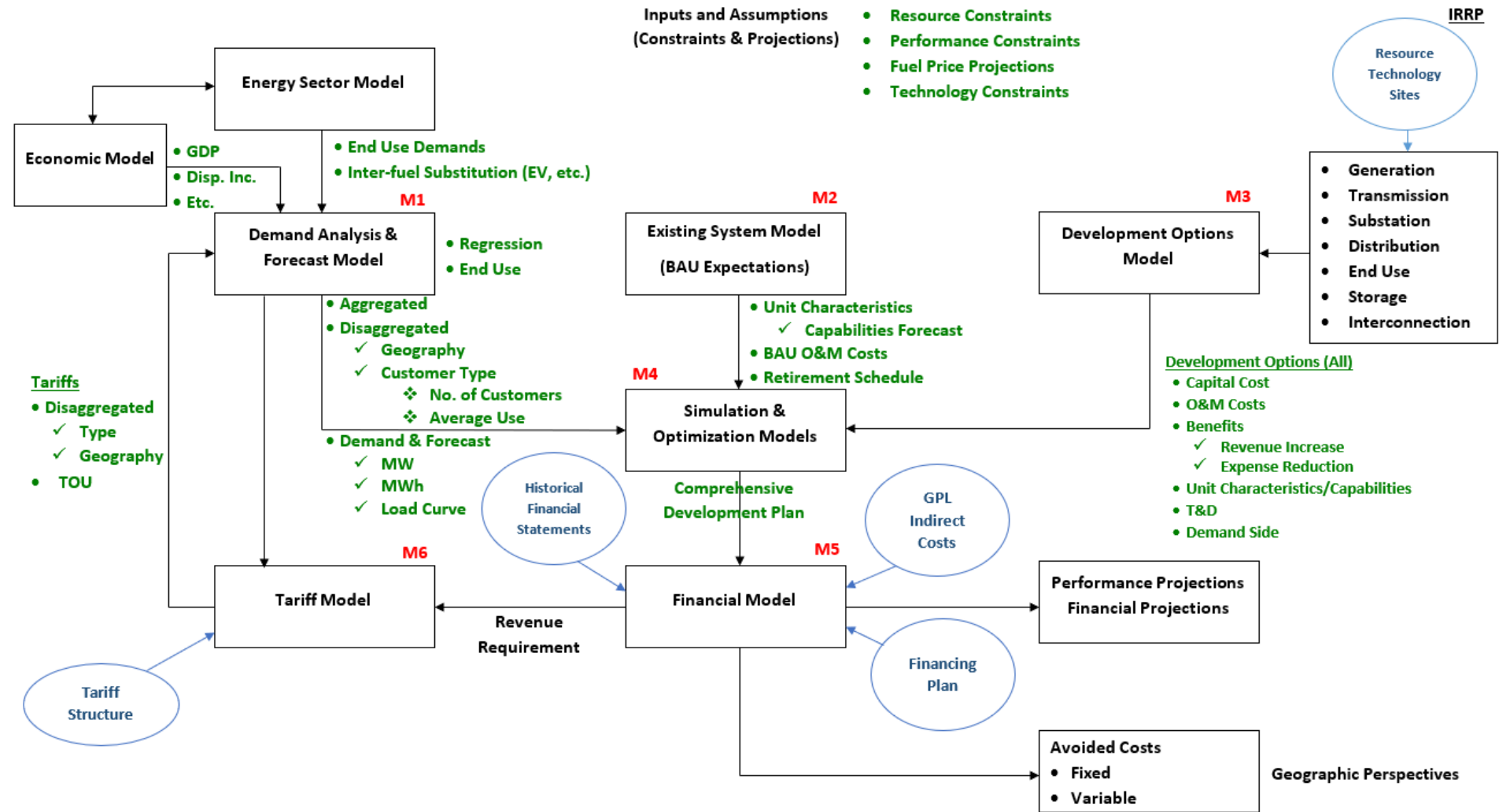
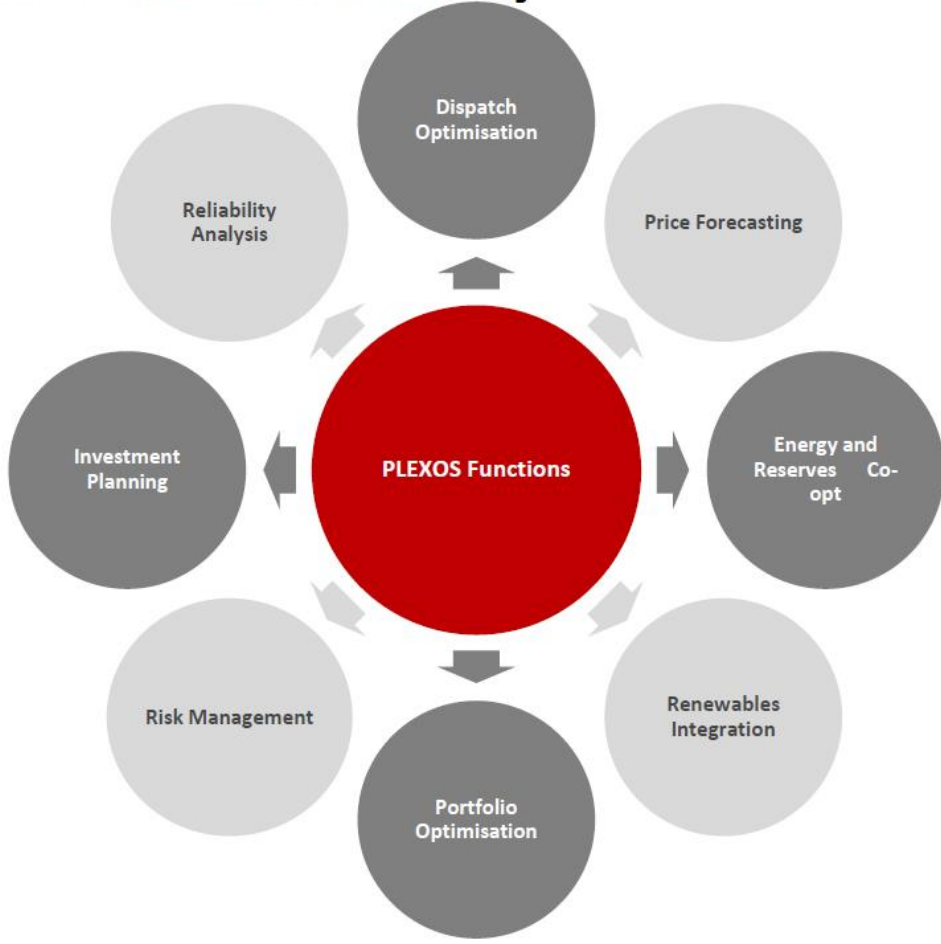


GPL IRRP Modelling Concept





Why use PLEXOS for Electricity





Thank You

General Reliability and Contingency Targets, and Horizon Timelines

- Loss of Load Expectation (LOLE) less than one (1) day per year;
- Mitigation of N-1 contingencies in the generation and transmission and systems.

Reliability and Contingency Targets applied to Short and Medium Terms Expansion Plans in the DBIS and Isolated Power (Anna Regina, Wakenaam, Leguan & Bartica)

Short Term = 2021-2022 (<2 years)

Medium Term = 2023-2025 (3-5 years)

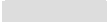


Long Term = 2026-2041 (> 5 years)

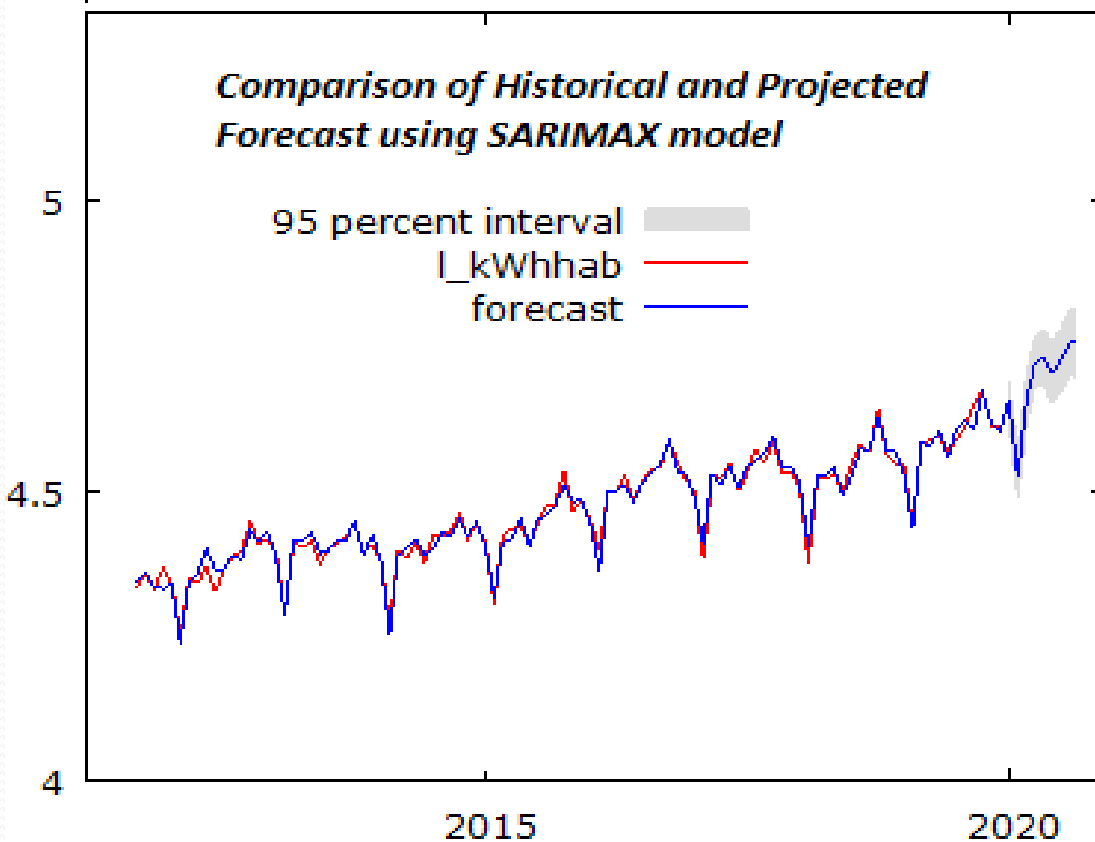
Background to updated Demand Forecast

- Prepared by GPL Forecasting Unit. The product of training and talent acquisition to build capacity in demand forecasting, supported under the PUUP financed by IaDB.
- Model Type is Seasonal Autoregressive Integrated Moving Average with Exogenous explanatory variables (SARIMAX). Utilizing 20 years historical monthly data on power generation / energy demand and Guyana's Real GDP sectoral breakdown.
- Model is theoretically sound and with a high degree of statistical relevance. It explains more than 99% of the historical variation in energy demand (R^2 of 0.992).

Model Performance

Comparison of Historical and Projected Forecast using SARIMAX model

95 percent interval 
l_kWhhab 
forecast 



Mean dependent var	-0.000149
Mean of innovations	-0.000446
R-squared	0.992544
Log-likelihood	580.4528
Schwarz criterion	-1069.526
S.D. dependent var	0.024988
S.D. of innovations	0.016091
Adjusted R-squared	0.991985
Akaike criterion	-1126.906
Hannan-Quinn	-1103.724

Economic Growth Assumptions

Real GDP Growth Rate Projections 2020-2030 in percent (%) p.a.



Real GDP	2020	2021	2022	2023	2024-2030
% change	50%	25%	40%	30%	11%

Source: MOF (2020) & IMF Article IV (2019)

Real GDP growth drivers:

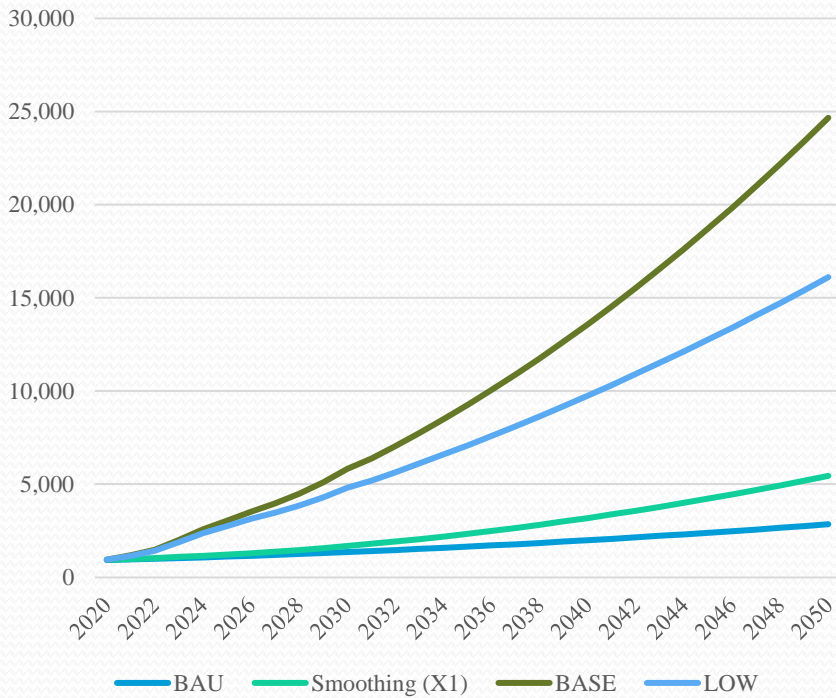
- Oil production from Liza 1 & 2, and Payara,
- Rebound in oil prices and overall growth in O&G sector despite the initial dampening effects of COVID19 and OPEC price war early in 2020,
- Growth in non-oil GDP expected to rebound and remain steady

Energy Forecast Scenarios

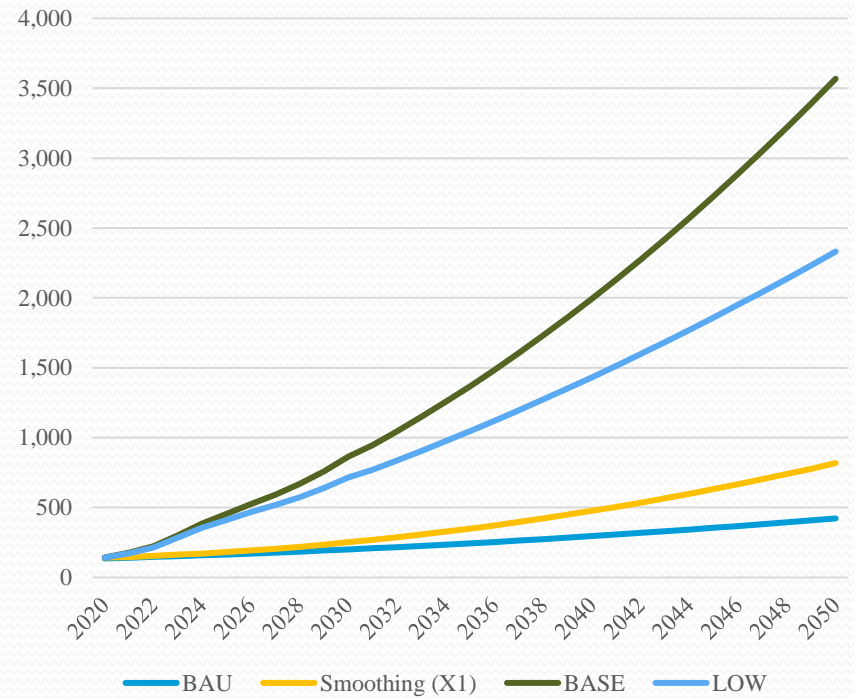
- Base Case – population growth 1.44% p.a., RGDP growth according to projections, dampened effect on energy demand growth from initial GDP growth due to oil (2020-2023),
- Low Case – population growth rate 1.44% p.a., RGDP growth marginally below projections, dampened effect on energy demand growth from initial GDP growth due to oil (2020-2023),
- Scenario X1 (smoothing energy demand growth) – applied for first 3 years (2020-2023) only new oil related GDP assumed to have limited immediate impact on energy demand,
- BAU – Business As Usual, assumes growth in energy demand follows historical growth patterns only without considering impact from growth in RGDP or population.

Forecast Results

Projected Annual Energy Demand (GWh)



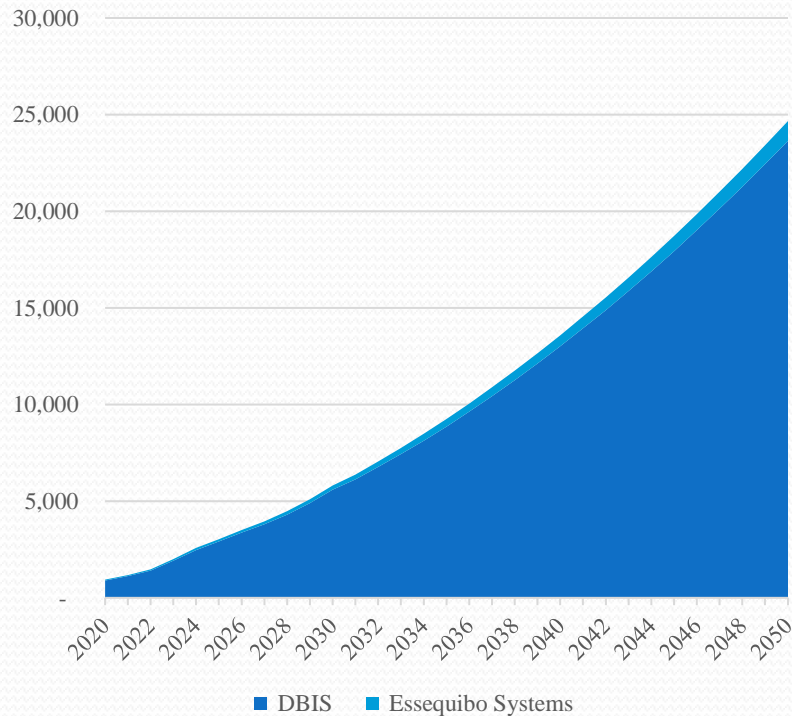
Projected Peak Power Demand (MW)



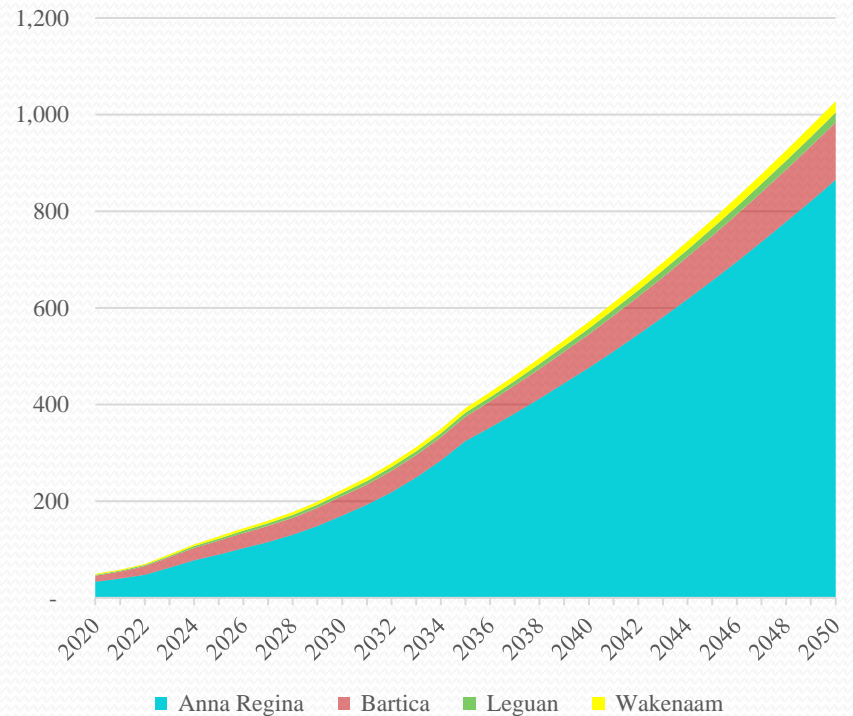
	2020		2025		2030		2035		2040		2050	
	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW
BASE	949	143	3,037	454	5,818	864	9,257	1,368	13,584	1,994	24,668	3,569
LOW	949	143	2,752	411	4,804	714	7,083	1,047	9,755	1,432	16,106	2,330
BASE CASE Annualized % change			26%	26%	14%	14%	10%	10%	8%	8%	6%	6%

Energy Demand (GWh) Forecast by GPL area systems

Composition of Base Case forecasts by GPL Area Systems (GWh)

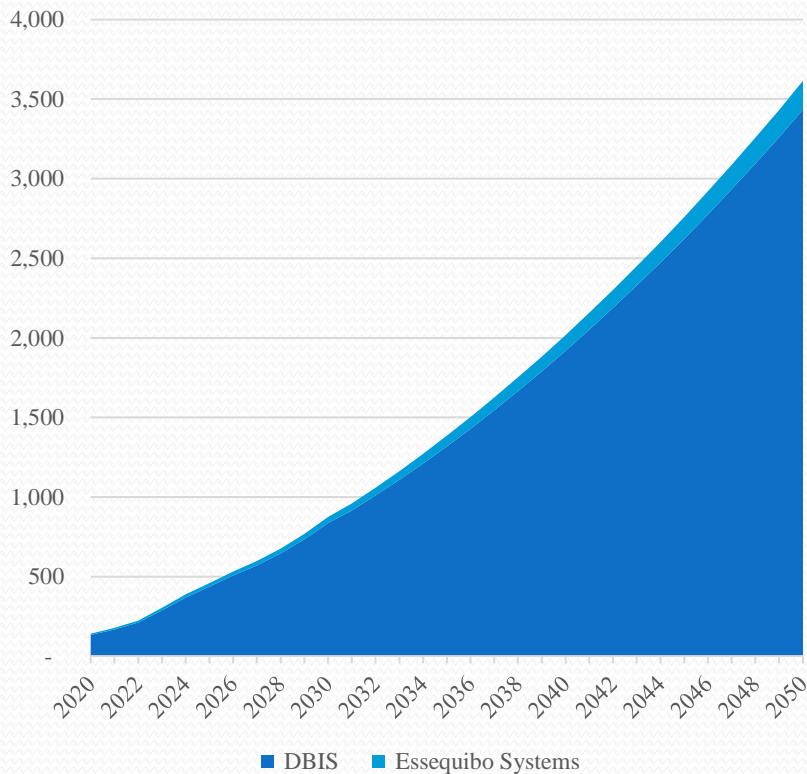


Composition of Essequibo Systems Base Case Forecast (GWh)

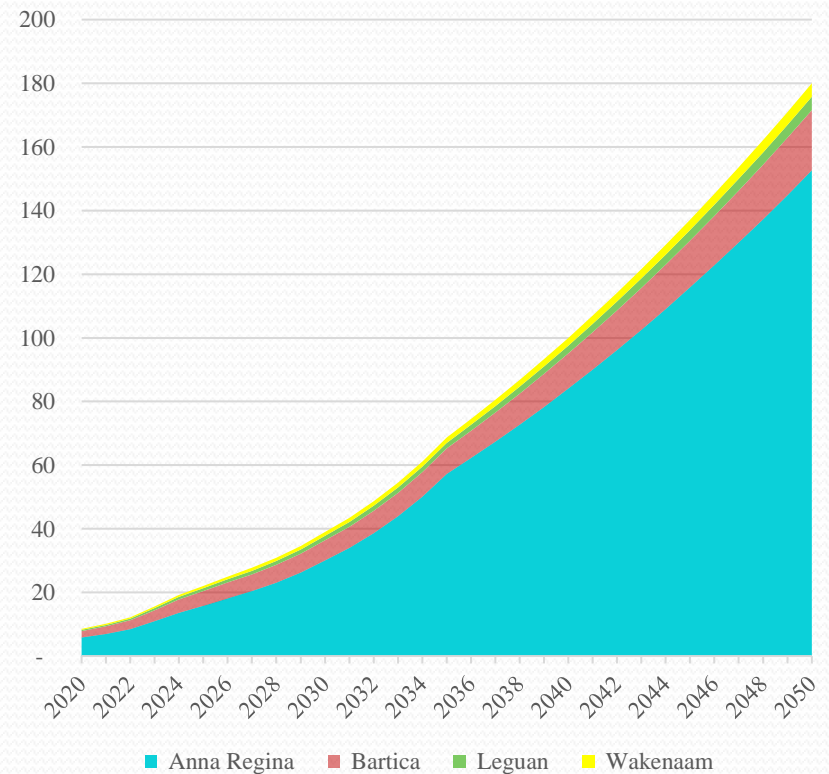


Peak Power (MW) Forecast by GPL area systems

Composition of Base Case Peak Power forecasts by GPL Area Systems (MW)



Composition of Essequibo Systems Base Case Peak Power Forecast (MW)



General Constraints to Power System's Reliability in GPL

- Unreliability in Electricity Supply (Generation);
- Failure of any major component (transmission line, substation transformer, circuit breaker, etc.);
- Significant deficiencies in the design and configuration of some substations and transmission corridors;
- Poor state of significant portion of aged infrastructure and inadequate maintenance;
- Non-compliance with Planning Code's N-1 contingency criteria; and
- Thermal overloading at some substations (substation transformer and circuit breaker).

Planned Major Projects for Short-term (2021-2022) – Power Generation Projects

- 30 MW IPP at Canefield (East Corentyne, Berbice) - Dec 1st 2020;
- Garden of Eden Phase 1 – 46.5 MW MF Power Plant - June 30th, 2021;
- Anna Regina Plant Extension – 1.8 MW HFO Generator - 2021;
- Wakenaam- 3 x 225 kVA LFO Generators - Dec 2021;
- Bartica Plant Extension – 2 MW LFO Generator - Jan 2021;
- Crab Island/East Bank Berbice Phase 1 - 90 MW - Oct 2022;
- and
- Anna Regina Plant Upgrade – 2 x 2.5 MW DF Generators (IPP).

Renewable Energy Projects – Short-term

- 10 MWh Committed Battery Energy Storage System – Aug 2021.
- 36 MWp Solar Farms With Battery Energy Storage Systems (Dec 2021):
 - Canefield (East Corentyne, Berbice) 10 MWp with 10 MWh BESS;
 - Golden Grove (East Bank Demerara) 10 MWp with 10 MWh BESS;
 - Edinburgh (West Coast Demerara) 10 MWp with 10 MWh BESS;
 - Anna Regina 4 MWp with 4 MWh BESS; and
 - Leguan 1 MWp Solar Farm with 1 MWh BESS;
 - Wakenaam Solar Farm Phase 2 – 0.5 MWp with 2.89 MWh BESS

Renewable Energy Projects – Short-term

- Wakenaam Solar Farm Phase 1 - 0.5 MWp with 0.51 MWh BESS
- Bartica Solar Farm 1.5 MWp with 1.5 MWh BESS
 - New Solar PV Farm with BESS and Interconnecting 13.8 kV line; and
 - Switchgear expansion at Plant to accommodate PV interconnection.

Key Drivers to Power System Upgrades – Transmission System and Substations

Due to Load and Power Generation Increase, transmission upgrades/ reinforcements, substation upgrades and extensions were mainly driven by:

- Thermal violation of lines and bus bars and circuit breakers;
- Short-circuit violation at the 13.8 kV level at DP1 – DP3 & G/Hope;
- Need for switching flexibility at substations;
- Need for voltage improvement at transmission level at the far Western and Eastern ends;
- Need to improve transmission reliability;
- Interconnection of RE and ESS Projects.

Upgrades & Expansion of Existing Substation – Short-term

- Garden of Eden (2021 & 2022)
- Canefield (2021 & 2022)
- Edinburgh (2021)
- New Sophia Switching Substation (2021)
- Sophia Upgraded (2021)
- New Georgetown (2021)
- Good Hope(2021)
- Columbia (Jan 2022)
- Onverwagt (2021)
- Golden Grove(2021)
- Kingston – 2021 and Vreed-en-hoop (2021): PUUP (IsDB), and other Planned Upgrades on the 13.8 kV sections, respectively.
- No. 53 Village (2022)

Construction of New Substations – Short-term

- Upgrades to existing SCADA and extending SCADA reach into Distribution and Generation Systems, and installation of AGC – Dec 2021
- Williamsburg (Sept 2022)
- Hydronie/Parika (2021)
- Wales (Sept 2021)
- Eccles (Sept 2021)
- Kuru Kururu (Sept 2022)
- Crab Island (Dec 2022)

Transmission System Short-term (2021)

- Kingston to Sophia transmission line upgrade and redundancy (L5 and L5R);
- New Sophia to Good Hope transmission line upgrade and redundancy (L16 and L16R);
- Kingston to New Georgetown new transmission line (L11);
- New Sophia to New Georgetown transmission lines upgrade (L10);
- Edinburgh to Hydronie/Parika Substation new transmission line (L8);
- Garden of Eden to Golden Grove transmission line upgrade (L1 and L3);
- Golden Grove to Eccles transmission line upgrade and splitting (L2-1 and L4-1);
- New Georgetown to Eccles new Transmission line (L15);
- Eccles to New Sophia transmission line upgrade and splitting (L4-2);
- Eccles to Old Sophia transmission line upgrade and splitting (L2-2);
- Garden of Eden to Wales new transmission line (L24); and
- Vreed-en-hoop to Wales new transmission line (L9).

Transmission System Short-term (2022)

- L12 and L13 Upgrade – to facilitate increased power transfer between Old and New Sophia Substations;
- Garden of Eden to Kuru Kururu new transmission line (L31);
- Garden of Eden to Eccles new transmission line (L14);
- Vreed-en-hoop to New Georgetown new transmission line (L32);
- Good Hope to Columbia redundant transmission line (L17R);
- Columbia to Onverwagt redundant transmission line (L20R);
- Onverwagt to Canefield redundant transmission line (L21R);
- Splitting of existing transmission lines from Canefield Substation to Williamsburg Substation (L22-1 & L22R_1) to interconnect with the Crab Island substation;
- Canefield to Williamsburg transmission line splitting (L22-1);
- Williamsburg to No. 53 transmission line splitting (L22-2);
- Canefield to Williamsburg transmission line redundancy (L22-1 and L22R-1);
- Williamsburg to No. 53 transmission line redundancy (L22-2 and L22R-2); and
- No. 53 to Skeldon transmission line redundancy (L23R).

Reactive Compensation Projects— Short-term

- 2 x 5 MVAR Shunt Capacitors (Static) at Canefield – JICA Grant (March 2021)
- 55 MVAR 69 kV De-tuned Fixed Capacitor Reactive Compensation System – Dec 2021:
 - 15 MVAR at New Sophia;
 - 15 MVAR at Good Hope;
 - 15 MVAR at New Georgetown; and
 - 10 MVAR at Edinburgh.

Distribution System Projects – Short-term

Upgrade of 13.8 kV Primary Distribution Feeders:

- JICA Grant - GPL to fund costs of line hardware and labour for below backbone upgrades:
 - Upgrade Onverwagt F2 Feeder;
 - Construction of express feeder to Ithaca
 - Install 1500 kVAr APFC on both lines;
 - Backbone upgrades:
 - G/Hope F4
 - Sophia F2
 - GoE F1
 - Replace SWER Transformers on WCD and WBD;

Distribution System Projects – Short-term

Upgrade of 13.8 kV Primary Distribution Feeders (2021):

- Garden of Eden F2 (from Tulip to Cosmos);
- Edinburgh F2 (from Tulip to Cosmos);
- Good Hope F2 (from Tulip to Cosmos);
- Canefield F3 (from Tulip to Cosmos);
- Load sectionalisation of Good Hope F4
- Upgrade existing 13.8 kV feeder from Anna Regina to Supernaam;
- Construction of express feeder from Anna Regina to Onderneeming – load pickup from Onderneeming – total feeder length to be upgraded to Cosmos;
- Upgrade of existing feeder from Anna Regina to Onderneeming using Cosmos;
- Express from Edinburgh to Philadelphia, WCD; and
- Sophia Substation improve reliability on the F2.

Distribution System Projects – Short-term

Construction of New of 13.8 kV Primary Distribution Feeders (2021):

- Eccles - 4 new active feeders
- Hydronie/Parika - 3 new active feeders
- Wales - 4 new active feeders
- Bartica:
 - Two new feeders to supply unserved areas (lower East Bank Essequibo River, and Mazaruni Prison and Gersham); and
 - Upgrade Feeder from Power Plant to 5 miles from Tulip to Cosmos and extend network to supply unserved areas (Itabali and Missions).

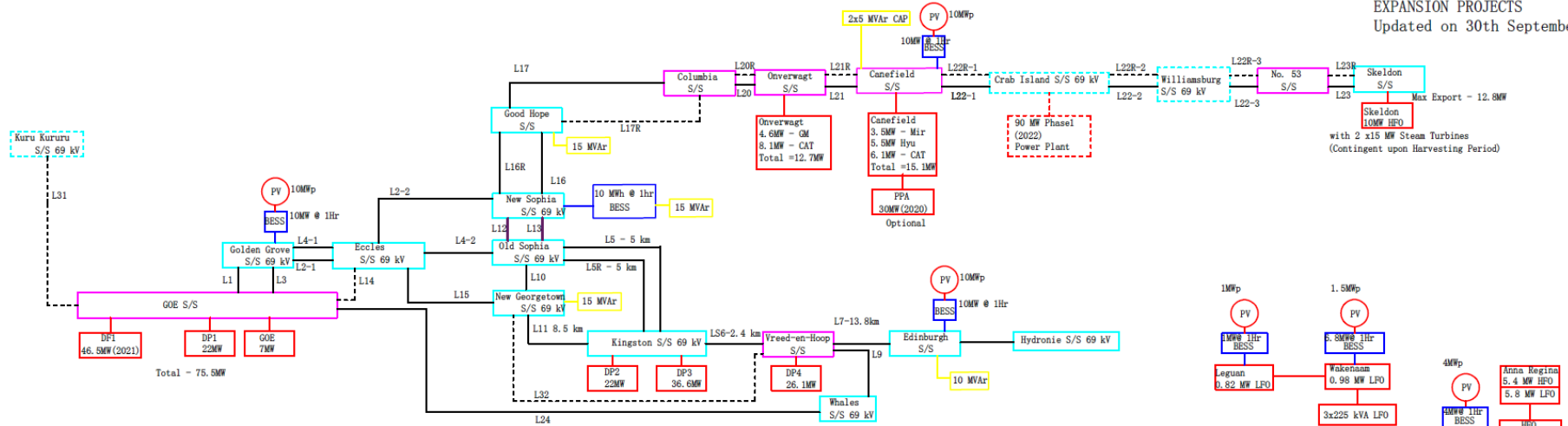
Distribution System Projects – Short-term

Construction of New and Express 13.8 kV Distribution Feeders (2022):

- Construction of two new feeders from Edinburgh substation;
- Construction of 13.8 kV express line from Lima Sands to Charity;
- Williamsburg - 4 new active feeders; and
- Kuru Kururu - 4 new active feeders - Sept 2022.

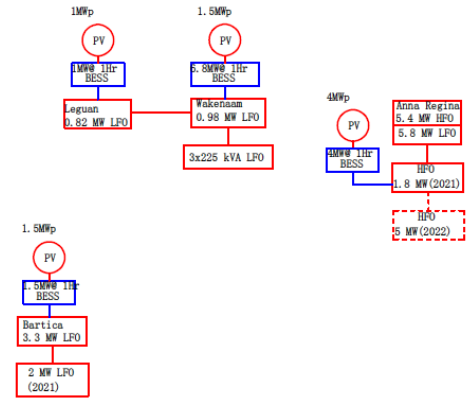
GPL Power Systems' Layout – end of Short-Term

GUYANA POWER AND LIGHT INC.
 DEMERARA BERBICE
 INTERCONNECTED SYSTEM
 2022 DEVELOPMENT AND
 EXPANSION PROJECTS
 Updated on 30th September, 2020



KEY

 	Existing Power Plant		230 kV Proposed Transmission Line
 	Proposed Power Plant		230 kV Existing Transmission Line
 	Existing Substation		Proposed PV Farm
 	Substation to be Upgraded		Proposed Capacitor Bank
 	Proposed 69 kV Substation		Proposed BESS
 	Proposed 230 kV Substation		Existing PV Farm
 	Existing 230 kV Substation		Existing Capacitor Bank
	69 kV Transmission Line		Existing BESS
	69 kV Proposed Transmission Line		
	69 kV Transmission Line to be Upgraded		



Planned Major Projects for Medium-term (2023-2025) – Power Generation Projects

- Garden of Eden Phase 2 – 46.5 MW – Oct, 2023;
- Crab Island/East Bank Berbice Phase 2 - 90 MW - June, 2023;
- East Bank Essequibo 90 MW MF Power Plant - Oct 2023;
- Anna Regina Plant Upgrade – 2x2.5 MW HFO – Sept, 2023;
- Natural Gas Fired 180 MW - Jan, 2024; and
- Ikuribisi 1 MW Hydro Power - 2025.

Renewable Energy Projects – Medium-term

- Kuru Kururu and Wales - 10 MWp Solar PV Farms - Jul 2023;
- Hope Beach, ECD (proposed IPP) - Feb 2023:
 - Wind Farm 20 MW;
 - Solar Farm 20 MWp; and
 - 40MWh BESS.
- Naarstigheid, West Coast Berbice 4 MWp Solar Farm - Jan 2025;
- Bartica, Ikuribushi Hydropower Plant - 1 MW - Dec 2025.

Existing Substation Projects Upgrades – Medium-term

- Edinburgh (2023 & 2024)
- Good Hope (2023)
- Garden of Eden (Sept 2023 & 2024)
- Kingston Substation (Sept 2023)
- New Georgetown (Dec 2024)
- Golden Grove (2023)
- Columbia (2023)
- Onverwagt (Sept 2024)

New Substation Projects Upgrades – Medium-term

- Natural Gas Plant Site (Jan 2024)
- Ogle (Jan 2024)
- Success (Jan 2024)
- Unity/Mahaica (Sept 2024)
- Wales (Dec 2024)
- Hydronie/Parika (Dec 2023, Jan 2024 & Dec 2025)
- East Bank Essequibo (Oct 2023)
- Leguan (Dec 2024)
- Wakenaam (Dec 2024)
- Suddie (Dec 2024)
- Devonshire Castle (Dec 2024)

Transmission System- Medium Term

- 69 kV Transmission Lines (2023):
 - Splitting of existing transmission lines from Good Hope Substation to Columbia Substation (L17-1 & L17R_1) to interconnect with the Hope Beach substation;
- 69 kV Transmission Lines (2024):
 - Natural Gas Plant site to Ogle new transmission lines (L25 and L25R);
 - Ogle to Success new transmission lines (L26 and L16-R2);
 - Success to Good Hope (L16R-3);

Transmission System- Medium Term

- 69 kV Transmission Lines (2024)
 - Splitting of existing transmission lines from Eccles to Old Sophia (L2-2) and Eccles to New Sophia (L4-2) to accommodate:
 - Eccles to Natural Gas Plant (L2-2, L4-2);
 - Natural Gas Plant to Old Sophia (L2-3); and
 - Natural Gas Plant to New Sophia (L4-3).
 - Good Hope to Unity/Mahaica transmission line splitting (L17-2);
 - Unity/Mahaica to Columbia transmission line splitting (L17-3);
 - Hydronie to Leguan new transmission line (L33);
 - Leguan to Wakenaam new transmission line (L34);
 - Wakenaam to Suddie new transmission line (L35); and
 - Suddie to Devonshire Castle new transmission line (L36).

Transmission System- Medium Term

- 69 kV Transmission Lines (2025)
 - Vreed-en-hoop to Edinburgh redundant transmission line (L7R);
 - Edinburgh to Parika/Hydronie redundant transmission line (L8R); and
 - Garden of Eden to Kuru Kururu redundant transmission line (L31R).
- 230 kV Transmission Lines (2024)
 - Natural Gas to Garden of Eden new transmission lines (HVL1, HVL1R);
 - Natural Gas to Crab Island new transmission lines (HVL2, HVL2R);
 - Garden of Eden to Wales new transmission line (HVL4); and
 - Wales to Hydronie new transmission line (HVL5).

Reactive Compensation Projects— Medium-term

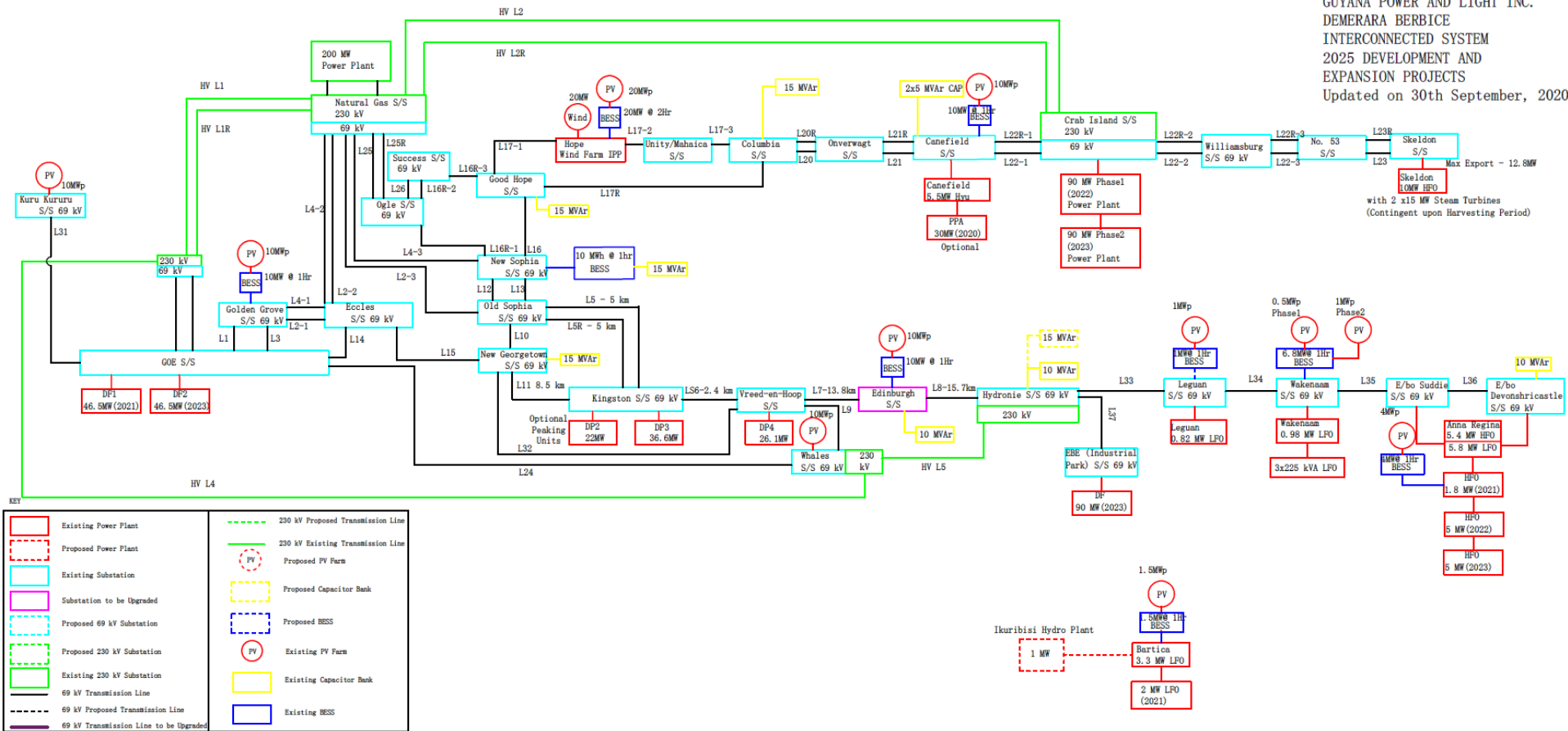
- 15 MVAr 69 kV De-tuned Compensation Systems at Columbia- Dec 2023
- Installation of 10 MVAr 69 kV De-tuned Compensation System at Hydronie- Dec 2023
- Installation of 10 MVAr 69 kV De-tuned Compensation System at Hydronie- Dec 2025
- 10 MVAR 69 kV De-tuned Compensation Systems at Devonshire Castle on the Essequibo Coast- Dec 2024

Distribution System Projects- Medium-term

- SCADA Integration Of Auto-reclosures and Automation of Distribution Networks; and
- New 13.8 kV Distribution Feeder form existing Substation (2023-2025)
 - Six (6) new feeders form Ogle Substation- 2023
 - Six (6) new feeders form Success Substation- 2023
 - Six (6) new feeders form Good Hope Substation- 2023
 - Two (2) new feeders form Onverwagt Substation- 2023
 - Two (2) new feeders form No. 53 Substation- 2024
 - Four (4) new feeders form Unity/Mahaica Substation- 2024
 - Four (4) new feeders form Golden Grove Substation- 2024
 - Four (4) new feeders form New Georgetown Substation- 2025
 - Four (4) new feeders form Crab Island Substation- 2025
 - Three (3) new feeders from Garden of Eden Substation-2025

GPL Power Systems' Layout – end of Medium-Term

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 2025 DEVELOPMENT AND
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Planned Major Projects for Long Term (2026-2041) – Generation & Renewable Energy Projects

- 1 MW Ikuribisi – interconnected with Bartica Power Plant;
- Amaila Hydropower Project;
- Convert DP2, DP3 and DP4 to Operate with Natural Gas – 2025.
- More Hydropower and Gas Fired Power Plants as required to satisfy forecast demand and LOLE Target (less than 1 day per year).

Planned Major Projects for Long Term (Beyond 2025) –

New Transmission System Projects

- 230 kV double circuit transmission line from Amalia Hydro Power Facility to Linden (HVL6 & HVL6 R);
- 230 kV double circuit transmission line from Linden to Kuru Kururu (HVL7 & HVL7 R);
- 230 kV double circuit transmission line from Kuru Kururu to Garden of Eden (HVL8 & HVL8 R);
- 230 kV single circuit transmission line from Hydronie to Industrial Park (HVL9);
- 230 kV single circuit transmission line from Industrial Park to Linden (HVL10);
- 230 kV single circuit transmission line from Linden to Crab Island (HVL11);
- 69 kV Single Transmission line from Parika/Hydronie to Bartica (L37);
- 25 MVAr 69 kV De-tuned Compensation System for Hydronie

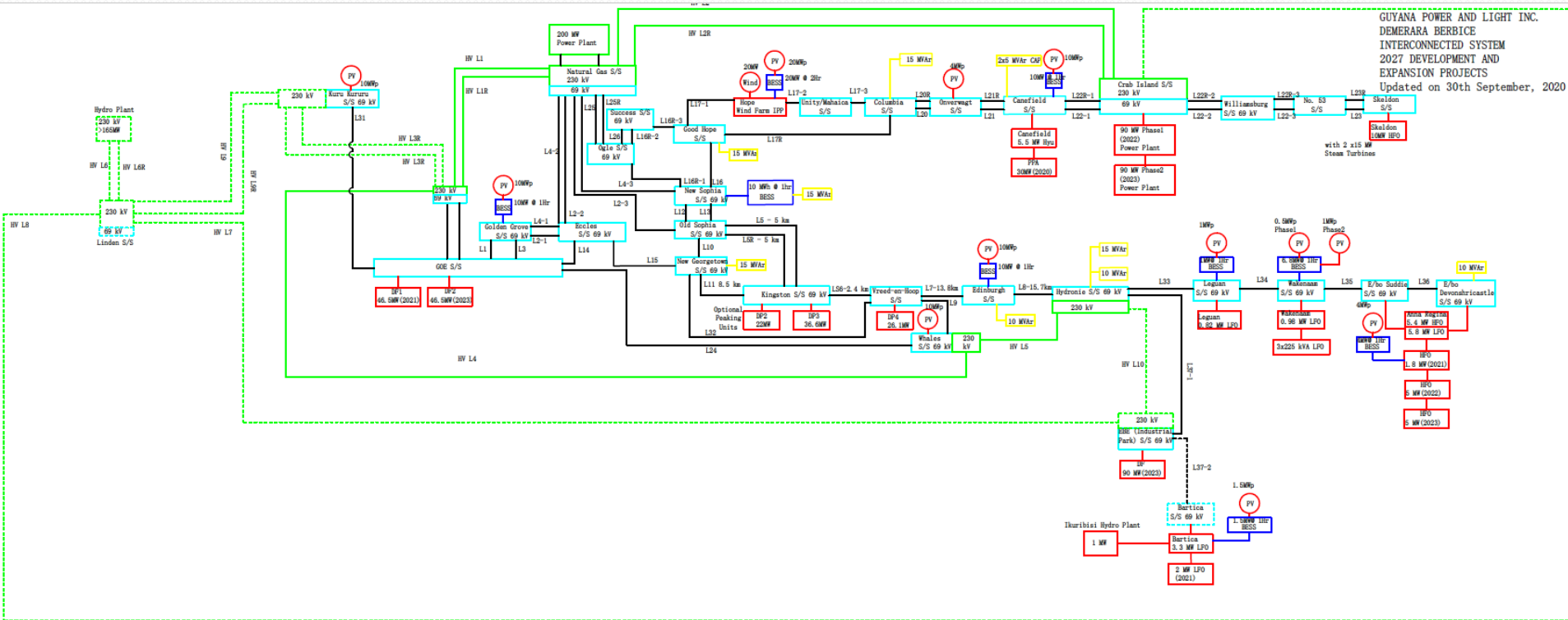
Planned Major Projects for Long Term (Beyond 2025)

Construction of New 230/69kV and 69/13.8 kV

Substation Projects:

- Amaila (230/69/13.8 kV);
- Linden (230/69/13.8 kV);
- Kuru Kururu (230/69 kV); and
- Bartica (69/13.8 kV).

GPL Power Systems' Layout – end of Long-Term



KEY

Existing Power Plant	230 kV Proposed Transmission Line
Proposed Power Plant	230 kV Existing Transmission Line
Existing Substation	Proposed PV Farm
Substation to be Upgraded	Proposed Capacitor Bank
Proposed 69 kV Substation	Proposed BESS
Proposed 230 kV Substation	Existing PV Farm
Existing 230 kV Substation	Existing Capacitor Bank
Existing 69 kV Transmission Line	Existing BESS
69 kV Proposed Transmission Line	
69 kV Transmission Line to be Upgraded	