



**UTILITIES REGULATION & COMPETITION AUTHORITY  
EVALUATION OF BAHAMAS POWER AND LIGHT COMPANY'S  
RENEWABLE ENERGY PLAN, 2020**

**Preliminary Determination and Draft Order**

ES 01/2021

Issue Date: 23 February 2021

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## 1 Introduction

The National Energy Policy 2013 – 2033 (“NEP”) of The Bahamas is encapsulated in section 5 of the Electricity Act, 2015 (“EA”). The NEP “sets a target of about 30% renewables in the energy mix by 2033.” As an electricity sector policy (“ESP”) objective, section 5(1)(c) of the EA requires “plans for the efficient use and supply of safe least cost, reliable and environmentally sustainable electricity.” Having regard for the NEP, section 25 of the EA establishes the requirement for a Public Electricity Supplier (“PES”) to develop a Renewable Energy Plan (“REP”) to achieve its objectives and to give “preference to renewable electricity resources in all procurement actions in the absence of compelling reliability or cost considerations.”

The Utilities Regulation and Competition Authority (“URCA”) is the independent regulator of the electricity sector, in accordance with the URCA Act, 2009 and the EA section 22. As a PES, Bahamas Power and Light (“BPL” or the “Licensee”) is a regulated entity licensed to operate in the electricity sector in accordance with its Public Electricity Supplier Licence (the “Licence”) effective 1 May 2018.<sup>1</sup> Accordingly, section 25(2) of the EA requires BPL to “develop and submit in writing for URCA’s approval... a time bound plan for the introduction of sustainable renewable energy technologies into the electricity supply system.”

Under cover of its letter dated 10 October 2019, BPL submitted its REP. Subsequently, under cover of its letter dated 12 November 2020, BPL submitted Appendices to form part of its REP. Appendix A of this document of this document includes the executive summary of the REP.

By publishing this Preliminary Determination and Draft Order, URCA hereby gives notice that it has completed its review of the BPL REP and intends to issue a Final Determination and Order to approve the plan. Persons shall have until 24 March 2021 to make representations about matters in this Preliminary Determination and Draft Order which URCA will consider in making its Final Determination and Order. Representations or objections should be submitted to URCA either:

- i. by hand addressed to the Director of Utilities and Energy, Utilities Regulation and Competition Authority, Frederick House, Frederick Street; or
- ii. by email to: info@urcabahamas.bs; or
- iii. by mail to: P.O. Box N-4860, Nassau, Bahamas; or
- iv. by facsimile to: (242) 393-0237.

The remainder of this document is set out as follows:

- Section 2: Background
- Section 3: Regulatory Framework
- Section 4: URCA’s Review of BPL’s Renewable Energy Plan
- Section 5: Preliminary Determination
- Section 6: Draft Order

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<sup>1</sup> License Number: PESL-18-0001

## 2 Background

BPL submitted its first version of the REP to URCA on 28 April 2016. URCA provided a response to the BPL's initial submission on 28 August 2017.<sup>2</sup> URCA's assessment of the initial submission was that it did not meet the statutory requirements of the EA. As a result, URCA outlined the items to be addressed by BPL prior to resubmission. Through a public consultation process URCA made a decision to implement the "small scale" renewable generation component of the BPL renewable energy plan while BPL revisited the larger scale components of the plan.<sup>3</sup> The "small scale" component was labelled Small Scale Renewable Generation ("SSRG"). The SSRG framework applies to grid-tied residential and small commercial BPL customers installing renewable energy systems up to a maximum capacity of 100 kW. The framework is primarily governed by section 27 of the EA and was operationalized in May 2017.

URCA requested that BPL revise and resubmit its renewable energy plan by 22 November 2017.<sup>4</sup> Due to missed deadlines and a lack of responsiveness from BPL, URCA issued a Preliminary Determination and Draft Order concerning suspected breaches by BPL of its License and obligations under the Electricity Act.<sup>5</sup> URCA exercised regulatory forbearance and, to progress electricity sector policy, it decided to establish a framework to facilitate renewable energy self-generation projects for Government, small-scale business, and commercial enterprises, in accordance with the EA section 28. The guidelines were issued for public consultation on 27 September 2019 and covered RE installations for these entities up to 1000kW.<sup>6</sup> The consultation closed on 29 November 2019. The Statement of Results and Final Decision was issued 28 February 2020.<sup>7</sup>

BPL wrote to URCA on 9 July 2019 to advise it was in the process of engaging a consultant to develop a "5-year preliminary Renewable Energy Plan (REP) for New Providence and the Family Islands." Part of the consultant's scope of work included:

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<sup>2</sup> Cambridge, Shevonn, URCA to Harreld, Mike, BPL "Response to BPL's Renewable Energy Plan.", 28 Aug. 2017

<sup>3</sup> Utilities Regulation and Competition Authority "ES 01/2018 Statement of Results and Final Determination on Bahamas Power And Light Limited's Small-Scale Renewable Generation Plan." 01 May 2018, [www.urbahamas.bs/wp-content/uploads/2018/06/SOR-and-FD\\_Bahamas-Power-And-Light-Limited%E2%80%99s-Small-Scale-Renewable-Generation-Plan-.pdf](http://www.urbahamas.bs/wp-content/uploads/2018/06/SOR-and-FD_Bahamas-Power-And-Light-Limited%E2%80%99s-Small-Scale-Renewable-Generation-Plan-.pdf)

<sup>4</sup> Letter from Shevonn Cambridge, URCA to Mike Harreld, BPL dated 28 Aug. 2017

<sup>5</sup> Utilities Regulation and Competition Authority "ES 05/2018 Preliminary Determination and Draft Order Issued to Bahamas Power and Light Company Limited (BPL) In the matter of Suspected Breach of License Conditions 9, and 17.2 and sections 25 and 26 under the Electricity Act, 2015." 16 May 2018, [www.urbahamas.bs/wp-content/uploads/2018/05/Preliminary-Determination-and-Draft-Order-Pursuant-to-Suspected-Breaches....pdf](http://www.urbahamas.bs/wp-content/uploads/2018/05/Preliminary-Determination-and-Draft-Order-Pursuant-to-Suspected-Breaches....pdf)

<sup>6</sup> Utilities Regulation and Competition Authority "ES 05/2019 Guidelines for the Approval of Renewable Energy Self-Generation Projects, Small Commercial and Government, Consultation Document." 27 Sep. 2019, [www.urbahamas.bs/wp-content/uploads/2019/09/Consultation-Document-Guidelines-for-the-Approval-of-RESG-Projects\\_FINAL-20190926.pdf](http://www.urbahamas.bs/wp-content/uploads/2019/09/Consultation-Document-Guidelines-for-the-Approval-of-RESG-Projects_FINAL-20190926.pdf)

<sup>7</sup> Utilities Regulation and Competition Authority "ES: 03/2020 Statement of Results and Final Decision on Guidelines for the Approval of Renewal Energy Self-Generation Projects" 28 February 2020, [www.urbahamas.bs/decisions/es-03-2020-statement-of-results-and-final-decision-on-renewal-energy-self-generation-projects/](http://www.urbahamas.bs/decisions/es-03-2020-statement-of-results-and-final-decision-on-renewal-energy-self-generation-projects/)

- Technical guidelines for interconnecting renewable energy systems
- Creation of a Grid Code
- Identifying grid and generation improvements to support higher penetrations of renewables
- Approaches to develop the introduction of Independent Power Producers
- Standard Power Purchase Agreements
- Development of an Integrated Resource Plan

URCA wrote to BPL on 2 October 2019 requesting BPL’s revised REP be submitted by 9 October 2019. BPL submitted, via email on 10 October 2019, “The Bahamas Power and Light Company Limited’s Executive Summary and Renewable Energy Consultancy with IRP Option – Five Year Renewable Energy Plan” (the “BPL REP”) in response to URCA’s letter of 2 October 2019. Subsequently, URCA published a summary of the BPL REP submission in accordance with the requirements of the EA section 25(5)(a).<sup>8</sup>

On 17 February 2020 URCA issued document ES 01/2020 to BPL outlining URCA’s preliminary decision following its review of BPL’s REP. BPL requested, and was granted, an extension to 10 July 2020 in order to provide a substantive response.<sup>9</sup> Subsequently BPL provided its response on 13 July 2020. In ES 08/2020 URCA set out its assessment of BPL’s response to ES 01/2020 and presented URCA’s final decision as to the revisions and/or next steps required to obtain URCA’s approval as envisioned in section 25(2) of the EA. BPL was instructed to comply with URCA’s Final Decision no later than 05 October 2020.

URCA wrote to BPL on 09 November 2020 expressing concern it had not received a response and requiring BPL to respond by 16 November 2020. BPL provided its submission on 12 November 2020 and appendices on 14 November 2020. The submission substantially addressed and incorporated the remedies set out in the URCA Statement of Results and Final Decision, ES 08/2020

### **3 Regulatory Framework**

Per the EA section 7(1) “All policy documents, regulatory and other measures, decisions and laws to take effect in the electricity sector in The Bahamas shall be taken or made with a view to implementing the main goal and governing principles and objectives of the sector policy and electricity supply regime.”

BPL, as a PES, is required to submit for URCA’s approval, “a time-bound plan for the introduction of sustainable renewable energy technologies into the electricity supply system.”<sup>10</sup> Section 25(3) of the EA sets out, as follows, what the REP shall include:

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<sup>8</sup> “Executive Summary of BPL’s Renewable Energy Plan.” URCA, 17 Dec. 2019, [www.urcabahamas.bs/publications/executive-summary-of-bpls-renewable-energy-plan/](http://www.urcabahamas.bs/publications/executive-summary-of-bpls-renewable-energy-plan/)

<sup>9</sup> Cambridge, Shevonn, URCA to Heastie, Whitney, BPL “Preliminary Decision ES 01/2020, BPL’s Renewable Energy Plan 2020”, 07 May 2020

<sup>10</sup> Electricity Act 2015, section 25(2)(a)

- (a) provisions for facilitating persons, including other public electricity suppliers, to apply to URCA to be licensed as independent power producers to participate in utility electricity generation to the relevant grid using renewable resources and technologies;
- (b) a policy statement giving preference to renewable electricity resources in all procurement actions in the absence of compelling reliability or cost considerations;
- (c) a plan to procure increasing specified minimum percentages of electricity products from eligible renewable electricity resources by a specified date, thereby allowing the phased increase in renewable generation;
- (d) provision to ensure the reliability of intermittent resources, taking into account the availability of cost effective storage technologies;
- (e) provisions for facilitating residential renewable energy generation to the grid and renewable energy self-generation projects;
- (f) an annual requirement for reporting the progress by the public electricity supplier with respect to its renewable electricity plan; and
- (g) a mechanism for formal review by URCA of the renewable electricity plan once every three years, which review will result in the public electricity supplier updating the plan to reflect developments in renewable electricity resources.

URCA is required to publish the REP and to “determine whether to approve the plan as consistent with the sector policy objectives and national energy policy.”<sup>11</sup>

URCA is empowered to make determinations<sup>12</sup> and, prior to issuing a determination, may issue a notice of preliminary determination.<sup>13</sup> URCA may also issue an order to enforce a determination.<sup>14</sup> A copy of the order it proposes to issue with the final determination shall be enclosed with the preliminary determination.<sup>15</sup> Except in the case of repeated breaches, URCA will not issue an enforcement order where the relevant person has complied with the obligations or remedied the consequence of the contraventions set out in the preliminary determination.<sup>16</sup>

#### **4 URCA’s Review of BPL’s Renewable Energy Plan**

A summary of the BPL REP was published on URCA’s website.<sup>17</sup> The BPL REP covers the five year period from 2019 to 2023. . For the reasons set out below, URCA considers that the BPL REP substantively complies with the requirements of the EA.

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<sup>11</sup> Electricity Act 2015, section 25(5)

<sup>12</sup> Electricity Act 2015, section 64(1)

<sup>13</sup> Electricity Act 2015, section 64(7)

<sup>14</sup> Electricity Act 2015, section 63(1)

<sup>15</sup> Electricity Act 2015, section 64(8)

<sup>16</sup> Electricity Act 2015, section 64(11)

<sup>17</sup> “Executive Summary of BPL’s Renewable Energy Plan.” *URCA*, 17 Dec. 2019, [www.urcabahamas.bs/publications/executive-summary-of-bpls-renewable-energy-plan/](http://www.urcabahamas.bs/publications/executive-summary-of-bpls-renewable-energy-plan/)

The BPL REP proposes 119 MW of solar PV be installed by 2023; 74 MW in New Providence and 45 MW of solar PV plus 11 MW of four-hour battery storage in the Family Islands. At that time just over 6 percent of demand in New Providence would be provided by solar PV; whereas, in the Family Island just over 10 percent of demand would be supplied by solar PV. At a 10 percent renewable energy penetration, Battery Energy Storage Systems (BESS) would be required in the Family Islands to address system stability and avoid curtailment of the PV system output. The BPL REP details how renewable generation will be increased island by island until 2023 where at that time it is projected to represent an 11 percent share of the total energy generated by BPL.

The BPL REP investigated potential locations for the installation of solar PV. It determined that the availability of space for roof top solar restricted its capacity to less than 30 MW in New Providence. It recommended using about a third of Lake Killarney which could facilitate up to 150 MW. In the Family Islands space is not considered to be a constraint.

The technical analysis for the BPL REP was conducted using PLEXOS planning software. Data to determine the inputs to the model was provided by BPL and certain assumptions were made. For New Providence it was assumed that six units out of service at Clifton Pier Power Station would remain out, 90 MW of rental generation would be discontinued and 234 MW of LNG generation would be added over the course of the five years. Historical data from BPL was used to calculate the System Load Factor, Gross System Loss, Load Growth Per Annum and Heat Rate or each island and plant. Spinning Reserves, Planning Reserves and Tertiary Reserves were factored in determining generation capacity. A Discount Rate of seven percent was assumed for the Weighted Average Cost of Capital (WACC).

Analysis to determine the impact on the network in New Providence was modeled using ETAP software. This included power flow studies, power system security (stability), and fault level analysis. The results highlighted several network issues and the actions required to resolve them; some of which are significant. It was not clear in the BPL REP if the necessary reinforcements to the system were included in the scenarios considered and recommended. No costs were provided for the remedies. The BPL REP did not include a similar analysis for the Family Islands.

In addition to utilizing technical factors to determine the amount of renewable energy capacity to add over the five-year period, the BPL REP also considered the cost in making its selection. The BPL REP showed the Levelized Cost of Electricity (LCOE), the cost per unit of energy generated, with and without the addition of solar PV and BESS. The results showed that for the proposed addition of solar PV and BESS the LCOE would be reduced over the period. The BPL REP also calculated the avoided cost of generation. It suggested that this cost can be utilized in pricing a Power Purchase Agreement (PPA) with an Independent Power Producers (IPP).

The appendices of the REP included the following:

- A Grid Code with which independent power producers and small-scale generating facilities must comply in accordance with BPL's License Condition 47.
- A Transmission Connection Agreement to facilitate connection to the grid in accordance with the Grid Code.

- A Power Purchase Agreement template in accordance with BPL’s License Conditions 45.4 and 51.

URCA considered the BPL REP was a significant improvement over BPL’s original submission in 2016 and represented a plausible intention to meet the NEP and ESP objectives. It comprehensively evaluated the technical and cost factors in setting out its plan to increase the percentage of renewable energy in its generation mix. And it set out the actions required to accommodate the proposed renewable generation on the network. It also included Power Purchase Agreement and Transmission Connection Agreement templates to facilitate connection to the grid.

## 5 Preliminary Determination

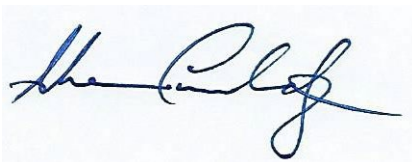
1. URCA has determined that BPL’s Renewable Energy Plan, 2020 substantially satisfies the requirements of section 25 of the EA and BPL’s License, PESL-18-0001.
2. URCA has determined to approve BPL’s Renewable Energy Plan, 2020 per section 25(5)(b) of the EA.

## 6 Draft Order

In accordance with the role, functions and powers conferred upon URCA in sections 37 and 38 of the EA, URCA hereby orders:

1. URCA approves the BPL Renewable Energy Plan, 2020 as fully contained in ES XX/2021.
2. BPL shall develop and submit in writing in October of each year, for URCA’s approval, an annual report on the accomplishments made against its Renewable Energy Plan.
3. BPL shall revise and submit an updated Renewable Energy Plan every three years after 10 October 2019, subject to URCA imposing different time periods for submission or revision.
4. BPL shall comply with the procurement procedures for utility scale renewable electricity generation as set out in section 26 of the EA.

Failure to comply with this Final Determination and Order may result in URCA taking the appropriate regulatory action in accordance with the EA and License.



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Shevonn Cambridge  
**Director of Utilities and Energy**

Date: 23 February 2021



## **7 Appendix A**

Executive Summary of Bahamas Power and Light (BPL) Renewable Energy Plan, 2020

# 1 EXECUTIVE SUMMARY

While renewable energy and energy efficiency are complementary alternatives to conventional generation, transitioning to them needs to be done in a thoughtful and iterative process that ensures that the core needs of the system – including stability, reliability, and financial viability, are met. The electrical system underpins the economic foundation of the Bahamas – so it is essential that it continue to operate as well as or better than the current operating system standard during and after the introduction of renewables if the uptake of renewable energy and energy efficiency is to be fully realized.

The Government of The Bahamas aims to achieve a significant renewable energy penetration by 2030 in order to replace expensive generation from fossil fuels and reduce dependency on fuel imports. According to the National Energy Plan, the target is to achieve 30% of electricity generation from renewable sources of the total generation portfolio. Given that the current renewable share is less than 1% of the overall generation, an ambitious and fast track programme is required to achieve this target.

In that respect, a 5-year Renewable Energy Plan for New Providence and the Family Islands has been developed. This plan shows a path for next 5 years to achieve the 2030 National Energy Plan Goals and outlines estimated level of investment that is needed to achieve these goals.

**Over the next 5 years The Bahamas should plan and pursue 119.08MW of solar PV in New Providence (73.7MW) and the Family Islands (45.38MW) supplemented with 10.96MW of 4-hour battery energy storage.**

It should be noted that these figures represent total amount of solar PV that should be installed, including ones that that will be procured through SSRG programme, as well as through BPL and IPP investment. The associated capital costs are **\$203.7 million** for solar PV and **\$25.3 million** for the battery storage. These investments result in an annual savings of **\$3.7 million** for BPL comparing to BAU (business as usual) case as shown in following table:

**Table 1 – NP+FI – Annual Cost Saving for proposed PV+BESS investments**

<i>NP + Family Islands</i>			<b>2019</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>	<b>2023</b>
PV+BESS case	<b>Total cost</b>	<b>mil\$</b>	358.9	368.8	386.0	415.3	427.3
	<b>Total generation</b>	<b>GWh</b>	2,018.6	2,113.1	2,221.5	2,300.0	2,356.7
	<b>Levelized cost of electricity</b>	<b>\$/MWh</b>	177.80	174.54	173.74	180.59	181.29
Base case (BAU)	<b>Total cost</b>	<b>mil\$</b>	358.8	368.6	389.1	421.9	436.4
	<b>Total generation</b>	<b>GWh</b>	2,018.6	2,113.1	2,221.4	2,299.7	2,356.2
	<b>Levelized cost of electricity</b>	<b>\$/MWh</b>	177.75	174.45	175.18	183.46	185.21

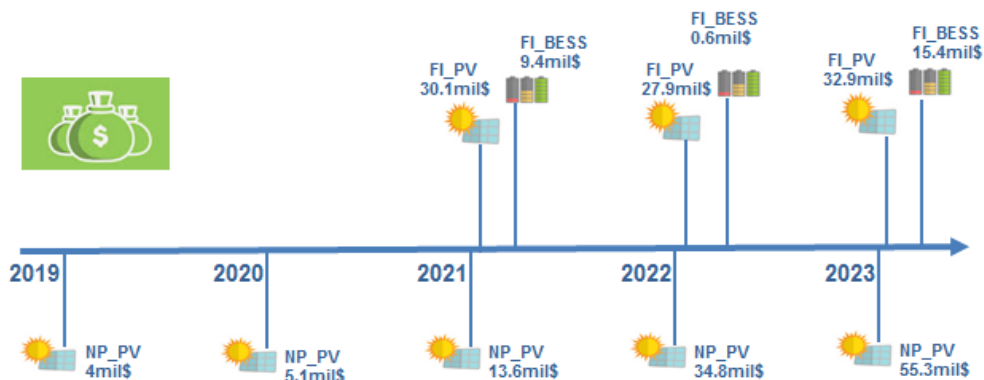
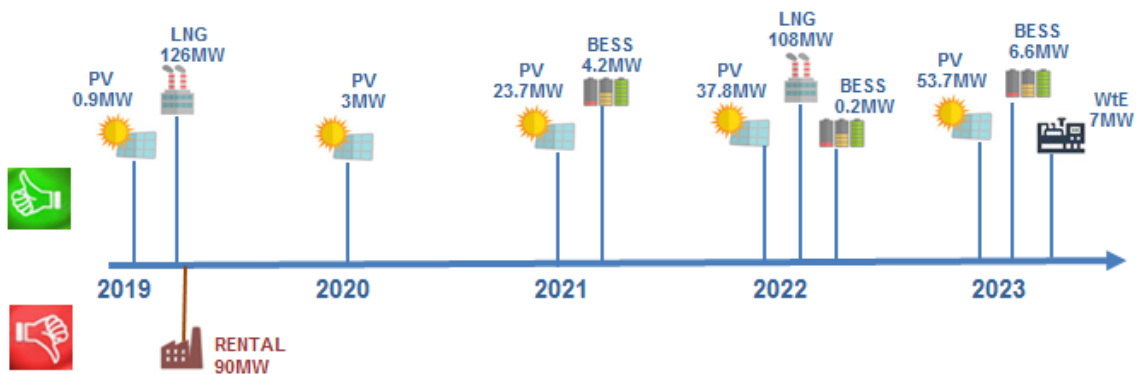
This plan provides details of the expected share of energy provided by renewable sources up to and including 2023 (in accordance with 2030 National Plan). The level of investments required to reach these targets has also been determined.

In the following table and figures review of recommended solar PV and battery energy storage facilities with associated costs for New Providence and Family Islands is given:

**Table 2 – NP+FI – Proposed PV and BESS investment**

Installed/Cost			2019	2020	2021	2022	2023	Total
NP	PV rooftop installed	MW	0.9	3.0	8.0	9.0	7.8	28.7
	CAPEX - PV rooftop	\$000	4,000	5,100	13,600	15,300	13,260	51,260
	PV Landfill installed	MW				15.0		15.0
	CAPEX - PV Landfill	\$000				19,500		19,500
	PV floating installed	MW					30.0	30.0
	CAPEX - PV floating	\$000					42,000	42,000
	BESS installed	MW						0
CAPEX - BESS	\$000						0	
FI	PV installed	MW			15.69	13.79	15.90	45.38
	CAPEX - PV	\$000			30,101	27,891	32,910	90,902
	BESS installed	MW			4.20	0.20	6.56	10.96
	CAPEX - BESS	\$000			9,360	560	15,368	25,288
NP + FI	PV installed	MW	0.9	3.00	23.69	37.79	53.70	119.08
	CAPEX - PV	\$000	4,000	5,100	43,701	62,691	88,170	203,662
	BESS installed	MW			4.20	0.20	6.56	10.96
	CAPEX - BESS	\$000			9,360	560	15,368	25,288

Timeline for these proposed capacities and investments is given graphically in the following figures.

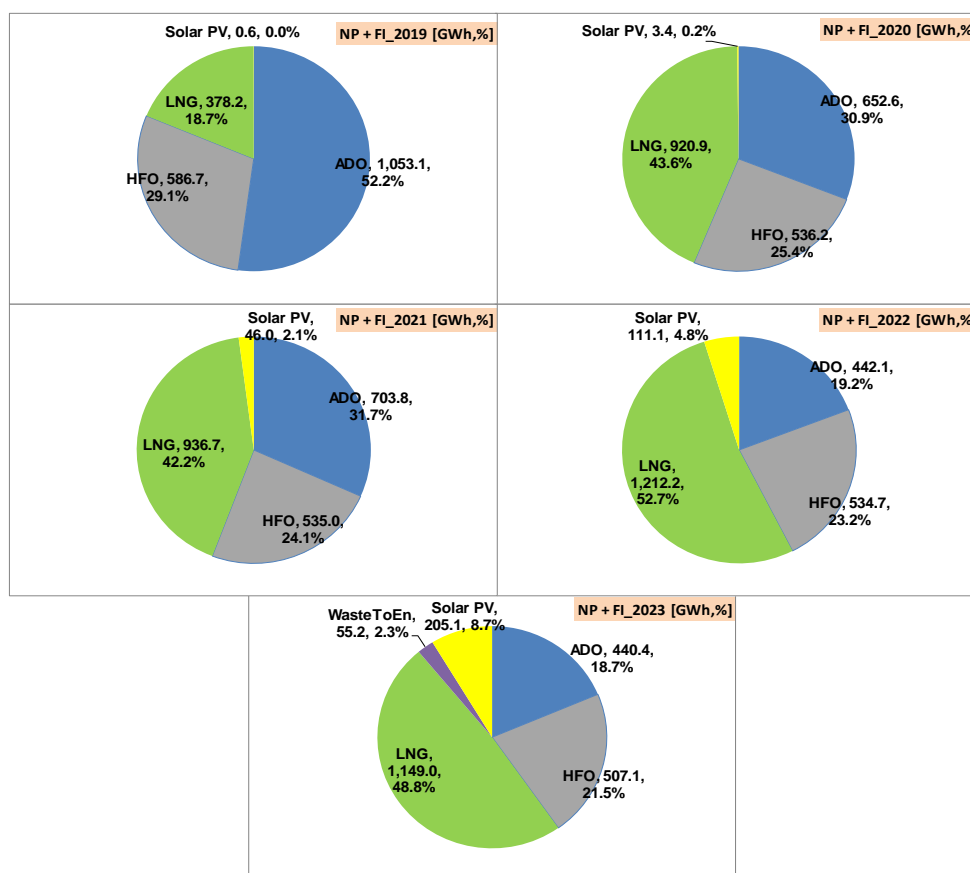


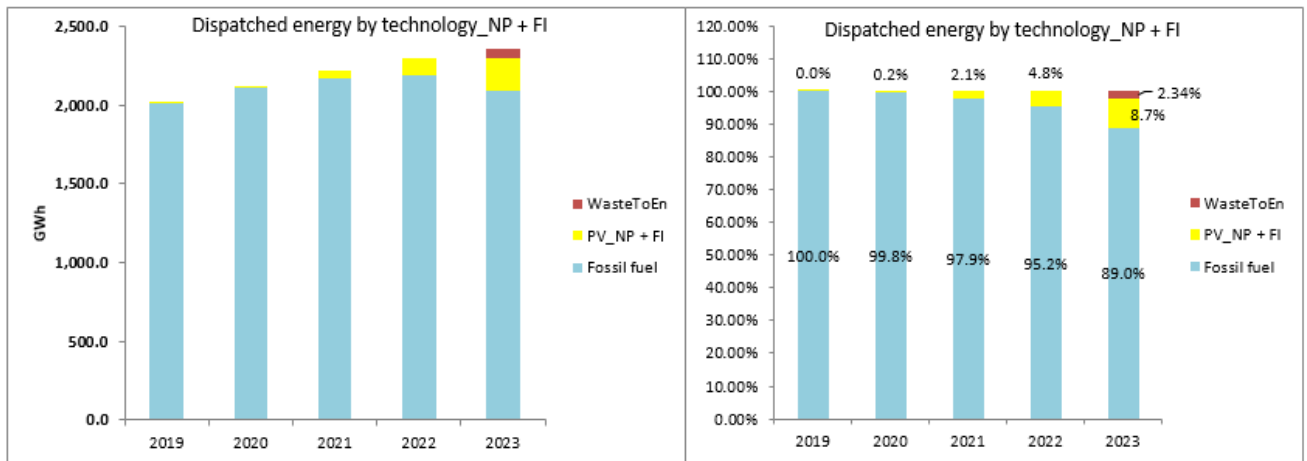
The first solar PV large scale facility, National Stadium (BPL/MOE/NSA) 900KW solar car park is envisaged to be online in June 2019. It is our assumption that all assessed potential rooftop PV facilities in New Providence would be installed just before the end of next 5-year period (in 2023). The amount of installed rooftop PV capacities in 2023 would be 28.7MW with annual production of 42.7GWh. Installation of 30MW of floating solar PV on Lake Killarney with annual production of 54.1GWh is envisaged in 2023. Further development of floating PV projects will be realized until 2030 year. Potential 15MW Landfill solar PV facility is assumed to be in operation in 2022. Installation of first ground mounted solar PV on Family Islands is planned for the beginning of 2021 year.

Due to the commercial arrangements and capacity factor for the planned LNG plant, PLEXOS analysis have shown that there is no incentive to invest in battery energy storage for provision of spinning reserve, as LNG units that have to be online will be providing sufficient reserve. However, there may be potential cases for battery storage such as backup for critical facilities, or to integrate additional renewable energy beyond 2023 targets.

On the other hand, investment in battery storage can be justified in Family Islands, as PV penetration level will reach 10-15% in 2023. When level of solar PV penetration reaches 10% of total annual demand (in 2023), shortages of spinning reserves as well as solar PV curtailments occur. Therefore, battery storage facilities with a 4-hour rating have been proposed to support normal system operation, provide spinning reserve, and avoid solar PV curtailment. The battery would be charged during daylight with excess PV generation and discharged during night hours, therefore would serve for regulation and load shaving. This battery storage will also support further integration of solar PV in following years up to 2030.

Considering recommended PV and BESS facilities and existing conventional generation fleet, calculated generation in next five years in New Providence and Family Island is provided in the next figures:





**Figure 1 – NP+FI – generation in next five years**

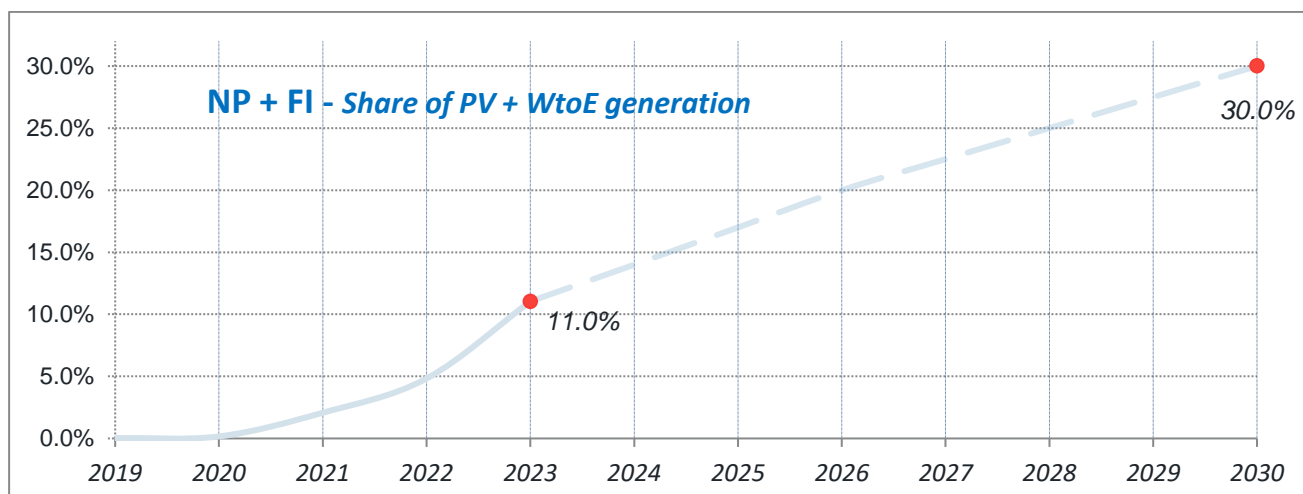
Total energy produced by generation type in GWh and % is summarized in table below:

Table 3 – NP+FI – generation in next five years

<i>NP + FI - generation</i>		2019	2020	2021	2022	2023
<b>Fossil fuel</b>	<b>GWh</b>	2,018.0	2,109.7	2,175.5	2,188.9	2,096.4
<b>PV (NP + FI)+WtoE</b>	<b>GWh</b>	0.615	3.395	46.003	111.063	260.262
<b>Total</b>	<b>GWh</b>	<b>2,018.6</b>	<b>2,113.1</b>	<b>2,221.5</b>	<b>2,300.0</b>	<b>2,356.7</b>

<i>NP + FI - generation</i>		2019	2020	2021	2022	2023
<b>Fossil fuel</b>	<b>%</b>	100.0%	99.8%	97.9%	95.2%	89.0%
<b>PV (NP + FI)+WtoE</b>	<b>%</b>	0.0%	0.2%	2.1%	4.8%	11.0%
<b>Total</b>	<b>%</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>

In 2023, overall percentage of solar PV plus Waste to Energy generation share for New Providence and Family Island is 11%, which is in line with goal to reach 30% in 2030.



**Figure 2 – NP+FI – planned trend of PV + WtoE generation share up to 2030**

In period 2024-2030, larger quantities of PV facilities should be installed in New Providence and Family Islands to reach 30% target in 2030. That will require more batteries to support further integration of renewable sources.

## KEY ASSUMPTIONS

A summary of assumptions used to derive a 5 year plan for New Providence (NP) and Family Islands (FI) is outlined below:

### New Providence (NP)

- Installation of all assessed quantities of roof top solar PV till the end of next 5-year period. The amount of installed solar PV capacities in 2023 would be 28.7MW with annual production of 42.7GWh.
- Installation of 30MW of floating solar PV with annual production of 54.1GWh in 2023. Further development will continue until 2030.
- Installation of 15MW of landfill ground mounted solar PV with annual production of 27.1GWh in 2022.
- New LNG power plant project will be realized in two phases. As phase one, seven units of 18MW would be in operation in August 2019. In the following phase, another six 18MW units is planned to be in operation in 2022.
- After commissioning of LNG phase 1, Aggreko rental units (90MW in the sum) will be cancelled. In the PLEXOS model LNG phase 1 is set up in operation at 01<sup>st</sup> August 2019, with the rental units A, B and CP being set out of operation at the end of August 2019. In real operation, these rental units should operate until full operating performances of LNG phase 1 are granted.
- Commissioning of the 7MW Waste to Energy power plant in the landfill, in 2023.
- Units DA11 and DA12 in Clifton Pier are considered as decommissioned due to failure (fire accident).
- Maintenance activities are not performed from May to September.

Following scenarios have been studied:

- **PV scenario** – considers all abovementioned assumptions, that is **preferential scenario**
- **PV + BESS scenario** – that is PV scenario including battery
- **PV Zero-Cost scenario** – PV scenario without taking into account capital and operating costs of PV plant – scenario used to determine the avoided cost value of PV
- **Base scenario** – without PV installed

### Family Islands (FI)

- Level of solar PV penetration on each island in 2023 reaches 10-15% of the total annual demand, in line with goal to reach 30% of total demand in 2030 year.
- When level of solar PV penetration reaches 10% of total annual demand (in 2023), shortages of spinning down reserves as well as solar PV curtailments occur. Therefore, battery storage facilities with a 4-hour rating have been proposed to support normal system operation, provide spinning reserve, and avoid solar PV curtailment. Battery will be charged during daylight with excess of PV generation and discharged during night hours. This battery storage will also support further integration of solar PV in following years.
- Maintenance activities are not performed in the period May – September.

Following scenarios have been studied:

- **PV+BESS scenario** – considers all abovementioned assumptions, that is **preferential scenario**
- **PV ZeroCost+BESS scenario** – PV+BESS scenario without counting capital and operating costs of PV plant – scenario used to determine the avoided cost value of PV+BESS
- **Base scenario** – without PV installed

## QUANTIFICATION OF PV PPA CEILING PRICE BY AVOIDED COST

PV ZeroCost scenario and the Base scenario have been analysed in order to compare costs of the scenarios, in such a way to quantify cost savings after installing solar PV plants in the system.

The PV ZeroCost scenario is the PV scenario (considers all recommended solar PV plants, and in the Family Islands also includes the BESS) without the inclusion of PV capital and operational costs. The Base scenario is without any solar PV installed. The difference between the scenarios is the avoided costs.

With the principle of avoided costs, assuming the solar PV facility as an independent power producer (IPP), the value of electricity (\$/MWh) from the solar PV may be expressed as difference of the total costs between PV ZeroCost (or PV ZeroCost+BESS when there is a battery installed) and Base scenarios (avoided cost), divided by electricity produced from solar PV. In that way, avoided cost (\$/MWh) may be good reference to determine the electricity price ceiling in a Power Purchase Agreement (PPA).

As it can be seen from the table below, the value for possible electricity price in PPA varies from 130 to 160 \$/MWh which is considered attractive for this type of power plants in Caribbean region.

In the following tables calculated avoided costs in New Providence, Family Islands and overall in New Providence and Family Islands are given:

**Table 4 – NP+FI – review of avoided costs in New Providence**

<i>New Providence</i>			2019	2020	2021	2022	2023
Base case	<b>Total cost</b>	<b>mil\$</b>	254.118	258.891	272.633	296.099	303.716
PV ZeroCost case	<b>Total cost</b>	<b>mil\$</b>	254.033	258.423	270.267	289.350	289.482
Delta	<b>Avoided total cost</b>	<b>mil\$</b>	<b>0.084</b>	<b>0.468</b>	<b>2.366</b>	<b>6.749</b>	<b>14.234</b>
PV Zero+BESS case	<b>PV generation</b>	<b>GWh</b>	0.62	3.39	17.71	58.17	123.73
Delta	<b>Energy cost - avoided</b>	<b>\$/MWh</b>	<b>137.34</b>	<b>137.81</b>	<b>133.60</b>	<b>116.02</b>	<b>115.04</b>

**Table 5 – NP+FI – review of avoided costs in Family Islands**

<i>Family Island - Total</i>			2019	2020	2021	2022	2023
Base case	<b>Total cost</b>	<b>mil\$</b>	104.716	109.725	116.547	125.795	132.692
PV ZeroCost+BESS	<b>Total cost</b>	<b>mil\$</b>	104.716	109.725	110.413	114.250	116.348
Delta	<b>Avoided total cost</b>	<b>mil\$</b>	<b>0.000</b>	<b>0.000</b>	<b>6.134</b>	<b>11.545</b>	<b>16.344</b>
PV ZeroCost+BESS	<b>PV generation</b>	<b>GWh</b>	0.00	0.00	28.30	52.89	81.35
Delta	<b>Energy cost - avoided</b>	<b>\$/MWh</b>	-	-	<b>216.77</b>	<b>218.27</b>	<b>200.91</b>
	<b>Total PV installed</b>	<b>MW</b>	-	-	<b>15.69</b>	<b>29.48</b>	<b>45.38</b>
	<b>BESS installed</b>	<b>MW</b>	-	-	<b>4.20</b>	<b>4.40</b>	<b>10.96</b>

**Table 6 – NP+FI – review of avoided costs in the Bahamas (New Providence and Family Islands)**

<i>New Providence + Family Island - Total</i>			2019	2020	2021	2022	2023
Base case	<b>Total cost</b>	<b>mil\$</b>	358.834	368.616	389.180	421.894	436.408
PV ZeroCost+BESS	<b>Total cost</b>	<b>mil\$</b>	358.749	368.148	380.680	403.600	405.830
Delta	<b>Avoided total cost</b>	<b>mil\$</b>	<b>0.084</b>	<b>0.468</b>	<b>8.499</b>	<b>18.294</b>	<b>30.578</b>
PV ZeroCost+BESS	<b>PV generation</b>	<b>GWh</b>	0.62	3.39	46.00	111.06	205.08
Delta	<b>Energy cost - avoided</b>	<b>\$/MWh</b>	<b>137.3</b>	<b>137.81</b>	<b>184.76</b>	<b>164.72</b>	<b>149.10</b>
	<b>Total PV installed</b>	<b>MW</b>	<b>0.9</b>	<b>3.9</b>	<b>27.59</b>	<b>65.38</b>	<b>119.08</b>
	<b>BESS installed</b>	<b>MW</b>	-	-	<b>4.20</b>	<b>4.40</b>	<b>10.96</b>