GOVERNMENT OF BERMUDA
Ministry of Economic Development

Department of Energy

The National Electricity Sector Policy for Bermuda Consultation Document

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Table of Contents

Appendices

Tables

Figures

Boxes

Abbreviations and Acronyms

BAU	Business as usual
BMD	Bermuda dollar
CO_2	Carbon dioxide
DG	Distributed generation
ECERA	Eastern Caribbean Energy Regulatory Authority
EE	Energy efficiency
ESCO	Energy services company
FTC	Fair Trade Commission (Barbados)
FIT	Feed-in tariff
GHG	Greenhouse gases
GWh	Gigawatt-hour
HFO	Heavy fuel oil
IPP	Independent power producer
kW	Kilowatt
kWh	Kilowatt-hour
LED	Light-emitting diode
LEED	Leadership in Energy and Environmental Design
LNG	Liquefied natural gas
MMBtu	Million British thermal units
MW	Megawatt
MWh	Megawatt-hour
O&M	Operation and maintenance
OTEC	Ocean thermal energy conversion
PPA	Power purchase agreement
PV	Photovoltaic

Definitions

Barrel	A unit of volume equal to 42 US gallons, or 159 litres
Carbon dioxide (CO_2)	A compound of carbon and oxygen which is formed during respiration or combustion of carbon-containing fuels. It is the main greenhouse gas that contributes to global warming
Capacity factor	The percentage of a power plant's maximum continuous power production capability that is achieved over a given time period, usually a year
Compact fluorescent (CFL) light bulb	A small gas-discharge light bulb that typically uses 75% less energy an incandescent light bulb
Demand-side resources	Conservation measures to limit or reschedule electricity use so that the size and number of generating facilities can be reduced or delayed. Demand-side resources are held by end users, and can include reducing overall energy consumption (energy efficiency), shifting consumption to off-peak times (peak load shifting), and reducing consumption during peak times (interruptible load)
Distributed generation	Generation capacity on the end user's premises that is connected to the distribution network and used to offset some or all of the customer's energy consumption
Distribution	The act or process of delivering electric energy from convenient points on the transmission system (usually a substation) to residential and commercial end users
Electric grid	The infrastructure necessary to deliver electricity between electricity generators and end users
Electric utility	A company that engages in the generation, transmission, distribution, and sale (retailing) of electricity. An electric utility may perform any combination of these functions
Electrical energy (or electricity)	The ability of an electrical current to produce work such as heat, light, or other forms of energy. The standard unit of measurement for electrical energy is the kilowatt-hour (kWh)
Energy audit	An inspection, survey, and analysis of energy usage in a building or process. Energy audits are used to identify cost-effective opportunities to reduce energy consumption
Energy efficiency	A ratio of the energy input required to operate an energy-consuming product, relative to the useful services received
Externality	A hidden or indirect cost associated with a product or service. Greenhouse gases produced by the combustion of fossil fuels are a common example
Feed-in-tariff	A predetermined rate that is paid for electricity supplied to the electrical grid by a third party
Fossil fuel	Any finite hydrocarbon-based fuel that is formed by the decay of organic material such as plants, trees, animals, and bacteria over millions of years. Examples of fossil fuels include coal, oil, and natural gas
Greenhouse gases (GHG)	Gases that contribute to global warming as they are transparent to solar radiation, but opaque to long-wave radiation. Examples include carbon dioxide, methane, water vapour, tropospheric ozone, and low-level ozone

Independent power producer (IPP)	Any entity other than the electric utility that generates electrical power for sale or distribution
Installed capacity	The maximum continuous power output available from an electrical generator, sometimes referred to as the nameplate rating
Interconnection	The physical interconnection of two or more electric systems to permit a flow of electricity between them. This permits the sale and exchange of electricity between an electric utility and an independent power producer, for instance
Integrated resource plan (IRP)	A public planning process to evaluate the optimal mix of utility resources and options. IRPs are comprehensive and seek to accomplish specified social and environmental goals by considering both demand-side resources (to reduce electricity demand) and supply-side resources (to redistribute types of generation among fuel types, locations, and so on)
Kilowatt (kW)	A standard unit of electrical power equal to 1,000 watts
Kilowatt-hour (kWh)	A unit of electrical energy equal to one kilowatt of power expended for one hour; the standard unit of measure used for electrical billing
Megawatt (MWh)	One million watts, or one thousand kilowatts of electrical power
Ocean thermal energy conversion (OTEC)	A process that uses the temperature difference between deep-ocean water and surface water to produce useful forms of energy
Off-peak	A time period when the electric system experiences relatively low demand. These periods often occur in daily, weekly, and seasonal patterns
Oil	A liquid fossil fuel composed of a mixture of hydrocarbons that usually exist in natural underground pools or reservoirs
On-peak	A time period when the electric system experiences relatively high demand. These periods often occur in daily, weekly, and seasonal patterns
Renewable energy	Energy that is obtained from naturally occurring sources that are replenished within our lifetimes. This term commonly includes, but is not limited to, solar, wind, ocean wave, ocean thermal, geothermal, hydropower, and tidal energy.
Smart meter	An electric meter that is capable of two-way communication between the electric utility, the end user, and compatible appliances
Solar water heater	A renewable energy technology that uses solar radiation to heat water
Solar photovoltaic (PV) technology	A renewable energy technology that converts solar radiation into direct current electrical energy
Transmission	The transportation of electric energy in bulk from a source or sources of supply to other systems or parts of a single system (such as large [industrial] end users, and to the distribution network)
Wheeling	Transmission of electricity by a company that does not own or directly use the power it is transmitting. Wholesale wheeling is the term used when there are bulk transactions in the wholesale market. This word is often used as a synonym for transmission. Retail wheeling allows power producers direct access to retail customers
Wholesale market	Purchase of electricity from generators for the purpose of reselling it to others, who then sell to retail customers. Also used to define markets for the ancillary services needed to maintain reliability and power quality at the transmission level

1 Introduction

Developments in technologies for renewable energy, energy efficiency, and conventional energy give Bermuda the opportunity to change how it sources and uses energy. Introducing new technologies to the Island may lower the cost of service, reduce local pollution produced by generation as well as emissions of global greenhouse gases (GHG), improve the security of supply, and improve affordability, all while maintaining or improving quality of service.

Developing new energy options requires a new framework of policy, legislation, and regulation. The current framework, developed when liquid fossil fuels were the only viable option, lacks the flexibility to integrate new options. The updated framework must also ensure that the benefits of introducing new technologies into Bermuda are shared among the utility, end users, and Government.

This National Electricity Sector Policy ('the Policy') will be Bermuda's highest-level step toward realizing these new opportunities; it will also lay the groundwork for the new Electricity Sector Act, an updated licencing framework, and a renewed regulatory framework. The Policy builds on the work done in developing the Energy Green Paper 2009, as well as the Energy White Paper 2011.

In this consultation document we present the elements of the Policy as they would appear in a final version; for example saying 'it is Policy to…' rather than saying 'the proposed Policy would be to…' None of the Policy elements as shown below are final.

The Policy will cover all the key elements of the electricity sector. The Policy:

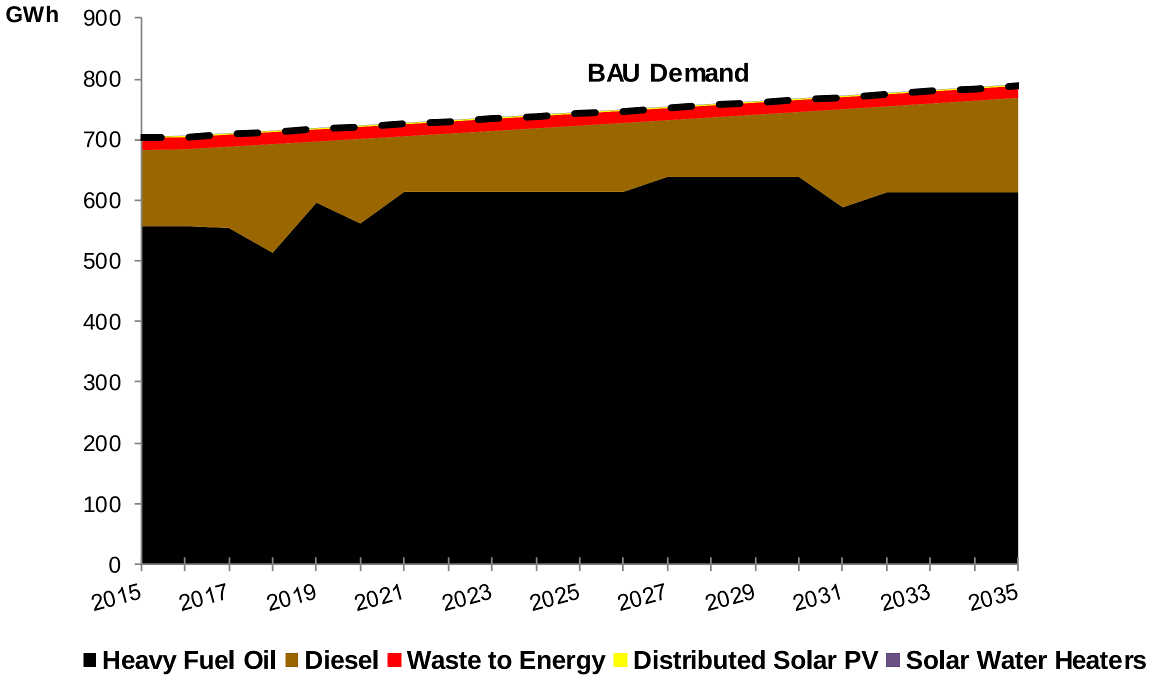
- Articulates Bermuda's objectives for the electric sector (Section 3)
- Presents a vision of what the sector will look like, using indicative targets based on an aspirational matrix of supply and demand-side options (Section 4)
- Shows the desired structure of the sector, including roles and responsibilities of the actors (Section 5)
- Defines a process for determining the sources of Bermuda's electricity generation, as well as defining who will provide that generation (Section 6)
- Defines the enabling framework for distributed generation (Section 7)
- Identifies the desired structure of the transmission, distribution, and retail subsector, and importantly, the role that subsector will play in accommodating new generation sources (Section 8)
- Defines Government support of more efficient use of electricity (Section 9)
- Identifies the legislative, licencing, and environmental permitting and planning framework that support Policy implementation (Section 10).

Section 11 explains the next steps in the policy development process. Appendix A provides references to sources consulted and Appendix B presents the assumptions used to develop the aspirational matrix. The Policy will be accompanied by an Implementation Plan. The Implementation Plan will define the steps to implement the Policy in the short to medium term.

2 Context

Bermudians have used electricity since 1907, when the first 50kW generating unit was installed in Hamilton. Demand has grown with the increase in population and the growth of the economy. But today, as in 1907, the economy depends on fossil fuels for over 99 percent of electricity. Figure 2.1 shows what a continuation of the current generation matrix would look like over the period 2015 to 2035.

Figure 2.1: Business as Usual (BAU) Electricity Matrix, 2015-2035



Note: Solar photovoltaic (PV) and solar water heater contribution are not visible at this scale

Bermudians have become increasingly concerned with the implications of their current mix of fossil fuel generation, particularly high cost, GHG emissions, and vulnerability to supply and price shocks. In light of these concerns, the Government created the Department of Energy in 2008, with a mandate to reduce fossil fuel dependency, maintain energy security, and encourage greenhouse gas emissions reductions.

The Department of Energy took on these challenges through the publication of the Energy Green Paper 2009, and the Energy White Paper 2011. The White Paper identified a range of goals for the electric sector, primarily focused on meeting emissions reduction targets. These actions included:

- Implementing a new electricity Act and regulatory framework, to:
  - Allow independent power producers (IPPs), large and small
  - Define a greater role for Government in the determination of Bermuda's mix of electricity generation
- Using feed-in-tariffs (FITs) to incentivize renewable energy
- Allocating land and seabed to renewable energy development
- Making end use of electricity more efficient.

The Policy is the culmination of the Green and White Papers, the work of the Energy Working Group, and consultations held in November 2014 and February 2015. The Policy covers the electricity sector themes introduced by the Green and White papers (it does not cover transport).

3 Objectives

The Government has defined four objectives for the electricity sector. Electricity service should be:

- **Least cost and high-quality**: electricity service that is delivered at the lowest possible financial cost, without compromising safety standards or failing end users' expectations
- **Environmentally sustainable**: electricity service that, over time, does not cause economic damage to the local and global environment
- **Secure**: electricity service that is provided using a mix of primary energy sources that is collectively resilient to shocks (such as dramatic changes in the availability or price of fuels, or binding commitments to reduce greenhouse gas emissions)
- **Affordable**: electricity service that allows all Bermudians to pay for at least a basic supply, while preserving the competitiveness of its productive sector.

This Policy defines how the Government will pursue these objectives. Where trade-offs are implied, the Government will pursue a public consultation process (defined in Section 5.2) to identify its course of action.

Box 3.1: Reflecting on Objectives

Defining the objectives simply and clearly signals to citizens and private companies what Bermuda values in the electric sector. The Policy intentionally does not rank order these objectives. Prioritising one objective above all others risks forcing the electricity sector in a particular direction without due consideration of the other objectives.

4 Vision

Through this Policy, the Government aspires to transform Bermuda's electricity matrix into one that provides least cost, high-quality electricity service that is also environmentally sustainable, secure, and affordable. The Government's vision for the sector is tied to indicative targets (Section 4.1) based on an aspirational matrix for 2035 (Section 4.2). The aspirational matrix shows the mix of generation and demand reduction the Policy aspires to see implemented in Bermuda.

4.1 Targets

The aspirational matrix sets indicative targets against which the Government can benchmark the sector in terms of emissions, diversity of supply, and share of renewable energy. These targets are presented in Table 4.1.

Table 4.1: Targets for Electricity Performance

Target	Unit	2020	2025	2035
Annual emissions	Tons CO_2	394,837 (34% below BAU)	288,011 (53% below BAU)	284,540 (56% below BAU)
Share of renewable energy	%	10%	37%	39%
Energy efficiency / conservation	Average annual consumption per end user, in MWh (includes self-generation	16.50 (5.2% below business as usual [BAU])	16.97 (5.2% below BAU)	17.93 (5.2% below BAU)
Share of generation by source (sums may not total 100% due to rounding)	Natural gas %	90%	63%	61%
	Tynes Bay %	3%	3%	3%
	Utility PV %	3%	3%	3%
	Distributed PV %	1%	2%	6%
	Solar water heaters %	2%	2%	2%
	Future base load/ ocean thermal energy conversion (OTEC) %	0%	28%	25%

Indicative targets provide a measuring post to track performance towards achieving the Policy's objectives. Because they depend on certain assumptions about the future, it may be that the targets are exceeded; or it may be that they are not met. Indicative targets are non-binding, meaning that no party will receive a fine or penalty if they are not met.

4.2 The Aspirational Matrix

The aspirational matrix below illustrates how these targets could be achieved. It considers both demand-side and supply resources. The aspirational matrix is adapted over time by periodically developing integrated resource plans (IRPs) (see Section 6.1).

The aspirational matrix includes the following energy sources replacing the current diesel and heavy fuel oil (HFO) generation:

- **Natural gas**—considering also the cost of the regasification terminal to convert liquefied natural gas (LNG) from its liquid state back to its gaseous state
- **Future zero emissions base load/OTEC**—this is a slot reserved for a future base load technology, with a priority for locally available resources; however it could be open to imported sources as well. This slot is built on the assumption that a technology can reach a generating cost of BMD 0.14 per kWh by 2025
- **Utility scale solar PV and distributed solar PV**—these resources grow over time to 30 percent of peak demand, assuming that the grid is updated and that the utility learns from experience how to best manage solar's generation profile

- **Solar water heaters**—adopted gradually over the period to provide hot water at the site of end use, displacing electricity generation.

It also assumes continued operation of the Tyne's Bay Waste-to- Energy facility.

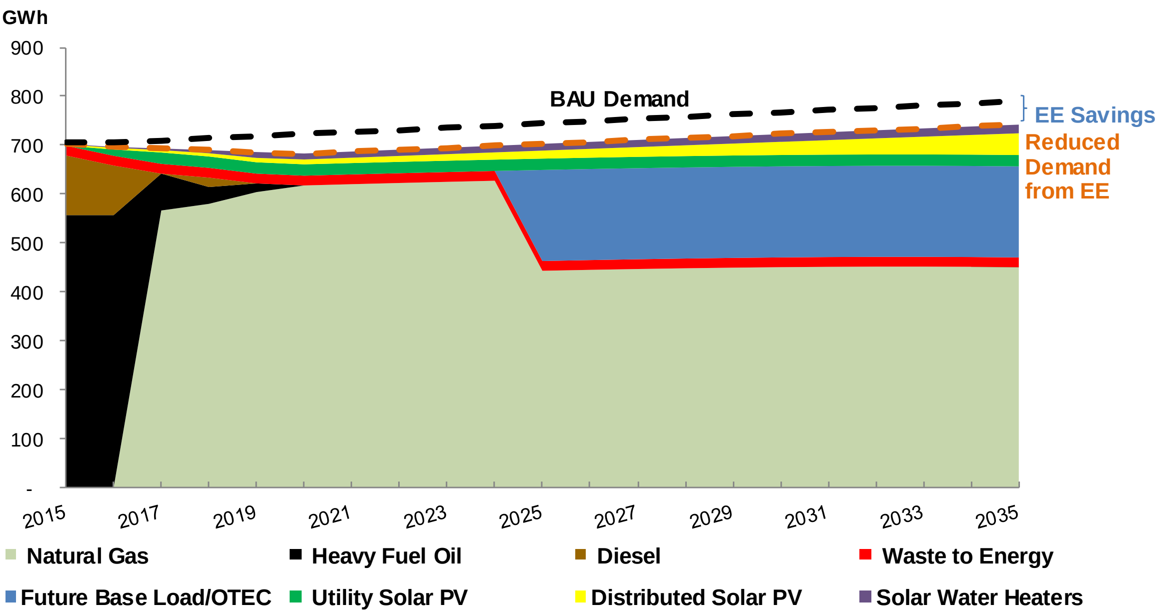
The aspirational matrix also accounts for a decrease in energy consumption from use of energy efficiency technologies and energy conservation measures across all customer classes. These technologies and conservation measures include:

- Efficient air conditioning
- Efficient lighting
- Efficient refrigeration
- Passive cooling (insulation, window tints, and so on)
- Efficient machinery in commercial buildings.

The cost of electricity supply over the forecast period under the aspirational matrix is six percent lower than the BAU scenario over the same period; BMD 1.33 billion for the aspirational matrix compared, to BMD 1.40 billion for the BAU scenario.

The assumptions used to develop the aspirational matrix are presented in Appendix B.

Figure 4.1: Aspirational Electricity Matrix, 2015–2035

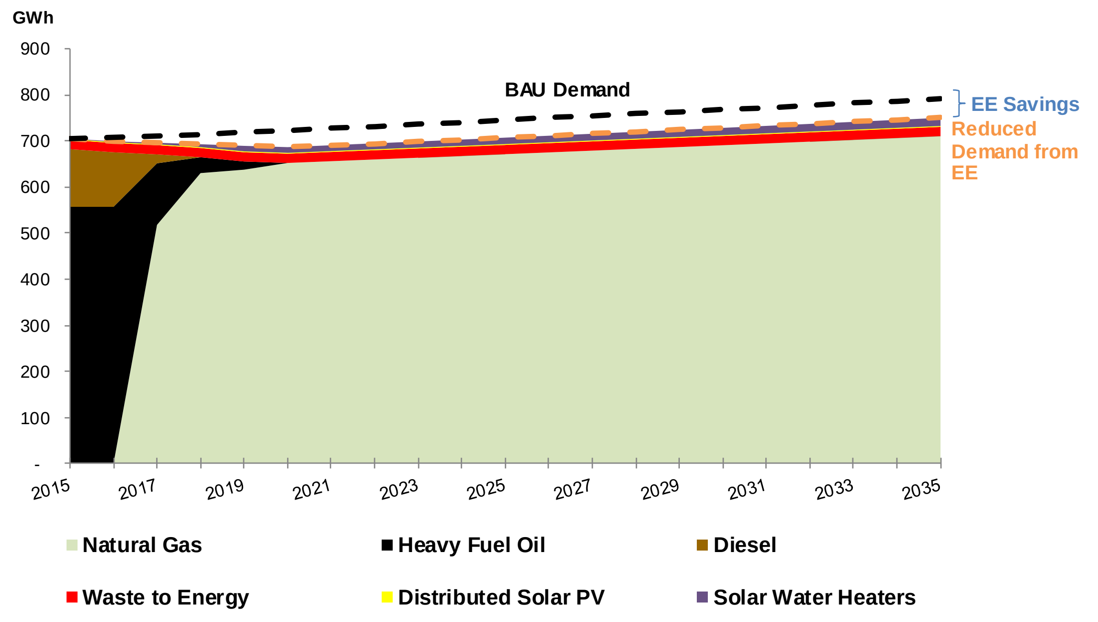


Box 4.1: Reflecting on the Vision

Based on the Green Paper, the White Paper, and consultations since, we understand that Bermudians may be willing to pay some premium for renewable energy generation. We have also heard that reducing costs overall is a priority. The Scenario presented in Figure 4.1 as the aspirational matrix (Scenario B) represents the middle ground between a financial least cost scenario (A) and an aggressive renewable energy scenario (C), both presented bellow for comment.

Scenario A

This scenario is driven by natural gas, and results in the lowest cost of power supply—9% less than the BAU scenario (BMD 1.29 billion compared to BMD 1.40 billion). It also has higher emissions than the aspirational matrix or Scenario C.



Scenario A has the following indicators:

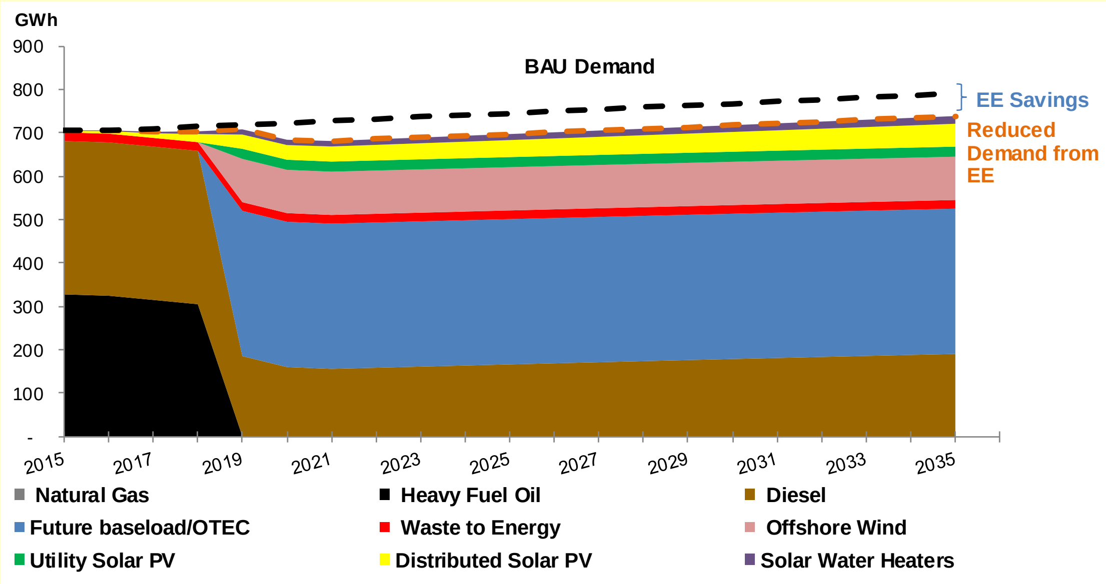
Target	Unit	2020	2025	2035
Annual emissions	Tons CO_2	416,875 (30% below BAU	429,013 (30% below BAU)	454,032 (31% below BAU
Share of renewable energy	%	5%	5%	5%
Average annual consumption per end user (includes self-generation	MWh	16.50 (5.2% below BAU)	16.97 (5.2% below BAU)	17.93 (5.2% below BAU)

Scenario A is based on the following assumptions:

- Conversion to natural gas generation in 2017, and elimination of diesel and HFO shortly after
- Adoption of a full suite of energy efficiency measures by 25 percent of the population by 2020
- Continued adoption of solar water heaters over the forecast period.

Scenario C

This scenario results in the lowest emissions. It is also the only scenario that raises costs over BAU—it is projected to raise cost of power supply by 26 percent (BMD 1.89 billion compared to BMD 1.40 billion).



Scenario C has the following indicators:

Target	Unit	2020	2025	2035
Annual emissions	Tons CO_2	149,618 (75% below BAU)	161,989 (73% below BAU)	184,887 (72% below BAU)
Share of renewable energy	%	77%	76%	74%
Average annual consumption per end user (includes self-generation	MWh	16.50 (5.2% below BAU)	16.97 (5.2% below BAU)	17.93 (5.2% below BAU)

Scenario C is based on the following assumptions:

- 45MW of OTEC in 2018 providing base load
- 8.6MW of solar PV in 2018
- 30MW of offshore wind in 2018
- Distributed solar PV growing to 35MW by 2035
- Installation of a 45MWh lithium ion battery in 2018 to back up intermittent generation
- Adoption of a full suite of energy efficiency measures by 25 percent of the population by 2020
- Continued adoption of solar water heaters over the forecast period.

Questions for Consultation:

- Is scenario B actually the preferred one for Bermuda, or rather is it scenario A or C?
- Any other technology to be considered?

5 Desired Structure of the Electricity Sector

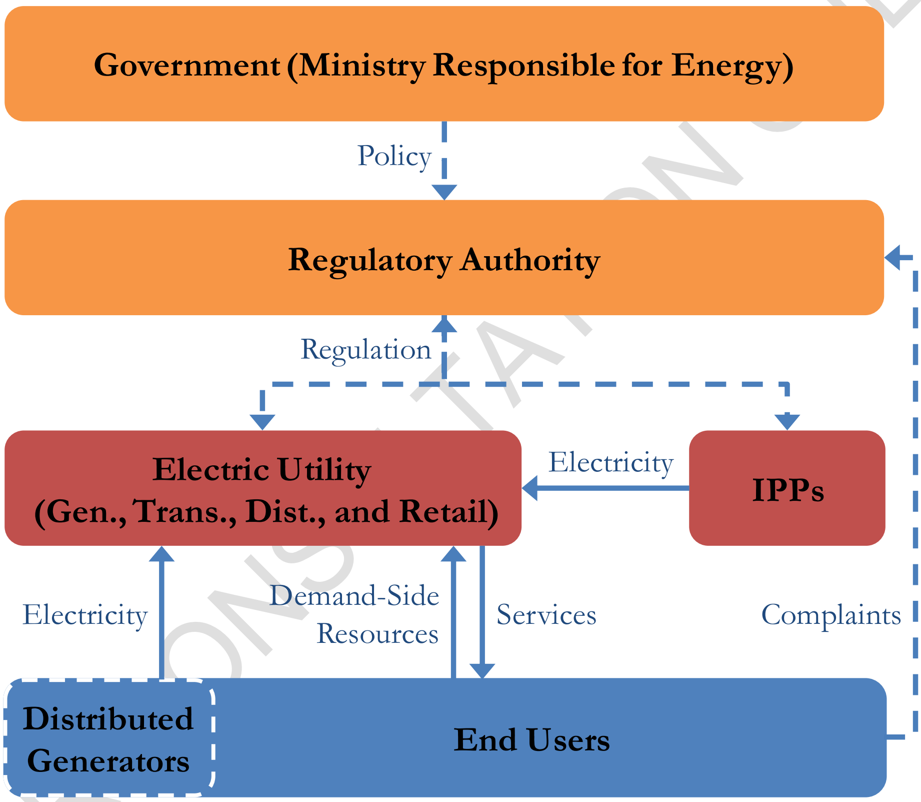
It is the policy of the Government that the structure of the electricity sector be designed to best serve end users. This requires appropriate institutional arrangements, including clearly defined relationships and responsibilities for:

- the Ministry Responsible for Energy (Section 5.1)

- the Regulatory Authority (Section 5.2)
- the Electric Utility (Section 5.3)
- IPPs (Section 5.4)
- End users (Section 5.5), and
- Distributed generators (Section 5.6).

The Ministry Responsible for Energy will develop policy, which guides the Regulatory Authority as it regulates IPPs, the Electric Utility, and transactions with end users. End users ensure a high quality of service by filing complaints with the Regulatory Authority. Figure 5.1 summarises the desired structure of the electricity sector, followed by descriptions of the roles and responsibilities of each entity.

Figure 5.1: Desired Structure of the Electricity Sector



The roles and responsibilities of each entity are described in the following sections.

5.1 The Ministry Responsible for Energy

The Ministry Responsible for Energy provides policy to guide the electricity sector. Policy making is responsive to the desires of voters who elect the Government, and consistent with the overall objectives of this Policy.

The Ministry leads the Government's efforts to coordinate and enable the development of large-scale electricity and infrastructure projects, for example infrastructure for importing LNG or an offshore wind farm. The Ministry is also responsible for leading cooperation with other countries, such as an energy efficiency labelling initiative.

The Ministry has three major responsibilities towards the Regulatory Authority. The Ministry:

- Participates in the process to select commissioners of the Regulatory Authority
- Provides general policy direction to the Regulatory Authority
- Ensures the Regulatory Authority performs its responsibilities as required by law.

> **Box 5.1: Reflecting on the Ministry Responsible for Energy**
>
> Through the Ministry Responsible for Energy, the Government seeks to create an enabling environment for major electricity infrastructure projects. For example, the Ministry may grant concessions for private entities to develop major projects on public lands, provided the Ministry is satisfied the project is in the public interest. However, the Ministry does not envision playing a role in itself developing, building, owning, or operating these projects.
>
> The Ministry also intends to provide general policy direction to the sector, and ensure that the Regulatory Authority has sufficient resources to carry out its mission (as described in Section 5.2).

5.2 The Regulatory Authority

The Regulatory Authority is the sole body responsible for economic regulation of the electricity sector. The Regulatory Authority's responsibilities include:

- **Overseeing the Electric Utility's generation, transmission, distribution, and retail lines of business.** The Regulatory Authority regulates tariffs and quality of service in a manner that promotes the public interest (as defined in this Policy) while allowing the Electric Utility's investors an opportunity to earn a fair return on investment
- **Regulating the Electric Utility's relationship with IPPs and distributed generators.** The Regulatory Authority ensures that all generation, whether owned by the Electric Utility or by third parties, has a fair opportunity to connect to the grid and sell power on commercially competitive terms
- **Investigating and responding to complaints from end users.** The Regulatory Authority serves as a single point of contact for end users to pursue grievances against the Electric Utility.

The Regulatory Authority conforms to general Government policy, but acts independently of the Government. The Regulatory Authority operates under the law, maintains arms-length relationships with private interests and the Government, and has organisational autonomy (including budgetary autonomy).

The Regulatory Authority is staffed with sufficient technical expertise to carry out essential functions, while outsourcing more specialised analyses and tasks to external consultants. For example, the Regulatory Authority engages external consultants to support rate cases and the IRP process. This approach:

- **Helps control regulatory costs**. A larger, conventional regulatory body has too high an overhead relative to the utility's total revenue on a small island
- **Ensures specialised skills remain available**. Regulation is a highly specialised skill, and it may be difficult for Bermuda to attract and retain skilled professionals needed to fully staff a conventional regulatory body

- **Improves the independence of the Regulatory Authority**. Ensuring an arms-length approach to business is difficult in any sector on a small island such as Bermuda. Moreover, the Electric Utility is the largest source of utility skills, and so it naturally can have a strong influence on the regulatory process.

Prior to issuing any determination, the Regulatory Authority holds consultations that provide an opportunity for analysis and comments to be submitted by all interested parties: the Electric Utility, IPPs, and end users (including distributed generators).

The Regulatory Authority also serves as an independent advisor to the Government on energy policy matters and helps the Ministry understand trade-offs implied by policy decisions. At the request of the Ministry Responsible for Energy, the Regulatory Authority initiates a consultation process on proposed policies, in which the Electric Utility is required to quantify both the financial and economic costs of the proposed policy. The Regulatory Authority is responsible for preparing its own cost-benefit calculation, reviewing the Electric Utility's analysis, and holding public consultations. This process is iterative, with both the Electric Utility and the Regulatory Authority providing feedback on the other's analysis. Once the Regulatory Authority is satisfied with the outcome of this process, it presents the final analysis to the Ministry Responsible for Energy; the Ministry uses this analysis to inform its decision.

Box 5.2: Reflecting on the Regulatory Authority

Independence is a central feature of the institutional design for regulators in many Caribbean jurisdictions, including for the Fair Trade Commission (FTC) in Barbados and for the Eastern Caribbean Energy Regulatory Authority (ECERA). Independence can be difficult to achieve on small islands. However, engaging external consultants can complement the regulator with specialised expertise, while also supporting the regulator's credibility.

When holding a consultation to advise the Government on energy policy matters, the Regulatory Authority requires the Electric Utility to submit a cost-benefit analysis of the proposed policy. The costs associated with its analysis are recoverable as a regulatory compliance cost, and would be reviewed during a rate case for prudence.

During such a consultation, the Regulatory Authority should also confirm that the Electric Utility's cost-benefit analysis uses appropriate financial assumptions, relies on a reasonable methodology, and is free of errors. For simpler matters, the Regulatory Authority may choose to carry out this review alone or, as with complex regulatory proceedings, it may choose to contract out some or all of these services to a consultant.

This consultation process will ensure that the most beneficial results are achieved from the Government's policies, particularly as conditions in the electricity sector evolve. It also ensures that proposed policies are fully considered by all major stakeholders.

Questions for Consultation:

- Should the Regulatory Authority serve as an independent advisor to the Ministry Responsible for Energy on energy policy matters?
- Should the Electric Utility be compelled to provide its own analysis of the costs and benefits associated with each policy alternative?

5.3 The Electric Utility

The Electric Utility is responsible for:

- Supplying electricity to end users
- Planning the electric system within the bounds set by policy, law, and regulation
- Operating its generation, transmission, and distribution assets efficiently
- Providing access to the transmission and distribution network in a non-discriminatory manner, including dispatching generation in merit order.

The Electric Utility is the single buyer (off-taker) of power from all generators. The Electric Utility meets demand by generating power itself, purchasing power from third parties (such as IPPs and distributed generators) under long-term contracts, and procuring demand-side resources. Demand-side resources are conservation measures that are designed to limit or reschedule electricity use so that the size and number of generating facilities can be reduced or delayed. The Electric Utility is responsible for forecasting demand and procuring energy to meet this demand, through the IRP process defined in this Policy.

The Electric Utility is also the sole party responsible for providing transmission, distribution, and retail services on the Island. The Electric Utility is subject to regulation by the Regulatory Authority.

Box 5.3: Reflecting on the Electric Utility

The Government affirms that there should be one transmission and distribution licensee in Bermuda. Transmission and distribution networks are natural monopolies, and it is not economically justified to build competing networks (separate physical assets) to deliver electricity to end users. Furthermore, it is not economically justified to separate the transmission and distribution functions of the Electric Utility.

The Government also affirms that there should be one electricity retailer in Bermuda. As a small island, the market for electricity retailing is not large enough to support the robust competition needed to realise cost savings for end users. Furthermore, retail competition would require complex regulatory provisions for a wholesale market and wheeling (use-of-system) charges, increasing regulatory costs without yielding meaningful savings for end users.

Few Caribbean islands have implemented retail competition. In Jamaica, the regulator has struggled to set wheeling charges that were at once cost reflective, transparent, simple to administer, and consistent with other tariffs. The regulator lacked the technical capacity to develop wheeling charges in-house, and the consultants that it hired developed an approach that was far too complex. The result was that the wheeling framework was overturned by the All-Island Electricity Tribunal in 2014 because it was inconsistent with the electric utility's bundled tariffs and failed to reflect costs.

Questions for Consultation:

- Should the Electric Utility have an accounting separation between its generation and transmission, distribution, and retail businesses? What would the costs and benefits of such a separation be, and would they be justified?

5.4 Independent Power Producers

It is the Government's policy to create an enabling environment for IPPs to introduce competition in generation, help reduce the cost of power in Bermuda, develop new energy sources, and contribute to achieving the other objectives of this Policy. For example, the Government recognises that IPPs may bring unique expertise that can yield high-quality generation using technologies not currently in the electricity matrix, thus promoting energy security and realising more opportunities to reduce local and global emissions.

IPPs generate and sell energy, capacity, and ancillary services (for example storage) exclusively to the Electric Utility under long-term contracts that have been secured through the IRP process, including least cost procurement (see Section 6).

> **Box 5.4: Reflecting on Independent Power Producers**
>
> This Policy is issued as the Electric Utility's generation asset base reaches the end of its useful life. IPPs can help replace some of this capacity with new technologies such as wind, solar, and cogeneration (among others). In some cases, IPPs may be able to generate at a lower all-in cost than a replacement unit owned by the Electric Utility, thus helping to reduce the average cost of power for Bermudians.
>
> **Questions for Consultation:**
>
> - Should the definition of IPPs be limited to those offering alternative energies (such as renewable energy, cogeneration, and so on)?
> - Should the definition of IPPs also include demand response aggregators (companies who get a group of customers to participate in a demand response program), provided they participate in the IRP process?

5.5 End Users

End users buy services from, and may sell services to, the Electric Utility. End users can buy energy, demand, and grid access services from the Electric Utility, but may also reduce their consumption during system peak load in exchange for compensation by the Electric Utility (other possible transactions are defined in Table 8.1). End users also play a key role in energy regulation and policymaking by filing complaints with the Regulatory Authority, and participating in public consultations.

> **Box 5.5: Reflecting on End Users**
>
> End users are at the heart of this Policy. The Policy aims to serve their needs by defining a framework for electricity service that is least cost, high-quality, environmentally sustainable, secure, and affordable. The Government strives to enable public participation in the policymaking and regulatory processes.
>
> **Questions for Consultation:**
>
> - Should any other mechanisms be defined in the Policy to enable public participation?

5.6 Distributed Generators

It is the Government's policy to create a clear, enabling regime for distributed generators. Distributed generators are end users with generation capacity that is connected to the distribution network and used to offset some or all of the end user's energy consumption.

An enabling regime for distributed generators hinges on a disaggregated tariff structure for the Electric Utility that:

- Ensures cost recovery by reflecting the Electric Utility's cost of providing services to distributed generators (energy, demand, and grid access services), and
- Fairly compensates distributed generators for the value of any energy produced by their distributed generation system.

Distributed generators also need assurances that they (i) will not be regulated as generation licensees; (ii) have an opportunity to recover the cost of their investment and earn a fair return over the economic lifetime of their investment; and (iii) face a consistent, efficient process for securing necessary permits and executing agreements with the Electric Utility subject to clear eligibility criteria. Section 7 of the Policy expands on these general principles for distributed generation within the electricity sector.

Box 5.6: Reflecting on Distributed Generators

As technology costs continue to fall, distributed generation is becoming increasingly accessible for Bermudians. Now more than ever, it is important to clearly define a regime for distributed generators, which explicitly recognises and provides for the unique needs of these end users.

Setting a price (or FIT) that fairly compensates distributed generators for the value of energy produced is difficult. General approaches fall into four broad categories:

- A FIT equal to the Electric Utility's avoided fuel cost to limit costs for ratepayers, and with a floor to ensure a reasonable opportunity to recover investment costs
- A FIT equal to the Electric Utility's avoided fuel cost plus a premium, and with a floor to ensure a reasonable opportunity to recover investment costs
- A FIT equal to the retail rate charged by the Electric Utility for energy purchased from the grid
- A FIT set above the Electric Utility's retail rate.

Setting the FIT at the retail rate for the ~1MW of solar PV currently installed imposes approximately BMD 450,000 per year in additional costs on the Electric Utility. This is equivalent to BMD 13.00 per rate payer per year. A FIT set above the retail rate would impose even higher costs. Ultimately, this decision must be made through public consultation by weighing economic costs with perceived benefits.

Section 7 of the Policy expands on the general principles defined here, and contains additional questions for consultation.

Questions for Consultation:

- Should the definition of distributed generation be modified to narrow or broaden its scope? For example, should the definition of distributed generation only include generators below a certain installed capacity (in kW) or using certain technologies (such as renewable energy)?
- Which approach should be used to set the FIT for energy from distributed generation? If the FIT generates additional supply costs, how should those costs be allocated?

6 Utility Scale Generation

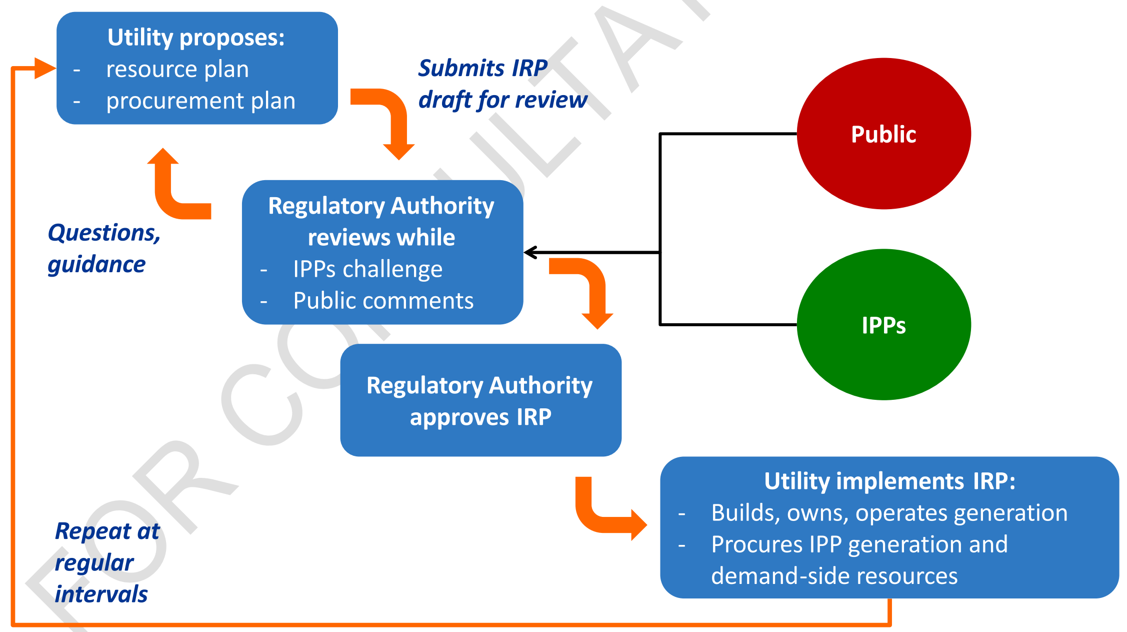
The Government affirms an IRP process as the only means for forecasting demand and planning for the resources (generation and demand-side resources) needed to meet it. An IRP creates an opportunity to periodically re-evaluate the country's aspirational electricity matrix in light of changing conditions (such as new technologies or cost reductions), while ensuring alignment with the long-term objectives defined in this Policy (Section 6.1). Once developed, an IRP also serves as a comprehensive roadmap for procuring needed resources (Section 6.2).

6.1 Developing an Integrated Resource Plan

It is Government's policy that the Electric Utility develop an IRP every three to five years, or as often as may be agreed between the Electric Utility and the Regulatory Authority. The IRP should clearly define expected demand, and how the Electric Utility plans to meet this demand over the planning horizon. In doing so, the IRP should consider all possible resources, including new generation capacity, demand-side resources (such as demand response and energy efficiency), and retirement of generation capacity. The IRP process weighs each potential resource against the objectives for the sector.

The IRP must be developed through an iterative, stakeholder-driven process involving the Electric Utility, IPPs, the Regulatory Authority, and the public. Figure 6.1 illustrates how the IRP process incorporates inputs from all of the major stakeholders.

Figure 6.1: Overview of the IRP Process



The process begins by the Electric Utility proposing an IRP containing (i) a resource plan and (ii) a procurement plan, both of which must comply with the objectives of this Policy. The resource plan should specify the mix of resources that will help meet forecasted demand: building or tendering new capacity, retiring capacity (if appropriate), and demand-side resources (such as demand response and energy efficiency). The accompanying procurement plan should specify how the Electric Utility plans to procure these resources.

The Regulatory Authority reviews the IRP, ideally with the assistance of external consultants to complement and support the Regulatory Authority's analytical capacity.

The Regulatory Authority should first review the IRP to see if the generation mix is least cost, and if the procurement plan is also designed to procure at least cost. In instances where least cost generation or procurement is not planned, the Regulatory Authority determines if:

- The Electric Utility's analysis is faulty (in which case the IRP will be rejected), or
- The plan is not least cost because of trade-offs made to accomplish other objectives (such as environmental sustainability or energy security).

If trade-offs have been made resulting in a plan that is not least cost, the Regulatory Authority scrutinises the Electric Utility's analysis of these trade-offs to ensure that they are consistent with this Policy's objectives.

The Regulatory Authority also accepts comments from the public, as well as formal challenges by IPPs and entities selling demand-side resources (such as peak load shifting or interruptible load). Challengers should be able to clearly articulate how their inclusion in the IRP would result in an electricity matrix that is more consistent with policy objectives (such as at a lower cost when considering any regulated externality costs). Furthermore, successful challengers should be able to demonstrate that:

- The proposed technology is commercially proven elsewhere
- They have secured an investment-grade feasibility study on the resource and the most appropriate technology
- They have experience in building, developing, and operating utility scale generation
- They have the financial resources to successfully execute the proposed project (such as through a performance bond).

If the Regulatory Authority is not satisfied that the IRP meets this Policy's objectives it submits questions or guidance to the Electric Utility. The Electric Utility responds to questions and critiques by submitting a revised IRP to the Regulatory Authority for reconsideration. This iterative process continues until the Regulatory Authority is satisfied with the IRP.

6.2 Executing the Integrated Resource Plan

The Electric Utility is responsible for securing generation and demand-side resources according to the approved procurement plan. The Regulatory Authority is responsible for supervising throughout the procurement process, with an independent transaction advisor contracted to support the Regulatory Authority. For projects approved in the IRP and involving public lands, the Regulatory Authority may choose to directly issue tenders if it can demonstrate this is in the public interest. The Regulatory Authority would draw on support from an independent transaction advisor to support the process.

In the case of IPPs (or demand response providers), the Regulatory Authority also oversees negotiations of power purchase agreements (PPAs) between the Electric Utility and these third parties. This ensures that transaction costs are minimised by ensuring a fair and efficient negotiation process. The Regulatory Authority also ensures that any negotiated PPA also allows the Electric Utility to guarantee quality of service for its end users.

It is also the Government's policy to promote an interconnection policy that enables IPPs that have executed a PPA to interconnect efficiently, and in a manner that is cost-neutral to the Electric Utility. This interconnection policy should ensure that:

- Network investments needed to accommodate IPP generation are only undertaken once an IPP has entered into an interconnection agreement with the Electric Utility
- IPPs are required to fund and finance connection costs upfront, but are not obliged to pay ongoing connection charges
- Eligible IPPs are permitted to use standardised interconnection agreements, depending on the size of the generator.

Box 6.1: Reflecting on Utility Scale Generation

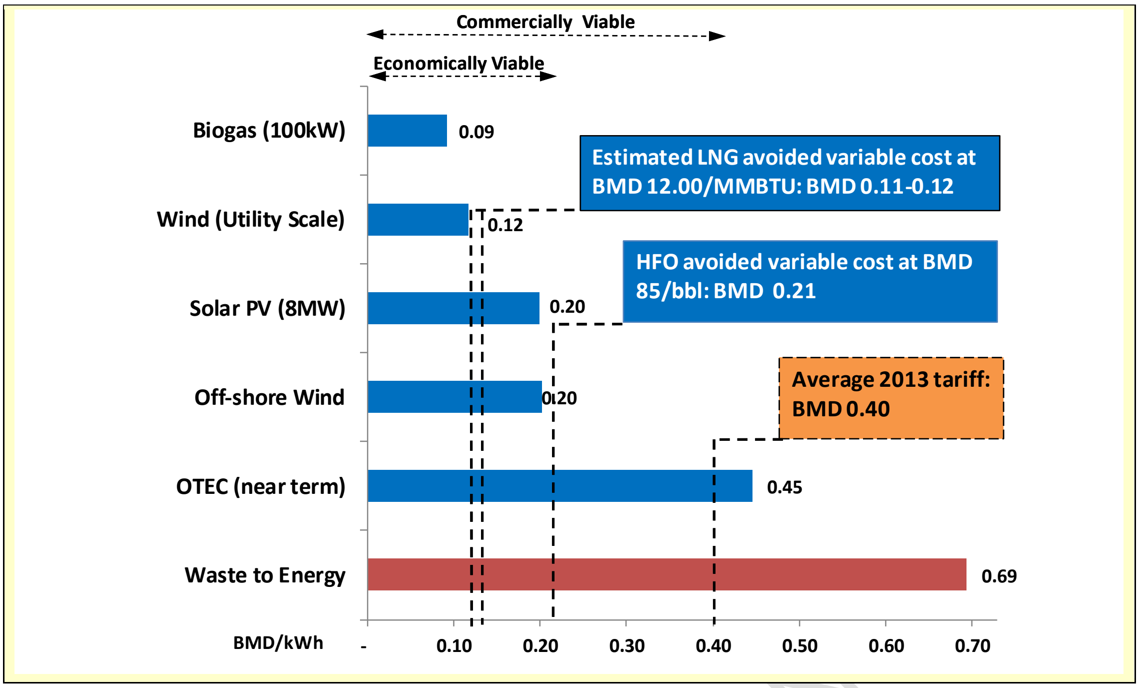
The IRP process supports an evolutionary path for generation, reflecting input from all stakeholders while remaining within the constraints of this Policy's objectives: electricity service that is least cost, high-quality, environmentally sustainable, secure, and affordable. The Regulatory Authority plays a central role in this process, and is responsible for ensuring that the resulting IRP is in the best interests of ratepayers (and the country).

Some jurisdictions in the Caribbean have adopted similar stakeholder-driven IRP processes. For example, in Barbados, an IPP may challenge the IRP before the Regulatory Authority, if the IPP is able to demonstrate it can generate at a price below the utility's avoided cost. In addition, over 39 states in the United States require utilities to periodically file IRPs, developed through a robust public consultation process.

The Regulatory Authority also plays a central role in ensuring that procurement resulting from the IRP is executed in a least cost manner. It does so by approving the procurement plan before the IRP is finalised, monitoring the procurement process (with the assistance of an independent transaction advisor), and stepping in when necessary to ensure that the procurement plan is executed efficiently and in the best interests of end users. In some instances, such as projects involving public lands, the Government may wish to be directly involved in the procurement process if it can demonstrate that this approach is in the public interest. The Regulatory Authority, with support from an independent advisor, must ensure that such tenders are least cost, fair, and transparent.

Questions for Consultation:

- In many jurisdictions in the United States, the utility is required to hold public consultations on the proposed IRP prior to submitting it for regulatory review (at which point formal comments can also be filed). To contrast, the Government proposes seeking public comment after the Electric Utility has initially filed its IRP with the Regulatory Authority. Should there be a consultation process during the Electric Utility's initial development of the IRP (before it is submitted formally to the Regulatory Authority)?
- Should the Regulatory Authority have a role in the procurement process, beyond monitoring and enforcing the Electric Utility's compliance with the procurement plan?
- How much of a price premium is acceptable to favour utility scale renewable energy generation over conventional generation (such as natural gas and HFO)? The figure below compares the estimated long-run marginal cost of generation from different utility scale renewable technologies with fossil fuel resources. Note that the waste to energy plant cost is based on the capacity expansion currently underway. All supply/demand scenarios in this document include the same waste to energy capacity.



7 Distributed Generation

It is the Government's policy to have an enabling environment for cost-effective distributed generation. High transaction costs and excessive regulatory barriers can prevent socially optimal investment in distributed generation. An enabling environment removes uncertainty for potential distributed generators by:

- **Clearly defining who is eligible**. The Regulatory Authority must establish eligibility requirements to be considered a distributed generator. These requirements may include limits on individual system capacity (in kW), total installed capacity on the grid (in MW), and specific technologies (for example, only renewable energy may be eligible). The Regulatory Authority may also set these limits in tranches, in order to enable 'learning by doing' while retaining flexibility to scale up over time
- **Creating exemptions from licencing requirements**. Exemption from the licensing regime reduces transaction costs and ongoing regulatory compliance costs for distributed generators
- **Creating a streamlined process for securing necessary permits**. Reduced or harmonised permitting requirements (such as environmental and planning permits) reduce regulatory uncertainty and transaction costs for distributed generators
- **Setting standard, simplified technical requirements for interconnection to the distribution network**. Standardised and simplified technical requirements reduce installation costs, as well as transaction costs (by enabling faster inspection and commissioning)
- **Establishing standard terms for fairly compensating distributed generators**. Standard terms set the price at which distributed generators will be compensated, the duration of the guaranteed price, metering arrangements, and so on. The price offered must be based in part on a cost-reflective,

disaggregated tariff structure set for the Electric Utility (and described in Section 8).

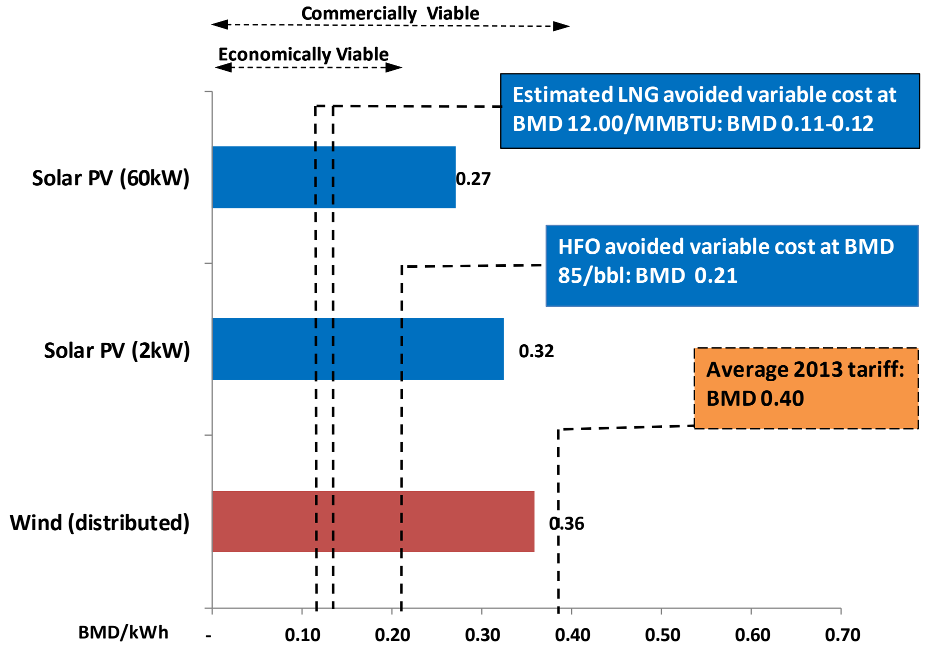
It is also the Government's policy that the Electric Utility's obligation to provide a high-quality electricity service supersedes its obligation to connect distributed generation, in the event that these conflict. The Electric Utility is not obligated to interconnect distributed generation if it can demonstrate to the end user (subject to verification by the Regulatory Authority) that doing so threatens quality of service.

Box 7.1: Reflecting on Distributed Generation

The Government is supportive of cost-effective distributed generation, by laying out clear pathways to secure resource rights, land, permits, and approval to interconnect to the Electric Utility's distribution network. However, this Policy does not prescribe a preferred commercial arrangement (such as a price premium over energy from the grid). Rather, it specifies a tariff structure that promotes a socially optimal level of investment in distributed generation.

Questions for Consultation:

- Should there be a price premium to favour distributed generation over generation from the grid? Should a premium only be afforded to distributed, renewable energy—or to all distributed generation? The figure below compares the estimated long-run marginal cost of generation from different distributed-scale renewable technologies to the appropriate benchmarks of fossil fuel generation.



8 Transmission, Distribution, and Retail

It is the Government's policy that there be a single provider of transmission, distribution, and retail services.

The Electricity Utility and end users have a transaction-oriented relationship, presenting opportunities for each party to buy and sell services to one another. For example, end users may choose to install distributed generation, with the intent of offsetting at least part of their energy consumption from the grid (see Table 8.1 for examples of other possible transactions). Transactions involving use of the transmission and distribution network should be subject to regulation by the Regulatory Authority, while other transactions can be unregulated because they are subject to competition from third parties.

Table 8.1: Examples of Transactions between the Electric Utility and End Users

Regulated Transactions	Unregulated Transactions
▪ Energy, demand (capacity), and grid access from the Electric Utility to end users ▪ Distributed generation from end users to the Electric Utility ▪ Load reduction during system peak from end users to the Electric Utility	▪ Energy efficiency services from the Electric Utility to end users ▪ Mini-grid solutions (for improved resilience) from the Electric Utility to end users ▪ Development and installation services for distributed generation, from the Electric Utility to end users

A transaction-oriented relationship between the Electric Utility and end users must be supported by a tariff structure that is disaggregated by service offered (energy, demand, network access, and other ancillary services) and reflective of the cost of offering each service. Such a tariff structure will ensure that the Electric Utility is made whole for its cost of offering these services, and that it similarly pays economically justified prices to end users who sell services (such as distributed generation, peak load shifting, interruptible load, and energy efficiency) to it.

Finally, the Regulatory Authority is responsible for carrying out routine benchmarking of the transmission and distribution performance of the Electric Utility against international peers. This process ensures that the Electric Utility's service standards continue to remain in line with global norms.

Where appropriate, the Regulatory Authority creates incentives for the Electric Utility to operate efficiently and to take actions that are supportive of this Policy's objectives. In setting these incentives, the Regulatory Authority ensures that the Electric Utility is allowed an opportunity to earn a fair return on investment.

Box 8.1: Reflecting on Transmission, Distribution, and Retail

The Government affirms its policy of a sole provider of transmission, distribution, and retail services because:

- Transmission and distribution are natural monopolies
- Retail competition would create additional costs that are not justified by the benefits in an electricity sector as small as Bermuda's.

However, the Government also recognises the need for effective regulatory oversight to ensure that the Electric Utility, as a monopoly, does not operate inefficiently or 'gold-plate' the system by making imprudent investments in order to seek higher revenue.

Questions for Consultation:

- What mechanisms should the Government consider to ensure that the Electric Utility operates efficiently (and thus controls costs for end users)?

9 End Use

It is the Government's policy to promote efficient use of electricity. Despite the high cost of electricity, many end users still do not use electricity efficiently. Often market barriers prevent private citizens, businesses, and government agencies from using technologies that save energy and save money, justifying some government intervention.

The Government promotes energy efficiency by:

- Planning for demand-side resources (Section 9.1)
- Ensuring that new facilities are energy efficient (Section 9.2)
- Helping existing facilities become more efficient (Section 9.3)
- Helping end users become more efficient (Section 9.4).

9.1 Planning for Demand-Side Resources

It is the Government's policy that the electric utility's system planning considers and uses efficiency as a resource to meeting the supply/demand balance. Just as a new generating unit can help supply and demand meet, so too should a targeted reduction of demand.

The use of demand-side resources should therefore be a part of the IRP process. Demand-side resources are conservation measures taken to limit or reschedule electricity use. This can reduce the size and number of generating facilities the utility requires, or delay new facilities. Consumers who limit or reschedule their use may be compensated for their efforts.

9.2 Ensuring that New Facilities are Energy Efficient

It is the Government's policy that both publically and privately owned buildings be constructed (or remodelled) in an energy efficient manner. This requires that building codes be updated on an ongoing basis to account for developments of new technologies and construction practices.

The Government also supports efforts to use internationally recognised efficiency standards and certifications in building construction and design. This makes it easier for households and businesses to improve building energy performance beyond the minimum standard. An example of such a certification is the Leadership in Energy and Environmental Design (LEED) certification.

The Government leads by example by meeting high energy efficiency standards in its facilities. The Government exceeds building code requirements in its new or remodelled buildings; it may do this by following a locally recognised voluntary standard. The Government supports efficient technology in other public facilities, in particular public lighting.

9.3 Helping Existing Facilities Become More Efficient

It is the Government's policy to support energy efficiency audits and retrofits for existing buildings, both public and privately owned. Businesses stand to gain from energy retrofits, but often lack the information or capital to make the upfront investment required. Similarly, the Government could be more efficient in its energy use, but often lacks the incentive structure to motivate decision makers to choose more efficient options. Also, like business, it may not have the capital for upfront investments.

It is the Government's policy to develop, as needed, support programs to help businesses improve the performance of existing facilities. The Government prioritises programs that help businesses understand and invest in money-saving energy efficiency initiatives such as:

- Convening business leaders for dialog around energy efficiency
- Coordinating the bundling of energy audits or retrofits among multiple businesses
- Creating a publicity campaign.

If these measures are insufficient, the Government may implement other measures such as:

- Creating a Government-financed fund to finance private sector retrofits
- Implementing financial incentives (tax relief, customs relief, or direct cash transfers) for energy efficiency equipment and services.

It is the Government's policy to monitor the energy performance of energy consuming public buildings and facilities, with the goal of identifying energy saving opportunities. It does this through periodic energy audits. Based on the results of the audits, the Government implements strategies to reduce energy use, such as contracting with an energy services company (ESCO), or making purchases of more efficient equipment.

9.4 Helping End Users Become More Efficient

It is the Government's policy to help end users consume electricity more efficiently by overcoming the barriers that prevent them from doing so. Example of barriers include: lack of awareness by end users of energy efficiency technologies, mistrust of new technologies, lack of financing to purchase energy efficiency equipment, and so on.

The Government helps end users understand and invest in money-saving energy efficiency initiatives using actions such as (and not limited to):

- Instituting public education curriculum on energy use and conservation
- Producing public outreach materials on energy use and conservation
- Requiring energy labelling on energy consuming equipment
- Considering time of use pricing (and the required smart meters) to help end users regulate their consumption.

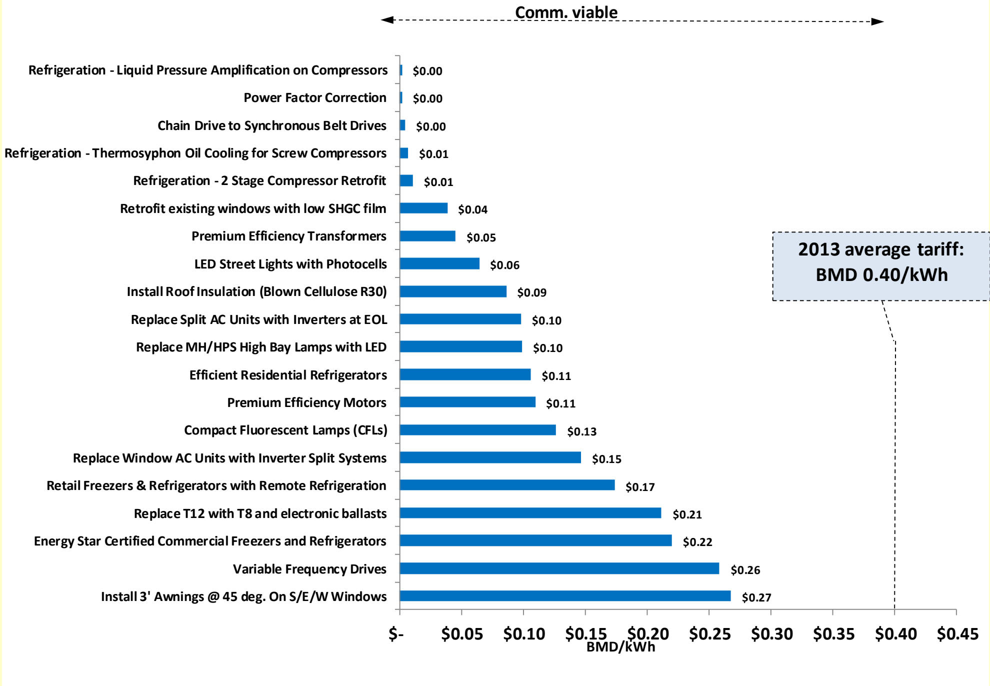
If these measures are not successful in spurring greater adoption of energy efficiency, the Government may consider other actions including:

- Creating a Government-financed facility for end users to finance energy efficient equipment
- Creating a subsidised audit program for residential end users
- Banning inefficient equipment.

For end users already receiving the Government's support for their electricity bills, the Government may consider direct grants for energy efficiency. These energy efficiency investments would maintain or improve the service the recipient receives, while also potentially reducing the subsidy the Government pays toward the recipient's electricity bill.

Box 9.1: Reflecting on End Use

Public interventions to support energy efficiency are common in other jurisdictions. Because power costs are relatively high in Bermuda, most efficiency technologies save money without any subsidies (see figure below).



For this reason, the policy prioritises initiatives that encourage end users to make money-saving investments in efficiency themselves. The policy also includes additional stronger actions, but specifies that they will only be used if the first set of actions are unsuccessful in meeting the Government's objectives.

Questions for Consultation:

- Are there specific energy efficiency programs that should also be given as examples in the Policy?
- What barriers are most common in preventing businesses from investing in energy efficiency? What about for private citizens?

10 New Legislation, Licencing, and Permitting

It is the Government's policy to provide the legal, licencing, and permitting framework necessary to achieve its objectives for the sector. This framework supports the structure of the sector, the policy measures governing generation (utility and distributed), and the policy measures governing transmission, distribution, and retail.

It is Government's policy that the Electricity Act ('the Act') and other relevant Acts create the sector structure defined in the Policy (Section 5). The Act gives responsibility for electricity regulation to the Regulatory Authority and defines its responsibilities. The Act defines the licencing regime for generation and transmission, distribution, and retail.

It is Government's policy that licenses for generation, transmission, distribution, and retail exist separately from the Act, according to the licensing regime defined by the Act. Licences define the rights and responsibilities of the licensees, in line with this Policy. The licences also define the regulatory process and how the licensees interact with the regulator.

It is Government's policy to have environmental permitting and planning requirements that appropriately govern development of new power sources in Bermuda in line with Bermudians' expectations. These requirements must be adequate to efficiently inform private investors in electricity of what they can and cannot do. Permitting and planning requirements shall cover:

- Renewable energy resources such as large scale solar, onshore wind, offshore wind, and marine energy (wave, tidal, ocean thermal)
- Liquid and gaseous fossil fuels used for power generation in Bermuda.

Box 10.1: Reflecting on New Legislation, Licencing, and Permitting

This section makes it Policy for Government to provide the legal and regulatory framework required to enable the sector structure and regulatory principles established in the Policy.

11 Next Steps in the Policy Development Process

The next steps in developing the Policy will be:

1. **Receive public comments** (until March 13, 2015)—the documents will be available online at www.energy.gov.bm, or in print from the Department of Energy office at Corner House, 4th floor, 20 Parliament Street. Comments will be welcomed until close of business, March 13, 2015
2. **Prepare Draft Policy based on public comments** (end of March, 2015)—the Department of Energy will review all comments prepare a Draft Policy based on those comments
3. **Present Draft Policy to Cabinet** (early April, 2015)—the Policy will be submitted for discussion by Cabinet.

Appendix A: References

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Appendix B: Assumptions Used in Electricity Scenarios

This appendix presents the assumptions used in the electricity sector scenarios, organized by topic.

Demand growth assumptions

Growth assumptions for peak demand and energy sales follow the Bermuda Electric Light Company's (BELCO) 'high' forecast for growth from its 2014-2015 IRP. These growth assumptions are:

- Peak demand
  - Growth through 2016: 0.2 percent per year
  - Growth after 2016: 0.6 percent per year
- Energy sales
  - Growth through 2016: 0.2 percent per year
  - Growth after 2016: 0.6 percent per year

These assumptions consider economic, population, and efficiency impacts on growth.

Energy efficiency

The sector scenarios assume that 25 percent of customers across every customer class (except street lighting) adopt the full-suite of energy efficiency measures available to them between 2015 and 2020. Each customer class is modelled uniquely to account for the different energy use profiles of that class. In every scenario all street lights are assumed to be retrofitted with light-emitting diode (LED) technology by 2021.

Fuel prices

All scenarios rely on the same fuel price assumptions. These are:

- Oil at US$85 per barrel
- Natural gas delivered at US$11.62 per million British thermal units (MMBtu); this cost is pre-regasification (regasification assumptions are explained in the capital cost section below). Specific components of this price are:
  - Well head price + margin: US$9.10 per MMBtu
  - Liquification: US$2.26 per MMBtu
  - Shipping: US$0.26 per MMBtu

Capital and generation costs

Capital costs in the scenarios are based on actual capital costs observed in small island markets in the region. Offshore wind prices are based on US Energy Information Administration assumptions for the United States. OTEC costs are based on the budget for a pilot project in Martinique. Table B.1 summarizes the capital costs and levelized generation costs by technology.

Table B.1: Capital and Generation Costs of Renewable Energy

Technology	Unit	Solar PV (60kW polycrystalline, fixed, commercial)	Solar PV (2kW thin film, fixed, small)	Solar PV (8MW monocrystalline, fixed, utility scale)	Off-shore Wind (Utility Scale)	OTEC	Tynes Waste to Energy	Wind (10kW distributed scale turbines)
Installed capacity (plant size)	kW	60	2	2,000	20,000	5,700	7,400	10
Unit Capital Cost	BMD/kW	$3,500.00	$ 4,250.00	$ 2,500.00	$5,600.00	$22,473.68	$9,459.46	$6,000.00
Discounted Future Unit capital cost	US$/kW	3,500.00	$4,250.00	$2,500.00	$5,600.00	$ 22,473.68	$9,459.46	$6,000.00
Fixed O&M costs per year (incl. insurance)	US$/kW/yr	$30.00	$30.00	$ 30.00	$74.00	$1,100.00	$270.27	$44.00
Fuel cost per kWh	BMD/kWh						$(0.32)	
Variable O&M Costs	US$/MWh						$0.43	$0.02
Lifetime	Years	20	20	20	20	25	20	20
Capacity Factor	%	17%	17%	17%	38%	85%	31%	22%
Output per kW capacity per year	kWh/kW/yr	1,489	1,489	1,489	3,329	7,446	2,699	1,910
Total system cost	US$	$210,000	$8,500	$5,000,000	$112,000,000	$ 128,100,000	$70,000,000	$60,000
Annualized capital cost	US$/yr	$22,353	$905	$532,208	$11,921,459	$12,621,150	$7,450,912	$6,386
Annual O&M costs	US$/yr	$1,800	$60	$60,000	$1,480,000	$6,270,000	$4,200,000	$440
Annual output per system	kWh/yr	89,352	2,978	2,978,400	66,576,000	42,442,200	19,974,000	19,097
Capital cost recovery factor per kWh	US$/kWh	$0.25	$0.30	$0.18	$0.18	$0.30	$0.37	$0.33
O&M cost per kWh + Fuel Cost	US$/kWh	$0.02	$0.02	$0.02	$0.02	$0.15	$0.32	$0.02
Total Long Run Marginal Cost	**US$/kWh**	**$0.27**	**$0.32**	**$0.20**	**$0.20**	**$0.45**	$0.69	$0.36

The scenarios account for certain decreases in capital costs. In each scenario, the cost of solar PV is assumed to decline by two percent per year over the forecast period. As explained in Section 4.2, the aspirational matrix uses a lower OTEC capital cost, in the spirit of leaving space for a future technology—which may or may not be OTEC. The underlying assumption is that a future technology will be able to provide base load generation at a cost equivalent to the variable cost of natural gas generation.

The scenarios with natural gas assume a capital cost of BMD 106 million to construct a regasification facility. This is based on feasibility studies done for the Caribbean. Such a facility may cost more, but the scenarios assume that other industries would use the facility, spreading the capital costs around (and reducing the capital cost counted to the electric sector).

Reserve margin

The business as usual scenario assumes an 'N-3' reserve margin. This means that the utility must have backup units to meet peak demand in the event that its three largest units are unavailable.

All scenarios besides the business as usual scenario assume an 'N-2' standard, meaning the utility has backup units to meet peak demand in the event that its two largest units are unavailable.

Carbon price

The scenarios assume that there is not a price on carbon when calculating cost of supply. The scenarios do calculate emissions in each scenario. This permits a calculation of the cost of supply under different carbon price scenarios.

GOVERNMENT OF BERMUDA

Ministry of Economic Development

Department of Energy