GPA Generation Reliability

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Purpose – Evaluate System Reliability with the Piti 8&9 Plant Retired

- Provide USEPA the expected system reliability based on the following:
  - Retirement Of Cabras 1 & 2 (132MW Gross)
  - Retirement of Piti 8&9 (88MW Gross)
  - Addition of Ukudu Combined Cycle Power Plant (198MW Net)
  - Addition of KEPCO Diesel Plant (42MW net)
  - Addition of Phase II Renewables (120MW net)
    - 120 MW net is the 25th year capacity
    - Initial capacity is 180 MW
  - Addition of Phase III (50MW + Energy Shifting Battery Energy Storage System (ESBESS))
  - Addition of Phase IV-A
    - Interconnection limited to 60 MW per project
    - Aggregate Minimum Energy Requirement is 300 MWH/year

Topics

- Assumptions
- Methodology
- Results
- Conclusions

Assumptions

- GPA Long Range Forecast of System Peaks, Annual Energy, Sales, and Hourly Loads (Utility Financial Solutions, LLC)
- Use Bid and KEPCO provided information on Ukudu CC CT Power Plant & Diesel Plant Characteristics
- Two-State Model for Generation Unit Reliability (Billinton)
- 3-Year hourly output data from 26.5-MW GlidePath Solar PV Plant
- Cabras 1&2 and Piti 8&9 Retired at Beginning of each System Scenario
- Ukudu Power Plant and KEPCO Diesel Power Plant Online
- Phase II & Phase III Renewable Energy Projects Online

COVID-19 Impact Adjusted Forecast

- Utility Financial Solutions adjusted the Peak Demand and Energy Forecast for the Impact of COVID-19

Analytical Methodology

- Develop Capacity State (MW) versus Capacity State Probability of Occurrence Model for”
  - Each Fossil Fuel-Fired Power Plant
  - Solar PV + Energy Shifting Battery Energy Storage System
- For Each Scenario of Generation Mix
  - Compute GPA Generation Capacity State and Probability for each Combination of Power Plant States
  - Determine the Peak Load Carrying Capacity (PLCC) for the GPA Generation System that just meets GPA’s minimum Generation System Reliability Criteria of One Day in 4.5 Years Loss of Load Expectation (LOLE)
  - Compare the PLCC with GPA’s Forecast

Methodology

1. Develop the SPV+ESBESS Capacity State Model
   - Using a dataset of Three Consecutive Years of hourly GlidePath Solar PV Plant power delivery, create a normalized capacity-state and probability for each state model for SPV+ESBESS additions
   - Use this information to compute the Generation System Available Capacity State
   - Scale the Model to the Level of SPV-ESBESS as required for each SPV-ESBESS addition scenario to the GPA Generation System

Methodology

2. Develop the Plant Capacity-State Model for Each Fossil-Fuel-Fired Power Plant
   - Assume Generator Units in a Power Plant are either In the ON or OFF State
   - Compute the Plant Available Capacity for each combination of unit ON-OFF States
   - Add the probabilities for each combination resulting in a common capacity state to get the probability for that Plant Available Capacity state.
   - Order the Plant Available Capacity States and their Probability of Occurrence from 0 MW to Plant MW Maximum Capacity
   - Repeat this for each Fossil Fuel-Fired Power Plant
   - Use this information to compute the Generation System Available Capacity State

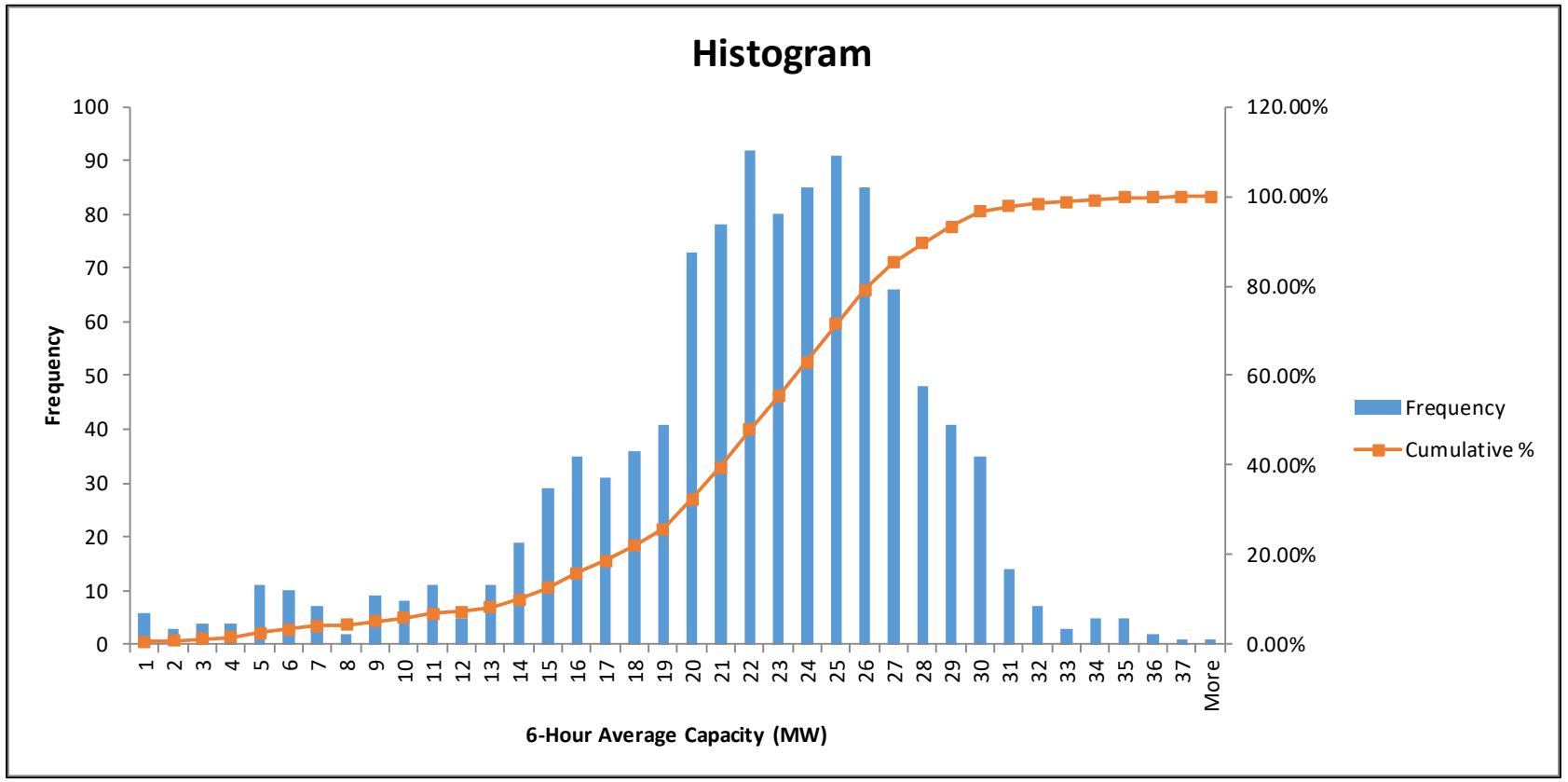
Methodology

3. Develop the GPA Generation System Available Capacity State Model
   - Compute the GPA Generation System Available Capacity for each combination of SPV-ESBESS and Fossil Fuel-Fired Power Plant States
   - Add the probabilities for each combination resulting in a common capacity state to get the probability for that GPA Generation System Available Capacity State scenario.
   - Order the GPA Generation System Available Capacity States and their Probability of Occurrence from 0 MW to GPA System Maximum Capacity (MW).
   - Use this model to determination the Peak Load Carrying Capability for the GPA Generation System

Methodology

4. Determine the Peak Load Carrying Capacity (PLCC) for the GPA Generation System that just meets GPA's minimum Generation System Reliability Criteria of One Day in 4.5 Years Loss of Load Expectation (LOLE).

GlidePath Energy Production System Peak Support Evaluation



- Evaluating the GlidePath System Capability to serve a six-hour system Peak indicates that the most reliable production from 20 to 26 MW occurs about 46.66% of the year.

Normalized ESS State Model

Normalized ESS Model			
State	**MW**	**P(X)**	**P(X) in Percent**
1	-	0.003653	0.4%
2	0.074	0.022831	2.3%
3	0.255	0.074886	7.5%
4	0.580	0.863927	86.4%
5	0.835	0.033790	3.4%
6	1.000	0.000913	0.1%

Scenario No.	Scenario	Peak Load Carrying Capability (PLCC) @ one day in 4.5 years LOLE (MW)	Implications Related to Forecast with Datacenter (High Load Case)
1	Phase III Solar PV + ES BESS; Ukudu Diesels Not Relocated	320.20	Meets LOLE standard until 2028 (2034 for Low Load Case)
2	Phase III Solar PV + ES BESS; Ukudu Diesels Relocated	>340.00	Supports System beyond FY 2041; LOLE better than one day in ten years
3	60 MW Solar PV + ES BESS; Phase III; Ukudu Diesels Not Relocated	>340.00	LOLE in 2040 is one day in 6.9 years
4	60 MW Solar PV + ES BESS; Phase III; Ukudu Diesels Relocated	>340.00	Supports System beyond FY 2041; LOLE better than one day in ten years
5	150 MW Solar PV + ES BESS; Phase III; Ukudu Diesels Not Relocated	>340.00	Supports System beyond FY 2041; LOLE better than one day in ten years
6	150 MW Solar PV + ES BESS; Phase III; Ukudu Diesels Relocated	>340.00	Supports System beyond FY 2041; LOLE better than one day in ten years

Results

- Generation Mix Changes Common to All Scenarios
  - Piti 8&9 Retired
  - Cabras 1&2 Retired
  - Ukudu CC CT online

Conclusions

- With the New Ukudu Power Plant, KEPCO Diesel Power Plant, and Phase II & III Renewable Projects Online, GPA can retire Piti 8&9 with Cabras 1&2 and still meet its one day in 4.5 years Loss of Load Expectation (LOLE)
- GPA can achieve better than a **one day in ten years** LOLE with addition of GPA's planned Phase IV SPV+ESBESS Bid.

Next Steps

- Looking at economic feasibility for additional power plant retirements
- Importance of GPA reserve margin policy
  - Significant reduction in the amount of reserve capacity to cover for generation outages
  - Prudent backstop to require two largest unit reserve margin.
- Bid for Renewable Energy plus Energy-Shifting Battery Energy Storage Systems every two years beginning this year to meet 50% GPA renewable goal by 2030. Continue
- Bid out for Grid Controller to manage conventional generation, energy storage systems, and renewable energy variable generation
  - Will recognize potential grid stability issues within one cycle (16.7 milliseconds) and take automatic corrective action within 10 milliseconds.

Bonus: Reaching 50% by 2029

- Phase IV Renewable Acquisition
  - 2022 Award Year; 2024 COD
  - 60 MW Interconnection Limitation
  - Minimum energy 300,000 MWH/year
  - 100% Energy Shifting
  - Grid Ancillary Services
- Phase V Renewable Acquisition
  - 2024 Award Year; 2026 COD
  - 60 MW Interconnection Limitation
  - Minimum energy 300,000 MWH/year
  - 100% Energy Shifting
  - Grid Ancillary Services
- Phase VI Renewable Acquisition
  - 2026 Award Year; 2028 COD
  - 60 MW Interconnection Limitation
  - Minimum energy 300,000 MWH/year
  - 100% Energy Shifting
  - Grid Ancillary Services
- GPA will bid for Renewable Energy every two years until we reach 100% or the economic limits for renewable energy.