which tariff class a customer is categorized. 4) Fuel Charge - this is the product of the customer’s present usage in kWh and the Fuel Clause Adjustment (FCA). This arguably the most variable component and is dependent upon changes to the world market spot price. Further discussion is necessary to understand the implications of this mechanism.
tax brackets may be asked to bear burden of the costs. Charlie explains that rapid expansion of renewables must consider people within this category. This fear may be sensationalized as PV is below grid parity and reduces the demand for fuel (i.e. the most significant component of electricity bills). Bobby explains that the motivation of the RER was to provide a service that is mutually beneficial to customers and the utility. Today the BL&PC is mostly owned by Emera, a Canadian utility company from Nova Scotia. Rick expressed concern that the FTC’s application of more lucrative credit for the customer-generators and more stringent regulation on pricing is lax due to a fear of the island losing foreign direct investment (FDI).

We wanted to do it because it is in national interest and we feel that if our customers, if we do it in the right way that is mutually beneficial. It is not good to be a barrier to things that we think are going to become an economically viable option as time goes on. It is better to be facilitating it and taking the lead than to it being pushed. 

Bobby, Utility

One of the fears that I have is that the upper classes will be able to put in systems for themselves once they become educated enough...then the burden of paying the rest of the electricity bill falls on the people at the bottom. Charlie, RE System Homeowner

I get the sense that governments is afraid to do anything that looks like they are doing something to the BL&PC in case the investors walk away...which is a Nova Scotia Canadian company. I mean it is ridiculous; they didn't raise strings at the rate hearing. Even the objectors who go, don’t talk about certain things, they think they shouldn’t talk about it!

Rick, Energy Finance

6.4.3.2 Building Codes

The status of the island’s building codes was a concern for six respondents. Revision of the codes was considered a potential avenue for enabling increased RE in the hotel sector. The 1993 draft addition of the Barbados National Building Code is used on the island as a standard; however, it is not legislated. Section 5.505.3 is the only concrete reference towards RETs within the document and makes provisions for the sizing of solar hot water heating systems. When questioned about building codes on the island, Eric of the GOB explains:

For fixed components which are the building structures, we don’t have standards. We have a draft building code but it has not been turned into law. For the appliances that you put into buildings we are now developing standards with the Barbados National Standards Institute.

Eric, Government

---

80 At the time of fieldwork, the country was coming to grips with the news of a tragic fire in which six young women could not escape a retail store in the capital Bridgetown. Public outrage in response to the victims’ inability to escape the building was evident in the media (Slinger 2010).
In 2012, the Barbados National Standards Institute began redrafting the building code to include energy efficiency and RETs; this code is to be enforced by the Barbados Standards Authority (Coward 2012). The new code has to be legislated and is not static according to the BNSI (Coward 2012).

6.4.3.3 System Approvals and Procedures

The agencies involved in public administration and approval are the Town and Country Planning department (T&CP), the Government Electrical Engineering Department (GEED), the Environmental Protection Department, and the BL&PC. The time taken to obtain approval for RET installation was suggested as a deterrent to the use of some technologies. It was indicated that approval may take a few months or years depending on the size of the project. “The absence of environmental impact assessment guidelines and legislation has arguably hindered the development of EIA in Barbados” (Pugh & Potter 2000:193). In some instances environmental impact assessments (EIAs) are required before projects can proceed. Wind projects need approval from the T&CP due to the potential impact on surrounding buildings as well as approval from the GEED to connect RET systems to the national grid. The Lamberts Wind project initiated in 2002 gained approval for construction was granted in 2010; the project is further delayed due to land disputes (CREDP 2011; Madden 2011). The time for approval may vary between projects and thus acts as a potential barrier to RETs. However, solar only needs approval for connection to the grid. If the system is biogas then the Environmental Protection Department may be involved in the approval process. Ultimately, the power to provide a license for interconnection rests with the Minister responsible for energy under consultation of an advisory committee (ELPA 2013). 81 The SEFB technical consultation suggests that the GOB should seek ways to integrate/streamline the permit and planning process to expedite RET implementation (Castalia 2010a).

6.4.4 Capacity Building

Most respondents highlighted the importance of training staff within the hotel industry and governance agencies. In particular, the implementation of continued education in energy management, RETs, and industry standards/certifications. A few actors mentioned their vision of a knowledge-based RE industry where services can be exported to other Caribbean islands.

---

81 This committee consists of the Permanent Secretary of Energy, the Chief Energy Conservation Officer; the Chief Electrical Officer, the Chief Town Planner. In addition the Minister may appoint five persons that are qualified in accounting, law or engineering to the committee.
I don’t find that Barbados in general has really worked at all at human capacity building...so teaching people about renewable energy so that they can be self-sufficient. The people who know about it have actively [sought] that information.

Susan, NGO

A general concern was that some hotels may not have employees that are familiar with energy best practice and RETs. Larger hotel businesses were said to have an advantage if their business model includes in-house engineers, architects and technicians to provide everyday monitoring and maintenance. Fiscal incentives exist to promote training in hospitality and in renewable energy. Currently, a tax deductibles of 150 percent of expenditure on training of staff in renewable energy is provided under the Income Tax Act 2013.

Some of the bigger hotels and chains have people who are focused on an area, whether it is an environmental officer or they have an engineer on staff...someone in the technical business who can take recommendations and run with them. Bobby, Utility.

A few respondents considered RETs to be a novelty on the island thus training is required for civil servants within the governmental agencies. Bobby explains that even the department responsible for approval of grid interconnections had challenges with new technology:

I know there are a couple of installations that the GEED have to inspect and the inspectors under the chief engineer were reluctant to take the decisions related to these installations because it is a new area. I think it will take a while for them to get comfortable and for the practice to become a norm. Bobby, Utility.

Proponents of RET education are optimistic that knowledge diffusion will occur within the labour force. Respondents mentioned the creation of formal education programs through workshops, seminars and the formation of environmental teams/officers. Most respondents maintained positive opinions of the impact of RET knowledge transfer at the hotel scale and at the national scale. They believe that energy and climate change education should be implemented at all levels of schooling on the island as part of a long-term vision. Furthermore, a few respondents mentioned RETs as an avenue to diversify the economy.

[RET deployment] would be a great opportunity. It makes a specialized area where people need to know about and not take lightly. It’s going to be opportunity for specialist at this stage for at least the next five years. Mike, Hotel Operator

...not only to train for Barbados but to train for export as well! Because once you do it you open the young people’s minds to the technology and they say that technology is always advancing Charlie, RE home system owner.

[Tourism] could be sensitive to a number of things outside of our control and that is why I believe that we should diversify the economy and make other sectors. Right now we are looking at the renewable energy sector. Rick, Energy Finance.
6.4.4.1 Access to Information

The ability to access sound information regarding RET implementation and energy management best practice was considered a barrier that affects institutional capacity building. In addition, some respondents believe that the “need” for RETs should be highlighted within awareness campaigns. Government is considered the key institution to facilitate access to reliable information.

There has been some very negative propaganda put out about the wind power. I mean you hear all sorts of crap about ‘oh it gives you cancer and it makes men impotent’ and all these kind of things. The turbines, oh it is terrible…and all the noise will kill you and you will go crazy. I mean that’s a lot of crap! Carol, Tourism Consultant

The average Joe out there knows that there is energy costs going up but in terms of renewable energy I am not too sure if we are driving the point across about the need! Edward, Energy and Regulation

People have been wrong or hyped one issue that is happening now but it always raises doubts and suspicion. How much of it is media hyping it more than what there is. John, Utility

The average populace is not really educated on renewable energy and they really don’t have the resources to find out the information that they need. So the NGOs [are important] and obviously we operate on very limited budgets, the same thing as the government; we try to do our best helping the community better itself. But it really is the government needs to offer more Susan NGO

Respondents explained that most knowledge transfer comes from consultation from outside of the country. Consulting services and technical assistance from other countries and supranational institutions were considered an asset to the island and added value to the island’s labor force.

Obviously hotels want to be world class and have to meet certain international standards. So people will bring people from other parts of the world to train their employees who might one day go on and start their own businesses and transfer that knowledge through the entire population. Maria, Hotel Operator

6.5 Market Barriers

Market barriers refer to factors that hinder the diffusion of cost-effective RETs into the electricity market and ultimately the hotel sector. These barriers decrease the competitiveness of RETs compared to other methods of electricity generation.
6.5.1 Restructuring of the Electricity Market

The fossil fuel and electricity markets are both vertically integrated.\textsuperscript{82} The BL&PC was considered to have monopolistic power in the electricity sector. Many respondents believe that the first step to establishing RET in the hotel sector is the need for restructuring of the electricity market. One approach of market restructuring, known as market liberalization or an “energy only market model”, is the horizontal restructuring of the electricity market resulting in competition between generating technologies. It involves the separation of the vertical components such as generation, transmission, distribution and retail supply (Cochran et al. 2013). In addition, it consists of the unbundling of tariffs and the creation of regulatory agencies to monitor the buyers and sellers of electricity (Jostow 2008). Frank believes that destabilizing the utility’s market power is necessary and achievable through market liberalization.

\begin{quote}
[Deployment of RETs] would lead to a liberalization of the whole energy sector. And which could mean that the Light & Power could lose some of its monopoly power and so on... I mean looking around the world our countries are going this way and I don't think it is a bad thing, especially if we are looking at things like the trend towards climate change which can have detrimental effects to the environment. \\
Frank, Energy Finance
\end{quote}

Frank’s suggestion of complete market liberalization is not necessarily the ideal model for a small island. The Caribbean Electric Utility Services Corporation (CARILEC) provides regional assistance for electric utilities and suggests that Caribbean islands follow a single-buyer model for market restructuring (CARILEC 2010). This model involves long-term contracts or power purchase agreements (PPAs) between the utility (buyer) and Independent Power Producers (IPP). Liberalization creates competition based on the interests of the individual producers; however, it may compromise the entire electric system. The quality of renewable resources like wind energy can vary across the island’s landscape and distribution network. The BL&PC has already established grid infrastructure and experience in grid management of this distribution network. Central planning and coordination is necessary to control the integration of distributed energy sources into the national grid. Elizabeth believed that the one-buyer model of restructuring is possible and points to the success of other Caribbean countries.

\begin{quote}
Both Trinidad and Jamaica have deregulated in that you have independent power producers so they have made it more competitive, so that you can produce, you really want to produce energy at a cheaper cost. \\
Elizabeth Energy Finance
\end{quote}

An identified mechanism for facilitating renewable energy generation is the use of RET auctions or competitive bidding to secure bilateral electricity contracts. To create such a framework requires policy

\textsuperscript{82} A vertically integrated monopoly in the electricity sector consist of an electric utility that has control over all the components of electricity supply: generation, transmission, distribution, and retail supply (Jostow 2008).
changes and time. Fred warns that market restructuring is an issue that must be immediately addressed and not delayed.

The most I could see happening is what happens in Jamaica...the generation is open to competition... So in Barbados it is possible yes, that is possible where it could either be a bidding or it could be more a policy driven objective...You would have to put in your information and show why you are the better person and it would be evaluated based on different criteria. But all of that is not in legislation yet. **Kate, Regulator**

Some [policies] are changing but only as incremental as the thing goes along. While it is not bad to have incremental change, if you only wait until something is broken before you change it, then we could be waiting a very long time! **Fred, Civil Society**

In December 2013, the Electric Light and Power Act (ELPA) amendment allowed for licensed generators to produce electricity. In addition, the public utility is mandated to offer interconnection to renewable energy generators and reimbursement at a rate agreed upon by the two parties and the regulator. This legislated bill places the executive power to grant IPP licenses in the hands of the Minister of Energy. This arrangement allows a limited quota to be generated and supplied to the grid but not to another party besides the BL&PC (single-buyer model) (Nationnews 2013). The BL&PC therefore is in control of distribution and transmission. The arrangement differs from the RER in that reimbursement is determined by the terms of each contract as opposed to the fuel component (the FCA). Initially, PPAs under the RER were not guaranteed beyond the two years. Transparent long-term contractual arrangements for power purchase were considered essential to deploying renewables and restructuring the market:

[A power purchase agreement] looks good, if you can get a long term contract! ...So yes we are doing this and trying this but there is no contractual obligation, a promise to do it. So why would you get into it for a year? And then you don’t have it anymore unless you are prepared to do it for yourself and come off the grid...The time period is not long enough for people to invest in it. **Rick, Energy Finance**

### 6.5.2 Manufacturing and Establishing Economies of Scale

The ability of RETs to achieve economies of scale was questioned by some actors. The establishment of manufacturing and a RET industry was considered a noble direction for the country. However, the incentives for such an endeavor were not enough compared to larger industrialized countries.

So the FITs in Germany were based on manufacturing needs for the photovoltaic sector as well as customer needs for the reasonable economics. Those FITs in Germany were not based on electric utility avoided costs. In Barbados, while customers too would want to have a reasonable economics and paybacks of five to seven years, we do

---

83 Transmission refers to the electricity being supplied from the generation source to strategically located substations at high voltages. Distribution to end users occurs after high voltages at substations are converted to lower voltages by transformers.
not have a local manufacturing sector for photovoltaics... The assembly can be done in Barbados. The market size is a little bit small but from a technological perspective [manufacturing] could be done in Barbados.  

Gavin, Energy Consultant

The other thing is the availability of the technology. Much of these technologies have their origin in the north and these are profit makers. Nobody is interested in selling sixty or a hundred solar panels through some small process, they want a trade! So that they have volumes! The size of the market here is not at the moment conducive to reducing price. It makes the price very high because somebody is going to go bring in a half a dozen or...so you do have some trade but the technology, the source of the technology is a barrier.

Fred, NGO

The manufacturing experience in Barbados was spurred through fiscal incentives for solar water heaters; however, some expansion of RETs has occurred. Recently, the 2013 Income Tax Act amendment has provided a ten year tax holiday to RE manufacturers and installers along with other deductibles. Numerous installation companies have begun to develop on the island. Caribbean LED Lighting Inc. has developed and patented a hybrid wind turbine and solar PV street lamp for export within the region (CLI 2013). The Barbados Light & Power Holdings Company created Emera Caribbean Renewables Limited (ECRL) to offer installation of residential and commercial solar on the island in a “highly competitive business with several other companies announcing their offerings to the market” (L&PH 2013:5). Frank predicted such a strategic move by the BL&PC.

So I really do see Light & Power itself moving into renewables. After all they are in the “Energy Business” and I don’t think that if they saw the loss of opportunities from sources that are hydrocarbon based that they would be holding out. I think right now that their operation is so large that they have been very much geared towards the use of hydrocarbon based fuels and therefore they use it, but I have no doubt when they look at it, they too might look at getting electricity from renewables!

Frank, Energy Finance

6.5.2.1 Competition and Manufacturing Logistics

The RET components utilized in Barbados are imported from around the world. The establishment of cost effective supply networks was a concern of some actors. There is an upward trend in the import of energy management technology. From 2006 to 2012, the import of photosensitive semiconductors and LEDs has increased significantly, from a value of BDS$145775 to $7440249 (BSS 2013). In addition, wind generator imports increased from a value of BDS$7710 to $84895. During this time, the USA (73%), China (18%) and Canada (3%) were the largest suppliers of photosensitive semiconductors and LEDs, whereas USA (47%) China (34%) and Taiwan (10%) were the largest suppliers of wind generators (BSS 2013).

In recent years, the GOB has attempted to facilitate the import of RETs and energy efficient materials. Hotels are allowed to import products to improve energy efficiency without any customs fees
According to part II B Item 87 of the Customs Tariff, RETs are exempted from import duty (BIDC 2012). Such incentives were considered conducive to market creation; however, respondents explain that monitoring the quality of RET products utilized in Barbados is important:

*Maybe some entrepreneur will find some way of manufacturing but with the high quality panels coming from USA and Canada and Germany and other European countries, customers may well be advised to buy those panels. There are now panels coming straight from China. They are not as reliable, there may be issues with quality but certainly the price is better than panels coming out of Europe or North America. So any developments, even in panel manufacturing in the Caribbean would be met with stiff competition from those who are already in the business.*  
*Gavin, Civil Society*

The potential for local manufacturing of technologies was a contentious topic for respondents. Civil society actors were the most optimistic about local manufacturing and explained that the region could benefit from such endeavors. Collaboration between the Caribbean countries with the resources needed for solar photovoltaic production was recommended. Countries in the region with developed manufacturing sectors like Trinidad & Tobago were considered better suited than Barbados to produce RETs:

*Trinidad certainly has the base...tons of engineers, a lot of industrial base, and access to large ports for shipping. There is potential in the region for manufacturing but what is available here would be more the assembly and support, as well as I think the services.*  
*Bobby, Utility*

*If we had a single plant doing PVs for the region then we just need to source raw materials... But to go the route of throwing all of your money back overseas again to get systems that reduce dependence on overseas is kind of a catch 22. So right now we have got no choice...we hopefully begin to learn at some point and begin to develop and manufacture some of these things right here, and begin to develop and supply those other markets. There is no reason why we can't compete with them.*  
*Cliff, Academic*

*People have thought about transporting sands from Guyana and Suriname to Trinidad and Tobago where you do have cheap electricity and supplies of it.*  
*Gavin, Energy Consultant*

Countries with more experience in manufacturing have begun to insert themselves within the region. For example, a Taiwanese firm, Speedtech Energy, began operation of a US$1.5 million photovoltaic manufacturing and assembly plant in St. Kitts in June 2013 (CaribJournal 2013). A strategic location in the Caribbean drives down the costs of PV in the region and may assist with knowledge transfer. Needless to say, other Caribbean countries like Jamaica and Aruba have pioneered wind energy in the region and have begun to develop the necessary operational acumen.
6.5.3 Competition with Natural Gas, Low Fuel Prices and Energy Companies

Respondents noted that the competition found in the energy sector expands beyond the borders of Barbados. Although not directly targeting Barbados, international resistance to RETs by large fossil fuel companies was a concern for some respondents. In addition, the small size of the economy can incite predatory tactics by RET manufacturers and installers themselves. It was generally found that conventional fossil fuel prices have the potential to out compete RETs and such phenomena have dictated the policies of Barbados in the past. However today, as seen in chapter 5, the cost of RETs has dropped below grid parity and in most cases is cheaper than the fuel component of electricity pricing:

If you do your research a lot of the same energy fuel companies have restricted the development of greener things because it is not in their interest, so they may go and buy up somebody doing environmentally friendly wind turbines to sort of control that market and restrict the development of it.

George, Architect

Renewable energy is doing okay and then someone says here is some cheap oil and people say ‘why don’t we throw away that wind turbine, water pumping wind mill throw it away, the sugar cane grinder throw it away’ because we can get these things done using electricity from fossil fuel cheaper. So the low prices is what killed renewable energy and now the prices have come back up, people are saying well, what became of my friend renewable energy. And renewable energy in some cases [is] cheaper.

Eric Government

This is basically the entire world but we have spent...we have massive, massive, massive capital investments in fossil fuel industry. So from generation plants to the system that carries fuel from one place to another, the whole system; massive capital investment. So to switch to a new renewable would be another massive capital investment which is a disincentive.

Jeff, utility

It took me two years to really understand this industry. And to understand the players and know how to attack my players ... anyone with enough money and enough retained earnings could decide for one year or two years to run all of their installation systems at cost price just to destroy the competition... that is what you call predatory attack!

Gerald, RE Installer

Well the utility is not going to do it. They are in the business of taking oil and plant and converting to electricity and getting money. That is their business! Anything else is a problem for them because wind power is intermittent, solar is intermittent.

Rick, Energy Finance

The BL&PC has planned for the future based on the expected availability of cheap natural gas. Natural gas is cheaper than all other fossil fuel sources in the projected scenarios for electricity and fuel price escalation found in the previous chapter; a 40 MW natural gas based turbine has a cost ranging from BDS$0.20-0.27 /kWh compared to $0.39-0.62/kWh for diesel based turbines, assuming costs of $??/GJ for natural gas and $??/GJ for diesel fuel. The natural gas turbine is thus projected by BL&PC to be cheaper
than all RETs assessed in chapter 5 except for onshore wind at $0.14 - 0.17/kWh. However, natural gas for power generation is not yet available and the future fuel cost is highly uncertain (BL&PC 2014).

Respondents had mixed opinions of the use of natural gas. Douglas, a governmental actor explains that he has seen a “very definitive and clear commitment” to develop an energy framework and new sources of fossil fuel supply; namely the Eastern Caribbean Gas Pipeline. In March 2012, the GOB announced that completion of the pipeline was scheduled for the end of 2013; however the project has not been completed (The Gleaner 2012). Such an effort would require substantive regional coordination between sovereign states with their own energy governance structures (Bailey et al 2013). The IDB believes transporting liquid natural gas (LNG) from Mexico or Trinidad is possible since ships can be accommodated by the large Bridgetown port (Bailey et al. 2013). In chapter 5, natural gas prices are assumed to range from BDS$10 -19/GJ compared to diesel at BDS$28 -76/GJ, which is [give fraction] less than the costs assumed by BL&PC, given above. Critics noted that natural gas is not renewable and will not create true energy security. In addition to utility generation, hotel self-generation using a Genset is dependent on the import of fossil fuels like diesel and natural gas:

*It’s still all fossil based but it is kind of the lesser between two evils...So for a lot of countries that is a reasonable first step; you can't go from oil to sun overnight so to go to gas which is less expensive, less harmful, it’s a good first move so that was a part of our plan as a first step.*

Cliff, Academic

*We are going to be getting our gas by pipeline from Trinidad which means the price [of RETs] is going to go up...whatever it is that we are importing, we have got to reduce our reliance on it...and this is where we are so stupid, because we have all the [renewable] resources out there...tap them!*

Carol, Tourism Consultant

*Previously we have looked at the issue of self-generation where we will be able to generate our own electricity. We were initially looking at using diesel generators but diesel generators will only be cost effective if we get the diesel duty free.*

Harry, Public Utilities regulation

6.5.4 Hotel Competition

Hotels compete locally and internationally in the Caribbean and the rest of the world. There are 96 places of accommodation on the island that all compete locally for the tourist market (BTA 2014). Hotels must make decisions on their plant investment based on how they stand up to competition. Other Caribbean

---

84 These include hotels, villas, and guest houses. The total is 147 if apartments, home accommodation and real estate are included (BTA 2014).
islands may be more competitive within the green tourism market but renewables may present an opportunity for Barbadian hotels to gain market share.

*Other competition and sometimes currency changes, just looking at currency changes, if our business is much more expensive, compared to another country and countries come on and have their plant*

*We are focusing on the sun, sea and sand so people come here to go to the beaches and party that’s it but what other countries are doing... I just went to Dominica and they are really into the ecotourism thing. And they are using ecotourism as a way to improve their infrastructure. Improve their tourism product in a sustainable way...but in terms of ecotourism we haven’t done a lot.***

*So while [Tourism] is a major contributor and considering development we have to give all the right things, the brand up, the customer service, keeping crime low and those things. You know anything in our control that would speak to keeping the destination attractive*

*An environment of perfect competition amongst hotels was considered influential on the type of investments hotels will make. Consequently, the competitiveness of the hotel industry is directly impacted by governance decisions and protectionism at the state level. As of December 2013, the GOB was the largest owner of hotels on the island with double the rooms of any private sector company (Loveridge 2013). Recently, in the attempt to attract investment and revitalize the hotel industry, the GOB negotiated with the Jamaican Sandals Resort International to purchase one of the islands oldest all-inclusive hotel properties—the Almond Beach Village. The GOB offered exclusive duty free breaks to food and beverage items for all-inclusive properties valued at $500 million (Madden 2013). However, the Sandals group is the only hotel business with the value to utilize such benefits. Such a move was critiqued by the BHTA and the political Opposition for creating an uneven playing field for other hotel businesses within the industry that may force competitors out of business (Barbados Today 2013; Madden 2013). The priorities of hotel decision makers change based on competitive advantages. And the advantage of RET must be clearly visible in the short and long terms.*

*Establishing green hotels may rekindle the industry’s competitiveness. The Casuarina Hotel was cited by nine respondents as a pioneer in the industry that established a hold on green marketing in the 80s and 90s. Jönsson (2005) explains that Casuarina demonstrated that proactive energy and environmental management could help other hotels in Barbados obtain global recognition (Jönsson 2005). However, ownership has changed hands and its reputation may have waned. Some respondents believe that green initiatives may increase the competitiveness of the hotel sector.*

---

85 The property closed in 2011.
Obviously [Renewable Energy] is a potential marketing tool for us because we are going to bring in additional guests from a market never tapped into before because back in the time at Casuarina which is one of our popular hotels... they were considered one of the only green hotels in the world.  

Dale, Hotel Operations

Since they [Casuarina] have changed ownership seven years ago, I’m not sure [environmental management] is maintained at the same level.  

Bobby, Utility

In the old days it was the Casuarina, That was the absolute champion of all, nowadays I wouldn’t call them green hotels necessarily but some really work hard at it...Unfortunately, not enough, definitely not enough!  

Carol, Tourism Consultant

6.5.5 The Market for Energy Efficiency

The majority of respondents mentioned that hotels must consider energy efficiency as a strategy. Respondents found it practical to prioritize energy savings over energy production and energy efficiency should be pursued up until the point where additional energy savings cost more per kWh than RET supply. As seen in the previous chapter, a more efficient hotel is beneficial and decreases the load that must be met by renewable generation. This provides hotels with larger paybacks if credited for the electricity produced by RETs. Hotels of all sizes can benefit from an increase in efficiency and management of load.

If you want to get into renewable energy, you don’t wait until you have the capital to go and do it. You start with energy efficiency and those hotels that have reached a certain level of energy efficiency can then take the next step because they would have begun to see savings...and they begin to self-finance in a way through their own savings.

Cliff, Academic

There is potential for things such as reduce the air-condition loads by insulating roofs, installing reflective film on windows; by installing door sweeps on doors to keep them closed. There is certainly the technical potential to introduce more efficient lighting systems

Gavin, Energy consultant

Some hotels have DSM software and work directly with the utility to monitor the time of use of electricity. Other hotels have not implemented computerized systems and rely on the relationship with the utility to monitor their consumption.

We do have a building management system. We manage our demand, especially in light of the fact that the power company now bills you on varying demand. Years ago it didn’t matter because you get the highest point and the bill will go for the next twelve months. Now they are reset every month.

Mike, Hotel Operator

No it’s not computerized. We just read the meters and then we take a recording of them and we put it into a spreadsheet and then we look at it from time to time. The BL&PC also sends us information on our usage, costs and rates and stuff like that... Our utility bill is one of our greater costs.  

Dale, Hotel Operator
The market for energy efficiency expands to all commercial sectors on the island. Carol suggested that there is an opportunity for energy service companies (ESCOs) to develop in Barbados and the Caribbean. These companies provide energy benchmarking for businesses and significantly improve savings within the public and private sector (Fang et al 2012).

*There are opportunities for ESCOs, there are not many energy service companies here in Barbados. There [are] a lot of them in Mexico, Canada, the States and such.*

**Carol Tourism, Consultant**

### 6.5.6 Research and Development

The need for further research and development (R&D) into island specific technologies was mentioned by a few actors. However, Rebecca warns that cautious examination of suitable technologies and strategies is essential.

*I believe the emphasis now on renewable energy, you might see a lot of peer research or R & D going into it and I believe the better understanding of material science. You might see some breakthroughs possibly in photovoltaic based renewable technology which could possibly lead to a reduction in price that could make photovoltaics more attractive too.*

**Frank, Energy Finance**

*I just hope that they really push ahead and try to do the research that they need to do. And also, not that they rush along either! Because I find sometimes, Barbados does that, we go to the other extreme where we don’t take our time properly and then things get done but not done properly. So you know a good pace, one step in front the other and not trying to do things too grandiose either.***

**Rebecca, Tourism Consultant**

So [larger countries] have a lot invested in research and development (R&D). Barbados again, we are a taker. We don’t have the capacity to do that level of research and development so to go put in a plant for one technology and then another technology takes off, we don’t have that capacity to absorb those sorts of situations. Unless a big company says, ‘hey Barbados has a competitive advantage within the Caribbean, let me produce there and sell throughout the Caribbean because we can do it cheaper than shipping it from China.*

**Jeff, Utility**

### 6.6 Economic Barriers

Economic barriers were found to be the largest category of identified barriers. Such barriers impact the financing of projects on the island (including RETs) and impact all sectors of the national economy. RETs require a large upfront investment that is financed over a 20 to 25 year period with revenue or savings generated by the project. Providing such upfront financing would be difficult under the best of times but

---

86 ESCOs provide services to clients that deliver increased efficiency in public and private sector operations; they also assess potential for RE implementation (Fang et al 2012). There are various contractual instruments to assist clients with financing e.g. energy performance contracting (EPC). Payment for energy services may be based partially or completely on the achievement of energy efficiency performance objectives (Hansen et al. 2009).
was rendered more difficult by the financial crisis of 2008-2009. Financing of projects depends on the investment climate and there are four options possible for hotels to secure the resources necessary to implement RETs: 1) Self-financing where a hotel has its own resources to purchase the RET; 2) debt financing where a hotel borrows money from a bank at a given interest rate; 3) investors provide equity and receive interest; 4) government funding/grants for RE initiatives/projects.

6.6.1 The Recession and the Investment Climate

Most respondents mentioned a reduction in investment and increased financial concerns as the deleterious effects of the 2009 global economic crisis. A few actors believed the financial crisis created a window of opportunity for rebuilding through the use of innovative green strategies and RETs.

For many hoteliers particularly at this point with the economic recession hitting very hard, it is going to be very difficult for them to be able to take the kind of investments of that kind now, I think in better times we will be able to do so but certainly not at this time!

Jason, Government

People are definitely looking to where they can save energy and money. I think that that is a good outcome of the recession in that it is forcing the people indirectly to think more green and environmentally.

George, Architect

Most respondents claim that the combination of the recession and the oil price spikes of summer 2008 had great economic impacts on hotel portfolios. The reduction in long stay tourist arrivals in the 2009 season was attributed to the inability of foreigners to finance their travel. However, the ability to adapt to the recession was considered necessary for businesses to survive the recovery period. Arthur, an academic explains “you have to invest now whilst you have the oil and the energy to actually drive the economy and you need to start planning now for the future”.

6.6.1.1 Credit Ratings Impacts

Since the recession, the island’s sovereign credit ratings were downgraded by credit rating agencies such as Standard and Poor’s (S&P) and Moody’s. These indicators provide foreign and local investors with an indication of political and financial risks of investment within a sovereign state. In 2010, S&P reduced Barbados’s credit rating to the lowest investment grade level due to the countries slow recovery and decline in tourism travel (Nation News 2010). In 2012, the foreign and local currency sovereign credit rating was downgraded since “economic fundamentals continue to weaken reflecting not only the external environment but also more pronounced competitiveness and other structural shortcoming.” (S&P 2012).

87 A BBB- is “the lowest investment grade by market participants” (S&P 2013).

88 BB+ is the highest speculative grade by market participants” (S&P 2013).
According to Moody’s, Barbados ranked poorly relative to other countries in its rating category as a consequence of declining debt indicators since 1999 (Moody’s 2013). Both agencies acknowledge the external impact of the recession but indicate that internal “structural issues are at play” in Barbados (Moody’s 2013).

The fiscal year 2013/2014 saw a fiscal deficit that exceeded 11 percent of GDP and gross financing needs at 30 percent of GDP in the 2014/2015 (Moody’s 2014b). This caused Moody’s to downgrade the government bond rating three notches to a B3 on June 2nd 2014. Such a rating reflects the negative outlook on the GOB’s willingness and capacity to generate local currency revenue and foreign currency to pay its local-currency and foreign denominated currency bonds on a timely basis (Moody’s 2014). Gerald believed that not enough was done by the GOB to prepare the country for the recession.

*The government is spending more money than it is taking in, so at some point the piggy bank is going to burst! And if they have got to run to the IMF then they have to make that public.*

Gerald, RET industry

The potential implications of such a burgeoning economic environment are the potential for devaluation of the currency and borrowing from the International Monetary Fund (IMF). The Prime Minster rejected the recent downgrades as “trash” since the current administration is determined to avoid excessive foreign borrowing (Caribbean360 2014). Nevertheless in June 2014, the administration has amended the *Special Loans Act* to increase its borrowing limit from BDS$1.5 billion to $2.5 billion (Caribbean360 2014b). This increase is to facilitate borrowing from other countries as opposed to international financial institutions (Caribbean 360 2014b).

Lorde et al. (2013) explain that without a high level of tourism, Barbados is not capable of sustaining the gap between inflows and outflows in its current account. In addition, the vulnerability to external shocks has placed pressure on net international reserves and the ability to maintain a fixed exchange rate regime (Lorde et al. 2013). Respondents were cognizant of such a dependent relationship and suggest now is the time to be serious on RETs.

*I am a bit concerned about the viability of the tourism markets given the economic downturn in the world. Barbados survives because of the contributions of the tourism*
sector in general, the hotel sector in particular. It also survives based on direct foreign investment, particularly in construction.

Gavin, Energy Consultant

The problem is, you see this country, is so dependent on foreign investment that they will take money from any of these people. There is a development that is going up on the west coast. Holy Shit man! I have never seen anything like it! You have got that monstrosity ...unfortunately because of the fact that we are dependent on outside investment; nobody is taking these things [RETs] into account sufficiently.

Carol, Tourism Consultant

So the tourism product or the tourism market can be very, very sensitive to change in the international environment, wars for instance, the economic downturn for instance!

Frank, Energy Finance

6.6.1.2 Labour and Hotel Seasonality

As seen in Table 8-11 of Appendix D, the unemployment rate on the island has increased steadily from 7.4 percent in 2007 to 11.7 percent at the end of 2013 (CBB 2014). Hotel businesses are dependent on visitors. The GOB attempted to protect the sector from the potential reduction in visitors caused by the recession. The BDS$15 million Tourism Industry Relief Fund (TIRF) was aimed at supporting job retention in eligible tourism accommodation and its ancillary services. This fund was implemented again in 2012 to assist hotels with the escalating energy prices.

The quid pro quos for that is that you had to try to maintain employment levels at the levels that you had in the previous year because there was a lot of talk about laying off staff because of difficulties. And we all know that once you lay off staff... that helps depress the economy a lot more. What you need to do is keep people working and spending and therefore help other businesses survive so once people have disposable income to be able to make their normal purchases and so on.

Jason, Government

Hotel operators are reluctant to invest in new technology when the priority is to qualify for funding and maintain employment. The accommodation market is seasonal with visitor numbers peaking at different times. Rachel, a tourism consultant believes that RETs may offer job stability in times of low tourist occupancy.

People from the communities are very often employed by the hotels...In low season when your occupancy levels are low, it is not economically or financially feasible to keep on all of [a hotel’s] employees so what they do as a practice in the low season, they lay off workers and that is going to have that multiplier effect...So if you have savings in terms of lowering your operation costs then you may actually be able to keep some of your staff on a full-time base.

Rachel, Tourism Consultant.

---

90 Available to establishments registered with the BHTA as accommodation or direct ancillary services; these establishments must have no outstanding national insurance debt and must have generated at least BDS$1.5 million in any of the three years prior to the recession (2006-2008) (EGFL 2009).
6.6.2 Upfront Cost of Systems and the Cost of Capital

The ability of hotels to finance projects due to high upfront costs of systems was the most identified barrier to RET in hotels. Respondents mostly mentioned the capital outlay necessary for photovoltaic systems and the need to balance investment priorities.

The upfront capital costs and the people being disappointed by promises from other technologies before. And the skepticism people have, whether they are really going to do the things they say they will do. In the case of renewables usually the paybacks are longer periods of time, and investments for twenty years so to get the benefit, these things have to work for twenty years. It is difficult for people to see that far ahead to say well this is going to work.

Jeff, Utility

[Hotels] would have to demonstrate, whether from their existing revenues, that investing in this plant would mean that they could still pay the debt. Because right now for solar panels, they are fairly expensive and to invest in it right now is going to be a major deterrent, the cost is a major deterrent for the hotels. Elizabeth, Energy Finance

The capital cost is very high! When you implement alternative energy solutions, it is equivalent to buying 20 years of your energy needs up front. Very few businesses can afford to do that. They don’t have the cash flow to do it.

Ian, RE system homeowner

I know with these things they are highly capital intensive, and can you really sustain the business if you know what you are paying for? Most places look for when will the results come, when will the payoffs come? As far as I am concerned, what are the costs to the business? Is it really feasible to implement?

Dale, Hotel operator

Chapter 5, illustrates that paybacks for PV systems occurred after six to ten years with larger systems (160kW) paying for themselves in six year. The cost of a 160 kW system was approximately BDS$ 934 000. At the time, the cost of systems were at parity with electricity from the grid. However few people recognized this fact as Eric explains:

We now have the fiscal incentives for the price of PV has now brought it to slightly better than electricity from the grid, but no one knows that.

Eric, Government

6.6.3 Funding Opportunities

Four ways of financing RETs for hotels are identified: 1) Self-financing where a hotel has its own resources to purchase the RET; 2) debt financing where a hotel borrows money from a bank at a given interest rate; 3) investors providing equity and receiving interest; and 4) government funding/grants for RE initiatives/projects.

6.6.3.1 Self-financing of RET Systems

Hotels may finance RE systems using their own resources generated through the tourism business. In this scenario hotels take on the full risk of the investment and must consider their minimum accepted
rate of return (MARR) when prioritizing investments. The MARR varies between hotels and is dependent on the capital structure, and the risks of conducting business at that point in time. It was explained that this option of financing may be considered too risky. Proactive hotels with adequate cash flows may consider this option.

*I think that the hoteliers in Barbados are going to have difficulty in taking actions on their own in this area...The really progressive ones will see the benefit of making the investment now because it is going to pay off in the long run.*  

Jason, Government

Some non-tourism industrial actors on the island have demonstrated that private financing is possible. Williams Industries is one of the largest companies in Barbados and since 2012 has installed 1.4 MW of photovoltaic capacity (Williams 2014). BICO is another major commercial company and since 2010 has utilized solar PV to run its ice cream storage facility and kiosks in urban centers; the company has also chosen to run manufacturing at night during the off-peak time (BICO 2010). These two companies use all electricity on site and these large players from outside the tourism industry have the operating capital to take on more risk than the hotel industry. In addition, such efforts were made before the new amendments to the electricity legislation.

### 6.6.3.2 Debt-financing via Commercial Banks

Hotels may finance projects by borrowing from local and international commercial banks. Such banks are the major source of debt financing in the Caribbean region (MCG 2013). Banks determine the credit worthiness of hotel clients by their ability to service the debt through disposable income, the willingness to pay, the size of initial down payment made on an asset, and the amount of available collateral in the case of default (MCG 2013). Consequently, credit worthiness determines the lending interest rate assigned to the hotel when financing RET systems through debt. As seen in chapter 5, the cost of electricity per kWh of RE rises dramatically with increases in interest rates. The average upper commercial lending rate on the island is 8.75 percent and the levelized costs per kilowatt hour of most systems are at grid parity.

*The hotel industry after getting knocked for a leap for the last two years, everyone is barely staying alive! And they are doing everything they can to cut costs. Nobody is going to have the money to spend twenty thousand US dollars, yet alone two million US Dollars on major sustainable energy projects unless the funding comes in. And the funding comes in at very good rates! Because a lot of people are going to need funding just to keep the cash flows okay and keep people employed.*  

Maria, Hotel Operator

In addition to credit worthiness, the capital structure of commercial enterprises is a factor that affects the rate of deployment of technologies. It was explained that even the BL&PC must borrow capital capital...
as electricity demand increases or infrastructure replaced and the capital structure of the BL&PC changed from a 78.56/21.44 to a 65/35 equity to debt ratio in 2010. Equity is generally more costly than debt and such costs fall upon the consumers when the price of electricity is raised to recover the cost of capital.

6.6.3.3 Private Investors and development partners

Hotels may rely on financing from willing private investors/shareholders in the form of equity. Investors typically require a higher return on their investment than debt financing and may require a shorter time period for the debt to be serviced. Earnings made through the hotel business are used to pay the interest to private investors. The investment climate on the island was considered bleak since the economic recession. The government has encouraged the importance of private sector investment and foreign investment in the tourism product. Foreign investors may offer a chance for financing however the small level of RET demand relative to larger global electricity markets may be a deterrent.

6.6.3.4 Government Grants, the Central Bank and Development Banks

Many large energy initiatives of the government and the BHTA are financed through development banks such as the Inter-American Development Bank (IDB) and the Caribbean Development Bank (CDB). Projects of national interest are often accompanied by policy-based loans that affect the hotel industry at a large scale as opposed to a single hotel firm requiring a line of commercial credit. Larger projects can thus obtain more suitable capital structures. Financing is conditional upon where responsibility for risks falls i.e. government or hotel corporations. Access to special funds created for national interests may be controlled through the Central Bank of Barbados (CBB). In 2009, the CBB established a credit guarantee scheme capped at BD$450 000 per customer, to assist viable tourism operations impacted by the world economic crisis. In addition, the CBB conducts due diligence on financial intermediaries such as the commercial banks and establishes parameters for lending to the hotel sector (CHENACT 2012).

The other factor that we could also consider is because we are very aware that the development banks have a focus on renewable energy and are actually able to do the funding that [commercial banks] are not able to do. [Commercial banks] would try to partner with the development banks. Elizabeth, Energy finance

So remember, [hotels] are putting these [RETs] on the property that’s going to be theirs, they are responsible, not any government organization so it has to be handled differently. [Development banks] can create the window and finance it and then it would be the responsibility of the Central Bank. Rick, Energy Finance

The Sustainable Energy Investment Program, also known as the Energy Smart Fund (ESF) is the most prominent loan facility initiated to date. The GOB is the borrower and the Energy Division is the
executing agency for the fund. The Enterprise Growth Fund Limited (EGFL) is the institution created as a financial intermediary to facilitate the Energy Smart Fund (ESF) that provides subsidized loans at an interest rate of 3.75 percent for renewable energy and energy efficiency projects (ED 2014). The objective of the ESF is to capitalize BDS$20 million for renewable energy and energy efficiency projects through low cost funding and grants. As seen in chapter 5, an interest rate of 3.75 is significantly cheaper for hotels with a 150 kWp PV system at BDS$0.32 cents/kWh compared to .48 cents/kWh at the commercial lending rate of 8.75%. The funds for the SEFB were intended to be released over five years.

Table 6-2 provides various RET funding opportunities for the island since 2006. It was found that international funds influence the policy debate however access to such funds may take time. A driver of distributed RET is that it reduces the utility’s need to borrow capital for plant. The European Investment Bank has provided the BL&PC with BDS$25 million in funding for their wind project in the north (Moore 2013). John explains the utility’s rational for RET investment however the degree to which RETs reduce the need to build other plants depends on the size of the capacity credit of the facility.92

If we have to buy a new plant then there are significant costs associated with that and then there are costs which we recover over a long period. And so the issue for BL&PC is going to be if we can defer investment in large category plant and find systems, or customers will find systems, to the extent to which that allows us to defer our large capital investment, there is a benefit to us! This in fact is built into the costs as part of the avoided costs, the financing of the plant that we avoid. John, Utility Market Actor

The BL&PC Wind Project has not come to fruition despite the available financing. In addition, access is conditional upon the policy direction envisioned by the executing agency.

92 Capacity credit refers to the amount of reliable output from a renewable energy source such as wind or solar and accounts for the reduction in required fossil fuel capacity at the utility as a fraction of installed peak PV or wind power (Harvey 2010b:43).
<table>
<thead>
<tr>
<th>Fund</th>
<th>Source</th>
<th>Date</th>
<th>Total</th>
<th>objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support for SEFB</td>
<td>IDB</td>
<td>2010</td>
<td>US $45 million</td>
<td>Programmatic policy based loan provided once policy conditions to implement SEFB considered satisfactory.</td>
</tr>
<tr>
<td>Energy Smart Fund</td>
<td>IDB</td>
<td>2010</td>
<td>US $20 million</td>
<td>To provide low interest loans (3.75%) for RET and EE projects for a value up to US$1.5 million.</td>
</tr>
<tr>
<td>CHENACT support</td>
<td>IDB</td>
<td>2011</td>
<td>US$2 million</td>
<td>Grant for four year project to help promote energy efficiency through energy audits in Caribbean hotels.</td>
</tr>
<tr>
<td>Second Generation Reforms to support SEFB</td>
<td>IDB</td>
<td>May 2012</td>
<td>$25 million</td>
<td>The objective is to assist the implementation of a legislative/policy framework for RETs, energy efficiency/conservation and rational use of fossil fuels.</td>
</tr>
<tr>
<td>Four Seasons Hotel</td>
<td>IDB</td>
<td>May 2012</td>
<td>US$55 Million</td>
<td>To assist in the completion of hotel resort development that was halted due to the global recession. The project has not been completed.</td>
</tr>
<tr>
<td>Public Sector Smart Energy Program (PSSE)</td>
<td>IDB and European Commission</td>
<td>June 2012</td>
<td>US$17 Million</td>
<td>To implement renewable energy solutions and energy efficiency and conservation measures by government agencies</td>
</tr>
<tr>
<td></td>
<td>European Commission</td>
<td></td>
<td>US$7.6 Million</td>
<td></td>
</tr>
<tr>
<td>Green business Barbados</td>
<td>Multilateral Investment Fund (MIF)/IDB</td>
<td>October 2012</td>
<td>$US150000</td>
<td>to help 20 Barbadian small and medium-sized enterprises (SMEs) achieve Green Business Certification</td>
</tr>
<tr>
<td>United Nations Development Assistance Fund (UNDAF)</td>
<td>United Nations</td>
<td>2012-2016</td>
<td>US$26.7 Million</td>
<td>To aid in achieving millennium development goal 7 assist with integration of sustainable development into country policies and help small island developing states(UNDAF 2011)</td>
</tr>
<tr>
<td>Solar photovoltaic Project</td>
<td>Global Environmental Facility (GEF) and United Nations Development Program</td>
<td>June 2014</td>
<td>US$17 Million</td>
<td>Used to leverage private sector photovoltaic installation developments.</td>
</tr>
<tr>
<td>BL&amp;PC Wind Project</td>
<td>European Investment Bank (EIB)</td>
<td>October 2006</td>
<td>US$12.5 Million</td>
<td>Funding for Lamberts Wind Project in the north of the island. Project has not come to fruition</td>
</tr>
<tr>
<td>Caribbean Climate Innovation Center</td>
<td>World Bank/IFC</td>
<td>March 2014</td>
<td>US$250000-50000</td>
<td>available to SME or individuals demonstrating proof of concept climate mitigation strategies</td>
</tr>
</tbody>
</table>

Table 6-2: Sources of funding geared towards hotel sector and RETs in Barbados since 2006 (Source: Moore 2013; IADB 2014; Joseph 2014)
6.7 **Technical Barriers**

There are various technical barriers identified that were said to limit the implementation of RET in the hotel industry. Technical barriers refer to conditions that limit the output of the technology. These barriers include siting, system aesthetics, size and scale of RET systems, the grid characteristics and transmission concerns and climatic conditions.

6.7.1 **Choosing the site for the technology**

Depending on the choice of renewable energy technology there is the barrier of finding an adequate location for the technology. As mentioned in chapter five, RETs have land/spatial and water requirements once implemented.

In terms of photovoltaics, respondents expressed concern over the amount of roof space available to hold a system and the orientation of the roof since south facing roofs provide the maximum output in Barbados’s latitude. However, a larger concern was the quality of the roof space and the proximity to trees. Some hotels already have structures on their roofs that hinder the implementation of photovoltaics. In some instances the roof space may be too small compared to the energy density of the hotel, as seen in Figure 6-1a below. Cliff suggested that hotels utilize car park space to produce electricity and shade vehicles. As seen in Figure 6-1b, car park solar thermal was used on the island at the Almond Beach Village since the 1990s and the first solar PV carport was opened on June 7th 2013 to charge electric vehicles in a business complex (Hutchinson 2013).

*I was up on the roof ... I was horrified when I saw the state upon it; glass broken! Tanks leaking! The whole roof looked like it was about to come apart! Branches and trees all over the place. You know I just thought to myself ‘by the time you get this thing repaired, it’s going to set them back about 20 000 dollars.’ These are the things that you see with a lot of the hotels; they are very dilapidated in some cases! They haven’t been up-keeping them and you must remember as well; once a hotel is twenty years old, its old!*

Carol, Tourism Consultant

*I mean there are already challenges with space for solar water heating panels. Some hotels have had to go to using on top of their car parks, which is really a very great idea...it is just open space. Nothing happens with the space...no real architectural designs to really battle with there.*

Cliff, Academic

*One of the greatest resources that will emerge this century if the renewable drive is sustained is the rooftop! So if you have square footage of say 2400 or 3200 ft² it is going to be very valuable for a household or a business.*

Edward, Energy and Regulation
Wind energy requires a large area and fall out radius for turbine blades. The hotel infrastructure on the island is mostly located along the coast in dense urban settings as seen in Figure 6-1c and d below. This is generally considered a technical barrier to implementing small wind or wind turbines.

### 6.7.1.1 Aesthetic Concerns

Most respondents expressed concern with the potential visual, acoustic, and olfactory impacts of RETs on hotel ambiance. Nevertheless, the type of brand and clientele targeted may determine acceptance.

> We are dealing with relatively old hotel plant [in Barbados] and while hoteliers might be well inclined to enhance their room to get a better room rate, they are less inclined to knock out a perfectly good window or start putting things to mess with the whole décor.

**Cliff, Academic.**

> We are in the business of customer service. Nothing can be too obtrusive or any way hinder the aesthetic of the property!

**Dale, Hotel Operator**

> People said that there is no way they are putting solar panels on their roofs, because it would make them look ugly...they are more instructed in the aesthetics...energy and saving the planet is not one of their concerns. You have to look at what your priorities are...what your values are.

**Charlie, RE System Owner.**

> It would depend on the property. Everybody likes to talk about aesthetics. There are certain types of guests who would, like to see [RETs]

**Mike, Hotel Operator.**

Such concerns are not limited to the hotel industry. Stakeholders raised concerns about noise impacts, visibility and shadow flicker during the public consultation for the utility company’s wind project (AMEC 2007).

The attempt of hotels to conceal technologies from the sight of tourists is illustrated in the photographs found in Figure 6-2. Notice that solar water heaters are generally placed on the roof of the hotel, and water tanks and ventilation units are placed behind foliage or hidden behind walls. Air conditioners can be found in both locations. In some instances like picture ‘e’, the solar water heaters may be shaded by foliage in an attempt to maintain the hotel’s ambiance. However, such actions reduce the efficiency of the solar panel that relies on direct exposure to sunlight.
Figure 6-1: Photographs illustrating the use of hotel space, hotel size and the proximity of hotels relative to other infrastructure.
Figure 6-2: Photographs demonstrating a hotel’s attempt to conceal various technologies on the roof or behind foliage, walls or fences.
6.7.2 Climatic Conditions

Respondents expressed concern that the inability to guarantee clement weather is a risk to grid reliability of non-dispatchable RETs like solar and wind. Jeff from the utility explains a preference for dispatchable fossil fuel generators. However, Jeff does not indicate a clear quantification of the potential capacity credit necessary.

You can’t tell the sun when to shine, you can’t tell the wind when to blow but theoretically speaking, you can pump oil into a generator and get it to work. With renewable sources you don’t have that privilege. You can’t say well I need 100 MW of capacity and the sun decided it is not shining and the wind [is] not blowing on a small island like this …then you have brownouts basically. So because it is not dispatchable the value is different to a generator that you can turn off when you want. **Jeff, Utility**

Despite the argument of dispatchability, respondents believed the wind and insolation regimes were amicable to photovoltaics and wind technologies. Few respondents expressed concern with the potential impacts of hurricanes/storm systems and high temperatures on RETs. According to the Caribbean Institute for Meteorology and Hydrology (CIMH), Barbados has a record low temperature of 16°C and a high of 35°C and an average of 27°C (CIMH 2010). These temperature ranges were not considered a problem (BL&PC 2014). In addition to wind and temperature, the percentage cloud cover was five eighths from 2000-2010 measured in the north of the island and four eighths in the south of the island over the same period (CIMH 2010). Cloud cover has the potential to affect photovoltaics. The SEFB study recommends offshore wind monitoring stations that can provide the utility with enough time to initiate backup generation in the case of inclement weather (Castalia 2010b).

One area of concern was the presence of salt in the air that hotel operators have faced in the past. The corrosive characteristics of sea spray were said to impact RETs and their balance of system components. Such experiences, create skepticism of the reliability of an RET investment. However, today there are more technologies built to withstand corrosion e.g. corrosion control systems in wind turbines (Musial and Butterfield 2004).

*People have been burnt...a lot of promises that things are going to solve their problems and they find that they don’t really work.”* **Jeff, Utility**

*We used to have solar panels previously, but the harsh climate with winds, all of the sea blasts. Most of these types of technologies breakdown after a few years, so we have shifted to the electric system.* **Maria, Hotel operator**

*Is [the technology] going to be sustained in Barbados as a Caribbean island exposed to sea salt? Is that same piece of equipment going to work in Barbados at the type of quality or capacity that they said you can get in Europe? For us in the Caribbean, our*
developers in the region need to bear in mind that you need to ensure that whatever plan has been put here is going to be able to deal with our climate.

Elizabeth, Energy Finance.

### 6.7.3 Grid Characteristics

Barbados has a grid frequency of 50 Hertz (i.e. 50 cycles per second) with a voltage of 115/230 for 3 wire single phase connections.\(^{93}\) The proximity to the BL&PC’s generation stations plays a factor on the ability of customers to feed in to the grid. Figure 3-14 illustrates the distribution network of the BL&PC. Proximity to the substations impacts the amount of RE electricity that can be received; the further away from the generation substations then the less a customer may be able to feed into the grid. Addressing this challenge requires an upsizing of conductors and an expansion of transmission lines at the national scale. In addition the storage of intermittent energy was considered costly.

*When that hotel builds the power plant on the east coast where we don’t have any transmission lines, all we have are low voltage distribution lines, how do we get the power into the grid. How much transmission and what is the length of the transmission line to get it there and back, it would have to be factored into the cost of the generating plant.*

**John, Utility**

*If you put too much wind on a small electric utility system it can, create problems unless you do what is necessary to avoid that which may involve energy storage. Some of the things that have been suggested were in our view a little optimistic.*

**Bobby, Utility**

Utility actors explained that the grid is designed to feed electricity to the consumers and therefore there is limited tolerance for inflows of independently produced electricity. The utility has warned that when customers feed electricity back into the grid there is the potential for disruption of the frequency. This disruption may vary based on the type of RET utilized. In addition, spinning reserves or backup capacity is required to ensure a level of reliability to the BL&PC’s customers. Intermittency thus becomes not only a technical barrier but an economic one. Such views are criticized as prescriptive by advocates of renewable energy since there is no complete intermittency study to date (Rogers 2013).

*So we have to have a spinning reserve which adds some costs to offset it. But you want the net effect to be still saving money... yes there are considerations in terms of the maximum penetration of an intermittent resource, because if you have 100% of it and it dips, then depending how much it dips by is the equivalent amount of customers that*  

---

\(^{93}\) Alternating Current (AC) is an “electrical current that changes amplitude continuously and periodically changes polarity” (Thompson 2006: 137). AC reverses its direction at a regularly occurring interval or frequency which is 50 times per second in Barbados. Single Phase is a cycle of voltage that operates in the same time phase i.e. all the voltages are in unison. “Single Phase service is where a facility has two energized wires coming into it. Typically serves smaller needs of 120V/240V and requires simpler equipment and infrastructure to support (less expensive)” (EEI 2005). Three-phase consists of three conductors where each phase is offset by a third of the period of the cycle. It is “electrical energy transmitted by three or four wires to a customer where relatively high voltage customers receive three phase power” (EEI 2005)
The barrier of storage was mentioned by five respondents. Storage options suggested for the island were batteries, compressed air storage and flywheels. The Inter-American Development Bank is assisting the country and the utility in assessing storage options for renewables (Balza et al 2014). The IDB has concluded that combining storage using lead-acid batteries with wind and solar energy is a suitable option; however further research is necessary (Balza et al. 2014).

6.8 Summary

Awareness of the connections between resource use (fossil fuels, energy, water, land, and food), technology choice and the economy is essential for addressing the challenge of sustainability transitions within the hotel sector of small islands like Barbados. Energy security is a greater driver for implementing RET than climate change. Fostering sustainability and implementing RETs in the hotel sector of Barbados faces five major barriers: 1) knowledge/socio-cultural/behavioral, 2) institutional, 3) market, 4) economic, 5) technical. These identified barriers provide a deeper understanding of the obstacles facing RET implementation in Barbados despite the grid parity of various RETs demonstrated in chapter 5. Table 6-3 below summarizes the identified barriers.
<table>
<thead>
<tr>
<th>Barrier Category</th>
<th>Identified Barrier</th>
</tr>
</thead>
</table>
| **Institutional**                | • Lack of policy or targets and uncertainty regarding established incentives  
• Weak legislative/regulatory framework  
• Lack of enforcement of polices and accountability  
• The nature of political will and platitude  
• Preference to utility initiatives  
• Division of political power  
• Lack of collaboration and stakeholder involvement in policy decisions  
• Level of bureaucracy/ inefficiencies within public agencies                                                                 |
| **Economic**                     | • An unstable macroeconomic context  
• The upfront costs versus payback time of RETs  
• Cost of capital and modes of financing  
• Inability of hotel to service debt  
• Trade-offs between financial priorities  
• The burden of cost of RE generation  
• Seasonality of tourists directly impacts operating capital  
• Competition between actors (e.g. between hotels locally and internationally)  
• Lack of entrepreneurs or investors due to perceived risks  
• The cost of conventional fossil fuel/competition between technology                                                                 |
| **Market**                       | • Sourcing and supply of technology (e.g. limited local manufacturing, logistics)  
• Inability to reach economies of scale  
• The need for greater R&D into island specific technologies  
• Type of electricity market structure                                                                 |   |
| **Technical**                    | • Variability of climatic conditions (temperature, salt air corrosion)  
• The orientation of hotel plant  
• The availability of space for technology on site (i.e. land acquisition, roof area)  
• The quality of hotel plant i.e. roof, building materials  
• Hotel energy density and consumption  
• The characteristics of the Barbados national grid  
• Distributed versus utility scale generation.                                                                 |
| **Knowledge, Socio-Cultural, Behavioral** | • Lack of trained workforce and agencies  
• Lack of awareness of energy policies and issues  
• Dissemination of knowledge not effective  
• Level of informational diffusion due to competitive industry  
• Level of awareness of technology types and climate change  
• Differences in priority, agenda and worldview  
• Aesthetics of the technology  
• High risk perception of RETs e.g. Not in my backyard (NIMBY)  
• Complacency and the lack of actor foresight or leaders  
• lack of ethic of public participation and the need for leaders                                                                 |

Table 6-3: Summary of identified barriers to renewable energy in the hotel sector of Barbados.
7 Analysis and Discussion

7.1 Introduction

This thesis is an attempt to identify the barriers to implementing renewable energy technologies (RETs) within the hotel sector of Barbados. The results indicate that the levelized costs of electricity are at grid parity for a variety of RETs. The average cost of utility generated electricity is approximately $0.70 per kWh. Most RETs have a LCOE that is less than the fossil fuel component of electricity costs (the fuel clause adjustment has reached as high as $0.49 per kWh). In particular, solar PV ranged from $0.36- $0.48 per kWh, onshore wind from $0.14-$0.17 per kWh, and small wind from $0.30-$0.51 per kWh. New natural gas based electricity generation may be as low as $0.18 per kWh for the utility’s proposed 40 MW combined cycle gas turbines. However, such infrastructural planning relies on the assumed availability of a consistent and cheap natural gas supply. RETs like Solar PV mean less utilization of existing assets and less vulnerability to changes in global fossil fuel prices. This is especially important if the energy produced is available during peak demand. Although beyond the scope of this thesis, storage and integration issues must be considered if the capacity for solar PV and other renewables goes beyond 20 percent of total energy supply.

In this chapter, I present an analysis of my findings as they correspond to the adaptive governance model known as Transition Management (TM). Firstly, I characterize the energy regime in Barbados based on the observed governance activities within the island. I discuss the dynamics observed between governmental actors, market actors such as the utility and hotels, and civil society actor using the multi-level perspective (MLP). Thirdly, I recommend potential opportunities to address the identified barriers to RET innovations within the hotel sector. I explain the potential benefits and challenges of these attempts to create protected niche space given the island’s characteristics. Finally, I present the limitations of this research, opportunities for future investigation, and my conclusion.

---

94 The Multi-level Perspective (MLP) refers to three interconnected empirical levels of analysis described in section 2.3.2: 1) niche-innovation (micro-level), 2) socio-technical regime (meso-level) and, 3) the socio-technical landscape (macro-level)
7.2 Transition Management and the Characterizing the Energy Regime in Barbados

Identification of potential energy transition pathways requires research analysts to “characterize” the existing energy regime, its internal tensions and the types of landscape pressures that influence the existing regime (Foxon et al. 2009:4). The system under investigation is characterised as the primary and secondary energy used to supply the hotel industry in Barbados. I begin with an explanation of governance activities of various actors and the context in which large structural change and niche development can occur. Although, the tourism industry can be considered an established regime of hospitality innovation, hotels remain niche areas for RET innovation and marketing involving green business models.

7.2.1 Governance activities

In TM, governance activities demonstrate how visions of sustainability are mobilized within a socio-technical system (Loorbach 2010). The results indicate strategic, tactical, operation and reflexive activities within the energy and hotel sectors.

7.2.1.1 Strategic

Strategic governance activities refer to collective long-term goal development/strategic discussion aimed at addressing systemic problems; such visions are typically a generation in length (30 years) (Loorbach 2010). My results demonstrate that such vision development is occurring in Barbados. However, the process has been in a constant state of refinement. Today, collaboration between the Inter-American Development Bank (IDB) and the Government of Barbados (GOB) has resulted in the Sustainable Energy Framework for Barbados (SEFB). The SEFB’s vision for 29 percent RET capacity by 2029 informs energy policy dialogues and is the first consistent strategic renewable energy target. This target is incorporated within the utility’s Integrated Resource Plan (IRP) for Barbados’s energy infrastructure. However, this preeminent reference for RET governance only considers the energy mix for 19 years into the future.95 Similar visions have been developed in other Caribbean islands; for example, Jamaica aims to achieve 30 percent RET capacity by 2030, St. Vincent and Grenadines aims for 60 percent by 2020 (Jacobs et al 2013).

The target is used as a voluntary commitment to sustainable energy developments for Small Island Developing States (SIDS-DOCK 2014). Such strategic international visions/alliances demonstrate solidarity on issues of climate change and energy, and potentially enable access to collective resources

95 Mobilizing increased RET requires dramatic power sector investments (IRENA 2014).
Regionally, the Caribbean Community (CARICOM) has established new energy policy as a guideline, informing member states to reinstate the vision to secure the Caribbean Single Market Economy (CSME) with a diverse supply of reliable, safe and secure energy (CARICOM 2013). Traditionally, regional coordination and integration of policy in the Caribbean is piecemeal, and lacks widespread popular support, and “domestic political pressures on national governments take priority” (Polanyi-Levitt 2004: 197). Thus, given the difficulties of regional coordination, governance agendas at the national-scale can be more easily mobilized in the short-term (Meadowcroft 2002).

### 7.2.1.2 Tactical

Tactical activities involve the establishment of coalitions and transition agendas for governmental, market and civil-society actors within an established system (Loorbach 2010). These agendas have timelines of ten to fifteen years. However, the space and willingness to contribute to innovation within a system is not evenly distributed and varies between socio-technical systems.

A Coalition between the hotel industry and the GOB clearly exists with the development of tactical activities focused on energy in hotels (e.g. the Tourism Master Plan 2011-2021). Coalitions are established locally between the Barbados Hotel and Tourism Association (BHTA), the Ministry of Tourism, the Energy Division and the BL&PC. International coalitions are established through the technical and sometimes financial assistance of the development partners from the IDB, the Caribbean Hotel and Tourism Association (CHTA) and United Nations Environmental Program (UNEP) and the Caribbean Electric Utility Service Corporation (CARILEC). In addition, agenda building has occurred through the coalitions of financial institutions and financial intermediaries such as Enterprise Growth Fund Limited (EGFL).

### 7.2.1.3 Operational

Operational governance activities are shorter experiments with innovations that last up to ten years (Loorbach 2010). The energy auditing of hotels via the Caribbean Hotel Energy Efficiency Action Program (CHENACT) and the creation of the energy smart fund (ESF) are two notable governmental operational activities. In addition, these operational activities include utility-driven experiments such as the time-of-use tariff (TOU), the interruptible service rider (ISR) and the renewable energy rider (RER).

---

7.2.1.4 Reflexive Activities and Cycles of Learning

TM emphasizes social learning through reflexive activities (Kemp and Loorbach 2005; Kern & Smith 2012). Such cycles of learning help actors evaluate and adapt governance to constantly changing socio-technical dynamics (Loorbach 2010). Examples of such activities include stakeholder dialogues with communities impacted by tourism or energy initiatives, and the dissemination of information using various media or platforms.

In the tourism sector, the Tourism Master Plan required the preparation of *The White Paper on the Development of Tourism in Barbados*. It recommends that the hotel industry and the private sector contribute to achieving a low-carbon economy and greater climate resilience. The results of the CHENACT study also aim to establish a baseline for comparing hotel energy consumption in small islands. Examples of reflexive activities in the energy sector include: 1) BL&PC’s consultation with stakeholder communities near the site selected for Lambert’s Wind Farm; and 2) stakeholder reviews of the RER and the IRP (BL&PC 2014). Experiments with the utility’s pilot programs have undergone constant review by the Fair Trading Committee (FTC). These reflexive experiments allow for incremental changes and have informed incremental legislative reforms to the Electricity Light and Power Act (2013).

7.2.2 The Multi-Level Perspective, Selective Pressure, and Adaptation in Barbados

Despite governance activities, my results indicate that the action space for RET innovation in hotels is not fully developed. To explain the stifled diffusion of RETs, I have identified the most mentioned internal and external selective pressures and the resultant power struggles that occur at the regime, landscape and niche levels. These are not comprehensive; however, I believe they characterize the complexity of the island’s energy dilemma.

7.2.2.1 Landscape

At the landscape-level, power is structural and the focus is directed to changing signification or legitimizing governance activities (Grin 2010). External landscape level pressures are perceived by actors as a major threat to the island however, such risks are not necessarily causally linked to regime change (Geels 2011). My results indicate that two predominantly mentioned disruptive shocks at the landscape level are: 1) the world economic crisis and 2) spikes in the global oil price. As seen in Turnheim and Geels (2012), crises can cause ambivalent responses among actors. Firstly, greater attention is given to energy transitions at the national and supranational levels, and secondly, internal resistance to new investments occurs (Turnheim & Geels 2012). In Barbados, actors demand new energy solutions to relieve the country’s economy but some actors remain immobile or cautious of new innovation. As such, the reduction in tourism business causes hoteliers to prioritize. Such immobility is further fueled by the global/regional
competitiveness of the industry. Smith et al (2005) explains that uncoordinated responses using external resources can be categorized as an emergent transformation. The island continues to struggle with adapting to the recession five years after.

7.2.2.2 Regime

The perceptions of market and civil society actors indicate that power is hierarchical in Barbados. In regimes, power is dispositional and focuses on rules, resources and the relative position of other agents (Grin 2010). I attempt to illustrate these dynamics with regard to the hotel and energy sectors in Barbados. Such struggles can indicate where agency lies within a regime. (Geels 2011; Nillson et al. 2011).

The government influences decisions in the energy regime that impact the hotel sector. The colonial British planning, legislative and political structures remain in place post-independence (Bunce 2008; Pugh & Potter 2000), and institutional traditions/norms have persisted and influence market, and civil society actors. Consequently, this historical trajectory built out of the island’s experiments with “development” means large industries like electricity have evolved to have natural monopolistic power (Carter 2012).

The socio-technical systems in Barbados rely heavily on the relationships between key industrial actors and the state (i.e. sugar industry, farming, construction, tourism industry, electricity). Government’s involvement with the BL&PC is reinforced because of the technical acumen that has accumulated over the last century; the BL&PC is a private company that supplies a product instrumental to society. This leverage is supplemented by the BL&PC’s access to foreign capital markets and foreign direct investment. Coalition is evident in the dynamic institutional relationship between the Government Electrical Engineering Department, the Energy Division and the BL&PC. Over time, civil society and market actors expect that decisions made by the regime incumbents must be in the nation’s best interest.

Today the utility is under pressure to provide dividends for its foreign shareholders, namely Emera. The established technological regime is based on aging hydro-carbon based machinery; this infrastructure requires significant investment to change. In addition, the BL&PC is now required to decommission most of its fossil fuel based thermal generation beginning in 2015. The utility must recover costs that are dramatically impacted by fossil fuel imports, their market prices and guarantee service. This has led the utility to seek natural gas as a cheaper fuel substitution for generating plant. Controlling the policy debate and leveraging the relationship with government allows the BL&PC to restructure incrementally. In addition, Emera has established a presence throughout the Caribbean by acquiring shares of other utilities
in the Caribbean: St. Lucia, Dominica, Bahamas, and Grenada (Emera 2014). An increased interest in RET disallows utilities to extract profit and maintain control (Sovacool 2009).

The tourism industry depends on island electrification to drive the industry’s growth, and was itself a new innovation post-independence (Greenidge 2004). The industry was nurtured by political incumbents with the hope of developing a comparative advantage. The energy industry and its infrastructure expanded to accommodate the vision of ‘development’ for the island. This innovation and the supporting institutions reached a point of dynamic stability (Geels 2011; Geels 2001). Regionally, the tourism industry expanded in other islands as well and the value chain/industry network was built out (i.e. tour operators, travel agencies, airlines). The success of tourism resulted from of the mobilization and coordination of resources in response to changing global pressures and internal politics. It was a teleological transformation and coalesced with the national agendas of the energy industry and increased structuration of both regimes with time (Gössling et al 2012). Thus, collectively, hotels on the island possess leverage to influence policy and lobby using local and regional trade associations (BHTA, CHTA).

My results demonstrate that disruption to the two regimes that historically worked in tandem has created windows of opportunity. Such multi-regime interactions evolve with time (Raven & Verbong 2007). Both energy and tourism regimes rely on a supply of external inputs to continue functioning: imports of fossil fuel and influx of tourists. The results illustrate the reality that the resources utilized by the island are external (development funding/ technical assistance) with a low level of coordination. Such an environment of limited natural resources has spurred RET innovation in countries like Germany; however, the success of these experiences was driven by well-established institutional capacity (Mez 2009).

Islands credited with initiating successful deployment of RET innovations benefit from geopolitical advantages: access to foreign capital, strong ties with former colonial empires, and an exogenous institutional regime. Types of capital available utilized to influence innovation are natural, financial, cultural, social, and human (Hall & Williams 2008). Such islands have the ability to mobilize resources towards technologies perceived to be risky like OTEC. For instance, the US Virgin Islands and Hawaii gain access to the resources of the United States of America and have extensive research and development assistance from the National Renewable Energy Lab (USVI 2014; Lantz et al. 2012). Reunion Island is a French territory and since 2000 implemented a Regional Plan for Renewable Energies and Rational Use of Energy (PRERURE) that includes direct subsidies, tax exemptions and feed-in tariffs (Praene et al.

---

97 Emera maintains US$9.9 Billion in assets and US$2.2 in revenue (Emera 2014).
There is expertise in the Caribbean region with technologies like wind in the former Dutch colonies of Curacao and Aruba. This illustrates that power can be unevenly distributed across small island landscapes and mobilization of resources is predominantly influenced by exogenous sources (Lawhon & Murphy 2011: STRN 2010).

The most needed resources to address the RET barriers in Barbados are financing and institutional capacity building through knowledge/technical assistance. As seen in my results, the Inter-American Development Bank has become the main institution to supply these resources. The IDB is the bank that facilitates most projects in the Caribbean and Latin America and directs the vision for Barbados. Policy based loans, such as those provided for the SEFB and CHENACT, assist with RET deployment but are conditional. The GOB thus is pressured to meet standards before money is released. It is due to this pressure that short-term visions or internal inertia creates a challenge for the established regime.

As seen in Kern and Smith (2008), short-term goals have the potential to undermine long-term visions and the process of changing institutional practices is difficult; regime incumbents control niche development and select incremental changes that fit within the existing regime. SEFB is beneficial because the agenda is to ‘bridge’ and mitigate short term pressures. Meadowcroft (2009) explains that there is significant power within politics due to the short-term nature of political cycles. This is a double-edged sword since political decisions may result in long-term negative or positive consequences for society (Mackard et al. 2012).

Increased public debt and the downgrading of the country’s credit ratings demonstrate the perception that the regime’s investment climate is compromised in Barbados (Moody’s 2014b; S&P 2012). Lending rates have increased post-recession and the cost of capital is a selection pressure that greatly affects hotel ability to finance RET. Market and civil society actors who are impacted by these pressures begin to lose faith in the government’s competence to protect their interests. This reduced faith in the state is exacerbated by the perception that policy action is a top-down process excluding non-incumbents from the collective dialogues.

Market actors have begun to place pressure on the GOB and the energy regulators to be less conservative in their decisions on renewables. Large industrial firms outside of the hotel industry have

---

98 Average interest rates on the island are approximately 9 percent compared to Canada (3%), USA (3.3%) and UK (0.5%). Islands with the lowest interest rates are Bahamas (0.5%) and Bahrain (5.9%), Trinidad and Tobago (7.5%). In 1992 when structural adjustment came into effect due to recession, the commercial lending rates on the island rose to 13.54% (BSS 2014; WB 2014).
begun to force the issue of RET deployment by taking action and self-generating beyond the regulated capacity (Williams 2014). Such pressure is influenced by the falling cost of solar PV internationally and the increasing average cost of electricity. Globally the price of solar PV is falling at a learning rate of 20-22% with every doubling of the cumulative market production (Channel et al. 2013; Fraunhofer 2012). “Although future declines may be less rapid, the cost to install PV will continue to decrease as a result of technological innovation, product optimization, economies of scale, learning by doing, and government efforts to reduce PV costs.” (IEA-RETD 2014: 9). Experiments in the niche come with high risks of failure and technological winners should not be preselected (Kern & Smith 2012). However, the GOB is not technologically neutral and has forced the agenda of solar energy due to its familiarity with solar water heating, and the commercial availability of the technology. 99

It is not easy to determine an exact transition pathway but the coalescence of the alliances and selective pressures thus far provide an understanding of the islands transition characteristics. Most of the pressure and resources utilized by the island are external with a low level of coordination. This type of timing and transition is similar to the description of de-alignment and re-alignment. However, transitions occur over a wide time frame making the trajectory impossible to categorize until more significant changes are observed in the future. The momentum of RETs is increasing and pressure is on the existing energy regime to adapt. Legitimacy of the current incumbents is eroding as public interest in the electricity sector has increased.

7.2.2.3 Niche

Power is relational at the experimental or niche level, where the focus is placed on the achievement of interacting agents and the difference in agent ability (Grin 2010). Industries are driven by competition and thus have the ability to influence innovation (Hall & Williams 2008). The way hotel businesses organize and interact with new innovations will determine diffusion; risk takers/niche leaders in the industry can drive diffusion to RETs. In Barbados, larger hotel firms have a greater ability to mobilize resources towards RETs than smaller firms. This provides leverage with the government as illustrated by the attempts to sell, buy and save properties that have closed or unable to maintain development. In addition, larger hotels have more physical space relative to their competitors. Hotels also have the ability to influence government decisions due to their role as economic engines.

99 Residential customers have taken the window of opportunity for photovoltaics, since smaller systems range in the BDS$30-40 000 range. Despite smaller internal rate of returns on 5kW (residential) systems, owners of households are more certain of keeping their household over the 20 year lifetime of the technology.
7.2.2.4 Protective Space and Empowerment

“Shielding” refers to processes that mitigate selective pressures whereas “nurturing” processes support the development of path-breaking innovation (Smith & Raven 2012: 1034). The GOB attempts to shield the hotel industry from selection pressures such as the recession through subsidies and fiscal policy; however, I believe that further protection is needed before RET innovation can be established. Empowerment occurs when an innovation becomes more competitive within the context of mainstream selection power (Smith & Raven 2012). Consequently, the creation of new spaces for innovation may be market-led, government-led or civil society-led (Foxon et al. 2009). In the 1970s, the GOB nurtured the hotel industry and the solar water heating industry by adapting fiscal policy with such protective space. Actors in Barbados must create such spaces for the adoption of RETs.

7.2.2.5 Windows of Opportunity and Steering?

The ability of actors to steer a transition has been contested (Shove & Walker 2008). Energy transition is highly dependent on a variety of preconditions (e.g. timing, socio-cultural, economic, and spatial). Transition management requires identification of windows of opportunity for innovation. Table 7-1: Windows of opportunity facilitating RET at the niche level within hotels lists windows of opportunity that exist at the different levels within the MLP.100

| Landscape       | • Changing world view on energy  |
|                | • Increased connectivity and exposure to ideas |
|                | • Economic recession             |
|                | • Increased supranational attention to climate change |
|                | • Oil concerns, changing technology |
| Regime         | • Pressure on the BL&PC to commission new generation capacity in the near-term. |
|                | • Support from both sides of political system for RET |
|                | • International support from development banks and supranational networks and financiers |
|                | • Familiarity with solar water heating industry |
|                | • GOB and experiments with fiscal incentives. |
| Niche          | • A baseline of energy use for most of hotel stock already exists via CHENACT |
|                | • Annual reductions in the cost of RETs; especial solar PV (Channel et al 2013). |
|                | • Most competitive industry can benefit from marketing and reduced costs. |
|                | • Larger space than the residential sector for technologies such as solar PV. |
|                | • No need for new land and hotels located near to main generation stations. |
|                | • An established tourism regime in need of remodeling. |

Table 7-1: Windows of opportunity facilitating RET at the niche level within hotels

100 It is not an extensive list but provides an insight of processes and patterns that are coevolving.
7.3 Recommendations

The transition pathway is not clear for Barbados, but renewable energy is gaining momentum due to reductions in the price of the technology. Nevertheless, BL&PC’s final Integrated Resource Plan (2014) recommends that in 2036 approximately 60 percent the island’s energy supply be met by new low-speed generators run on natural gas and approximately 30 percent run on biomass and waste. The solar share is proposed to be practically non-existent, at less than 1 percent (BL&PC 2014b: 131).

I believe that a greater share of RET capacity is possible, and experiments/demonstrations using hotels may encourage the uptake of RETs. Karagiorgas et al. (2006), explain that it has been proven that hoteliers are motivated to invest once they have observed other local or regional competitors’ installations of commercialized RET technologies. I provide a few recommendations for niche-innovation applicable to the government, the utility, RET businesses, and hotels. These areas need further research to assess their viability.

7.3.1 Governmental Recommendations

It is necessary for government to regulate the interests of all actors involved within a regime. The GOB can mitigate conflict between such actors and enforce energy policy.

7.3.1.1 Legislated Measures and Regulatory Reforms

As illustrated in the results, legislation is considered essential to the implementation of RETs within the hotel sector. A start has been made to reform the electricity and income tax laws in Barbados. Although such acts have been passed in Parliament but await proclamation (ELPA 2013). There needs to be timely implementation because I believe that further legislative and regulatory experiments are necessary to diffuse RET innovations.

7.3.1.1.1 Feed-in Tariffs/Micro-Fit policies

Feed-in tariffs (FITs) are legislated pricing agreements whereby independent power producers (IPPs) are paid rates that provide profitability for their investment in RET (Mendonca 2007). FITs are appropriate for technologies that remain costly and are the most effective policy incentive to promote rapid deployment of RET innovations in niche markets (Couture 2010; Stokes 2013; Batlle et al. 2011). Traditionally, these policies offer guaranteed connection to the grid, stable long-term purchase agreements, and above-market price payment levels, and enforce a purchase obligation on the utility (Azuela & Barroso 2011). Tailoring policies/ incentives to the technology is a common practice with the development of

101 Experiments were an effective strategy utilized in the European Union’s HOTRES project aimed at systematic application of RETs in the tourism industry of the Mediterranean (Karagiorgas et al. 2006).
successful feed-in tariffs (Couture 2010; Mendonca 2007). FITs are particularly successful at facilitating distributed solar-PV (IEA-RETD 2014). I believe that a FIT can be designed specifically for the hotel industry to incentivize RET development. The major difference to the current RER is that such policies are legislated/government driven and rates vary depending on the technology.

The ELPA (2013) and the RER each have characteristics of traditional FITs. The utility-driven RER offers IPPs a guaranteed rate relative to the avoided costs of fuel for a minimum of ten years for the sale of excess electricity and systems limited at a capacity of 150kW. There is no cap or minimum payment given to IPPs (FTC 2013). The ELPA offers guaranteed inter-connection licenses/power purchase agreements (PPAs) without a predetermined timeline for the contracts. PPAs are arranged between the utility, the Minister of Energy and the Electric Light and Power Committee (ELPA 2013).102 In addition, systems are limited to 100kWp and any larger must be specially negotiated. The terms of both these arrangements do not offer enough incentive to hotels that consume more electricity than they produce and may be a source of confusion. Policy or legislative designs that conflict are potential ineffective (Mallon 2006).

The results indicate that project tendering seems to favor well capitalized players (e.g. Cahill waste-to-energy plant) and contractual negotiations occur between elite actors. Consequently, approvals are at the discretion of regime actors within the government and the utility. Well-designed FITs offer transparent long-term contracts to citizens, investors, businesses (Couture et al. 2010). This mitigates risks because ownership of RETs can be spread among many people and benefits may be perceived as collective/social empowerment. Furthermore, distributed electrical sources allow more than simple substitution of utility technology.

FITs are cost-based payments for generation and are established below the retail price of electricity in much of the world and sometimes below the avoided costs (Couture 2010). High FITs benefit investors but may place a burden on electricity consumers (Klein et al. 2008). There must be efforts to articulate the true costs of the technologies and inform the public. Civil society actors outside of the hotel industry may offer resistance to such a scheme if not aware of the falling costs of technologies. The LCOE in chapter 5 illustrate that many distributed technologies are at the retail price of electricity and in some instances below the price of the variable fuel surcharge. This means that if fixed at the cost of technology, customer-generators can be credited without adverse financial impact on the utility. If a premium is offered above

---

102 This committee consist of the Permanent Secretary in the Ministry, the Chief Conservation Officer, the Chief Electrical Officer, the Chief Town Planner and five other persons (must be qualified in accounts, engineering or law or at the discretion of the Minister).
the cost of grid electricity, RET investment may increase rapidly.\textsuperscript{103} However, it is important to avoid boom and bust cycles of investment with RETs (Mallon 2006). If planned carefully, FITs allow markets to scale and buyers are the sum total of households and businesses within the jurisdiction, thus spreading the risks of such a scheme among many actors (Couture 2010b; Mendonca et al 2010).

The US Virgin Islands (USVI) has recently implemented a national FIT scheme with the aggressive target of 20 percent RET capacity by 2015. It offers a long-term guarantee of payment for no shorter than ten years and no longer than 30 years. These PPAs are set between the utility and the developer. Rates are set by the commission depending on the electricity technology, project size or location of the project. The rates are set at percentage discount to the avoided costs. If these avoided costs change then the FIT rates are liable to be adjusted. Every sixty days is an opportunity for the committee to adjust the tariff (USVI 2014). Three barriers to the Act are that 1) tariffs may not exceed the avoided costs, 2) tariffs may be adjusted at any time for parties within an existing contract, and, 3) the capacity is limited between 10 to 500kWp per RET development. These areas can be perceived as risky for lenders and may not provide enough incentive for development.

The FIT should not be funded through taxes but costs should be recovered by sale to consumers. Mendonca et al. (2010) suggest that FITs should not be based only on the avoided costs. FITs require the design of robust financing mechanisms. Design of such a hotel or tourism specific micro-FIT scheme requires further investigation. I believe the FIT for the island should be capped to reduce investor risks and available for generation capacities below 1 MW on a buy all and sell all basis. In developing countries where electricity price increases are politically sensitive, caps are recommended. In some instances a FIT fund may be developed to reduce such risks (Mendonca et al. 2010). However, creating such a fund may be problematic given the public debt in Barbados and will require supranational assistance (Stoke 2013). Furthermore, since the government is a significant owner of hotels, then financing through the government has the potential to cause political backlash. Moreover, it requires a greater reliance on the regulatory body (FTC) for administering contracts, enabling fair prices, and revisions to caps. Table 7-2 illustrates some of the advantages and disadvantages of FITs implementation.

\footnote{103 Known as front loading (Couture 2010).}
<table>
<thead>
<tr>
<th>Barriers addressed</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Institutional: (transparency)</td>
<td>• Influences rapid RET deployment.</td>
<td>• Can be complex</td>
</tr>
<tr>
<td>• Market (structural)</td>
<td>• based on technology type</td>
<td>• Consistent monitoring and adjustment when prices are fixed.</td>
</tr>
<tr>
<td>• Technical (climatic)</td>
<td>• credited for full cost of system</td>
<td>• Risky if funded through government budgets.</td>
</tr>
<tr>
<td>• Economic (fuel)</td>
<td>• legislation offers transparency and perceived level playing field for hotels</td>
<td>• Ancillary adjustments create complexity</td>
</tr>
<tr>
<td></td>
<td>• Scalable to market size.</td>
<td>• Requires significant administrative capacity</td>
</tr>
<tr>
<td></td>
<td>• Caps or floors reduces over or underpayment.</td>
<td>• Costs may increase in the beginning of implementation.</td>
</tr>
<tr>
<td></td>
<td>• Can be based on a premium or fixed</td>
<td>• Price increases are politically sensitive</td>
</tr>
<tr>
<td></td>
<td>• Ancillary adjustments for inflation or create price depression over lifetime.</td>
<td>• Hotel business longevity is uncertain.</td>
</tr>
<tr>
<td></td>
<td>• Tariffs offered can coincide with profile of utility demand.</td>
<td>• Larger hotels may have greater incentive given space.</td>
</tr>
<tr>
<td></td>
<td>• Long-term guaranteed and predictable revenue stream.</td>
<td>• Needs low interest financing to initiate at the hotels.</td>
</tr>
<tr>
<td></td>
<td>• Demonstrates a “collective effort” by the GOB/BL&amp;PC</td>
<td>• Requires significant mobilization and firm political commitments.</td>
</tr>
<tr>
<td></td>
<td>• Creates distributed sources over the island thus mitigating weather issues.</td>
<td>• Threatens Emera /BL&amp;PC market power</td>
</tr>
<tr>
<td></td>
<td>• Technologies with miniscule variable costs such as PV are locked-in.</td>
<td>• Cost of implementing smart metering</td>
</tr>
<tr>
<td></td>
<td>• Can help countries reach targets aggressively</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Rates can be more carefully matched with time of generation i.e. the real value of energy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Can be combined with other policy supports</td>
<td></td>
</tr>
</tbody>
</table>

Table 7-2: The advantages and disadvantages of feed-in tariff implementation

(Source: Couture 2010; Stokes 2013; Mendonca et al. 2010; Azuela & Barraso 2011; Klein et al. 2008).

7.3.1.1.2 Land-use/Environmental Reforms

I believe that reforms to planning legislation are necessary to guide the use of land and water when utilizing RETs. The consequences of environmentally unstable choices must be fully understood (Mallon 2006). I recommend the creation of renewable energy zones to develop an understanding of the transmission costs for further grid development. In coordination with the utility and the Town and Country Planning Department (TCPD), these zones enable anticipatory transmission planning to occur resulting in greater control of grid expansion/inter-connection. Currently in Barbados, the new energy incentives create reactionary transmission planning whereby any additional transmission build-out will occur after the request of IPPs for grid connection (Wu et al. 2006). Although on a small island transmission costs may be limited, anticipatory planning provides a more structured and coordinated platform for grid development. This would require the BL&PC to undertake and disclose the results of a RET grid integration study. Such information should be made publicly available for potential hotels, developers and homeowners to inform their decisions.
<table>
<thead>
<tr>
<th>Barriers addressed</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Knowledge</td>
<td>• Maps provide a better understanding of the islands resources for investors, government and civil society.</td>
<td>• Takes time to implement and catalogue.</td>
</tr>
<tr>
<td>• Technical</td>
<td>• Open access to the information streamlines approval process</td>
<td>• Pointless without methods of enforcement/sanctions.</td>
</tr>
<tr>
<td>• Socio-cultural</td>
<td>• Ideal locations are utilized on one of the most population dense small islands in the world.</td>
<td>• Social and political backlash because people express their rights to use the land.</td>
</tr>
<tr>
<td>• Behavioural</td>
<td>• Hotels in ideal locations are notified of their location relative to zones.</td>
<td>• Long-term goals contend with short-term political cycles.</td>
</tr>
<tr>
<td>• Institutional</td>
<td>• Important to optimize land-use and mitigate any deleterious environmental impacts as the RET industry grows. (W2E).</td>
<td>• Requires technical assistance from overseas.</td>
</tr>
<tr>
<td></td>
<td>• Minimize confrontation between developers and society.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Planning of transmission systems allows control of deployment and efficient access to grid.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Easier for government to implement sustainability goals.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Creates streamlining of approval process</td>
<td></td>
</tr>
</tbody>
</table>

Table 7-3: Advantages and disadvantages of environmental legislation/land use/planning reform.

7.3.1.1.3 Integration of RETs into Building Codes

Legislation to implement RET within the construction standards for new and retrofitted hotels is essential. These codes should include procedures for all stages of building asset lifecycle: design, site development, construction, commissioning, operation and decommissioning. Provisions regulating the construction of buildings are currently being developed and the time taken to implement creates opportunity costs for potential investors/developers. Creating RET standards can create energy awareness within many industries and accelerate procedural processes. Categories of energy use should be catalogued for the different types of accommodation on the island and for the functional zones within the hotels themselves (e.g. restaurants, kitchens, laundry) (Chan 2012). Such an effort requires continued support and resources for initiatives like CHENACT. In addition, new roofs should provide space for solar-PV on south facing roofs.

7.3.1.1.4 Tax Policy Reform: Operational Framework, Added Allowances and Workshops.

Fiscal policy is the most utilized policy instrument of the GOB. I recommend that the Barbados Revenue Authority provide a clear outline of the framework for receiving tax benefits in respect RET implementation. There is also the need to clarify and remove unclear and conflicting provisions within the Income Tax Act (2013) and the Tourism Development Act (2002). Furthermore, workshops and research to gauge public opinion and awareness of these policies and framework is necessary. In addition, taxing for externalities such as utility/hotel emissions, and solid waste can be met with resistance from all actors within a society. Nevertheless, I believe there must be reconsideration and expansion of the green concessions given for international environmental certifications and energy management strategies. Tourists entering the country may pay an eco-fee used to pool resources dedicated to renewable energy
deployment within the hotels. This requires the coordination of many actors throughout the tourism commodity chain: tour operators, travel agents and the marketing agencies of Barbados and the Caribbean.

<table>
<thead>
<tr>
<th>Barriers addressed</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Economic&lt;br&gt;• Institutional&lt;br&gt;• Market&lt;br&gt;• Knowledge</td>
<td>• Businesses and Investors are provided with transparency on investments if they understand the clear mechanisms for tax revenue.&lt;br&gt;• Increases the regime’s legitimacy.</td>
<td>• Introduces political risks for regime actors&lt;br&gt;• Inherent opposition based on cultural understanding/emotion&lt;br&gt;• Market and civil society interests cannot all be met&lt;br&gt;• If unsuccessful lowers moral.&lt;br&gt;• Must be clearly outlined and requires technical expertise/capacity.&lt;br&gt;• May be short term (4-5 years) versus long term lifespan of technology.</td>
</tr>
</tbody>
</table>

Table 7-4: Advantages and disadvantages of creating transparent tax framework and workshops.

7.3.1.2 Information Portals and Awareness Campaign

There is the need for clear information exchange on energy efficient products and renewable energy technologies. There is the need to develop benchmarks of quality assurance and open enforcement of standards. The development of non-profit organizations geared towards informing customers of their options may help the island and the region develop a market for energy. It also acts as a deterrent to bad business practice and develops standards through the market.

7.3.2 Financial Institutions

Financial institutions can assist the deployment of RETs within the hotels by providing low interest loans for the purchase of equipment. As seen in the results chapter, the interest rate allocated to a loan (i.e. the weighted cost of capital) significantly impacts the costs of energy systems. There is a need for well-informed and effective collaboration between banks, government, and insurance industry to determine financial instruments for “green financing”. This process must include capacity building and awareness campaigns since these institutions extend to all areas of society.

7.3.3 Utility Recommendations

There are a few opportunities for the utility to assist in niche development within the hotel industry.

7.3.3.1 Grid Penetration Study and Storage Options for RETs

The issue of major national concern is addressing the true grid penetration. The BL&PC recommended 10 percent of total peak and this was accepted by the regulators without a study (Rogers 2013). The consultation for the SEFB suggested this as a conservative measure and it is built into the
island’s targets for RET deployment (Castalia 2010a). In addition, investigation of storage options for RET electricity may mitigate concerns.

### 7.3.3.2 Extend the Time of Use and Interruptible Service Rider Programs to Hotels

There are opportunities for BL&PC to utilize the hotel industry to foster RET deployment. In Jamaica, Grand Palladium Resort and Spa inaugurated a 1.6 MW solar system with a blocking system for on-site use of energy (Peschel 2014). The hotels that can utilize such blocking systems may benefit from interruptible service tariffs available to industrial actors. This is only if storage is utilized or hybrid systems. A more reasonable option is for the utility to offer hotels time-of-use (TOU) rates and assist in the shifting of the peak (e.g. laundry services can be undertaken at night).

### 7.3.3.3 Avoid Hydrocarbon Lock-In of Electricity Infrastructure

Combined cycle gas turbines (CCGTs) supplied by natural gas are cheaper and more efficient than the current diesel and heavy fuel oil based generation in Barbados. Nevertheless, the utility should reconsider a heavy reliance on natural gas for their twenty year plan since the uncertainty of natural gas supply is a risk for Barbados. If climate change is on the agenda then we must prioritize RETs not only at the distributed scale but also for baseload capacity such as OTEC (HSAC 2013). Natural gas is a short-term solution that reduces the costs of generation and may offer an interim solution to high energy (incremental reasoning). I believe that the timing now is perfect given the decommissioning of much of the utility scale electrical plant. It is better to avoid fossil fuel lock-in than to prolong commitment to hydrocarbon-based infrastructure. Such a strategy is short-term and driven from the least-cost argument. Policy makers must consider the fact that the cost of RETs are constantly falling, especially for solar-PV (IEA-RETD 2014; Channell et al. 2013). According to the Carbon War Room (2014), when driving towards a RET transition, natural gas should only play a supporting role to RETs.

### 7.3.3.4 On-bill Financing

In light of the development of Emera Caribbean Renewable Ltd, the opportunity may exist for the utility to provide on-billing financing. This model of renewable energy procurement entails the utility providing the upfront capital for a system and installing it on the hotels. The systems will then be repaid with a surcharge (including interest payments) in the hotel’s regular utility bill over the repayment period (Johnson et al. 2011). This option allows the utility to maintain control of the expansion of renewables, making it easy to coordinate since the utilities have access to low-risk financing (IEA-RETD 2013). Transparency of the pricing mechanism may be a potential concern. Johnson et al. (2011) explain that Hawaii’s utility experimented with this model for residential solar water heaters; however, they caution
that such programs should focus on RETs with short payback periods (<12 years) for non-residential customers (Johnson et al 2011; HBCEF 2013).

<table>
<thead>
<tr>
<th>Barriers addressed</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Market</td>
<td>• BL&amp;PC maintains power/control over generation, distribution, transmission.</td>
<td>• It must be limited to 10-12 years</td>
</tr>
<tr>
<td>• Economic</td>
<td>• Can be built into the IRP</td>
<td>• Can be complicated if the utility methodology for billing changes.</td>
</tr>
<tr>
<td>• Knowledge</td>
<td>• Develops technical acumen within the utility’s workforce. Labor exported to other islands owned by Barbados Light and Power Holdings.</td>
<td>• Requires significant input from regulator to ensure transparency of tariffs.</td>
</tr>
<tr>
<td></td>
<td>• May speed up the process and ensure quality interconnection not compromising the grid.</td>
<td>• Hotels must have be in good financial standing.</td>
</tr>
<tr>
<td></td>
<td>• Incremental response</td>
<td>• Risk of disconnection may deter hotel industry dependent on electrical service to customers.</td>
</tr>
<tr>
<td></td>
<td>• No upfront costs, cost savings and secure repayment of loan via utility bill.</td>
<td>• May require mandating by the government.</td>
</tr>
<tr>
<td></td>
<td>• The liability can be transferred to if ownership changes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Incentivize for energy efficiency at the hotels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Strengthens relationships between banks, utility and hotels.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Creates room for coordinated energy monitoring.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The cost of electricity to the hotel falls if fuel surcharge fall with additional capacity.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Can be combined with grants created for the hotel industry</td>
<td></td>
</tr>
</tbody>
</table>

Table 7-5: Advantages and disadvantages of on-bill financing for hotels in Barbados.

7.3.3.5 Wheeling

Since aesthetics is a concern, there may be opportunity on islands for hotel groups or partnerships to develop RET sites away from the hotels. This type of experiment requires the regulator to allow wheeling of electricity whereby energy generated by a hotel owned RET site is sent to the hotel via the utility’s transmission and distribution networks.\(^\text{104}\) Currently, the BL&PC is the sole entity in charge of distribution and transmission on the island. A wheeling scenario will not challenge the role of the BL&PC but will require that the electricity produced is only used by hotels involved in the RET development. Potential challenges may arise with land acquisition and transparency of transmission costs. In Mexico, private developers of RETs found it difficult to estimate the wheeling transmission fees. The solution was for the utility to establish a wheeling tariff-based on the variable costs of transmission lines (CCAP 2011). Another challenge is the regulatory framework identifying which entities in a hotel resort chain can receive

\(^{104}\) Wheeling is the moving of electricity from one utility or system to another; wheeling occurs usually when there are independent generators needing to exchange energy to meet the demand of either side.
energy if registered as separate business (Makhijani et al. 2013). This option requires significant coordination, but has been considered in Jamaica where large commercial business operators have expressed interests (Makhijani et al. 2013). Wheeling is beneficial if the national vision is to displace fossil fuel and can offer a level of market control to established regime actors. It provides the utility with incremental control over the grid and power relative to new market entrants (i.e. IPPs).

<table>
<thead>
<tr>
<th>Barriers addressed</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Market entry</td>
<td>• Hotels use properties away from the hotel to mitigate aesthetic concerns.</td>
<td>• Requires significant regulatory and technical monitoring/reform</td>
</tr>
<tr>
<td>• Economic</td>
<td>• Hotel can more clearly estimate costs once monitoring begins.</td>
<td>• Transparency of costs is questionable.</td>
</tr>
<tr>
<td>• Behavioural</td>
<td>• Reduction in peak capacity for the utility</td>
<td>• May create land acquisition issues.</td>
</tr>
<tr>
<td></td>
<td>• Utility still maintains control</td>
<td>• This is a potentially risky endeavor that may only be achievable in large partnerships of hotels.</td>
</tr>
<tr>
<td></td>
<td>• Hotel group or hotel is developer and utility does not need to invest in new plant.</td>
<td>• Costs may fall indirectly on local residents if utility pressured to make profits.</td>
</tr>
<tr>
<td></td>
<td>• Utility controlled niche development</td>
<td></td>
</tr>
</tbody>
</table>

Table 7-6: The advantages and disadvantages of hotels wheeling electricity via utility infrastructure.

7.3.4 Hotel Recommendations

Photovoltaics, solar water heating and small wind turbines are distributed scale technologies beneficial to hotels. There is potential for further penetration of these technologies into the hotel industry. I recommend that the energy benchmarking initiated with the CHENACT project be continued and energy management systems utilized to carefully monitor energy use. A greater focus on carbon dioxide reduction as a driver for hotel energy transitions may be a potential benefit (Tsoutsos et al. 2013)

Energy is not the only way to increase competitiveness within the hotel industry. Capacity building within the hotel industry is essential and hotel sponsored awareness campaigns/training must continue after the CHENACT experiment. Changing employee behavior and tourist behaviours is necessary. Workshops will increase awareness of resource consumption. Social learning campaigns must not discredit local knowledge and room made for community planning. Technical support is provided by the IDB to assist with regional integration and goal development within the private sector. However, such initiatives require coordination and exposure across many levels. There is no one solution.

7.3.4.1 Community/Employee Coownership Models

One potential experiment for the hotel industry is to offer surrounding communities or employees the opportunity to own the technology at the hotels. In my results, collective action was considered essential to mitigate climate change/deploy energy solutions. The aim of community-based models is to “create partnership networks for collective action among the different stakeholders” (Wen Li et al.
Creation of such a model requires research in the form of stakeholder analysis. These models of ownership can be arranged to have different legal and financial arrangements (Walker 2008). These models may be in the form of cooperatives, community charities, development trusts, or in the form of shares owned by local community organization (Walker 2008; Hicks & Ison 2011). Such an endeavor requires further research to qualify community or employee acceptance and mitigate buy-in skepticism.

Governance activities based at the community scale may initiate larger policy instruments (Truffer and Coenen 2012). Legal arrangements and reform may be necessary before such a novel approach is deployed. The cost and willingness to buy into such a partnership must be assessed before such a model is mobilized. Most cases observed have occurred in more developed European countries (Walker 2008; Loring 2007). The size of credit provided and the size of the system determines how much wealth is to be shared.

<table>
<thead>
<tr>
<th>Barriers addressed</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institutional</td>
<td>Usually observed in rural communities. As such, East coast hotels may consider this option.</td>
<td>Share ownership only benefits willing investors</td>
</tr>
<tr>
<td>Market</td>
<td>Local income provided directly to communities/employees</td>
<td>Complex legal conditions for operation</td>
</tr>
<tr>
<td>Economic</td>
<td>Gives individuals a stake in the two industries and development.</td>
<td>May disrupt power of regime actors.</td>
</tr>
<tr>
<td>Knowledge</td>
<td>Helps mitigate loss of income during hotel off-season.</td>
<td>Novel to the island and may require refinement/research, culturally sensitive issue.</td>
</tr>
<tr>
<td></td>
<td>Bottom up approach with decentralized energy production provides empowerment to locals.</td>
<td>Dependent on good relationships between the utility/hotel/locals or employees.</td>
</tr>
<tr>
<td></td>
<td>Increases tax benefits, and eligibility for international certification.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Projects may be more readily accepted by adjacent communities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The model may be transplanted to other societal activities. E.g. schools.</td>
<td></td>
</tr>
</tbody>
</table>

Table 7-7: Advantages and disadvantages of community/employee co-ownership of technology at hotels. (Berry 2013; Hicks & Ison 2011; Walker 2008)

7.3.4.2 Tourist owned energy and development of a Hotel Sector Renewable Energy Fund.

An option that needs further investigation is allowing tourists the opportunity to buy time shares at hotels conditional upon contribution to a renewable energy fund. The client is offered the right to use a property at a lower rate than the standard hotel visitors for a set time period over the years. Money obtained from these foreign investors then is pooled and reinvested into the hotel sector or the community for RET projects that are on-grid or off-grid. This may be a viable opportunity for organizations like the Barbados Hotel and Tourism Association (BHTA) to market the industry as a green destination. BDS$100 million in branding is already spent annually (GOB 2012).
Reinvestment into the community can help members of the society bare the cost of renewable energy systems. It also guarantees continued visitation by environmentally minded tourists. Foreign exchange is therefore directed towards projects that reduce expenditure on fossil-fuel import.

Such an endeavor requires significant coordination and needs technical and legal assistance to develop. There must be transparency with such a scheme and further researcher into the potential for buy-in is required.

7.3.4.3 Collaboration with University of West Indies and Global Research Initiatives

The increased global attention to renewable energy has created the space for further research. The hotel industry may benefit from collaboration between the educational institutions on the island and the hotel properties. Experiments with RET installation on hotel sites may be beneficial to developing awareness, skills, and new community based models of tourism. In addition, offering the sites as “laboratories” for new innovations may attract international investment and attention. This option may be considered risky.

7.3.4.4 Energy for Villas and Small Hotels

The results indicated that 51 kW spread amongst four villas was the total installed solar PV capacity at the beginning of 2014. This is a miniscule capacity and most likely established at small properties. The current RER may benefit some of these establishments as illustrated by the LCOE demonstrated in chapter 5. There may be an opportunity to increase the RER tariff allotted to such customers to incentivize interconnection.

7.3.5 Energy Service Companies Business Models

It is also extremely necessary for installers of RET to bring new business models. Such models may help foster green growth beyond the hotel sector (Beltramello et al. 2013). These models must be appropriately suited to the hotel industry’s characteristics.

7.3.5.1 Leasing of Technology

In some instances, hotels may be able to enter a leasing agreement with an ESCO or a bank. The lessor owns the RET asset during the leasing period (IEA-RETD 2013). This method of financing may be complicated, more expensive than a loan and have high operational risks for the lessor (IEA-RETD). The benefit is that hotel can avoid upfront costs and still access capital for other investments (Beleyl & Schinnerl, 2008). However, this practice is not common due to the high level of uncertainty involved.
7.3.5.2 Integrated Energy Contracting

The hotel industry may provide opportunity in future for ESCOs using Integrated Energy Contracting (IEC) models with long term contracts. Owners of hotels may outsource the economic risks of the upfront costs including the cost of operation and maintenance. These models are performance based over the life-cycle of the technology (IEA-RETD 2013). This is an opportunity to combine energy efficiency and energy production. The ESCO is remunerated based on the useful energy output delivered to the customer. To increase profit these companies may include energy efficiency measures in the contract (IEA_RETD 2013). These companies must require adequate resources to mitigate their risk. If strictly focused on energy efficiency the company may take on the initial risks of converting equipment (IERTD 2013; Hansen 2006). The leverage offered to hotels is that they continue to pay a baseline rate for electricity and the ESCO bares the upfront cost of RET or EE. Thus, over the length of the contract (e.g. ten years) the EPC is paid leaving the hotel with a technology that continues to save energy in the future beyond that contracted period. As seen in chapter 5, most large systems take 6 to 8 years to pay for themselves given the three scenarios of electricity price escalation.

<table>
<thead>
<tr>
<th>Barriers addressed</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>No upfront cost to the hotel and risks are outsourced.</td>
<td>Contracts are lengthy and complex</td>
</tr>
<tr>
<td></td>
<td>Hotels already benefit with the import of equipment so reduced costs of service.</td>
<td>Focuses on larger projects to make a return so small hotels may not benefit as much.</td>
</tr>
<tr>
<td></td>
<td>Payments for energy are based on performance therefore it is an added incentive to ensure efficiency to RET deployment.</td>
<td>The operational budget of the hotels. Thus successful hotels may be more inclined to enter.</td>
</tr>
<tr>
<td></td>
<td>Creates energy awareness</td>
<td>Requires significant training of staff.</td>
</tr>
<tr>
<td></td>
<td>Large projects are necessary for business to make sustained returns. Larger hotels are ideal.</td>
<td>Willingness of hoteliers to enter into long term contracts with new company.</td>
</tr>
<tr>
<td></td>
<td>Market-based initiative requires little policy involvement; however, the benefits awarded to registered hotels assist in sourcing equipment.</td>
<td></td>
</tr>
</tbody>
</table>

Table 7-8: Advantages and disadvantages of integrated energy contracting for deploying RET in hotels (IEA-RETD 2013; Hansen et al. 2009).

7.4 Limitations and Future Research

Throughout the course of this study, a number of limitations to my research became apparent. These include, but are not limited to:

1. The methodology may increase rigor by using a broader range of hotel operators/corporate owners. In addition, a follow-up with respondents would be beneficial by showing how perspectives have changed. There needs to be a longitudinal approach to hotel sector since economic recession and implementation of RET legislation.
2. Transition Management can be used only as a heuristic device to explain processes that occur over generations.

3. The study was limited by the availability of information and the limited access to information. Especially with regards to hotel quantitative data (business reports) and use of governmental information.

4. The levelized cost of data could be improved by statistical analysis of a wider quantity of locally sourced costs inputs. This information was limited since renewable energy beyond solar water heating is new to the island. Start-up companies and those with traction in the market were concerned with sharing of cost data.

Additionally, there are many potential areas for future research based on sustainability transitions in Small Island Developing States, which range from the technical to the theoretical.

1. The motivations voiced for energy transitions in Barbados are based on fuel scarcity. Research into opinions of climate change and climate focused incentives could be beneficial to policy makers and hotels.

2. Further qualitative and quantitative research on the awareness of water/energy/food nexus within the hotel sector and residential sector.

3. Research quantifying the potential rooftop space available for the islands building stock using Geographical Information Systems.

4. Research to determine the rate of RET growth and whether financing can be maintained or be coordinated with this growth i.e. controlled growth.

5. Further econometric modelling for the development of tax regimes and the incorporation of environmental externalities.

6. Research focused on the creation of hybrid renewable energy systems and micro-grids.

7. Future research must consider the perspectives on energy transitions of a larger number of hotel actors to include owners, developers, trade associations, employees. Appropriate visions of these individual actors may assist with the development of more cohesive hotel energy policy.

8. Need for economic analysis/modelling of how the hotel sector and other economic sectors can respond to electricity prices/ incentives.

9. Research into the willingness of tourists to pay eco-fees for renewable energy in Caribbean hotels. A study focused on the Greek islands found that tourists from countries with high energy awareness were more likely to comply. The tourists not willing to pay were of the belief that energy practices should be already implemented and used anyway (Tsagarakis et al 2011).
7.5 Conclusion

In conclusion, the multi-level perspective (MLP) used in Transition Management demonstrates the role of geopolitics and scale in the diffusion of innovation. Barbados has set targets at a national scale that provide access to international assistance. The island is perceived to be more susceptible to large sudden shocks. Due to limited internal resources, the coordination and recovery to shocks is difficult. Knowledge and capacity building are essential to the development of the RET market. This must be done in a way to balance the interest of the established utility in their roles of transmission and distribution. Distributed generation with Independent Power Producers offers ways to reduce fuel imports and conserve foreign reserves.

RET transitions are met with many barriers despite levelized costs that are below grid parity for most RETs. It is essential that Barbados avoid carbon lock-in by not mobilizing resources towards fossil fuel based infrastructure. Deployment of RETs in the hotel sector requires new models of financing to mitigate the perceived risk of investment. These approaches can be market-led, community-led or government-led. Structural changes are necessary for policy makers to achieve the collective targets for RET capacity and to revitalize a struggling hotel industry. The effectiveness of these solutions is dependent on the mitigation of institutional, economic, market, technical, and socio-cultural/behavioural barriers.
8 Appendixes

8.1 Appendix A: Utility Information

<table>
<thead>
<tr>
<th>Category</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apartments</td>
<td>Large residences, apartments for locals, and landlord panels</td>
</tr>
<tr>
<td>Businesses</td>
<td>Barbados water authority, desalination plants, sewage pumps, pumping stations, reservoirs</td>
</tr>
<tr>
<td>Reservoirs</td>
<td>Gas stations, department stores, oil companies, retail businesses, hairdressers, pharmacies, cars and car parts, markets, hardware, warehouses,</td>
</tr>
<tr>
<td>Commercial</td>
<td>Video Rentals, nightclubs, cinemas, racing services, art galleries, local restaurants, bars, and taverns, swimming pools, gymnasiums, stadium, sports clubs, lottery</td>
</tr>
<tr>
<td>Hospitals</td>
<td>Tailors, textiles, draperies, upholstery Mattresses, Dressmakers, wood products and furniture, confectionary, meat produce, bakery and flour, diary and juice products, beverages, sugar factories, printing, recording, pharmaceuticals, cosmetics, metal products, water heaters, metal windows, electronics, plastic and fiberglass, cement, clay tiles, chemicals, BNOC, plants, cartons and packaging paper, recycling, flour milling, craft and pottery, ice production, animal feed, ware houses, agriculture, sugar factories, irrigation.</td>
</tr>
<tr>
<td>Industry</td>
<td>Sea Port and airport</td>
</tr>
<tr>
<td>Services</td>
<td>Utilities (except BWA, electric, telephone, gas), radio station, taxi services, property management, travel agents, advertising agencies, architects, airlines, accountants, lawyers, design engineers, secretarial, software/electrical services, refrigerators, advertising, conference centres, construction, laundry services, sanitation services, cleaning services, transport security, car rentals, equipment, catering, funeral homes and workshops</td>
</tr>
<tr>
<td>Tourism</td>
<td>Restaurants (tourist areas, directly associated with hotels, etc.), full service hotels, apartment hotels, guest houses, tourist attractions, villas and condominiums, water pumps and sanitation, sewage treatment services, other breakwater pumps</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>Schools, street lamps, traffic lights, churches, charities, missions, government ministries, clubs, associations, embassies and high commissions, post offices, nursing homes, children homes, agricultural services stations, fire stations, police stations, sewage pumps, water pumps (at schools, etc.)</td>
</tr>
</tbody>
</table>

Table 8-1: Breakdown of economic sector categories used to demonstrate electricity demand (Source: BL&PC 2014).
Note on the calculation of the Fuel Clause Adjustment (FCA)

The FCA can be given with the following equation (FTC 2013b):

\[ FCA_n = \frac{\text{FuelCost}_{n-1}}{\text{Energy Generation}_{n-1} \cdot (1 - \text{Aux}_{n-1}) \cdot (1 - \text{losses})} \, \text{BDS/kWh} \]

\( FCA_n \) = fuel cost adjustment for month \( n \). This includes any under or over recovery from the previous month. This refers to the expected fuel used minus the actual fuel used for current month

\( \text{Fuel Cost}_{n-1} \) = Fuel cost for month before \( n \).

\( \text{Energy Generation}_{n-1} \) = previous month’s energy generation

\( 1 - \text{Aux}_{n-1} \) = auxiliary consumption as a percentage of total generation refers to “the quantum of energy consumed by auxiliary equipment of the generation unit/s and transformer losses within the generating station, expressed as a percentage of gross energy generated” (FTC 2013b: 19)

This method of calculating was approved the 11\(^{th}\) of October 2013 however the method for calculation used to be based on the projected costs of fuel to the utility:

\[
\frac{\text{Projected Cost of Fuel} + \text{or } - \text{previous month’s under or over recovery}}{\text{Projected sales kWh}}
\]

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>$0.135406</td>
<td>$0.290777</td>
<td>$0.336561</td>
<td>$0.337912</td>
<td>$0.405668</td>
</tr>
<tr>
<td>February</td>
<td>$0.161709</td>
<td>$0.290777</td>
<td>$0.357891</td>
<td>$0.439711</td>
<td>$0.431478</td>
</tr>
<tr>
<td>March</td>
<td>$0.172685</td>
<td>$0.319299</td>
<td>$0.394738</td>
<td>$0.467002</td>
<td>$0.439379</td>
</tr>
<tr>
<td>April</td>
<td>$0.158099</td>
<td>$0.424633</td>
<td>$0.453870</td>
<td>$0.493526</td>
<td>$0.434315</td>
</tr>
<tr>
<td>May</td>
<td>$0.184356</td>
<td>$0.336871</td>
<td>$0.484401</td>
<td>$0.476181</td>
<td>$0.415305</td>
</tr>
<tr>
<td>June</td>
<td>$0.223399</td>
<td>$0.322438</td>
<td>$0.473105</td>
<td>$0.430266</td>
<td>$0.412246</td>
</tr>
<tr>
<td>July</td>
<td>$0.249719</td>
<td>$0.307056</td>
<td>$0.471443</td>
<td>$0.402808</td>
<td>$0.398415</td>
</tr>
<tr>
<td>August</td>
<td>$0.268980</td>
<td>$0.291349</td>
<td>$0.431732</td>
<td>$0.413764</td>
<td>$0.417291</td>
</tr>
<tr>
<td>September</td>
<td>$0.269048</td>
<td>$0.309430</td>
<td>$0.447178</td>
<td>$0.410961</td>
<td>$0.401498</td>
</tr>
<tr>
<td>October</td>
<td>$0.270151</td>
<td>$0.319795</td>
<td>$0.429438</td>
<td>$0.413151</td>
<td>$0.411980</td>
</tr>
<tr>
<td>November</td>
<td>$0.274151</td>
<td>$0.336020</td>
<td>$0.458392</td>
<td>$0.429585</td>
<td>$0.416705</td>
</tr>
<tr>
<td>December</td>
<td>$0.271449</td>
<td>$0.337912</td>
<td>$0.458823</td>
<td>$0.439224</td>
<td>$0.390698</td>
</tr>
</tbody>
</table>


(Source: BL&PC 2014; FTC 2014)
### Domestic Service (DS)

<table>
<thead>
<tr>
<th>Tariff</th>
<th>Components</th>
<th>Customer Charge</th>
<th>Demand Charge</th>
<th>Base Energy Charge</th>
<th>Fuel Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Parameter</td>
<td>0-150kWh</td>
<td>151-500kWh</td>
<td>Over 500 kWh</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$6.00</td>
<td>$10.00</td>
<td>---</td>
<td>$0.15</td>
</tr>
<tr>
<td>Monthly Rate ($/kWh)</td>
<td>$6.90</td>
<td>$11.50</td>
<td>$16.10</td>
<td>---</td>
<td>$0.17</td>
</tr>
<tr>
<td>rates monthly (VAT Included)</td>
<td>$6.90</td>
<td>$11.50</td>
<td>$16.10</td>
<td>---</td>
<td>$0.17</td>
</tr>
</tbody>
</table>

### General Service (GS)

<table>
<thead>
<tr>
<th>Tariff</th>
<th>Components</th>
<th>Customer Charge</th>
<th>Demand Charge</th>
<th>Base Energy Charge</th>
<th>Fuel Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Parameter</td>
<td>0-100kWh Wh</td>
<td>101-500kWh Wh</td>
<td>Over 500 kWh</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$8.00</td>
<td>$11.00</td>
<td>---</td>
<td>$0.18</td>
</tr>
<tr>
<td>Monthly Rate ($/kWh)</td>
<td>$9.20</td>
<td>$12.65</td>
<td>$16.10</td>
<td>---</td>
<td>$0.21</td>
</tr>
<tr>
<td>rates monthly (VAT Included)</td>
<td>$9.20</td>
<td>$12.65</td>
<td>$16.10</td>
<td>---</td>
<td>$0.21</td>
</tr>
</tbody>
</table>

### Secondary Voltage Power (SVP)

<table>
<thead>
<tr>
<th>Tariff</th>
<th>Components</th>
<th>Customer Charge</th>
<th>Demand Charge</th>
<th>Base Energy Charge</th>
<th>Fuel Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Parameter</td>
<td>each service</td>
<td>per kVA</td>
<td>All kWh/kWh</td>
<td>All kWh / kWh</td>
</tr>
<tr>
<td>Monthly Rate ($/kWh)</td>
<td>$20.00</td>
<td>$24.00</td>
<td>$0.14</td>
<td>FCA</td>
<td></td>
</tr>
<tr>
<td>rates monthly (VAT Included)</td>
<td>$23.00</td>
<td>$27.60</td>
<td>$0.16</td>
<td>FCA x 1.15</td>
<td></td>
</tr>
</tbody>
</table>

### Large Power (LP)

<table>
<thead>
<tr>
<th>Tariff</th>
<th>Components</th>
<th>Customer Charge</th>
<th>Demand Charge</th>
<th>Base Energy Charge</th>
<th>Fuel Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Parameter</td>
<td>each service</td>
<td>per kVA</td>
<td>All kWh/kWh</td>
<td>All kWh / kWh</td>
</tr>
<tr>
<td>Monthly Rate ($/kWh)</td>
<td>$300.00</td>
<td>$22.00</td>
<td>$0.12</td>
<td>FCA</td>
<td></td>
</tr>
<tr>
<td>rates monthly (VAT Included)</td>
<td>$345.00</td>
<td>$25.30</td>
<td>$0.13</td>
<td>FCA x 1.15</td>
<td></td>
</tr>
<tr>
<td>Tariff</td>
<td>Time of Use (TOU)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>components</td>
<td>Customer Charge</td>
<td>Demand Charge</td>
<td>Base Charge</td>
<td>Fuel Charge</td>
<td></td>
</tr>
<tr>
<td>parameter</td>
<td>Each service</td>
<td>Per kVA</td>
<td>All kWh/kWh</td>
<td>All kWh/kWh</td>
<td></td>
</tr>
<tr>
<td>Monthly Rate ($/kWh)</td>
<td>$300</td>
<td>$18.00</td>
<td>$0.2190 off peak</td>
<td>$0.044 off peak</td>
<td>FCA</td>
</tr>
<tr>
<td>rates monthly (VAT Included)</td>
<td>$345</td>
<td>$20.70</td>
<td>$.25185 on peak</td>
<td>$.0506 off peak</td>
<td>FCA* 1.12 on peak</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tariff</th>
<th>Interruptible Service Rider (ISR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>components</td>
<td>Operated in conjunction with normal rate</td>
</tr>
<tr>
<td>parameter</td>
<td>Between 8 a.m. - 9 p.m.</td>
</tr>
<tr>
<td>rates monthly (VAT Included)</td>
<td>$12 / kVA MID</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tariff</th>
<th>Renewable Energy Rider</th>
</tr>
</thead>
<tbody>
<tr>
<td>components</td>
<td>reimbursement</td>
</tr>
<tr>
<td>parameter</td>
<td>Up to 1.5 current usage.</td>
</tr>
<tr>
<td>Monthly Rate ($/kWh)</td>
<td>1.6*FCA</td>
</tr>
</tbody>
</table>

Table 8-3: Electricity tariffs available in Barbados and incentives.  
(Source: BL&PC 2014)
8.2 Appendix B: Methods Materials

Sample Interview Questions:

Has government provided incentives for your renewable systems?
What are the operating and maintenance costs of a PV system?
How long of a payback do you require?
What could you identify as the benefits of the tourism industry?
Are there any incentives that may be given to the hotel industry to reduce demand or generate energy?
What do guest have to say about renewable energy?
Are there any operations that you shift to nighttime?
Are any renewable energy policies legislated?
Are there community incentives for ownership of renewable energy projects?
Are there mechanisms within the hotel rooms to conserve energy?
What are some of the planning issues with renewables in Barbados?
Are you aware of building regulations for energy management in hotels?
Are you aware of the term Anthropogenic Global Warming?
Are you aware of the term peak oil?
How the hotel industry does influences energy policy?
Can the pricing be increased for the Renewable Energy Rider?
Could you describe the collaboration between the private sector, the ministry of tourism and ministry of energy?
Could you explain Barbados’s electricity rates structure?
Could you explain how the recent electricity rate increase affects the hotel industry?
Could you explain the sustainable energy framework?
Could you explain the role of the bank with regards to renewables?
Who are the decision makers that would influence the deployment of RETs in the hotel sector?
Could you identify the main decision makers on the island with regards to energy policy?
Do you feel much is done to implement strategies for climate change?
What is your opinion of public participation and policy collaboration?
Could you give me a brief history of the development of the CHENACT initiative?
What is your opinion of the FIT-Rider or pilot?
Could you identify which RE sources would be most applicable to Barbados?
Could you see renewable energy playing a role with dealing with economic shocks to the economy?
Could you walk me through the process of setting up RET as an hotelier?
Did the IADB provide funding for alternative energy?
Do energy policies or provisions cover all stages of the Renewable Energy Lifecycle from research and development through demonstration and commercialization?
Do hotels peak shift without incentives?
Do you see an interest of local involvement with regards to renewable energy?
Do you see Barbados undertaking any taxes, carbon or environmental?
Do you see the potential for the BL&P to diversify its generation mix further?
Do you see the potential for the hotel industry to adopt renewables at a more rapid pace?
Do you think Barbados will deregulate the electricity market?
### 8.3 Appendix C: Economic Calculation Materials

<table>
<thead>
<tr>
<th>WACC</th>
<th>0.01</th>
<th>0.02</th>
<th>0.03</th>
<th>0.04</th>
<th>0.05</th>
<th>0.06</th>
<th>0.07</th>
<th>0.08</th>
<th>0.09</th>
<th>0.1</th>
<th>0.11</th>
<th>0.12</th>
<th>0.13</th>
<th>0.14</th>
<th>0.15</th>
</tr>
</thead>
<tbody>
<tr>
<td>5kWp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 years</td>
<td>$0.32</td>
<td>$0.34</td>
<td>$0.37</td>
<td>$0.40</td>
<td>$0.43</td>
<td>$0.46</td>
<td>$0.49</td>
<td>$0.52</td>
<td>$0.56</td>
<td>$0.63</td>
<td>$0.67</td>
<td>$0.71</td>
<td>$0.75</td>
<td>$0.78</td>
<td></td>
</tr>
<tr>
<td>25 years</td>
<td>$0.28</td>
<td>$0.30</td>
<td>$0.33</td>
<td>$0.36</td>
<td>$0.40</td>
<td>$0.43</td>
<td>$0.46</td>
<td>$0.50</td>
<td>$0.54</td>
<td>$0.58</td>
<td>$0.62</td>
<td>$0.66</td>
<td>$0.70</td>
<td>$0.74</td>
<td>$0.78</td>
</tr>
<tr>
<td>30 years</td>
<td>$0.25</td>
<td>$0.28</td>
<td>$0.31</td>
<td>$0.34</td>
<td>$0.38</td>
<td>$0.41</td>
<td>$0.45</td>
<td>$0.49</td>
<td>$0.53</td>
<td>$0.57</td>
<td>$0.61</td>
<td>$0.66</td>
<td>$0.70</td>
<td>$0.75</td>
<td>$0.79</td>
</tr>
<tr>
<td>55kWp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 years</td>
<td>$0.29</td>
<td>$0.31</td>
<td>$0.33</td>
<td>$0.36</td>
<td>$0.39</td>
<td>$0.42</td>
<td>$0.44</td>
<td>$0.47</td>
<td>$0.51</td>
<td>$0.54</td>
<td>$0.57</td>
<td>$0.61</td>
<td>$0.64</td>
<td>$0.67</td>
<td>$0.71</td>
</tr>
<tr>
<td>25 years</td>
<td>$0.25</td>
<td>$0.28</td>
<td>$0.30</td>
<td>$0.33</td>
<td>$0.36</td>
<td>$0.39</td>
<td>$0.42</td>
<td>$0.45</td>
<td>$0.49</td>
<td>$0.52</td>
<td>$0.56</td>
<td>$0.60</td>
<td>$0.63</td>
<td>$0.67</td>
<td>$0.71</td>
</tr>
<tr>
<td>30 years</td>
<td>$0.23</td>
<td>$0.25</td>
<td>$0.28</td>
<td>$0.31</td>
<td>$0.34</td>
<td>$0.37</td>
<td>$0.41</td>
<td>$0.44</td>
<td>$0.48</td>
<td>$0.52</td>
<td>$0.56</td>
<td>$0.60</td>
<td>$0.63</td>
<td>$0.67</td>
<td>$0.71</td>
</tr>
<tr>
<td>75kWp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 years</td>
<td>$0.28</td>
<td>$0.30</td>
<td>$0.33</td>
<td>$0.35</td>
<td>$0.38</td>
<td>$0.41</td>
<td>$0.44</td>
<td>$0.47</td>
<td>$0.50</td>
<td>$0.53</td>
<td>$0.56</td>
<td>$0.60</td>
<td>$0.63</td>
<td>$0.66</td>
<td>$0.70</td>
</tr>
<tr>
<td>25 years</td>
<td>$0.25</td>
<td>$0.27</td>
<td>$0.30</td>
<td>$0.32</td>
<td>$0.35</td>
<td>$0.38</td>
<td>$0.41</td>
<td>$0.45</td>
<td>$0.48</td>
<td>$0.51</td>
<td>$0.55</td>
<td>$0.58</td>
<td>$0.62</td>
<td>$0.66</td>
<td>$0.70</td>
</tr>
<tr>
<td>30 years</td>
<td>$0.23</td>
<td>$0.25</td>
<td>$0.28</td>
<td>$0.31</td>
<td>$0.34</td>
<td>$0.37</td>
<td>$0.40</td>
<td>$0.44</td>
<td>$0.47</td>
<td>$0.51</td>
<td>$0.55</td>
<td>$0.59</td>
<td>$0.62</td>
<td>$0.66</td>
<td>$0.70</td>
</tr>
<tr>
<td>160kWp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 years</td>
<td>$0.27</td>
<td>$0.30</td>
<td>$0.32</td>
<td>$0.34</td>
<td>$0.37</td>
<td>$0.40</td>
<td>$0.43</td>
<td>$0.45</td>
<td>$0.48</td>
<td>$0.51</td>
<td>$0.55</td>
<td>$0.58</td>
<td>$0.61</td>
<td>$0.64</td>
<td>$0.68</td>
</tr>
<tr>
<td>25 years</td>
<td>$0.24</td>
<td>$0.26</td>
<td>$0.29</td>
<td>$0.31</td>
<td>$0.34</td>
<td>$0.37</td>
<td>$0.40</td>
<td>$0.43</td>
<td>$0.47</td>
<td>$0.50</td>
<td>$0.53</td>
<td>$0.57</td>
<td>$0.60</td>
<td>$0.64</td>
<td>$0.68</td>
</tr>
<tr>
<td>30 years</td>
<td>$0.22</td>
<td>$0.24</td>
<td>$0.27</td>
<td>$0.30</td>
<td>$0.33</td>
<td>$0.36</td>
<td>$0.39</td>
<td>$0.42</td>
<td>$0.46</td>
<td>$0.49</td>
<td>$0.53</td>
<td>$0.57</td>
<td>$0.61</td>
<td>$0.64</td>
<td>$0.68</td>
</tr>
</tbody>
</table>

Figure 8-1: LCOE for four photovoltaic systems at different commercial lending rates and lifespans

---

105 Red indicates costs that occur around grid parity for the four PV systems.
<table>
<thead>
<tr>
<th>System Capacity kW dc</th>
<th>5</th>
<th>55</th>
<th>75</th>
<th>160</th>
</tr>
</thead>
<tbody>
<tr>
<td>module size (m²)</td>
<td>1.6335</td>
<td>1.6335</td>
<td>1.6335</td>
<td>1.6335</td>
</tr>
<tr>
<td>number of modules</td>
<td>20</td>
<td>200</td>
<td>280</td>
<td>639</td>
</tr>
<tr>
<td>system area (m²)</td>
<td>32.67</td>
<td>326.70</td>
<td>457.38</td>
<td>1043.81</td>
</tr>
</tbody>
</table>

**SYSTEM LANDED INSTALLED COSTS**

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV Panels (Trina TSM Solar PA05-250)</td>
<td>$9,200</td>
</tr>
<tr>
<td>PV Mounting system</td>
<td>$1,756</td>
</tr>
<tr>
<td>Roof Mounted Cable Tray</td>
<td>$300</td>
</tr>
<tr>
<td>Inverters, Inverter Distribution Panel</td>
<td>$5,800</td>
</tr>
<tr>
<td>Isolators/disconnects, BL&amp;P Metering</td>
<td>$901</td>
</tr>
<tr>
<td>DC Cabling (Inverter to Panel)</td>
<td>$1,350</td>
</tr>
<tr>
<td>AC Cabling: Inverters, Inverter/customer distribution panels transformer</td>
<td>$80</td>
</tr>
<tr>
<td>Telecommunication and monitoring system</td>
<td>$1,890</td>
</tr>
<tr>
<td>Labor for above</td>
<td>$2,640</td>
</tr>
<tr>
<td>Crane Rental</td>
<td>$0</td>
</tr>
<tr>
<td>Total Installed Costs before profit margin</td>
<td>$23,917</td>
</tr>
<tr>
<td>Margin for profit &amp; Indirect Cost Factor</td>
<td>$4,783</td>
</tr>
<tr>
<td>Total Installed Costs after profit margin (B) plus 17.5% Value Added Tax</td>
<td>$33,723</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost Component</th>
<th>Cost (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation and Maintenance Costs at 0.5% of total costs</td>
<td>$968.61</td>
</tr>
<tr>
<td>Insurance Costs at 1% of total installed cost</td>
<td>$337.23</td>
</tr>
<tr>
<td>$/m² installed</td>
<td>$1,032.23</td>
</tr>
<tr>
<td>$/W_{AC} installed</td>
<td>$6.74</td>
</tr>
</tbody>
</table>

Figure 8-2: Sample of the installation costs for four photovoltaic systems in Barbados provided by an installation company.
### PHOTovoltaics

<table>
<thead>
<tr>
<th>WACC</th>
<th>residential (5kW)</th>
<th>Commercial (100kW)</th>
<th>Industrial (500kW)</th>
<th>Utility (25000kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>low</td>
<td>high</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>1%</td>
<td>$0.25</td>
<td>$0.36</td>
<td>$0.27</td>
<td>$0.33</td>
</tr>
<tr>
<td>2%</td>
<td>$0.26</td>
<td>$0.38</td>
<td>$0.29</td>
<td>$0.35</td>
</tr>
<tr>
<td>3%</td>
<td>$0.28</td>
<td>$0.40</td>
<td>$0.31</td>
<td>$0.37</td>
</tr>
<tr>
<td>4%</td>
<td>$0.29</td>
<td>$0.43</td>
<td>$0.32</td>
<td>$0.39</td>
</tr>
<tr>
<td>5%</td>
<td>$0.31</td>
<td>$0.45</td>
<td>$0.34</td>
<td>$0.41</td>
</tr>
<tr>
<td>6%</td>
<td>$0.33</td>
<td>$0.48</td>
<td>$0.36</td>
<td>$0.44</td>
</tr>
<tr>
<td>7%</td>
<td>$0.35</td>
<td>$0.51</td>
<td>$0.38</td>
<td>$0.46</td>
</tr>
<tr>
<td>8%</td>
<td>$0.37</td>
<td>$0.53</td>
<td>$0.40</td>
<td>$0.49</td>
</tr>
<tr>
<td>9%</td>
<td>$0.39</td>
<td>$0.56</td>
<td>$0.43</td>
<td>$0.51</td>
</tr>
<tr>
<td>10%</td>
<td>$0.41</td>
<td>$0.59</td>
<td>$0.45</td>
<td>$0.54</td>
</tr>
<tr>
<td>11%</td>
<td>$0.43</td>
<td>$0.62</td>
<td>$0.47</td>
<td>$0.57</td>
</tr>
<tr>
<td>12%</td>
<td>$0.45</td>
<td>$0.66</td>
<td>$0.50</td>
<td>$0.60</td>
</tr>
<tr>
<td>13%</td>
<td>$0.47</td>
<td>$0.69</td>
<td>$0.52</td>
<td>$0.63</td>
</tr>
<tr>
<td>14%</td>
<td>$0.50</td>
<td>$0.72</td>
<td>$0.55</td>
<td>$0.66</td>
</tr>
<tr>
<td>15%</td>
<td>$0.52</td>
<td>$0.75</td>
<td>$0.57</td>
<td>$0.69</td>
</tr>
</tbody>
</table>

Table 8-4: Calculated LCOE for Solar PV systems at different commercial rates.

### Wind

<table>
<thead>
<tr>
<th>WACC</th>
<th>onshore (3500kW)</th>
<th>offshore (7500kW)</th>
<th>small wind (100kW or less)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>low</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>1%</td>
<td>$0.09</td>
<td>$0.11</td>
<td>$0.19</td>
</tr>
<tr>
<td>2%</td>
<td>$0.10</td>
<td>$0.12</td>
<td>$0.20</td>
</tr>
<tr>
<td>3%</td>
<td>$0.10</td>
<td>$0.12</td>
<td>$0.21</td>
</tr>
<tr>
<td>4%</td>
<td>$0.11</td>
<td>$0.13</td>
<td>$0.21</td>
</tr>
<tr>
<td>5%</td>
<td>$0.11</td>
<td>$0.14</td>
<td>$0.23</td>
</tr>
<tr>
<td>6%</td>
<td>$0.12</td>
<td>$0.14</td>
<td>$0.24</td>
</tr>
<tr>
<td>7%</td>
<td>$0.13</td>
<td>$0.15</td>
<td>$0.25</td>
</tr>
<tr>
<td>8%</td>
<td>$0.13</td>
<td>$0.16</td>
<td>$0.26</td>
</tr>
<tr>
<td>9%</td>
<td>$0.14</td>
<td>$0.17</td>
<td>$0.27</td>
</tr>
<tr>
<td>10%</td>
<td>$0.14</td>
<td>$0.17</td>
<td>$0.28</td>
</tr>
<tr>
<td>11%</td>
<td>$0.15</td>
<td>$0.18</td>
<td>$0.29</td>
</tr>
<tr>
<td>12%</td>
<td>$0.16</td>
<td>$0.19</td>
<td>$0.31</td>
</tr>
<tr>
<td>13%</td>
<td>$0.16</td>
<td>$0.20</td>
<td>$0.32</td>
</tr>
<tr>
<td>14%</td>
<td>$0.17</td>
<td>$0.21</td>
<td>$0.33</td>
</tr>
<tr>
<td>15%</td>
<td>$0.18</td>
<td>$0.22</td>
<td>$0.35</td>
</tr>
</tbody>
</table>

Table 8-5: LCOE calculated for wind systems at different commercial rates.
<table>
<thead>
<tr>
<th>WACC</th>
<th>Waste to Energy 135000kW</th>
<th>BIOMASS COGEN 25000kW</th>
<th>Solar Thermal Water Heating residential</th>
<th>Solar Thermal Water Heating commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>low</td>
<td>high</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>1%</td>
<td>$0.25</td>
<td>$0.34</td>
<td>$0.24</td>
<td>$0.27</td>
</tr>
<tr>
<td>2%</td>
<td>$0.26</td>
<td>$0.36</td>
<td>$0.25</td>
<td>$0.27</td>
</tr>
<tr>
<td>3%</td>
<td>$0.28</td>
<td>$0.38</td>
<td>$0.26</td>
<td>$0.28</td>
</tr>
<tr>
<td>4%</td>
<td>$0.29</td>
<td>$0.40</td>
<td>$0.26</td>
<td>$0.29</td>
</tr>
<tr>
<td>5%</td>
<td>$0.31</td>
<td>$0.42</td>
<td>$0.27</td>
<td>$0.30</td>
</tr>
<tr>
<td>6%</td>
<td>$0.33</td>
<td>$0.45</td>
<td>$0.28</td>
<td>$0.30</td>
</tr>
<tr>
<td>7%</td>
<td>$0.34</td>
<td>$0.47</td>
<td>$0.29</td>
<td>$0.31</td>
</tr>
<tr>
<td>8%</td>
<td>$0.36</td>
<td>$0.50</td>
<td>$0.29</td>
<td>$0.32</td>
</tr>
<tr>
<td>9%</td>
<td>$0.38</td>
<td>$0.52</td>
<td>$0.28</td>
<td>$0.33</td>
</tr>
<tr>
<td>10%</td>
<td>$0.40</td>
<td>$0.55</td>
<td>$0.31</td>
<td>$0.34</td>
</tr>
<tr>
<td>11%</td>
<td>$0.42</td>
<td>$0.58</td>
<td>$0.32</td>
<td>$0.35</td>
</tr>
<tr>
<td>12%</td>
<td>$0.44</td>
<td>$0.60</td>
<td>$0.33</td>
<td>$0.36</td>
</tr>
<tr>
<td>13%</td>
<td>$0.46</td>
<td>$0.63</td>
<td>$0.34</td>
<td>$0.37</td>
</tr>
<tr>
<td>14%</td>
<td>$0.48</td>
<td>$0.66</td>
<td>$0.35</td>
<td>$0.38</td>
</tr>
<tr>
<td>15%</td>
<td>$0.50</td>
<td>$0.69</td>
<td>$0.36</td>
<td>$0.39</td>
</tr>
</tbody>
</table>

Table 8-6: LCOE for waste-to-energy, biomass cogeneration and LCOE cooling for Solar Water Heaters at different lending rates.

<table>
<thead>
<tr>
<th>WACC</th>
<th>OTEC 25000kW</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>low</td>
</tr>
<tr>
<td>1%</td>
<td>$0.21</td>
</tr>
<tr>
<td>2%</td>
<td>$0.22</td>
</tr>
<tr>
<td>3%</td>
<td>$0.23</td>
</tr>
<tr>
<td>4%</td>
<td>$0.24</td>
</tr>
<tr>
<td>5%</td>
<td>$0.25</td>
</tr>
<tr>
<td>6%</td>
<td>$0.27</td>
</tr>
<tr>
<td>7%</td>
<td>$0.28</td>
</tr>
<tr>
<td>8%</td>
<td>$0.29</td>
</tr>
<tr>
<td>9%</td>
<td>$0.31</td>
</tr>
<tr>
<td>10%</td>
<td>$0.32</td>
</tr>
<tr>
<td>11%</td>
<td>$0.33</td>
</tr>
<tr>
<td>12%</td>
<td>$0.35</td>
</tr>
<tr>
<td>13%</td>
<td>$0.36</td>
</tr>
<tr>
<td>14%</td>
<td>$0.38</td>
</tr>
<tr>
<td>15%</td>
<td>$0.39</td>
</tr>
</tbody>
</table>

Table 8-7: LCOE of ocean thermal energy conversion at different lending rates.
### 8.4 Appendix D: Governance Information

<table>
<thead>
<tr>
<th>Incentive</th>
<th>Section</th>
<th>Description</th>
<th>Limitations or similarities</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment tax credit</td>
<td>Part IV (29)</td>
<td>A tax credit to hotel operator equal to 20 percent of capital costs of components of waste water disposal system</td>
<td>Greater clarity on the technologies utilized needed. If RETs fall under electronics that increase energy conservation of the entire hotel property, then also conflicts with Part II B (87) of the Custom tariff where there is no ministerial approval needed to allow duty and levy exemption for import of RET components</td>
<td></td>
</tr>
<tr>
<td>Duty free import &amp; reductions</td>
<td>Second Schedule Section 15,37</td>
<td>No customs duty on items such as air conditioner units, light fittings, toilets, water pumps, water heaters, energy efficient light bulbs and fittings, computer controlled systems to regulate energy, electronics that increase energy conservation at hotel, all kitchen equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Section 21</td>
<td>If owner of hotel secures loan from a private lending institution for upgrade of hotel plant or refurbishment then 150% of the interest paid on the loan may be deducted when calculating assessable income.</td>
<td>Must be differentiated from section 37(j) of Income Tax Act 2013. The ITA (2013) may not act as a new incentive.</td>
<td></td>
</tr>
<tr>
<td>Deductions on expenditure</td>
<td>Section 31</td>
<td>Deductions of 150% of expenditure on the development of: nature trails, Green Globe Certification, community tourism programs, direct linkages to other economic sectors, visitor exchange programs with other countries, or software to monitor tourism performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Section 23</td>
<td>Deduction of 150% of expenditure on training in tourism related courses. An additional 50% of expenditure may be claimed where the tourism product has an employee share ownership scheme meeting criteria prescribed by the minister.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Section 24, 25, 26</td>
<td>Concessions to investors who construct, new hotels, inland hotels or small hotels. These are scaled to the number of rooms and deductions of 150% on loans with limits of $40M, $20M, $15 respectively</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Section 27 &amp; 28</td>
<td>Deduction of 150% of interest paid on loan not exceeding 3 million for investors who secure loan to upgrade attractions and facilities based on cultural heritage. The investor shall be eligible for investment tax credit equal to 30% of initial capital expenditure on equipment and plant used in the upgrading process, once costs exceed $100000.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8-8: Incentives offered to hotels for energy under the Tourism Development Act
### Table 8-9: Incentives under the Income Tax Act 2002 and the amendment 2013

<table>
<thead>
<tr>
<th>Incentive</th>
<th>Section</th>
<th>Description</th>
<th>Limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deductible</td>
<td>2007 section 12E.10</td>
<td>When calculating assessable income allows deduction of 150% of amount spent in the tax year on environmental certification e.g. Green Globe</td>
<td>Same incentive as section 31 of the TDA (not a new incentive)</td>
</tr>
<tr>
<td>Deductible</td>
<td>1996 section 12C1</td>
<td>Allowance of maximum deductible $3500 to a hotel for installation of water storage facilities using tanks.</td>
<td></td>
</tr>
</tbody>
</table>

### Income Tax (Amendment) Act 2013

<table>
<thead>
<tr>
<th>Incentive</th>
<th>Section</th>
<th>Description</th>
<th>Limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tax holiday</td>
<td>section 9 (1)aa:</td>
<td>There is to be no taxes on the income generated from RET system. This applies only to homeowners of residential property.</td>
<td>Only applies to households and not commercial entities. Non-resident villa owners and Barbadian residents who own properties in corporate entities. They will not be able to claim this exemption.</td>
</tr>
<tr>
<td>tax holiday</td>
<td>37(i)</td>
<td>A certified developer, installer or manufacturer of RET shall receive 10 year tax holiday.</td>
<td></td>
</tr>
<tr>
<td>Deduction</td>
<td>37(J)</td>
<td>150% deductible of amount paid on a loan for construction, upgrade of facility to supply renewable energy or energy efficiency products. This is given to a person &quot;carrying on an eligible business&quot;(37J)</td>
<td>Term &quot;eligible business&quot; must be confirmed to include hotels. The definition under section 37 (4) is &quot;business generating and distributing electricity from a RE source or business producing, distributing and installing RE systems for electricity generation and energy efficient products&quot; certified by Ministry of Energy. A certificate of compliance that the facility is used “exclusively” for the provision of electricity however there is no definition of the term &quot;facility&quot;; it may be considered a structure on a hotel complex that provides electricity. Furthermore this interest deduction is similar to section 21 of the TDA</td>
</tr>
<tr>
<td>Deduction</td>
<td>37(K)</td>
<td>Deduction of 150% of expenditure on marketing of RET and EE products</td>
<td>Does not benefit the hotels.</td>
</tr>
<tr>
<td>Deduction</td>
<td>37(L)</td>
<td>Deduction of 150% of expenditure on product development and research in RE generation and sales and installation and servicing of RET systems or EE products.</td>
<td>May not apply to hotels.</td>
</tr>
<tr>
<td>Exemption</td>
<td>37(O)</td>
<td>For a ten year period, RET company shareholders have exemption from payments of withholding tax on dividend.</td>
<td>The RET company must be exclusively engaged in supply of RET or EE products</td>
</tr>
<tr>
<td>Exemption</td>
<td>37(P)</td>
<td>Exemption from tax payment for ten years on interest earned by financial institutions for financing RET and EE development, manufacturing and installation</td>
<td>This offers no real incentive to financial institutions according to Tibbits (2014)</td>
</tr>
<tr>
<td>Exemption</td>
<td>37(N)</td>
<td>Exemption of corporation tax for ten years if venture capital funds invested in RE sector and EE sector.</td>
<td>This is attempts to engage private sector. Some hotel shareholders may be included.</td>
</tr>
</tbody>
</table>
Figure 8-3: Governance framework of Barbados as identified by respondents.\textsuperscript{106}

\textsuperscript{106} Pink refers to government actors, blue is local actors and grey represents international actors.
## NOTEABLE BUDGET INCENTIVES PROPOSED 2006-2013

### Budget 2006
- Government promotion of 30 MW Fuel Cane Project and pre investment plan.
- Support of BL&PC Lambert’s Wind Farm Project
- Proposal of Energy Efficiency and Retrofit Fund of 10 Million dollars as revolving loan fund for Tourism Industry to be managed by Enterprise Growth Fund (p113).
- The target for the islands RE capacity was proposed to be 30% by 2012.
- Development of Renewable Energy Program: Incentives proposed for energy audits and conditional exemptions to customs duty on PV, Wind and Biofuels

### Budget 2007
- Proposal of need to develop new tax regime for Green Products. Householders should be allowed to deduct $5000 for greening of household.
  - Tourism Energy Efficiency Audit & Retrofit Fund to manufacturer groups

### Budget 2008
- propose Energy Conservation and Renewable Energy Deduction of maximum of $5000 over 5 years and 50% the cost of retrofitting or installing a RE system. Propose the need for Tourism Master Plan. Proposal for increase and expansion of concessions in the TDA.

### Budget 2010
- Tourism Loan Guarantee Facility (TLGF) proposed to extend credit to financial intermediaries for existing debt service and short term loans for hotels; this facility is for working capital to repair hotels or service debt payments. This guarantee was proposed up to $100M
- Proposed Small Hotel Refurbishment Fund of BDS$20M to be executed by Small Hotel Investment Fund.
**Budget 2011**

- 50% land tax rebate to manufacturers of solar energy and producers of solar energy.
- Proposed that Energy Conservation and Renewable Energy Deduction increase from $5000 to $25000 for businesses. This is also available to lessees of buildings once in good standing with Inland Revenue Department. Furthermore businesses will be allowed to write off 150% of costs to change to RE over five year period.
- Sustainable Energy Investment Program through the Smart Fund to take effect.
- Propose negotiation for another US$75 M Policy Based Loan (PBL) facility through the IADB
- Expressed intent to have RE and EE legislation drafted within months of the speech
- Discontinuation of duty free concessions for import of electric heaters to the hotel and manufacturing industry.

**Budget 2012**

- The incentives outlined in the Income Tax Act Amendment 2013 are based on this Budget.
- Propose that through the facility of the US$20M grant from the IADB, the Smart Energy Fund will assist with financing at a subsidized interest rate of 3.75% for RET. Government intends to use home grown private sector investment.
- BDS$100 M in form of low interest loans over 8 years to tool and capitalize the RE industry via financial intermediaries and Central Bank
- Establish through the National Insurance Scheme a Hotel Refurbishment, Energy Efficiency and Food. To be financed through NIS surpluses. Proposed that 50 M goes to hotel refurbishment plans and 10M to National Alternative Energy.
- Proposed introduction of Municipal Solid Waste Levy and aggressive action towards construction of Waste to Energy Plant.
**Budget 2013**

- Plan to find new tourism markets over the next 18 months.
- *Electric Light & Power Bill* and *Income Tax Amendment Bill* open for discussion in Parliament with first reading complete
- Proposal of private sector invitation to own and operate solar systems on government buildings through a Public-Private Partnership (PPP) modality of a *Solar Power Purchase Agreement* (SPPA). The electricity to be used on-site and excess sold to BL&P company
- BDS $20M Smart Energy Fund with 2M grant from GEF, UNDP.
- 19 schools with solar contracts awarded to 3 companies already.
- 12 solar systems on government buildings funded by the Public Sector Smart Energy Program funded by IADB and European Union
- US$2M to solar systems on Hurricane Shelters on the island.
- 50M Hotel Refurbishment Fund for material for the construction, rehabilitation or refurbishment of hotels.
- Incentives for local food production for hotels

---

**Table 8-10: Budgetary Announcements 2006-2013**

Source: (GOB 2014)
A number of parliamentary and extra parliamentary stages are involved in moving ideas on policy to the stage of legislation. They are as follows:

### 1. Preparatory Stages

It is usual for political parties to publish in Manifestos or to issue or make statements expressing their intention, if elected to implement particular policies. When elected the Government of the day sometimes consult with interested parties either by meeting with them or by producing and publishing a Green or White Paper on the subject matter of the contemplated Bill. A Green Paper is usually issued at an early stage of consultation and is moved up to the stage of a White Paper when the policy has become more formalized. These documents are discussed not only in Parliament but by the public at large and the public’s comments are generally taken into consideration before the legislative process begins.

The life of the legislation begins in the relevant Government Ministry or Department responsible for the subject e.g. Ministry of Energy. The drafting of the legislation is done by legally qualified civil servants e.g. Permanent Secretary and/or Chief Parliamentary Counsel. Actual drafting may take some time especially where the subject matter is complex. It is usual for versions of the draft Bill to be passed back and forth between Parliamentary Counsel and the Ministry so as to ensure that the intended policy is clearly reflected in the draft Bill.

Once the Bill is settled it is then taken to the Cabinet for approval. After being approved by Cabinet it is printed and laid on the table of the House of Assembly on the way to being introduced through Parliament. Parliament in Barbados consists of the House of Assembly and the Senate. Legislation which is passed by both of these bodies must obtain the Assent of the Governor General as the Queen’s representative before it can become effective (Innis 2008).

### 2. The Parliamentary Stages

#### A. The House of Assembly

There are five stages in the life of a Bill before it can be passed and implemented. They are:

(i) **First Reading**

The draft Bill as approved by Cabinet is formally presented before the House of Assembly and its title is read out. There is no debate on the contents of the Bill at this stage. The first reading allows the Bill to be printed and distributed and to move forward to the Second stage.

(ii) **Second Reading**

At this stage the Bill is introduced and debate is opened by a Government Minister, usually from the appropriate Ministry with responsibility for the subject e.g. Minister of Energy. The Bill is then debated by the Members of the House of Assembly, both Government and Opposition. This is an opportunity to discuss the policies in full and to offer suggestions for amendments or changes in the Bill. After the debate is concluded a motion is made that the Bill be read a second time.
After the Bill is read a second time, it is referred to a Standing Committee of the House of Assembly. Usually the Speaker of Parliament is not present at this stage but the Chairman of Committees presides over the process.

(iii) The Committee Stage

At this stage Members can debate the Bill clause by clause and are entitled to suggest changes or accept or reject the Bill. After each clause has been considered by the Committee the Chairman of the Committee is asked to report to the whole House that the Bill has been passed in Committee.

(iv) Report Stage

At the report stage the House can make further amendments. It need not accept the amendments made.

(v) Third Reading

The final stage is the Third Reading. Usually at a Third Reading the Bill cannot be substantively amended but it can be opposed and defeated or passed by a majority of the Members of the House. (Innis 1991; Innis 2008).

B. The Senate

The Parliamentary Stages in the Senate

(i) The Bill as passed by the House is then sent to the Senate from the House of Assembly and it goes through the stages similar to those as took place in the Senate, until it is passed at the Third Reading stage

The Governor General’s Consent

(ii) The Bill is then certified as passed and sent to the Governor General for his signature.
(iii) The Bill comes into effect either by proclamation or on the date legislated.
The process although on the face of it straightforward can take several months and sometimes years because the Government has not given it the push as required.
Likewise the preparatory stage can take years since although a Manifesto has been published there has not been the same push to bring the policy into effect. The Manifestos of political parties in 1999, 2003, 2008 and 2013 all enunciated policies in respect of the environment energy and climate change but the required legislation has in many cases not been put into effect and implementation of the appropriate policies has been slow (BLP 2013, 2008, 2003, 1999; DLP 2013, 2008, 2003, 1999).

Figure 21: Note on the Steps Necessary to create Legislation in Barbados
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Real growth (%)</td>
<td>5.7</td>
<td>1.7</td>
<td>0.3</td>
<td>-4.1</td>
<td>0.3</td>
<td>0.8</td>
<td>0.0</td>
<td>-0.1</td>
<td>-1.2</td>
<td>-0.4</td>
</tr>
<tr>
<td>Tradables (%)</td>
<td>8.1</td>
<td>-7.3</td>
<td>-0.3</td>
<td>-4.3</td>
<td>-0.4</td>
<td>-2.5</td>
<td>-4.3</td>
<td>-1.1</td>
<td>-0.9</td>
<td>-0.8</td>
</tr>
<tr>
<td>Non-tradables (%)</td>
<td>5.0</td>
<td>4.5</td>
<td>0.5</td>
<td>-4.1</td>
<td>0.4</td>
<td>1.7</td>
<td>1.1</td>
<td>0.1</td>
<td>-1.2</td>
<td>-0.2</td>
</tr>
<tr>
<td>Inflation (%)(^1)</td>
<td>7.3</td>
<td>4.0</td>
<td>8.1</td>
<td>3.6</td>
<td>5.8</td>
<td>9.4</td>
<td>4.5</td>
<td>1.8</td>
<td>3.5</td>
<td>1.7</td>
</tr>
<tr>
<td>Avg. Unemployment (%)</td>
<td>8.7</td>
<td>7.4</td>
<td>8.1</td>
<td>10.0</td>
<td>10.8</td>
<td>11.2</td>
<td>11.6</td>
<td>11.7</td>
<td>11.3</td>
<td>N/A</td>
</tr>
<tr>
<td>Foreign Exchange Reserves ($)</td>
<td>1,194.1</td>
<td>1,549.9</td>
<td>1,359.3</td>
<td>1,488.7</td>
<td>1,435.2</td>
<td>1,423.3</td>
<td>1,457.3</td>
<td>1,147.1</td>
<td>1,429.7</td>
<td>1,143.0</td>
</tr>
<tr>
<td>Foreign Exchange Reserves (^\text{a}))</td>
<td>16.0</td>
<td>20.9</td>
<td>16.4</td>
<td>21.1</td>
<td>18.4</td>
<td>17.8</td>
<td>19.9</td>
<td>15.6</td>
<td>19.5</td>
<td>16.0</td>
</tr>
<tr>
<td>BoP current account (as % GDP)</td>
<td>-8.2</td>
<td>-5.4</td>
<td>-10.7</td>
<td>-6.8</td>
<td>-5.8</td>
<td>-12.8</td>
<td>-9.5</td>
<td>-10.5</td>
<td>-3.3</td>
<td>-3.2</td>
</tr>
<tr>
<td>Net capital inflows</td>
<td>709.9</td>
<td>1,020.2</td>
<td>546.1</td>
<td>731.7</td>
<td>512.1</td>
<td>1,925.5</td>
<td>278.3</td>
<td>449.2</td>
<td>14.4</td>
<td>92.0</td>
</tr>
<tr>
<td>Net Government Debt/GDP</td>
<td>34.7</td>
<td>34.9</td>
<td>35.2</td>
<td>45.4</td>
<td>54.9</td>
<td>59.3</td>
<td>67.7</td>
<td>80.7</td>
<td>70.3</td>
<td>82.0</td>
</tr>
<tr>
<td>Net Public Sector Debt/GDP</td>
<td>29.6</td>
<td>27.2</td>
<td>28.0</td>
<td>38.5</td>
<td>50.3</td>
<td>52.9</td>
<td>57.0</td>
<td>66.9</td>
<td>61.6</td>
<td>70.2</td>
</tr>
<tr>
<td>External debt service to BoP current account credits</td>
<td>5.6</td>
<td>4.2</td>
<td>6.9</td>
<td>5.8</td>
<td>13.3</td>
<td>6.0</td>
<td>6.4</td>
<td>6.6</td>
<td>7.6</td>
<td>7.6</td>
</tr>
<tr>
<td>Treasury-bill rate</td>
<td>6.6</td>
<td>4.9</td>
<td>4.8</td>
<td>3.4</td>
<td>3.4</td>
<td>3.4</td>
<td>3.6</td>
<td>3.2</td>
<td>3.6</td>
<td>3.2</td>
</tr>
<tr>
<td>US treasury-bill rate</td>
<td>4.9</td>
<td>3.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Average deposit rate(^1)</td>
<td>5.1</td>
<td>4.8</td>
<td>4.1</td>
<td>2.7</td>
<td>2.7</td>
<td>2.7</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Average loan rate(^1)</td>
<td>10.9</td>
<td>10.7</td>
<td>10.3</td>
<td>9.7</td>
<td>9.4</td>
<td>8.8</td>
<td>8.4</td>
<td>8.5</td>
<td>8.5</td>
<td>8.1</td>
</tr>
<tr>
<td>Fiscal deficit (% of GDP)</td>
<td>-2.7</td>
<td>-3.4</td>
<td>-4.9</td>
<td>-7.2</td>
<td>-8.7</td>
<td>-4.4</td>
<td>-8.0</td>
<td>-11.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fiscal Current Account (as % of GDP)</td>
<td>1.7</td>
<td>-0.3</td>
<td>-2.4</td>
<td>-6.2</td>
<td>-8.3</td>
<td>-3.4</td>
<td>-7.5</td>
<td>-10.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenue (as % of GDP)</td>
<td>29.8</td>
<td>31.5</td>
<td>28.6</td>
<td>25.3</td>
<td>25.7</td>
<td>29.2</td>
<td>27.7</td>
<td>24.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expenditure (as % of GDP)</td>
<td>32.9</td>
<td>35.4</td>
<td>38.7</td>
<td>38.1</td>
<td>39.5</td>
<td>38.0</td>
<td>41.1</td>
<td>41.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gov’t interest payments (as % of revenue)</td>
<td>14.7</td>
<td>13.9</td>
<td>15.3</td>
<td>18.8</td>
<td>22.3</td>
<td>20.7</td>
<td>23.9</td>
<td>28.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8-11: Economic Indicators for Barbados as of April 2014 (Central Bank of Barbados 2014).\(^{107}\)

\(^{107}\) BoP is Balance of Payments, (P) is provisional; (’e’) is estimate; 1 is current data at end of February 2014, 2 is current data at end of April 2014.
9 References


Craigwell, R and Mitchell, T (2009), ‘An investigation of price asymmetries between crude oil and gasoline prices in the ECCU and Barbados.’ Department of Economics, University of the West Indies, Cave Hill Campus, Bridgetown.


Madden, M. (2013). ‘Hotels may have to close’in Nation Newspaper 15th November 2013.[Online]:


Energy Roadmap: Pathways to an Affordable, Reliable, Low-Emission Electricity System.
Wordwatch Institute. Washington D.C.


Mascoll, C. (2011) “What matters most don’t blame the fuel subsidy” November 3rd 2011. <Online>:

Mason, M. (2010) Sample size and saturation in PhD studies using qualitative interviews. Forum:
Qualitative Social Research 11(3): N/A

Consultants Group and IFOK for Organization of American States. <Online>:
https://csep.gopagoda.com/outcomes/the-financiers-guide-to-sustainable-energy-lending-in-the-

Meadowcroft, J. (2002). Politics and scale: some implications for environmental governance. Landscape

Meadowcroft, J. (2009). What about politics? Sustainable development, transition management and long

Earthscan.

Handbook. London: Earthscan

Mez, L. (2009) “Renewables in electricity generation: Germany as pioneer?” in Eberlein, B. and Doern, 
B. (Eds.). Governing the Energy Challenge: Canada and Germany in a Multi-Level Regional

2013.


Mullings, B. (1999). Insider or outsider, both or neither: some dilemmas of interviewing in a cross-cultural setting. Geo Forum 30: 337-350


The Electricity Act (1971) [Cap 277] Laws of Barbados


The Income Tax (Amendment) Act (2013) (Cap 73) Laws of Barbados


