Government of Bermuda
Ministry of Economic Development

The National

Electricity Sector Policy

of Bermuda

5th June, 2015

Government Administration Building • 30 Parliament Street • Hamilton HM 12 •
Telephone: (441) 296-1574 • Fax: (441) 296-0137

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Abbreviations and Acronyms

ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BAU	Business as usual
BELCO	Bermuda Electric Light Company
bEQ	Building Energy Quotient
BMD	Bermuda dollar
CO_2	Carbon dioxide
DG	Distributed generation
EE	Energy efficiency
ESCO	Energy services company
FIT	Feed-in tariff
GHG	Greenhouse gases
GWh	Gigawatt-hour
HFO	Heavy fuel oil
IPP	Independent power producer
IRP	Integrated Resource Plan
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
PPA	Power purchase agreement
PV	Photovoltaic
US	United States

Definitions

Barrel	A unit of volume equal to 42 US gallons, or 159 litres
Bulk generation	Generating system that (unlike distributed generation) is built on a dedicated site, is developed for commercial purposes of selling all energy produced, and is connected to higher voltage lines for being distributed to the entire customer base. Importantly, bulk generation may be operated by the Electric Utility or by IPPs
Carbon dioxide equivalent (CO_2e)	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. In 'equivalent' terms, all other greenhouse gases can be added up and expressed as CO_2 based on their global warming potential, that is their ability to trap radiation (greater for some GHGs than for others)
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
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	Generating system on the premises of an end user (residential, commercial, or industrial) that is connected to the distribution network and used to offset some or all of the customer's energy consumption; this could also include an energy storage system. Depending on the type of end user implementing it, a distributed generation system may be at a residential, commercial, or industrial scale
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 ('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 electric 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
Electricity generation ('generation')	The process of producing electric energy, or the amount of electric energy produced by transforming other forms of energy into electrical energy
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)	Entity that provides energy, capacity, and ancillary services for commercial purposes at a bulk scale to the Electric Utility under long-term contracts that have been secured through the IRP process
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, etc.)
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 (MW)	One million watts, or one thousand kilowatts of electrical power
Megawatt-hour (MWh)	A unit of electrical energy equal to one megawatt of power expended for one hour

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
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)

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 as well as emissions of global greenhouse gases (GHG) produced by electricity generation, 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 Electric Utility, end users, and Government.

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

The Policy:

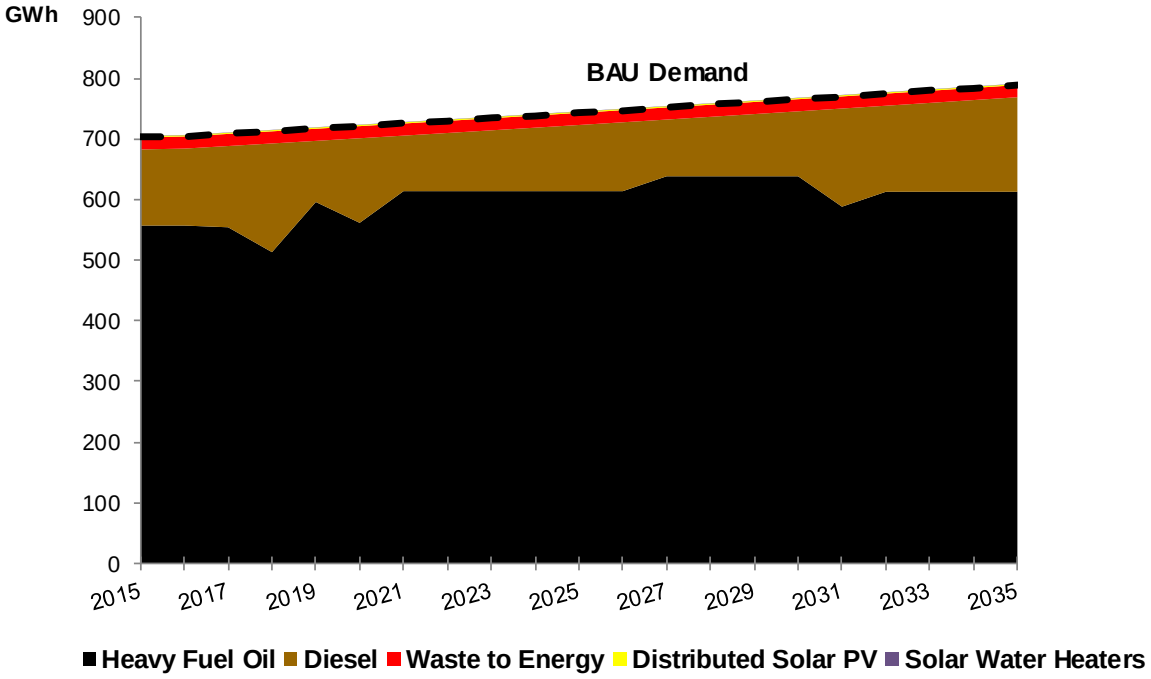
- Articulates Bermuda's objectives for the electric sector (Section 3)
- Presents a vision of what the sector will look like, using indicative targets based on an aspirational matrix of supply- and demand-side options (Section 4)
- Shows the desired structure of the sector, including roles and responsibilities 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 this subsector will play in accommodating new generation sources (Section 8)
- Defines Government support of more efficient use of electricity (Section 9)
- Identifies the legal framework that supports Policy implementation (Section 10).

Appendix A provides references to sources consulted, and Appendix B presents the assumptions used to develop the aspirational matrix.

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 generation. 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.

Priority policy actions identified to address these concerns include:

- Implementing a new Electricity Act and regulatory framework, to:
  - Allow generation by independent power producers (IPPs), as well as distributed generation by residential, commercial, and industrial customers
  - 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 includes the work of the Energy Working Group, as well as the outcome of consultations with energy sector stakeholders and the public held in November 2014 and January–February 2015.

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 for reliability and customer service
- **Environmentally sustainable**: electricity service that, over time, does not cause economic harm to Bermuda's sensitive natural environment, or cause economic harm to the global environment
- **Secure**: electricity service that is provided using a mix of primary energy options that are procured from reliable sources and under terms that make Bermuda resilient to shocks (such as dramatic changes in the availability or price of fuels, or the introduction of binding commitments to reduce greenhouse gas emissions)
- **Affordable**: electricity service that allows all Bermudians to pay for at least a basic supply, while preserving (where cross-subsidies for ensuring basic supply are involved) the competitiveness of Bermuda's 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.

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).

These indicative targets, and the aspirational matrix, were derived from an electricity sector planning model that was commissioned by the Government for the purposes of defining this Policy. The model forecasts demand for, and supply of, electricity in Bermuda over a 20-year period. The Government held public consultations to help select the preferred scenario, which consists of a mix of least-cost and renewable energy generation, along with a reduction in demand over time. The assumptions used in this model to develop the aspirational matrix (and indicative targets) are presented in Appendix B.

4.1 Targets

Indicative targets shown in Table 4.1 allow benchmarking the sector in terms of share of renewable generation, diversity of supply, emissions of GHGs, and energy efficiency.

Table 4.1: Targets for Electricity Performance

Target	Unit	2020	2025	2035
Share of renewable generation	%	8%	35%	38%
Share of generation by source	Natural gas %	92%	65%	62%
	Waste to Energy %	3%	3%	3%
	Bulk Scale Solar PV %	2%	2%	2%
	Distributed Solar PV %	1%	2%	6%
	Solar water heaters %	2%	2%	2%
	Future Renewable Energy Base Load %	0%	26%	25%
Share of peak demand by source †	Natural gas %	91%	117%	122%
	Waste to Energy %	6%	6%	6%
	Bulk Scale Solar PV %	8%	7%	7%
	Distributed Solar PV %	6%	9%	24%
	Solar water heaters %	7%	8%	10%
	Future Renewable Energy Base Load %	0%	21%	20%
Annual emissions	Tons CO_2e	401,488 (-33% vs BAU)	289,980 (-52% vs BAU)	294,663 (-55% vs BAU)
Energy efficiency / conservation	Average annual consumption per end user, in MWh (includes self-generation)	16.50 (5.2% below BAU)	16.97 (5.2% below BAU)	17.93 (5.2% below BAU)

Note: † Share of peak demand by source adds up to more than 100% due to reserve margin (installed capacity > peak demand). BAU = business as usual. CO_2e = carbon dioxide equivalent.

Specifically, the targets include:

- **Share of renewable generation**: a percentage expressing the amount of total energy generated (in GWh) that comes from renewable energy sources—from almost nothing today, to about 38 percent in 2035
- **Share of generation by source**: a percentage expressing the amount of total energy generated (in GWh) from each generation source. Adding together the shares of each renewable energy source results in the overall 'share of renewable generation' mentioned above
- **Share of peak demand by source**: a percentage expressing the portion of peak electricity demand that is met by each generation source. Peak demand is defined as the instantaneous power that can be served by installed generation capacity (measured in GW). To use an analogy from the water sector, energy (in GWh) would be equivalent to the volume of water that can flow through a pipe over a certain amount of time. Capacity (in GW) is equivalent to the diameter, or width, of that pipe and its pressure rating. Total installed capacity of an electric system (particularly on an island such as Bermuda) needs to exceed peak demand by a 'reserve margin' to allow for meeting peak demand even if some generation capacity is unavailable. This is why the sum of the percentages for this target exceeds 100 percent. Furthermore, percentage shares of peak demand by source differ from percentage shares of generation for these same sources. This is because some types of plant can generate energy at any time as long as there is fuel (such as natural gas or waste)—these are called 'firm' generation sources, which can be used to serve 'base load,' or serve demand at all hours. Other types of plant only generate energy some of the time (such as wind or solar)—these are called 'non-firm' generation sources, or sometimes 'intermittent' generation sources. Given a same installed capacity, firm generation sources will generally produce more energy than non-firm generation sources
- **Annual emissions**: these are GHGs expressed in tons of carbon dioxide equivalent (that is, various GHGs all added up as the main GHG, carbon dioxide, based on each GHG's ability to trap radiation and contribute to global warming). As Bermuda's generation mix becomes more renewable in time, emissions of GHGs decrease (even as total generation increases to meet demand), reaching 55 percent less than business as usual by 2035
- **Energy efficiency and conservation**: this shows average consumption by end user which, in spite of an overall increase in demand over time, can be contained by over 5 percent less than business as usual thanks to energy efficiency (consuming less for a same level of production or welfare, or consuming the same for a higher level of production or welfare, thanks to new and better equipment and material) and energy conservation (not consuming energy that is not needed, thanks to better practices).

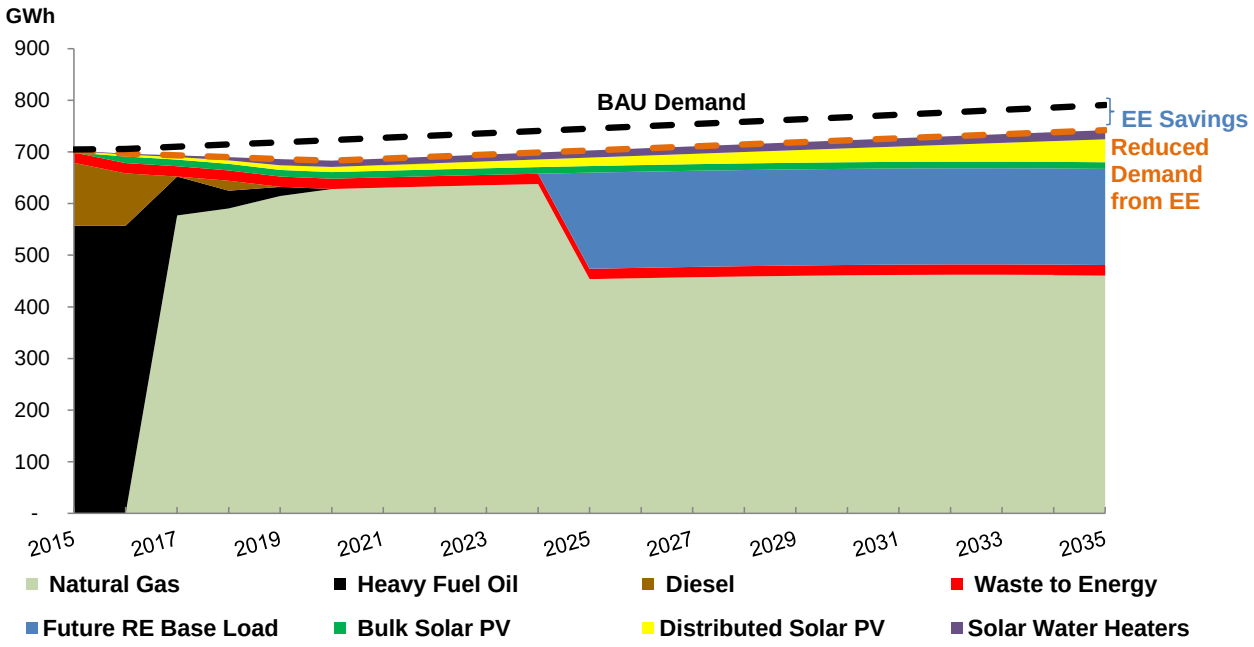
Indicative targets provide a measuring post to track performance towards achieving the Policy's objectives. Because they depend on certain assumptions about the future, it may be that the targets are exceeded; or it may be that they are not met. Indicative targets are non-binding, meaning that no party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

4.2 The Aspirational Matrix

The aspirational matrix (Figure 4.1) illustrates how the indicative targets for renewable energy generation and energy efficiency/conservation could be achieved over a 20-year period, from 2015–2035. For example, by 2025 the Government believes that 35 percent of electricity generated can come from renewable energy—with 26 percent coming from a future renewable energy technology, 4 percent coming from solar PV, 2 percent coming from solar water heating, and 3 percent from waste to energy. The aspirational matrix also assumes that energy demand can be reduced by 5.2 percent relative to business as usual, through energy efficiency and conservation.

The electricity sector model used to derive this matrix assumes both demand-side and supply resources will be used, without prescribing specific investments to be made. Actual investment decisions are made through an integrated resource plan (IRP), which reviews and revises the aspirational matrix using the best available data at the time the IRP is produced (see Section 6.1). Investment decisions made through the IRP process may differ from those shown in the aspirational matrix.

Figure 4.1: Aspirational Electricity Matrix, 2015–2035



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

- **Natural gas**—considering also the cost of the regasification terminal to convert liquefied natural gas (LNG) back to its gaseous state
- **Future renewable energy base load**—this is a slot reserved for a future base load renewable technology, with a priority for locally available renewable resources; however it could be open to imported renewable sources as well. This slot is built on the assumption that such renewable technology can reach a generating cost of BMD 0.14 per kWh by 2025 (at the level of LNG generation)

- **Bulk scale solar PV and distributed solar PV**—these resources grow over time to a combined level of about 31 percent of peak demand, assuming that the grid is upgraded and that the Electric Utility learns from experience how to best integrate solar
- **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: (i) efficient air conditioning; (ii) efficient lighting; (iii) efficient refrigeration; (iv) passive cooling (insulation, window tints, and so on); and (v) 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.

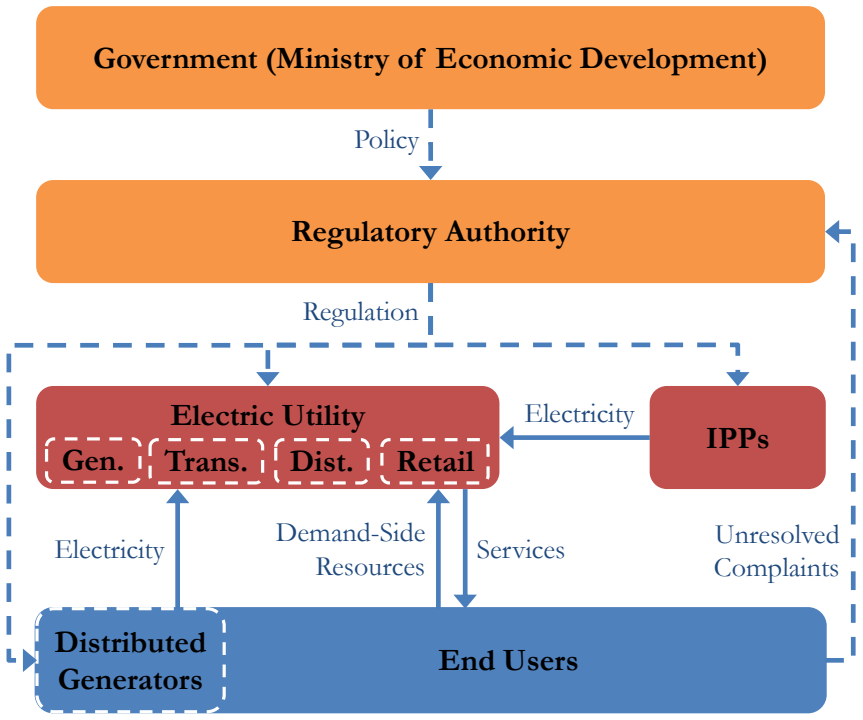
5 Desired Structure of the Electricity Sector

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 of Economic Development (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 of Economic Development 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. Private businesses that compete to provide goods and services to each of these entities are an important part of the electricity sector, but for simplicity are not illustrated below.

Figure 5.1: Desired Structure of the Electricity Sector



Notes: Dotted arrows indicate policy or regulation. Solid arrows indicate goods or services. Functions of the Electric Utility are divided to indicate separate regulatory accounts.

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

5.1 The Ministry of Economic Development

The Ministry of Economic Development 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 within the Government (and with other countries) on smaller-scale policy matters, such as an energy efficiency labelling initiative.

The Ministry has two 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.

5.2 The Regulatory Authority

The Regulatory Authority is the sole body responsible for 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 that have not been solved through the Electric Utility's own customer service processes.

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 Electric Utility's total revenue on a small island

- **Ensures specialised skills remain available**. Regulation is a highly specialised skill; the Regulatory Authority needs to ensure sufficient skills in-house to regulate the electricity sector, while outsourcing those skills that are only needed on specific occasions every several years
- **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.

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 those who are distributed generators at a residential, commercial, or industrial scale).

The Regulatory Authority also serves as an independent technical advisor to the Government on energy policy matters and helps the Ministry understand trade-offs implied by policy decisions; the Regulatory Authority does not advise on which policy direction to take. At the request of the Ministry of Economic Development, 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 of Economic Development; the Ministry uses this analysis to inform its decision.

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 bulk power itself, purchasing power from third parties (bulk generation from IPPs, and distributed generators from residential, commercial, and industrial end users) 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 resources 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. To facilitate effective regulation, and particularly cost-reflectiveness of tariffs, the Electric Utility will maintain separate regulatory accounts for each of its lines of business (generation, transmission, distribution, and retail).

5.4 Independent Power Producers

It is the Government's policy to create an enabling environment for IPPs to introduce competition in bulk 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 are entities that provide energy, capacity, and ancillary services (for example storage) for commercial purposes, exclusively to the Electric Utility under long-term contracts that have been secured through the IRP process (see Section 6).

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 unsolved complaints with the Regulatory Authority, and participating in public consultations. The Regulatory Authority may also, at its discretion, establish advisory committees consisting of a representative mix of end users. Advisory committees support the regulatory process by establishing a dedicated mechanism for the Regulatory Authority to seek feedback from the public on various matters within the electricity sector.

5.6 Distributed Generators

It is the Government's policy to create a clear, enabling regime for distributed generators. Distributed generators are end users (residential, commercial, or industrial) with generating units that are 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. This may be set to reflect financial value (according to avoided generation cost), as well as economic value (accounting for externalities and benefits not captured in avoided cost).

Matters of cost recovery and the value of distributed generation will be regulated by the Regulatory Authority.

Distributed generators also need assurances that they: (i) can easily secure a licence through a standardised and streamline application process; (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.

6 Bulk Generation

'Bulk generation' refers to generating systems that (unlike distributed generation, treated in the next section) are built on a dedicated site, are developed for commercial purposes of selling all energy produced, and are connected to higher voltage lines for being distributed to the entire customer base. Importantly, bulk generation may be operated by the Electric Utility or by IPPs.

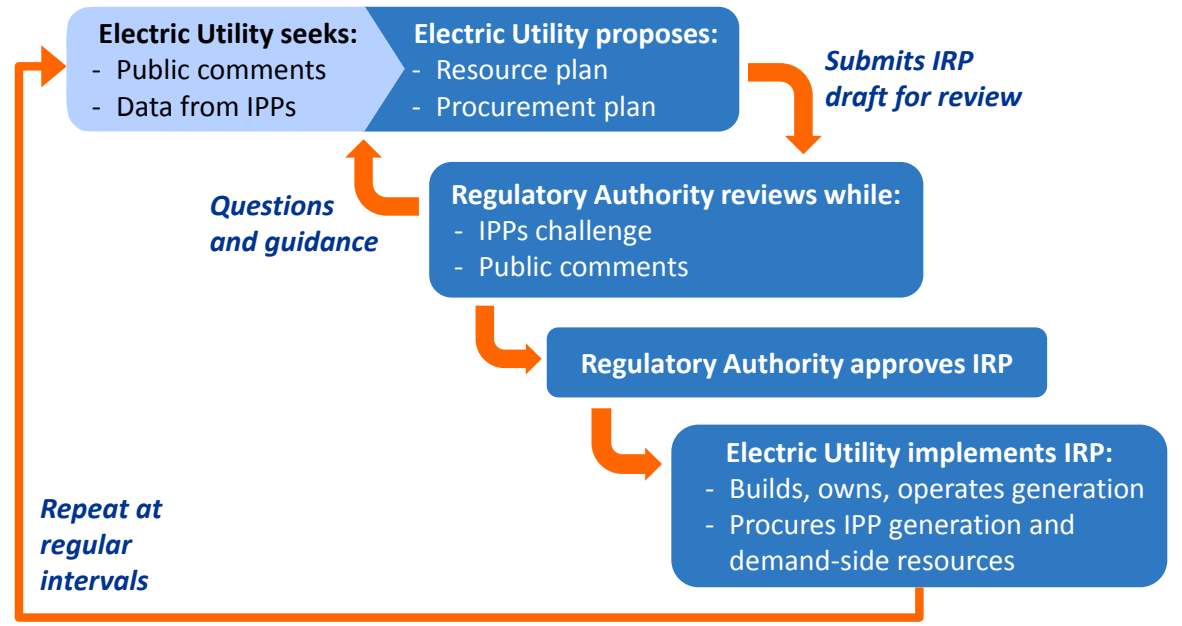
The Government affirms an IRP process as the only means for forecasting demand and planning for the resources (generation and demand-side resources) needed to meet it. An IRP creates an opportunity to periodically re-evaluate the country's aspirational electricity matrix in light of changing conditions (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 at an interval determined by 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 seeking public comments and data from prospective IPPs, which the Electric Utility uses to develop and propose a draft IRP. The draft IRP contains (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 draft 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 draft 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 draft 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 draft 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 bulk generation plant (or have a partner with this experience)
- 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 draft 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 draft IRP to the Regulatory Authority for reconsideration. This iterative process continues until the Regulatory Authority is satisfied with the IRP and it is finalised.

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 overseeing the procurement process, with an independent transaction advisor contracted to support the Regulatory Authority, if necessary. For projects approved in the IRP and involving public lands, the Government or the Regulatory Authority, with the approval of the Government, 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 customers; the Regulatory Authority will determine the interconnection charges. 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 the capital costs directly required for the interconnection to the grid; however, in the case of extraordinary costs, the Regulatory Authority may allocate those costs in a transparent and proportional manner. The ongoing costs of operating and maintaining these new network assets are recovered from ratepayers in the same manner as other network operating costs, with charges determined by the Regulatory Authority
- Eligible IPPs are permitted to use standardised interconnection agreements, depending on the size of the generator.

7 Distributed Generation

'Distributed generation' refers to generating systems that (unlike bulk generation, treated in the previous section) are located on the premises of an end user (residential, commercial, or industrial); interconnected to the lower-voltage distribution network, and used to offset some or all of the customer's energy consumption. Depending on the type of end user implementing it, a distributed generation system may be of three main types:

- Residential
- Commercial
- Industrial.

The scale of distributed generation systems (and the degree of complexity they are dealt with), typically grow from residential (smallest/lowest) to industrial (largest/highest).

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 standardised licencing requirements**. Uniform requirements for distributed generators reduce transaction costs and ongoing regulatory compliance costs. These requirements should also be simple, since distributed generation is a less complex undertaking relative to bulk generation (which would require a traditional generation licence)
- **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 to create this enabling environment for distributed generation while ensuring that the Electric Utility can maintain stability and high quality of service for all customers.

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.

The Regulatory Authority is responsible for ensuring that the Electric Utility operates efficiently and takes actions that are supportive of this Policy's objectives. It does so through a mix of obligations and incentives, while allowing the Electric Utility to earn a fair return on investment. To discharge its responsibility, the Regulatory Authority carries out routine benchmarking of the generation, transmission, distribution, and retail performance of the Electric Utility against international peers; the benchmarking process aims at making the Electric Utility's service standards continuously in line with increasing global standards.

9 End Use

It is the Government's policy to promote efficient use of electricity. Despite a competitive market for energy efficiency goods and services, and 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 Electric 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. Examples of such a certification are the Leadership in Energy and Environmental Design (LEED) certification and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards.

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. 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.

It is also 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 energy audits (and possibly retrofits) for multiple businesses at a time, using a recognised building energy rating program such as ASHRAE's Building Energy Quotient (bEQ)
- Creating a publicity campaign.

If these measures are insufficient, the Government may consider other measures such as supporting privately financed retrofits for end users, or setting fiscal and customs rules that incentivize energy efficient equipment and services and discourage inefficient ones.

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 may implement strategies and investments that reduce energy use, including contracting energy services companies (ESCOs) or purchasing 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 a misalignment of incentives (such as tenants who might not invest in efficiency because they will not realize the savings).

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.

As part of its duties, the Regulatory Authority will consider 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 subsidised audit program for residential end users
- Banning, or imposing higher taxes or duties on, inefficient equipment.

For end users already receiving the Government's support for their electricity bills, the Government may consider special programs that can help increase energy efficiency for these vulnerable customers.

10 Legal Framework

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

It is Government's policy that a new Electricity Act, the Regulatory Authority Act 2011, and other relevant Acts provide for the sector structure defined in the Policy (Section 5).

A new Electricity Act to replace the Energy Act 2009

A new Electricity Act will replace the existing Energy Act 2009. The new Electricity Act will give responsibility for electricity regulation to the Regulatory Authority, and define its responsibilities. It will also define the licensing regime for generation, transmission, distribution, and retail.

The sections below lay out the desired framework for the new Electricity Act.

Purpose

The purpose of the Electricity Act will be to facilitate the achievement, as far as possible, of the objectives of least cost, high quality, environmentally sustainable, secure and affordable electricity service for the people of Bermuda through the establishment of a regulatory framework that includes:

a) an independent regulator for the electricity sector;

b) processes for setting and implementing electricity policy that are participative and which encourage the achievement of competing objectives in the manner that best serves the public interest;

c) rules that promote diversity in the primary energy sources for electricity generation and demand reduction strategies; and

d) a licensing regime that facilitates competition in electricity generation and monopoly in transmission, distribution and retail.

General Functions of the Minister of Economic Development

The Electricity Act will define the role and responsibilities of the Minister regarding electricity, particularly in setting general policies and giving policy directions for the sector, such as for the Integrated Resource Plan.

General Functions of the Regulatory Authority

The Electricity Act will constitute the Regulatory Authority as the regulator for the electricity sector.

The Regulatory Authority will regulate grid-connected electricity generation by the Electric Utility, IPPs, and distributed generators (and relationships between the Electric Utility and IPPs and distributed generators); as well as the Electric Utility's transmission, distribution, and retail lines of business.

The Regulatory Authority will approve the Electric Utility's procurement plan for generation.

The Regulatory Authority will also be responsible for carrying out routine benchmarking of the generation, transmission, distribution, and retail performance of the Electric Utility against international peers, to ensure that its service standards remain in line with improving global standards.

The Regulatory Authority will approve power purchase agreements for bulk generation between the Electricity Utility and IPPs, with the aim of ensuring that the quality of service for end users is preserved. Bulk generation by IPPs will be interconnected based on a reference interconnection agreement used by the Electric Utility and subject to approval of the Regulatory Authority in every case.

Distributed generation will be provided by the Electric Utility with a standard power purchase agreement and a standard interconnection agreement. The Regulatory Authority will approve the standard agreements, but will not have to approve the conclusion of each individual agreement.

The Regulatory Authority will provide independent technical advice to the Minister responsible for electricity of policy matters related to electricity; and carry out financial and economic analysis on matters pertaining to the electricity sector.

Market structure

Electric Utility

The Electric Utility will be subject to regulatory scrutiny. The Electric Utility will:

- Be the sole party responsible for providing transmission, distribution, and retail services on the island
- Be the single buyer of power from all other generators
- Have a duty to operate all of its assets efficiently
- Be required to maintain stability of the system and a high standard of service
- Be allowed to always recover its costs, and earn a fair return on investment
- Be subject to accounting separation of its generation, transmission and distribution, and retail lines of business
- Be required to submit to the Regulatory Authority all retail rates for approval, and only allowed to charge retail rates with such approval
- Be subject to a universal service obligation to supply electricity to all end users
- Be responsible for meeting all demand by end users, except where end users supply to themselves.

Interconnections and power purchase agreements

There will be criteria for those who wish to connect to the grid operated by the Electric Utility.

The Electric Utility will provide access to its grid in a transparent and non-discriminatory manner, and will dispatch generation in an economically efficient order as prescribed by the Regulatory Authority.

The Electric Utility will only undertake grid investments needed to accommodate IPPs once it enters into an interconnection agreement with IPPs.

IPPs will be required to fund and finance the capital costs directly required for the interconnection to the grid; however, in the case of extraordinary costs, the Regulatory Authority may allocate those costs in a transparent and proportional manner. The ongoing costs of operating and maintaining these new network assets will be recovered from ratepayers in the same manner as other network operating costs, with charges determined by the Regulatory Authority.

IPPs and distributed generators will be required to have interconnection and power purchase agreements with the Electric Utility. Such agreements may be standard ones, and will be subject to the approval of the Regulatory Authority. The Regulatory Authority will approve interconnection and power purchase agreements for bulk generation in every case, but will not have to approve every individual interconnection and power purchase agreement concluded for distributed generation.

Integrated Resource Planning (IRP)

The Electric Utility will be responsible for developing an IRP that covers supply-side and demand-side resources for electricity. The IRP will include a procurement plan detailing how the Electric Utility intends to procure required power and energy, including:

- Own generation
- Competitive bidding, in particular for bulk generation
- Feed-In Tariffs, in particular for distributed generation.

The Electric Utility will submit the draft IRP to the Regulatory Authority for approval within an iterative and inclusive process.

The Regulatory Authority will define the IRP process in detail, set the duration and internal timeline of the process, and determine the frequency of the process's iteration, which will not be less than five years.

The Regulatory Authority will initiate and manage the consultation with the industry and the public around the IRP.

The Regulatory Authority will be responsible for reviewing the electric utility's assumptions and analyses in the IRP, and for approving or rejecting the IRP based on its review. The Regulatory Authority may ask the Electric Utility to revise the IRP as a result of its review and the consultation process, to ensure that it conforms to policy; requests for revision may also involve the procurement plan.

The Electric Utility will be responsible for finalizing the IRP to the Regulatory Authority's satisfaction.

End users' rights and obligations

End users will buy electricity, but may also sell services to the Electric Utility. They will pay for the services they receive from the Electric Utility, based on rates approved by the Regulatory Authority.

End users who limit or reschedule their electricity use may be compensated for their efforts.

The Electric Utility will be subject to consumer protection obligations, such as a customer bill of rights; and will be responsible for maintaining confidentiality of customer data.

The Regulatory Authority will investigate and respond to end users' complaints that fall outside the remit of Consumer Affairs.

Licences

The Electricity Act will make the Regulatory Authority responsible for issuing licenses for bulk generation by the Electric Utilities, distributed generation by the IPPs, and transmission, distribution, and retail services by the Utilities. The Authority will also be responsible for licensing the provision and distribution of fossil fuels used for power generation, including the current pipeline used to supply BELCO.

Licenses will be subject to conditions, particularly for ensuring quality of service and safety, and may include reporting obligations.

Fees

There will be authorization fees for bulk generation by the Electric Utility and IPPs, and for transmission, distribution, and retail services. There will be no authorization fees for residential distributed generation (that is, the ones operated by residential customers); but there shall be a nominal application fee.

There will be Regulatory Authority Fees for the electricity sector, including both general regulatory fees and service fees. These shall be established for each financial year in accordance with the Regulatory Authority Act 2011, section 44. General regulatory fees recommended by the Regulatory Authority for application to all licensees will be based on a percentage of the relevant turnover of the licensee.

The Regulatory Authority will submit a request for fees to the Minister responsible for electricity, accompanied by reasonable supporting data to justify the requested fees.

The Government Fees Regulations Act may be subject to amendments in order to empower the Government to assess fees on different types of licenses.

Tariffs and Rates

The Electricity Act will set a process for reviewing and setting retail rates for electricity consistent with the framework of the Regulatory Authority Act and in line with the provisions of the Electricity Policy.

The Electric Utility will not charge any retail rate without the approval of the Regulatory Authority.

Offenses and fines

Operating without a license or changing control without written consent of the Regulatory Authority will be an offence. If convicted, an individual will be liable for two years' imprisonment of a fine of $50,000, or both; if a person other than an individual, the person will be liable on conviction to a fine of $150,000.

Operating a transmission and distribution system without a license will be an offense. If convicted, an individual will be liable for two years' imprisonment of a fine of $50,000, or both; if a person other than an individual, the person will be liable on conviction to a fine of $150,000.

Failure to pay fees imposed in accordance with authorization or regulatory fees will be an offence. The penalty will be a fine of $50,000, and a further fine of $5,000 per day for every day during which the offence continues; and to pay to the Regulatory Authority a sum equal to twice the amount of any fee that would have been payable otherwise.

Transmitting electricity without a license, or receiving electricity from an unlicensed provider, will be an offence, and the penalty will be a $50,000 fine.

Importation or sale of equipment used for the production of electricity that is non-compliant with safety standards as set out by licenses will be an offense. If an individual is convicted, the penalty will be one year's imprisonment or a fine of $25,000, or both. If a person other than an individual is convicted, the penalty will be a fine of $50,000.

The willful damage of electricity transmission and distribution infrastructure or the generation assets of the electric utility or any IPP will be an offense. If convicted of a summary offence, an individual will pay a fine of $20,000 or be subject to one year's imprisonment, or both; in the case of a continuing offence a further fine of $500 for every day during which the offence continues will be imposed. Upon conviction on indictment, an individual will pay a fine of $50,000, or be subject to 5 years' imprisonment, or both. If a person other than an individual is convicted, the person will pay a fine of $150,000, and for a continuing offence there will be a fine of $5,000 for each day during which the offence continues.

Electricity theft will be an offence. If an individual, the summary conviction is imprisonment of one year or $20,000 fine, or both; if convicted on indictment, the penalty will be two years' imprisonment or $50,000 fine, or both. If a person other than an individual is convicted, the penalty will be a fine of $150,000.

Obstruction of the Minister or the Regulatory Authority or any public officer in the exercise of power conferred on them by the Electricity Act will be an offence. Upon summary conviction, the penalty will be imprisonment of six months or a fine of $10,000, or both.

Transitional Provisions

The Electricity Act will provide for existing licensees to be put under the new regime, and for any irregularities arising from this to be solved.

Pending rate cases and other business will be transferred to the Regulatory Authority for final disposition. The Regulatory Authority may evaluate the rate cases anew if decisions have not yet been rendered at the time of transfer.

Miscellaneous Provisions

There will be the need for emergency powers to be exercised in the event of catastrophe or national emergency.

An amended Regulatory Authority Act

The Regulatory Authority Act 2011 will be amended as needed, in particular:

- To name the electricity sector a regulated industry in the Schedule
- To increase the number of Commissioners from three (3) to five (5)
- To make all *ex parte* communications with the Minister of Economic Development during a public consultation or hearing subject to a public notice.

Other Legislation

There may be consequential changes required to other Acts as they relate to energy generation, including but not limited to the Clean Air Act that may have to be amended to avoid requiring a Controlled Plant License for solar PV generation.

Cabinet approval will be required to allow the Attorney General's Chambers to make minor amendments to other Acts as they relate to electricity.

Licensing

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 Electricity Act as described above. 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 Regulatory Authority.

Environmental Permitting and Planning

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. Environmental 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 (including their local distribution).

Appendix A: References

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Appendix B: Assumptions Used in the Aspirational Matrix and Business as Usual Scenario

This appendix presents the assumptions used in the aspirational matrix and BAU scenario, 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 aspirational matrix assumes 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. Street lights are assumed to be retrofitted with light-emitting diode (LED) technology by 2021.

Fuel prices

The aspirational matrix and BAU scenario assume:

- 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 aspirational matrix are based on actual capital costs observed in small island markets in the region, wherever possible. Table B.1 summarises data sources for the capital and levelized generation costs presented in Table B.2 and Table B.3.

Table B.1: Data Sources for Capital and Generation Costs

Technology	Data Sources
Solar PV (60kW poly-crystalline, fixed, distributed scale)	▪ Electric utilities and generation holding companies operating in the Caribbean ▪ 2012 Bloomberg solar PV white paper
Solar PV (2kW thin film, fixed, distributed scale)	▪ A Bermuda-based solar installer (data were provided confidentially)
Solar PV (8MW mono-crystalline, bulk scale)	▪ Jamaica 2013-2014 Renewable Energy Tender
Off-shore Wind (bulk scale)	▪ U.S. Department of Energy – Energy Information Administration – National Renewable Energy Laboratory
Future RE base load	▪ Based on the budget for an ocean pilot project in Martinique, modified to assume that any such technology may become cost-competitive with LNG generation
Tynes Bay Waste to Energy	▪ Bermuda Ministry of Public Works, Department of Works & Engineering
Wind (10kW distributed scale turbines)	▪ Wind Project Development data from Barbados
Diesel Gas Turbine 8.4MW	▪ BELCO 2014 Integrated Resource Plan ▪ Projects developed or under development in the Caribbean, and benchmarks for the U.S. market used for these assignments
HFO Medium Speed Diesel Engine (1) 7MW	
HFO Medium Speed Diesel Engine (2) 7MW	
Natural Gas (1) 14MW	
Natural Gas (2) 14MW	
Convert Gas Turbine from Diesel to NG 14MW	

The aspirational matrix also accounts for certain decreases in capital costs. 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 capital cost for the future renewable energy base load generation option, in the spirit of leaving space for any such option (using locally sourced or imported renewable resources) that may become cost-competitive with LNG generation.

The aspirational matrix assumes a capital cost of BMD 106 million to construct a LNG terminal, storage, and regasification facility (but not a pipeline, because it is assumed these facilities and the plant would be co-located). This is based on feasibility studies commissioned by the Inter-American Development Bank for the Caribbean. Such a facility may cost more if LNG throughput is higher, but other industries would use the facility, spreading the capital costs around (and reducing the capital cost counted to the electric sector).

Table B.2: Capital and Generation Costs of Renewable Energy

Technology	Unit	Solar PV (60kW poly-crystalline, fixed, distributed scale)	Solar PV (2kW thin film, fixed, distributed scale)	Solar PV (8MW mono-crystalline, bulk scale)	Off-shore Wind (bulk scale)	Future RE base load	*Tynes Bay 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	$8,000.00	*$8,000.00*	$6,000.00
Discounted Future Unit capital cost	US$/kW	$3,500.00	$4,250.00	$2,500.00	$5,600.00	$8,000.00	*$8,000.00*	$6,000.00
Fixed O&M costs per year (incl. insurance)	US$/kW/yr	$30.00	$30.00	$ 30.00	$74.00	$300.00	*$270.27*	$44.00
Fuel cost per kWh	BMD/kWh						*$(0.32)*	
Variable O&M Costs	US$/MWh						*$0.43*	$0.02
Lifetime	Years	20	20	20	20	25	*20*	20
Capacity Factor	%	17%	17%	17%	38%	90%	*31%*	22%
Output per kW capacity per year	kWh/kW/yr	1,489	1,489	1,489	3,329	7,884	*2,699*	1,910
Total system cost	US$	$210,000	$8,500	$5,000,000	$112,000,000	$45,600,000	*$59,200,000*	$60,000
Annualized capital cost	US$/yr	$22,353	$905	$532,208	$11,921,459	$4,492,775	*$6,301,343*	$6,386
Annual O&M costs	US$/yr	$1,800	$60	$60,000	$1,480,000	$1,710,000	*$10,500,000*	$440
Annual output per system	kWh/yr	89,352	2,978	2,978,400	66,576,000	44,938,800	*19,974,000*	19,097
Capital cost recovery factor per kWh	US$/kWh	$0.25	$0.30	$0.18	$0.18	$0.10	*$0.32*	$0.33
O&M cost per kWh + Fuel Cost	US$/kWh	$0.02	$0.02	$0.02	$0.02	$0.04	*$0.21*	$0.02
Total Long Run Marginal Cost	**US$/kWh**	**$0.27**	**$0.32**	**$0.20**	**$0.20**	**$0.14**	***$0.53***	**$0.36**

Notes: Long-run marginal costs may not equal the sum of its capital and O&M components because of rounding. Capital costs shown are estimated replacement costs for what would be a new plant today; however, investments in the Tynes Bay project have already been made in different instalments since 1996.

Table B.3: Capital and Generation Costs of Fossil Fuel Energy

Technology	Unit	Diesel Gas Turbine 8.4MW	HFO Medium Speed Diesel Engine (1) 7MW	HFO Medium Speed Diesel Engine (2) 7MW	Natural Gas (1) 14MW	Natural Gas (2) 14MW	Convert Gas Turbine from Diesel to NG 14MW
Installed capacity (plant size)	kW	8,400	7,000	7,000	14,000	14,000	14,000
Unit Capital Cost	BMD/kW	$1,259.00	$1,838.00	$2,123.00	$2,123.00	$1,255.00	$340.00
Discounted Future Unit capital cost	US$/kW	$1,259.00	$1,838.00	$2,123.00	$2,123.00	$1,255.00	$340.00
Fixed O&M costs per year (incl. insurance)	US$/kW/yr	$19.00	$18.00	$18.00	$18.00	$18.00	$18.00
Heat rate	btu/kWh	11,100	7,900	11,100	8,260	11,490	8,260
Fuel cost per kWh	BMD/kWh	$0.24	$0.15	$0.21	$0.10	$0.13	$0.10
Variable O&M Costs	US$/MWh	$7.00	$11.00	$7.00	$11.00	$11.00	$11.00
Lifetime	Years	20	20	20	20	20	20
Capacity Factor	%	95%	90%	90%	90%	95%	90%
Output per kW capacity per year	kWh/kW/yr	8,322	7,884	7,884	7,884	8,322	7,884
Total system cost	US$	$10,575,600	$12,866,000	$14,861,000	$38,436,781	$26,284,781	$13,474,781
Annualized capital cost	US$/yr	$1,125,684	$1,369,478	$1,581,829	$4,091,272	$2,797,794	$1,434,277
Annual O&M costs	US$/yr	$648,934	$733,068	$512,316	$1,466,136	$1,533,588	$1,466,136
Annual output per system	kWh/yr	69,904,800	55,188,000	55,188,000	110,376,000	116,508,000	110,376,000
Capital cost recovery factor per kWh	US$/kWh	$0.02	$0.02	$0.03	$0.04	$0.02	$0.01
O&M cost per kWh + Fuel Cost	US$/kWh	$0.25	$0.16	$0.22	$0.11	$0.15	$0.11
Total Long Run Marginal Cost	**US$/kWh**	**$0.27**	**$0.19**	**$0.25**	**$0.15**	**$0.17**	**$0.12**

Note: Long-run marginal costs may not equal the sum of its capital and O&M components because of rounding.

Reserve margin

Reserve margin is measured in terms of the number of generating units that can be out of service at any given time while still meeting peak demand. This margin is commonly expressed relative to the total number of generating units (N) interconnected to the grid. The aspirational matrix assumes an 'N-2' standard, which means that the utility has backup units to meet peak demand in the event that the two largest units are unavailable. The BAU scenario assumes an 'N-3' standard, which means that the utility has backup units to meet peak demand in the event that the three largest units are unavailable.

Carbon price

Neither the aspirational matrix nor the BAU scenario assumes a price on carbon when calculating cost of supply.

END