December 30, 2022

The Honorable Chair and Members
of the Hawaiʻi Public Utilities Commission
Kekuanaoʻa Building, First Floor
465 South King Street
Honolulu, Hawaiʻi 96813

Dear Commissioners:

Subject: Docket No. 2022-0012
Competitive Bidding Process to Acquire Energy Storage
Development of North Kohala Energy Storage RFP
Updated Re-study Results to the North Kohala Microgrid + BESS Project

Pursuant to Order No. 38699, issued on November 10, 2022 in the subject proceeding, Hawaiian Electric[1] respectfully submits the updated re-study results for the North Kohala Microgrid + BESS project enclosed as Exhibit 1 to this letter. Although the full North Kohala Energy Storage Request for Proposal ("RFP") and updated cost estimate are not yet available at this time, the Company is providing the updated re-study results to give the Commission the opportunity to begin its review.

The updated drafts of the RFP and model Energy Storage Service Agreement ("ESSA") will be filed no later than January 13, 2023 and will subsequently be made available to the public on Hawaiian Electric's website at https://www.hawaiianelectric.com/NorthKohalaEnergyStorageRFP ("RFP Website"). Updates are being made where applicable to conform the terms of the RFP and ESSA with the Stage 3 RFPs, filed on November 7, 2022 for Hawaiʻi Island and on December 22, 2022 for the islands of Maui and Oʻahu. Similarly, the update to the pricing of the Microgrid + BESS project are being completed and will be filed no later than January 13, 2023.

Based on the re-study results, the Company is recommending a change of BESS size from 5 megawatts (MW) / 22 megawatt-hours (MWh) of energy storage capacity to 5 MW / 30 MWh, see Table 2 of Exhibit 1. The updated energy storage capacity reflects a number of updated findings, which will ultimately provide better reliability to the North Kohala area than previously contemplated. The major assumption changes to the updated BESS capacity is as follows:

1. Removal of 15% load deduction. The initial use of a 15% load deduction for voluntary calls of conservation was speculative. Since this initial study, there have been several calls for conservation on Hawaiʻi Island, which did not result in an actual reduction in demand from the forecast peak. Therefore, it is concluded that voluntary reduction in load cannot be relied on to reduce demand served by the microgrid.

[1] Hawaiʻi Electric Light Company, Inc. is referred to as "Hawaiian Electric" or the "Company".

2. Removal of reliance on 500 kW generator. While there exists a 500 kW generator on Hawai‘i Island which has the potential to be deployed in various areas there is no existing setup to allow the connection of this generator in the North Kohala area.
3. Use of updated net load for the North Kohala area. The updated analysis uses the net load from the time period between October 1, 2021 to October 1, 2022. This updated net load also includes contribution from existing customer-sited PV generation, which the prior study included net load with a PV adjustment – effectively including too much contribution from customer-sited PV generation. The sizing was selected to accommodate all but the highest demand for the planned outage duration, with the reasoning that the highest demand time period could be avoided.

As noted above, no later than January 13, 2023, Hawaiian Electric will file the updated RFP, ESSA, and pricing for the Microgrid + BESS project. The Company looks forward to resuming the docket upon the filing of this information.

Sincerely,

/s/ Ken Aramaki

Ken Aramaki
Director, T&D and Interconnection Planning

Attachment

cc: Division of Consumer Advocacy

S&C ELECTRIC COMPANY
Excellence Through Innovation

Battery Energy Storage System Sizing Study

Kohala, Hawaii

Hawaiian Electric

S&C Project Number: 19429

Revision: 0

Preliminary Report

December 8, 2022

S&C ELECTRIC COMPANY
Excellence Through Innovation

REPORT REVISION HISTORY:

REV	DATE	PREP	RVW	APPD	DESCRIPTION
A	11/17/2022	AS	MT	MFK	Issued for customer comments
B	12/06/2022	AS	MT	MFK	Included some more scenarios based on customer feedback
0	12/08/2022	AS	MT	MFK	Final Report

AUTHORS:

Prepared By:

Azadeh Shadman
Design Engineer
S&C Electric Company

Reviewed By:

Mohammad Tasdighi, Ph.D., MBA
Project Engineer
S&C Electric Company

Approved By:

M. Fareed Kandlawala
Manager- Consulting and Analytical services
S&C Electric Company

S&C ELECTRIC COMPANY
Excellence Through Innovation

TABLE OF CONTENTS

1. Executive Summary 4
2. Model Development 4
3. Case Studies Under Consideration 6
3.1 Case 1 – BESS without 5% Load Deduction 7
3.2 Case 2 – BESS with 5% Load Deduction 9
3.3 Case 3 – GENERATOR AND BESS with 5% Load Deduction 11
4. BESS Sizing Study Results with Considering BESS'S MINIMUM SOC and Degradation Limit at 20% 14
5. BESS Sizing Study Results Considering BESS's Minimum SOC at 0% and Degradation Limit at 1% 15

LIST OF FIGURES

Figure 1: A Simplified One-Line Diagram of the System in HOMER Pro 5
Figure 2: North Kohala Microgrid Load Profile 5
Figure 3: System Behavior During an Example Day with Considering BESS's Min. SOC & Degradation Limit at 20%(Case #1) 8
Figure 4: System Behavior During an Example Day with Considering BESS's Min. SOC & Degradation Limit at 20%(Case #2) 10
Figure 5: System Behavior During an Example Day with Considering BESS's Min. SOC & Degradation Limit at 20%(Case #3) 13
Figure 6: System Behavior During an Example Day Considering BESS's Min. SOC at 0% & Degradation Limit at 1% (Case #1) 17
Figure 7: System Behavior During an Example Day Considering BESS's Min. SOC at 0% & Degradation Limit at 1%(Case #2) 18
Figure 8: System Behavior During an Example Day Considering BESS's Min. SOC at 0% & Degradation Limit at 1% (Case #3) 19

LIST OF TABLES

Table 1: Summary Results with Considering BESS's Minimum SOC and Degradation Limit at 20% 15
Table 2: Summary Results with Considering BESS's Minimum SOC at 0% and Degradation Limit at 1% 16

1. Executive Summary

Hawaiian Electric has been considering different options to increase reliability for customers in the North Kohala area, which is an isolated rural community that receives power through a single 34.5 kV line approximately 24 miles long. The line was built in the 1950s and its deteriorating condition is one of the main causes of power interruptions to customers in the area.

One of the options to increase reliability is to develop a microgrid with Battery Energy Storage System (BESS) that will be operated while the 3300 Line is rebuilt. The goal of the North Kohala microgrid would be to provide power from BESS to keep the loads energized during the daily outage, 6:00 a.m. to 4:00 p.m., due to rebuilding the existing sub-transmission line. The line will return to service before the evening peak.

S&C Electric Company (S&C) was tasked to perform a BESS sizing study for the North Kohala Microgrid.

The study will consider equipment energy operating characteristics, resource availability, loads, locations, and the needed new energy distribution. S&C will utilize interval energy data of the North Kohala loads in determining the ratings of the BESS.

Per customer request, Section 5 of this report summarizes the North Kohala's BESS sizes for the previously studied 3 cases of operation but this time without considering BESS's degradation limit and minimum State of Charge (SOC) in the analysis. In other words, the resultant BESS size in this case is the net size required for system's functional operation and the actual size is assumed to be adjusted by BESS provider vendor to account for associated minimum SOC and degradation limits with their equipment if needed.

2. Model Development

An analysis model of North Kohala microgrid was developed using HOMER Pro. Figure 1 below shows one-line diagram of the model.

S&C ELECTRIC COMPANY
Excellence Through Innovation

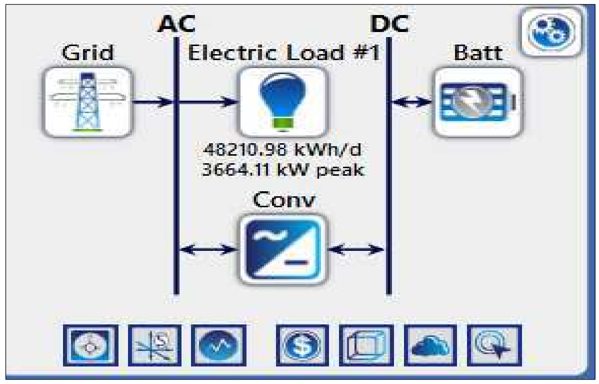


Figure 1: A Simplified One-Line Diagram of the System in HOMER Pro

As shown in Figure 1, the model consisted of the following components:

- North Kohala microgrid Electric Load
  - The net SCADA 15-minute interval North Kohala microgrid electric load was provided by the customer. There were several time periods where load data was unavailable. S&C adjusted the load by copying the previous 15-minute interval. Figure 2 Provides a visual illustration of the North Kohala microgrid load data.

  Please note that the existing behind the meter 2.173 MW_{AC} PV was considered in the provided net load. Therefore, the effect of PV in supplying energy is considered the provided net load and exclusive PV modeling is not required for this study.

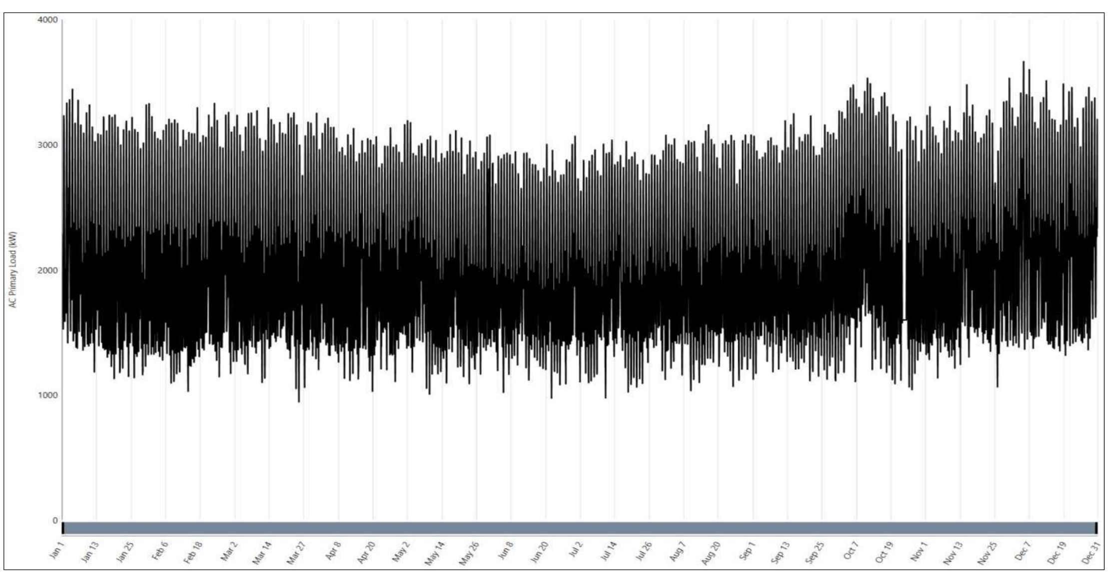


Figure 2: North Kohala Microgrid Load Profile

S&C ELECTRIC COMPANY
Excellence Through Innovation

- Utility Grid
  - Reverse flow of power from North Kohala microgrid to the grid is not allowed.
  - The BESS can be charged from grid as much as needed.
- Energy Storage System (ESS)
  - AC-DC ESS Converter
    - The round-trip efficiency of the ESS converter was modeled at approximately 95%
  - Battery (TBD)
    - S&C recommends a BESS size appropriate to keep the loads powered during the daily outage, 6:00 a.m. to 4:00 p.m.
    - The battery is programmed to maintain a minimum state of charge (SOC) of 20% throughout a year of operation.
    - The battery degradation limit is considered at 20%.

Note that energy losses attributable to interconnection and auxiliary services are not considered in this study but should be taken into account during the detailed system design phase.

3. Case Studies Under Consideration

To obtain the optimum design, several cases were evaluated considering various sizes of BESS after discussion with the customer. The system was modeled such that no power purchase from the grid occurs during the day from 6:00 a.m. to 4:00 p.m. and the BESS can be charged from the grid. The customer has recommended reducing the load by 5% as a scenario. The 5% load deduction did not apply to the load for the Case #1, to conservatively estimate the largest BESS size needed in case of zero demand response, but the load was adjusted by 5% deduction for the Cases #2, and #3. Below are the three (3) operating cases considered in this study.

S&C ELECTRIC COMPANY
Excellence Through Innovation

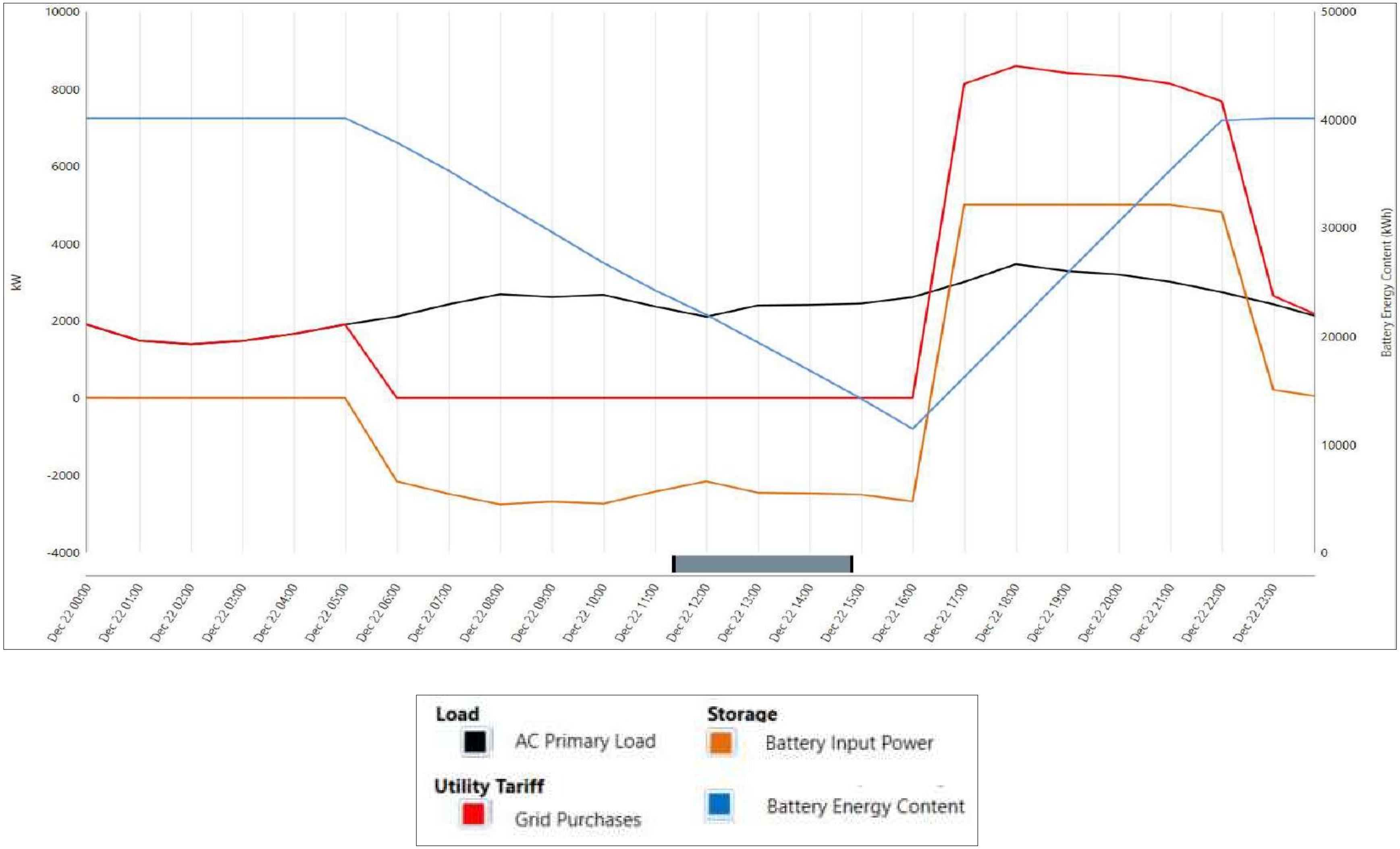
3.1 Case 1 – BESS without 5% Load Deduction

This case is proposed to demonstrate the BESS size without considering the 5% load deduction in the system.

Figure 3 depicts an example of one day operation of the system (December 22). Note that the load is being served off-grid between 6:00 a.m. to 4:00 p.m., using only BESS. Figure 3 can be broken down into sequential events as follows:

- The North Kohala load is served entirely by the grid from midnight to 6:00 am. The BESS is being charged from the grid (if needed). The BESS input power (shown by orange color in Figure 3) is zero when the BESS is fully charged, and the load is supplied by the least expensive source which is the grid.
- Between 6:00 a.m. to 4:00 p.m., when the grid is out, the load is served by the BESS.
- After 4:00 p.m., when the grid is back and the BESS's state of charge (SOC) is low, the load will be served entirely by the grid while the BESS is also being charged.

The minimum size of the BESS that can serve the load in this configuration is calculated to be 5 MW/40 MWh (8 hours at rated power).



Leftmost scale (kW) applies *Rightmost scale (kWh) applies*

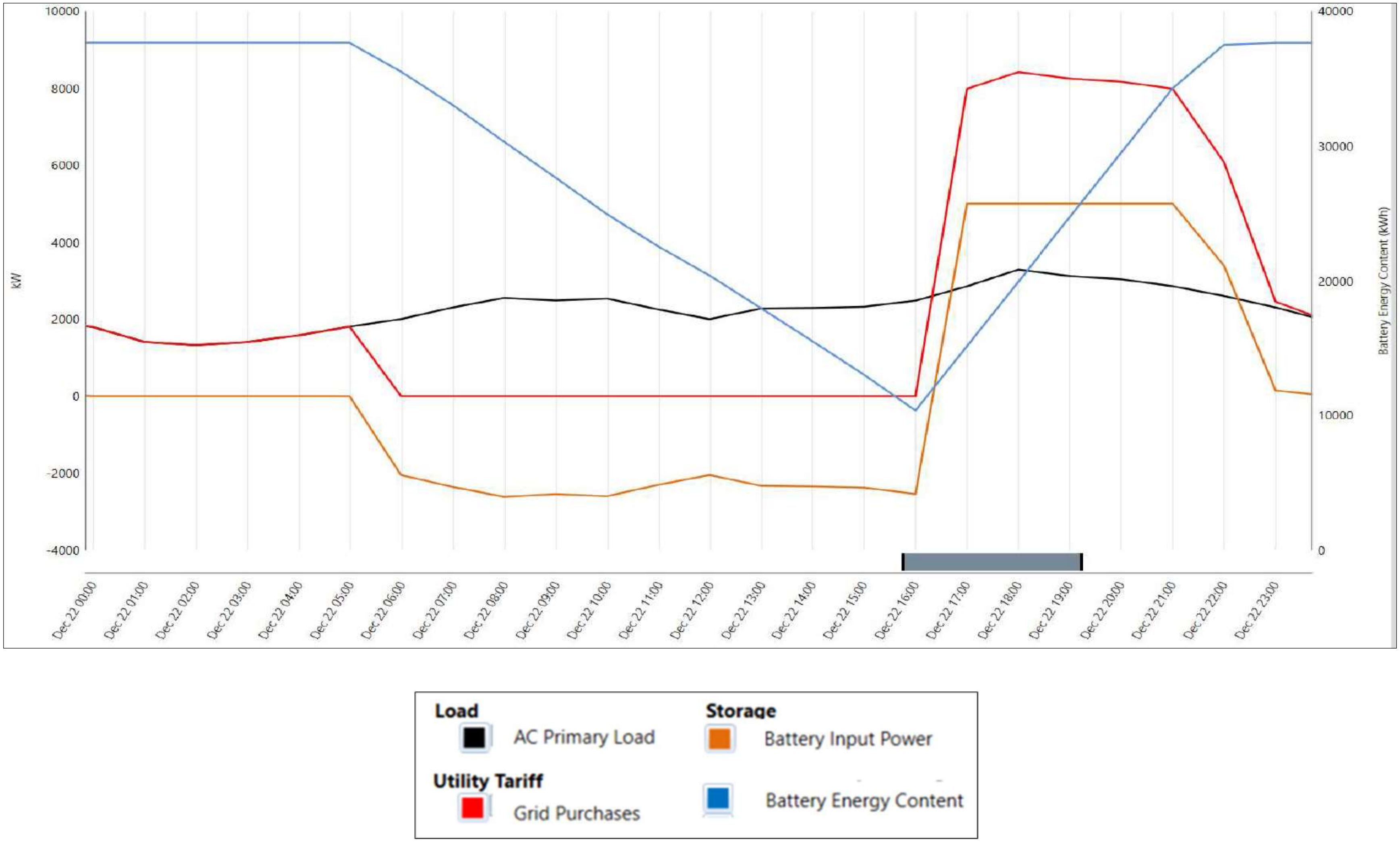
Figure 3: System Behavior During an Example Day with Considering BESS's Min. SOC & Degradation Limit at 20%(Case #1)

3.2 Case 2 – BESS with 5% Load Deduction

In this case we considered applying 5% load deduction to the load profile based on the customer's requirements, which brings the peak load to 3,480 kW. Figure 4 depicts an example of one-day operation of the system (December 22). Note that like Case #1 the load is being served off-grid between 6:00 a.m. to 4:00 p.m., using only BESS. Figure 4 can be broken down into sequential events as follows:

- The North Kohala load is served entirely by the grid from midnight to 6:00 a.m.
- Between 6:00 a.m. to 4:00 p.m., the load is served by the BESS. There is no contribution from the grid to serve the load during these hours.
- After 4:00 p.m., when the BESS's SOC is low, the load will be served entirely by the grid while the BESS is also being charged.

The minimum size of the BESS that can serve the load in this configuration is calculated to be **5 MW/37.5 MWh (7.5 hours at rated power).**



Leftmost scale (kW) applies *Rightmost scale (kWh) applies*

Figure 4: System Behavior During an Example Day with Considering BESS's Min. SOC & Degradation Limit at 20%(Case #2)

S&C ELECTRIC COMPANY
Excellence Through Innovation

3.3 CASE 3 – GENERATOR AND BESS WITH 5% LOAD DEDUCTION

In this case, we repeated the Case 2 scenario with addition of a 500-kW generator to the model. Hawaiian Electric owns a 500-kW mobile generator for emergency response. Hawaiian Electric has indicated that this generator may be used for short durations but shouldn't be permanently installed in a single place. The generator is programmed to turn on only during off-grid period, i.e., 6:00 a.m. to 4:00 p.m. S&C considered the generator's minimum load ratio at 30% based on engineering judgement. When the generator turns on, HOMER Cycled Charging algorithm kicks in to optimize the output power of the generator. The minimum output of the generator will be 136.5 kW based on the 30% minimum load ratio. If this much output power, combined with the output of the BESS is sufficient to meet the load, when the BESS has an SOC more than 20%, the generator output does not go above the minimum level. Otherwise, the generator is dispatched at its prime rate of 455 kW to not only help meeting the load, but also avoiding BESS's SOC to reach or go below 20%.

Note that the optimum operating point of the generator, outside the cycled charging logic, should be investigated separately in a power flow and operation study.

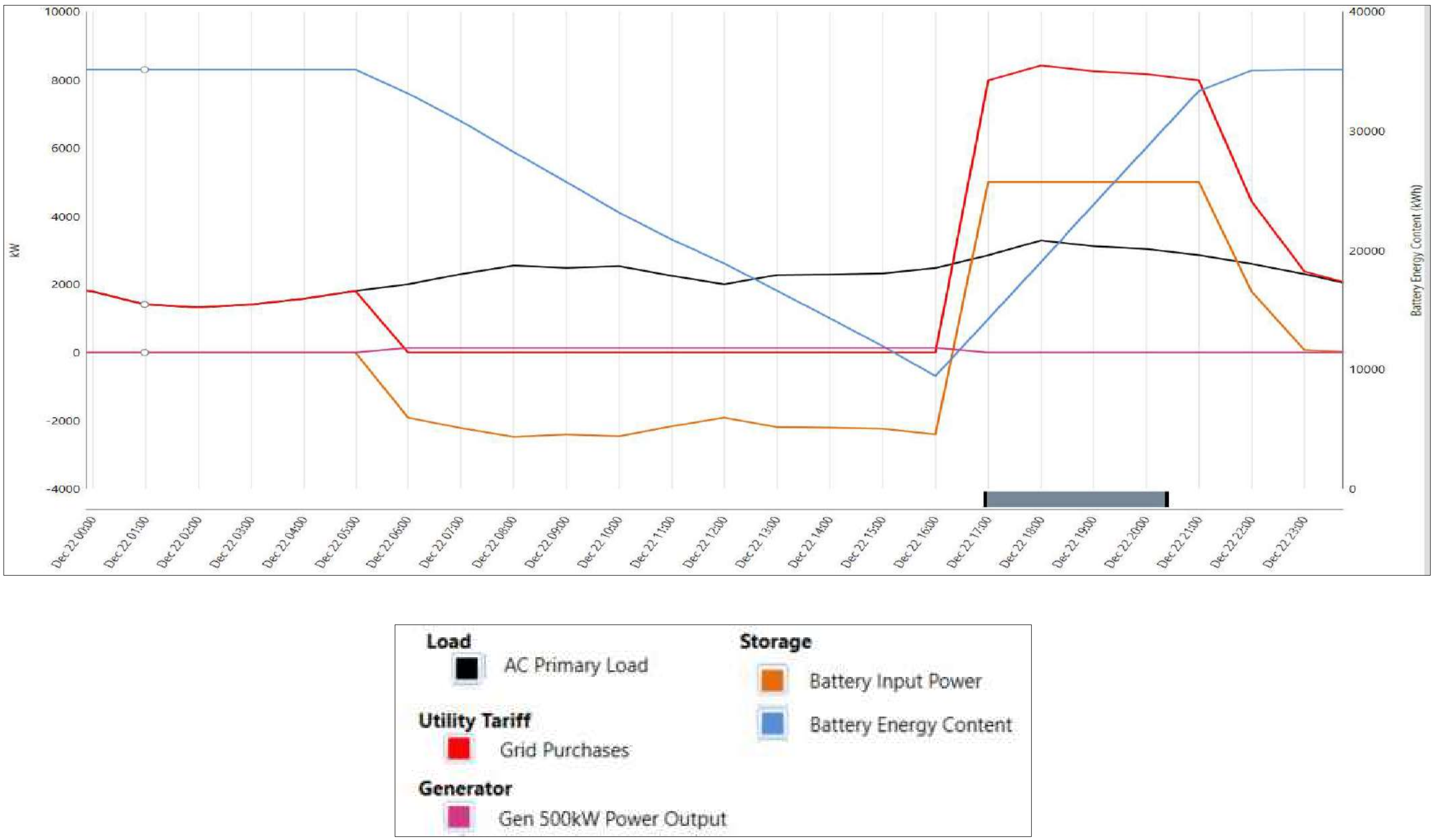
Figure 5 depicts an example of one-day operation of the system (December 22). Note that the load is served off-grid between 6:00 a.m. to 4:00 p.m., using generator and BESS. Figure 5 can be broken down into sequential events as follows:

- The North Kohala load is served entirely by the grid from midnight to 6:00 a.m.
- Between 6:00 a.m. to 4:00 p.m., the generator dispatched at its minimum load ratio to serve the load when there is enough energy in BESS to serve the remaining load and BESS has not depleted below 20% SOC. For example, there is 2299.675 kW load at 7:00 a.m. in December 22nd. The load is served by the generator which produced at its minimum load ratio, 136.5 kW, and the remaining 2163.175 kW load was served by the BESS which is operating at above 80% SOC. If the BESS is reaching the minimum 20% SOC, so the generator produced at its prime rate, 455kW, to help serving the load fully and increasing BESS SOC.

- After 4:00 p.m., when the grid is back on, the generator is turned off, and the load will be served entirely by the grid while the BESS is also being charged.

In this case, the BESS contribution to serve the load is less compared to the previous case (Case #2) because generator must be always ON during off-grid period with at least a minimum output of 136.5 kW.

The minimum size of the BESS that can serve the load in this configuration is calculated to be **5 MW/35MWh (7 hours at the rated power)**.



Leftmost scale (kW) applies *Rightmost scale (kWh) applies*

Figure 5: System Behavior During an Example Day with Considering BESS's Min. SOC & Degradation Limit at 20%(Case #3)

S&C ELECTRIC COMPANY
Excellence Through Innovation

4. BESS Sizing Study Results with Considering BESS's MINIMUM SOC and Degradation Limit at 20%

A feasibility study was performed for Hawaiian Electric to optimize the size of the proposed Battery Energy Storage System (BESS) to increase reliability for customers in the North Kohala area. The system was modeled such that no power purchase from the grid occurs during the day from 6:00 a.m. to 4:00 p.m. and the BESS can be charged from the grid. To avoid damaging the BESS by excessive discharge, the BESS's minimum SOC was considered 20%. Furthermore, the BESS's degradation limit was considered 20% in HomerPro simulation. The customer has recommended to reduce the load by 5% as a scenario during the off-grid period, i.e., 6:00 a.m. to 4:00 p.m., and the expectation is that the consumption is being reduced by about 5%. S&C developed three (3) cases in HOMER Pro, including a case with BESS without considering 5% load deduction, a case with BESS and considering 5% load deduction, and a case with existing 500 kW generator and BESS and considering 5% load deduction. The objective of the system is to avoid import of power from grid during the day from 6:00 a.m. to 4:00 p.m. A summary results listed in Table 1 indicates that the inclusion of the generator in the system is expected to result in a smaller energy rating (MWh) of the BESS.

The results revealed that the minimum size of the BESS for the case 1, i.e., without the generator and without considering 5% load deduction, should be **5 MW/40 MWh**. For the case 2, i.e., without generator and with considering 5% load deduction, BESS's minimum size should be **5 MW/37.5 MWh,** and for the case 3, i.e., with generator and considering a 5% load deduction, the minimum size of the BESS should be **5 MW/35 MWh**.

S&C ELECTRIC COMPANY
Excellence Through Innovation

Table 1: Summary Results with Considering BESS's Minimum SOC and Degradation Limit at 20%

	System is off grid between 6:00 a.m. to 4:00 p.m.		
	Without 5% Load Deduction	**With 5% Load Deduction**	
	No Generator	**No Generator**	**500 kW Generator Energized between 6:00 a.m. to 4:00 p.m.**
	BESS: 5 MW/40 MWh (8 hours)	**BESS: 5 MW/37.5 MWh (7.5 hours)**	**BESS: 5MW/35 MWh (7 hours)**
AC Primary Load (kWh/yr)	17,597,009	16,717,164	16,717,164
Generator Production (kWh/yr)	0	0	548,366
Grid Purchase (kWh/yr)	18,682,839	17,750,452	17,122,001
Battery Energy In (kWh/yr)	8,195,156	7,787,106	7,174,367
Battery Energy Out (kWh/yr)	7,507,137	7,131,782	6,569,285

5. BESS Sizing Study Results Considering BESS's Minimum SOC at 0% and Degradation Limit at 1%

During review of Rev A of the study report with the customer, the customer has requested to perform the sizing of the proposed BESS under the 3 operation cases discussed above without considering BESS's minimum SOC and the BESS's degradation limit. In Homer Pro, BESS's degradation limit value must be greater than 0% and less than 100%. Therefore, S&C considered this value at 1%, which is quite negligible, for the analysis. Figure 6 to Figure 8 illustrate an example of one-day operation of the system for each case under this updated consideration.

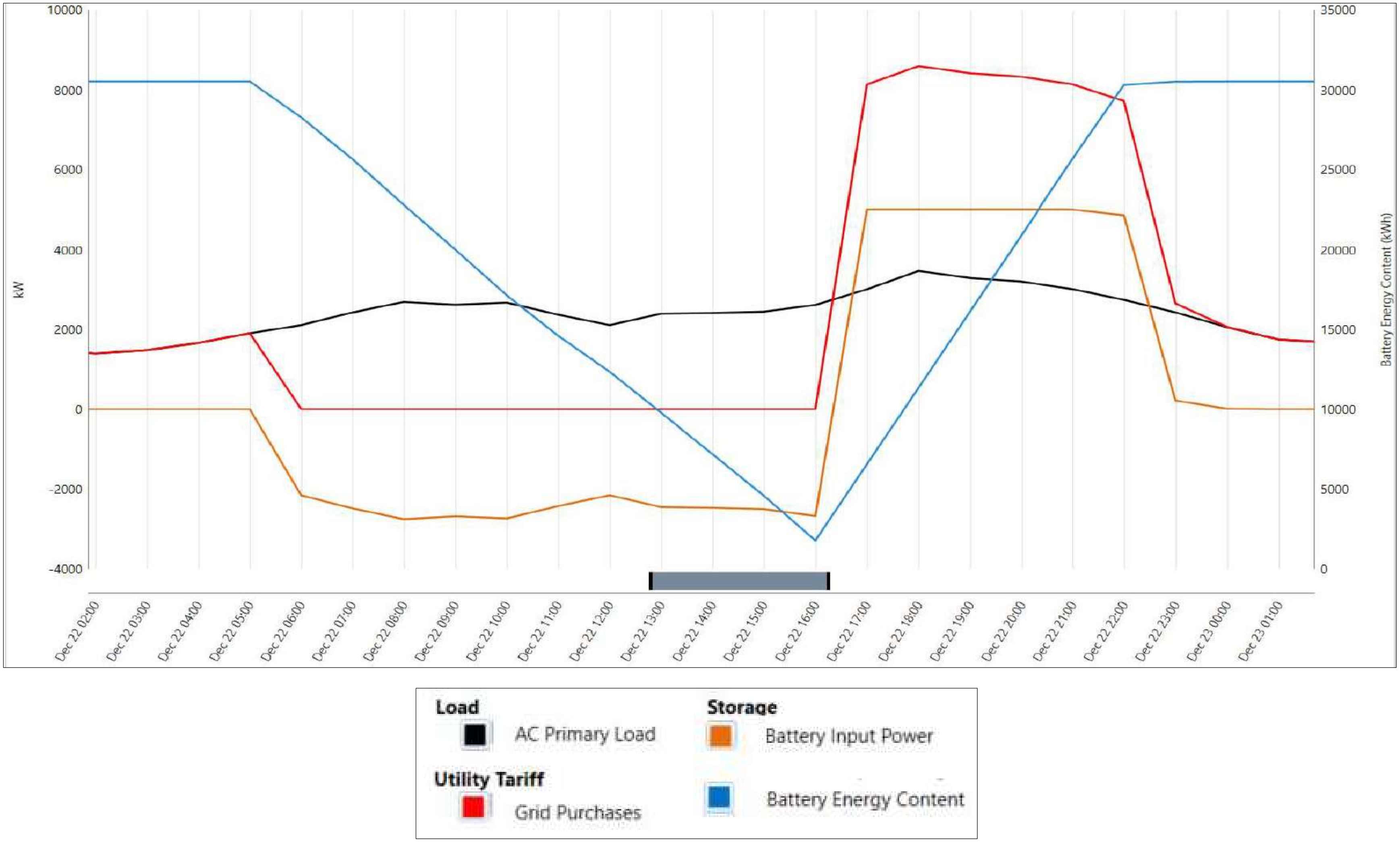
A summary of results listed in Table 2 indicates that the system will require smaller sizes of BESS per each operating case as expected.

The results revealed that the minimum size of the BESS for the case 1, i.e., without the generator and without considering 5% load deduction, should be **5 MW/30 MWh**. For the case 2, i.e., without generator and with considering 5% load deduction, BESS's minimum size should be **5 MW/27.5 MWh,** and for the case 3, i.e., with generator and considering a 5% load deduction, the minimum size of the BESS should be **5 MW/25 MWh**.

S&C ELECTRIC COMPANY
Excellence Through Innovation

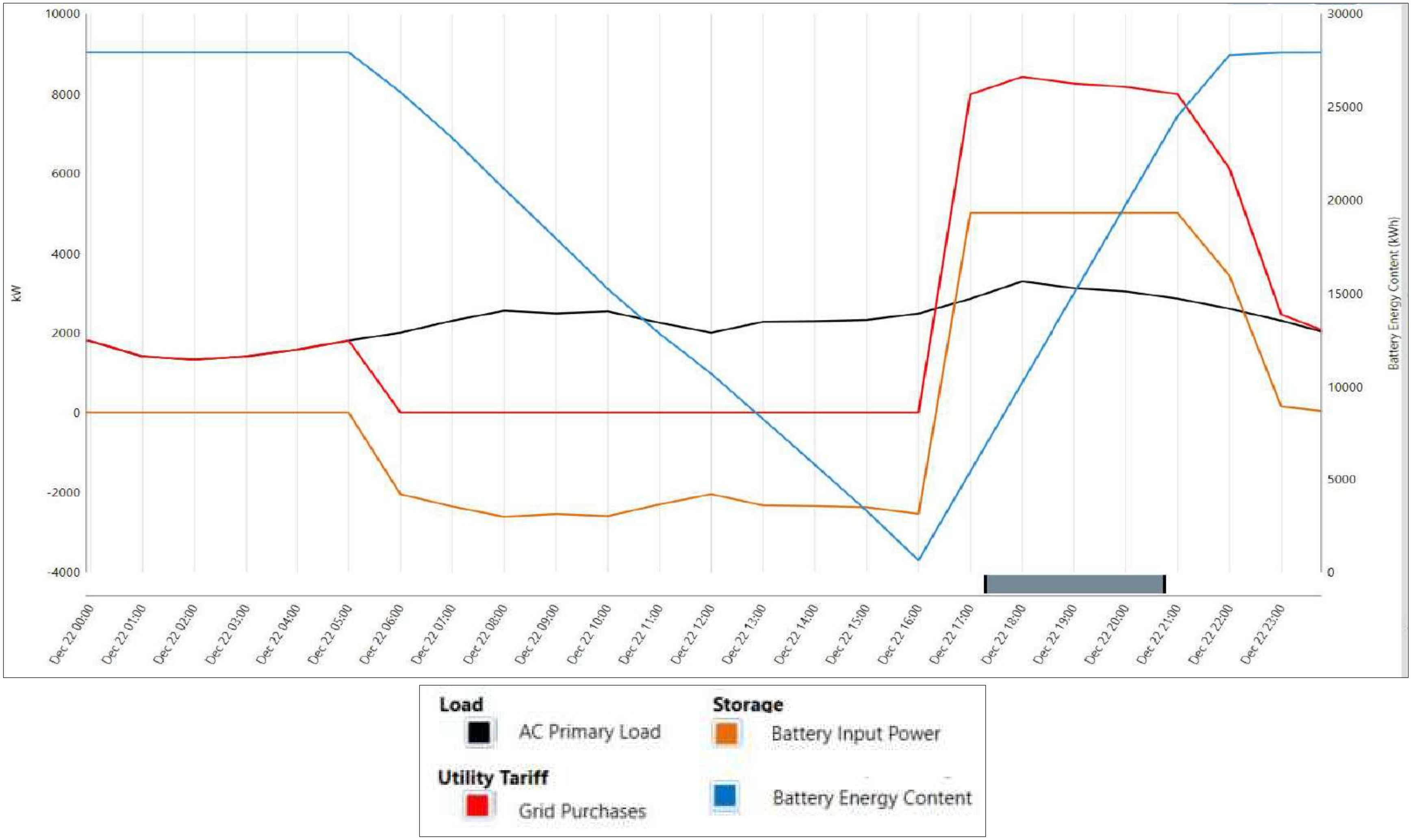
Table 2: Summary Results with Considering BESS's Minimum SOC at 0% and Degradation Limit at 1%

	System is off grid between 6:00 a.m. to 4:00 p.m.		
	Without 5% Load Deduction	**With 5% Load Deduction**	
	No Generator	**No Generator**	**500 kW Generator Energized between 6:00 a.m. to 4:00 p.m.**
	BESS: 5 MW/30MWh (6 hours)	**BESS: 5 MW/27.5 MWh (5.5 hours)**	**BESS: 5MW/25 MWh (5 hours)**
AC Primary Load (kWh/yr)	17,597,009	16,717,164	16,717,164
Generator Production (kWh/yr)	0	0	549,560
Grid Purchase (kWh/yr)	18,649,383	17,761,862	17,131,099
Battery Energy In (kWh/yr)	8,206,411	7,798,231	7,183,237
Battery Energy Out (kWh/yr)	7,506,314	7,129,980	6,564,753



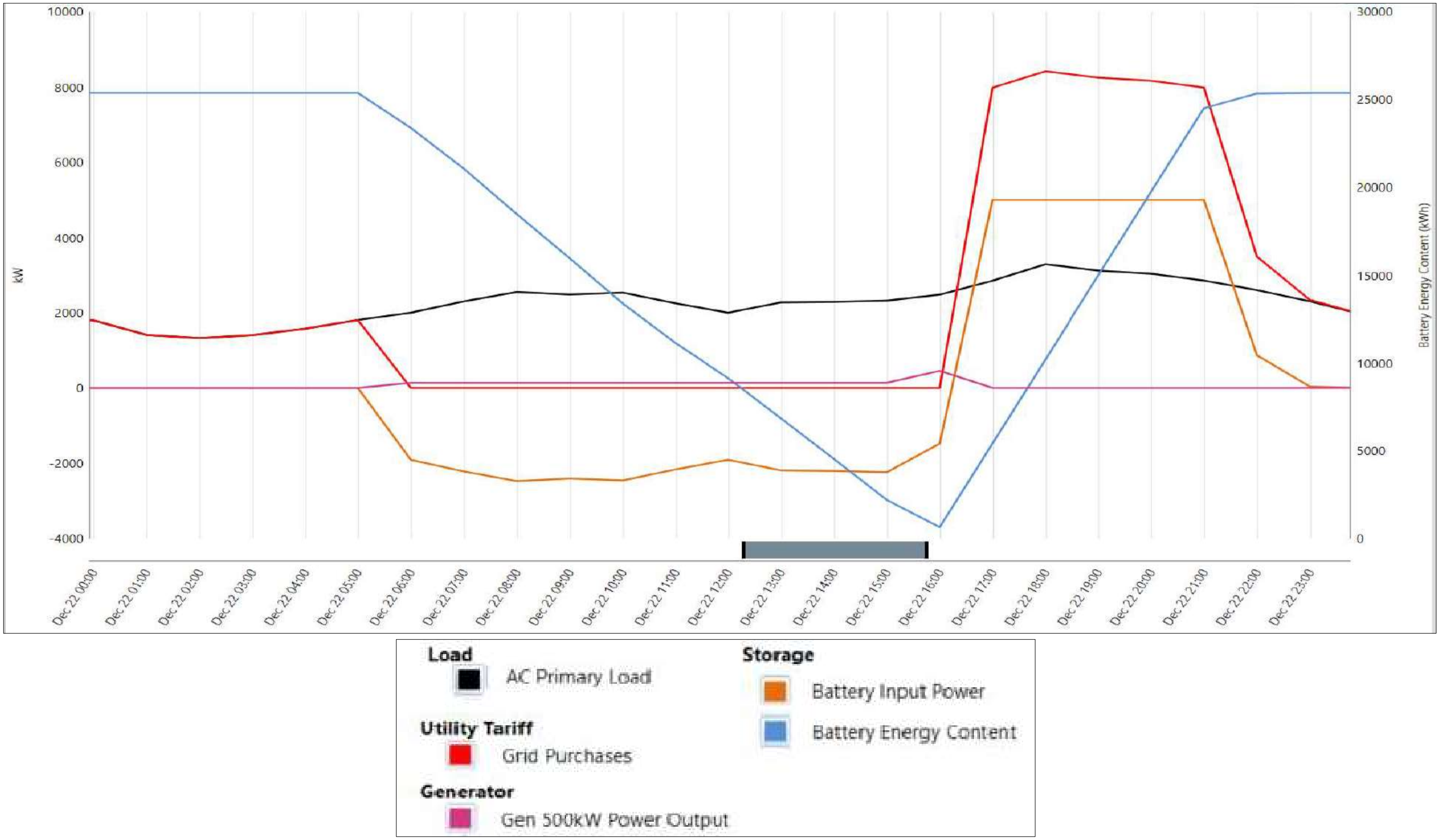
Leftmost scale (kW) applies *Rightmost scale (kWh) applies*

Figure 6: System Behavior During an Example Day Considering BESS's Min. SOC at 0% & Degradation Limit at 1% (Case #1)



Leftmost scale (kW) applies *Rightmost scale (kWh) applies*

Figure 7: System Behavior During an Example Day Considering BESS's Min. SOC at 0% & Degradation Limit at 1%(Case #2)



Leftmost scale (kW) applies *Rightmost scale (kWh) applies*

Figure 8: System Behavior During an Example Day Considering BESS's Min. SOC at 0% & Degradation Limit at 1% (Case #3)

Nojiri, Andrew

From: puc@hawaii.gov
Sent: Friday, December 30, 2022 10:25 AM
To: Nojiri, Andrew
Subject: Hawaii PUC eFiling Confirmation of Filing

Your eFile document has been filed with the Hawaii Public Utilities commision on 2022 Dec 30 AM 10:20. The mere fact of filing shall not waive any failure to comply with Hawaii Administrative Rules Chapter 6-61, Rules of Practice and Procedure Before the Public Utilities Commission, or any other application requirements. Your confirmation number is ANDR22102038562. If you have received this email in error please notify the Hawaii Public Utilities Commission by phone at 808 586-2020 or email at hawaii.puc@hawaii.gov.