Renewable Integration Study

An evaluation of the integration costs of renewable resources on the Southern Company System

11/18/2021

PREPARED FOR

Southern Company Services

PREPARED BY

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Executive Summary

The purpose of this study is to determine the integration costs associated with a range of solar penetration scenarios on the Southern Company system, including scenarios representing the existing and committed solar resources on the system. The intermittent nature of solar resources creates unexpected swings in the momentary net demand on the system, which must be met using the inherent flexibility of the system, including the flexibility associated with available operating reserves. If these unexpected swings in net demand become greater than the system's inherent ability to manage through its existing operating reserve profile, the result will be the inability of the system to meet NERC operating standard requirements. The integration costs identified by this study represent those costs associated with any increase in operating reserves necessary to make sure the Southern Company system maintains its ability to meet those reliability standard requirements.

The table below indicates the 7 solar penetration scenarios considered.

Table 1. Solar Penetration Scenarios

Scenario	Solar Penetration	Notes
A	~3,000 MW	Pre 2019 IRP Levels
B	~5,000 MW	Post 2019 IRP Levels
C	8,000 MW	
D	10,000 MW	
E	12,000 MW	
F	15,000 MW	
G	20,000 MW	

In addition, the study considered how the addition of Battery Energy Storage System (BESS) resources and Reciprocating Internal Combustion Engine (RICE) resources would impact the integration costs associated with those solar penetration scenarios. As such, the table below indicates the level of BESS and RICE resources considered for each of the 7 solar penetration scenarios.

Table 2. BESS and RICE Penetration Assumptions

Scenario	Solar MW	BESS MW	RICE MW
A	3,000	500	500
B	5,000	775	780
C	8,000	1,150	1,160
D	10,000	1,500	1,500
E	12,000	1,675	1,680
F	15,000	2,000	2,000
G	20,000	2,500	2,500

Each of these 3 portfolios represents 7 scenarios each for a total of 21 scenarios to be evaluated. Each scenario was evaluated to determine the amount of additional operating reserves (modeled as additional load following reserves) that would be needed to return the system back to a level of reliability consistent with that prior to the existence of any solar resources on the system.

The three tables below reflect the results of the analysis for each of the seven scenarios in each of the 3 portfolios - the solar only portfolio, the solar plus BESS portfolio, and the solar plus RICE portfolio, respectively. The graph following the three tables shows the combined three sets of results graphically.

Table 3. Portfolio 1 Mitigation Costs

Scenario	Solar MW	Mitigation Cost ($/MWH)
A	3,000	2.68
B	5,000	2.88
C	8,000	2.50
D	10,000	3.25
E	12,000	3.19
F	15,000	4.83
G	20,000	6.64

Table 4. Portfolio 3 (BESS) Mitigation Costs

Scenario	Solar MW	BESS MW	Mitigation Cost ($/MWH)
A	3,000	500	2.78
B	5,000	775	2.83
C	8,000	1,150	1.88
D	10,000	1,500	1.35
E	12,000	1,675	1.85
F	15,000	2,000	1.37
G	20,000	2,500	1.52

Table 5. Portfolio 3 (RICE) Mitigation Costs

Scenario	Solar MW	RICE MW	Mitigation Cost ($/MWH)
A	3,000	500	2.74
B	5,000	780	2.54
C	8,000	1,160	1.75
D	10,000	1,500	1.68
E	12,000	1,680	1.67
F	15,000	2,000	2.10
G	20,000	2,500	2.56

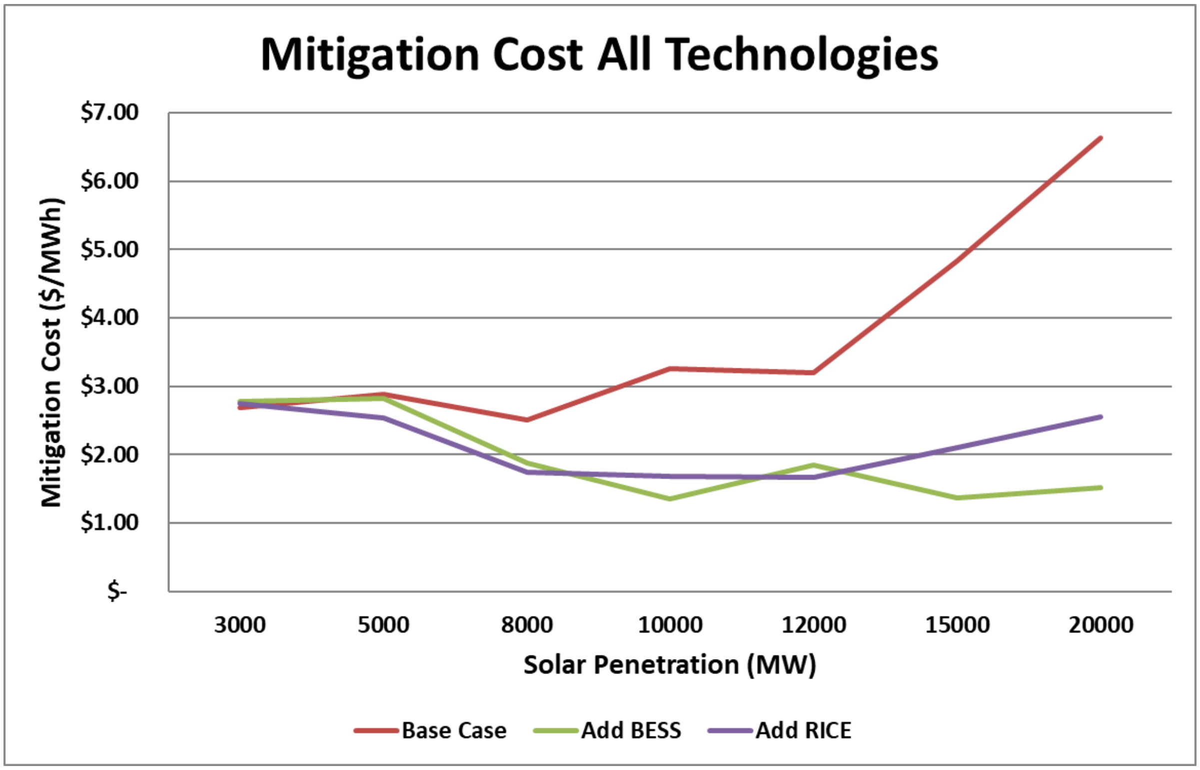

Figure 1. Comparison of Mitigation Costs by Technology Portfolio

In addition to the integration costs identified above, the study also evaluated the potential impact on generation curtailment, sometimes referred to as overgeneration. Two sets of curtailment profiles were identified. The pre-mitigation profile – that is, the amount of curtailment that the simple addition of the solar resources adds to the system, represents the amount of curtailment that should be considered in the initial evaluation of any potential new solar resources. The post-mitigation profile represents the total curtailment after implementing the mitigation procedures (i.e., the additional operating reserves). The increase between the pre- and post-mitigation curtailment should be considered an additional integration cost to those identified above.

The tables and figures on the following pages represent the pre-mitigation and post-mitigation curtailment profiles, respectively.

Table 6. Pre-Mitigation Curtailment Impact (MWH)

Solar MW	Solar Only	BESS	RICE
3000	72	0	0
5000	90	0	76
8000	5,473	51	4,752
10000	62,631	631	44,239
12000	278,285	11,661	220,725
15000	1,255,231	151,189	758,255
20000	5,222,657	1,713,614	3,068,090

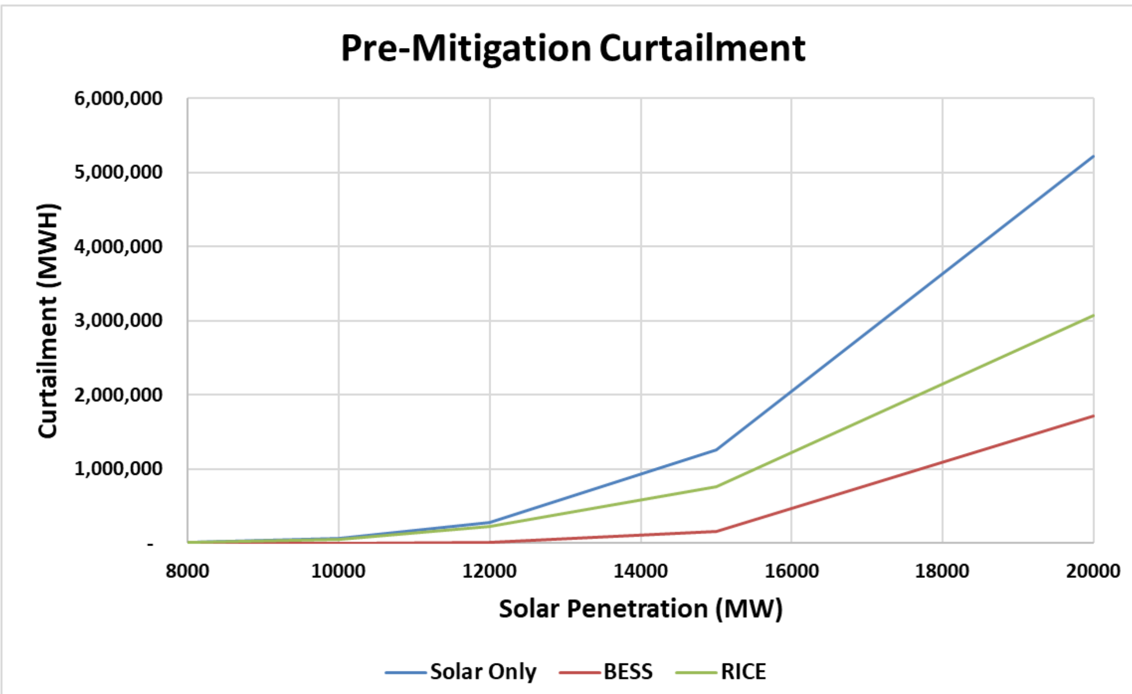

Figure 2. Pre-Mitigated Curtailment Impact

Table 7. Post-Mitigation Curtailment Impact (MWH)

Solar MW	Solar Only	BESS	RICE
3000	208	47	236
5000	572	89	229
8000	14,430	253	9,281
10000	163,716	3,031	75,137
12000	649,582	69,547	346,162
15000	2,781,999	333,138	1,147,722
20000	9,325,828	2,383,882	4,184,069

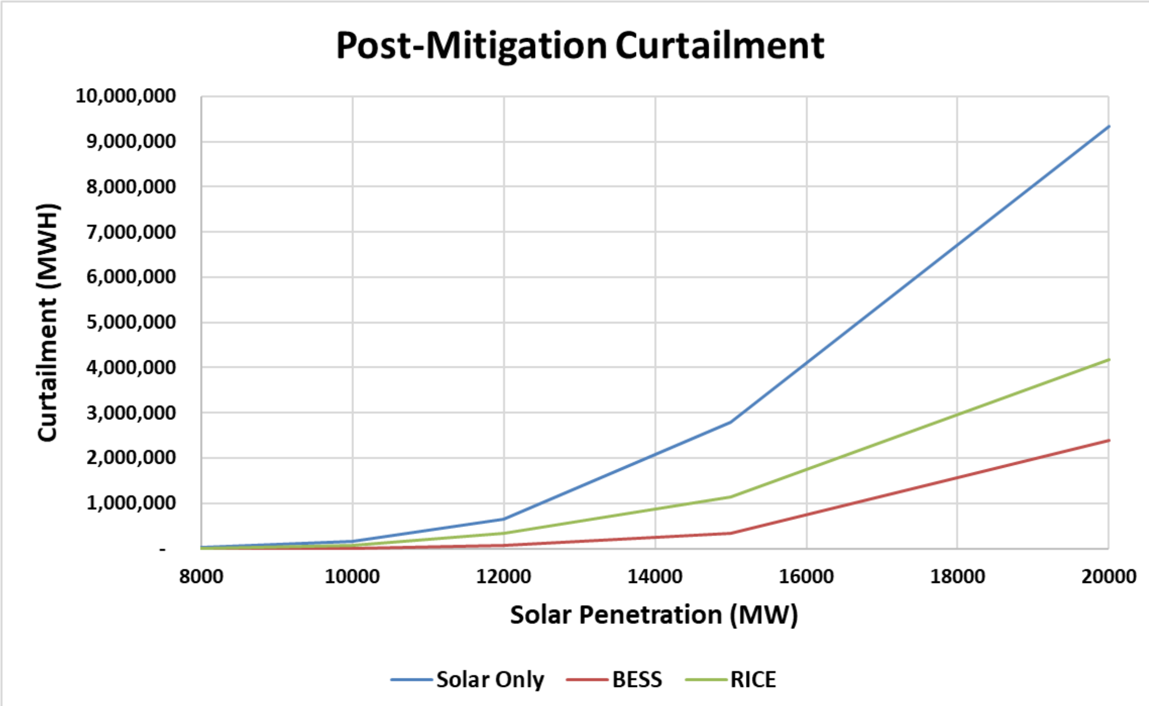

Figure 3. Post-Mitigated Curtailment Impact

Table of Contents

Table of Figures

Table of Tables

Abbreviations Used in Report

BESS	Battery Energy Storage Systems
CAP_{LOLE}	Capacity LOLE (a measure representing capacity shortfall events)
CT	Combustion Turbine
DG	Distributed Generation
EMC	Electric Municipal Cooperative
EUE	Expected Unserved Energy
IRP	Integrated Resource Plan
JOU	Jointly Owned Units
LOLE	Loss of Load Expectation
MEAG	The Municipal Electric Authority of Georgia
NERC	North American Electric Reliability Corporation
RICE	Reciprocating Internal Combustion Engine Generator
SERVM	Strategic Energy and Risk Valuation Model

1. Scope of Analysis

The analysis associated with this study involved the evaluation of the integration costs of seven (7) different scenarios, representing tranches of solar penetration as follows:

Table 8. Solar Penetration Scenarios

Scenario	Solar Penetration	Notes
A	~3,000 MW	Pre 2019 IRP Levels
B	~5,000 MW	Post 2019 IRP Levels
C	8,000 MW	
D	10,000 MW	
E	12,000 MW	
F	15,000 MW	
G	20,000 MW	

Each of these solar penetration scenarios would be compared against a base case containing no solar resources. Two reliability criteria were established for the study:

The first reliability criterion was a Loss of Load Expectation (LOLE) for capacity (CAP_{LOLE}) of ~0.1 days/year. This criterion was established to ensure comparability. All the scenarios as well as the base case were calibrated to the same level of reliability, specifically a CAP_{LOLE} of ~0.1 days/year. The Case Development section describes how this was subsequently determined.

The second reliability criterion was a measure of the intra-hour flexibility of a given system, measured in terms of flexibility violations. A flexibility violation benchmark was established to determine the integration cost for each renewable tranche. This represented the primary analysis for the study, with the flexibility for each of the solar penetration scenarios benchmarked to the levels established in the base case. The Study Methodology section describes how this benchmarking was accomplished and how the resulting integration cost was determined.

The integration costs for each of the seven solar penetrations were calculated for three separate sets of system generation mix portfolios. The first portfolio represented Southern Company's current expectation of system mix. The second portfolio represented a view of system mix that relied upon Battery Energy Storage Systems (BESS) to enhance the flexibility of the system. The third portfolio represented a view of system mix that relied upon Reciprocating Internal Combustion Engine (RICE) generators to enhance the flexibility of the system. For both the BESS and RICE portfolios, the size of the BESS/RICE fleet for each level of solar penetration was chosen based on the intrinsic volatility of the underlying solar fleet (within the constraints of the modeled unit sizes). The following table shows the RICE and BESS penetration assumed for each of the seven (7) solar scenarios.

Table 9. BESS and RICE Penetration Assumptions

		Flexible Capacity Addition		
Scenario	Solar MW	None	BESS MW	RICE MW
A	3,000	0	500	500
B	5,000	0	775	780
C	8,000	0	1,150	1,160
D	10,000	0	1,500	1,500
E	12,000	0	1,675	1,680
F	15,000	0	2,000	2,000
G	20,000	0	2,500	2,500

Any minor differences in BESS and RICE sizes are attributable to differences in modeled unit sizes (see Case Development section below for assumptions regarding BESS and RICE unit sizes).

In total, integration costs were determined for a total of 21 scenarios (7 solar penetration scenarios applied to three generation mix portfolios).

2. Case Development

The following sections describe the process used to develop the base case and solar penetration scenarios. The Strategic Energy and Risk Valuation Model (SERVM) was utilized for this study. The SERVM model used for this study is the same model used for resource adequacy evaluations performed by Astrapé for utilities nation-wide including (among others) such utilities as

The Tennessee Valley Authority (TVA),
Duke Energy,
Louisville Gas and Electric,
Pacific Gas and Electric (PGE),
Ameren Corporation,
DTE Energy,
Xcel Energy, and
Public Service Company of New Mexico (PNM).

2.1. The Base Case

The starting point for the development of the base case was the Southern Company 2020 SERVM base case provided by Southern. All solar resources were then removed from this case.

To ensure the proper identification of integration costs without dilution from interactions with outside entities, the Southern Company base case was evaluated as an islanded system, which included the joint dispatch of Southern Company generation resources with firm commitments to serve Southern Company load. Since they are a partial requirements customer that is served in part by Southern Company resources and thus can impact the availability of resources needed to meet flexibility requirements, the analysis also included the joint dispatch of resources owned by the Municipal Electric Authority of Georgia (MEAG). This included both jointly owned units (JOU) dispatched by Southern on MEAG's behalf and units owned and dispatched by MEAG itself.[1]

Southern Company's operating reserve requirements (and thus the ancillary service values in the base case provided by Southern Company) are contingent upon the amount of solar resources on the system. Removing the solar also required appropriately adjusting the ancillary services to levels reflecting no solar resources on the system.

[1] There are several Combustion Turbine (CT) resources committed to Southern Company load but owned and operated by certain Electric Municipal Cooperatives (EMC) in Georgia which can only be called upon on a day-ahead basis during the winter months. This commitment constraint was modeled in SERVM.

The following table shows the ancillary services modeled in the base case.

Table 10. Base Case Ancillary Services

Ancillary Service	Value
Regulating Reserves	500 MW
Spinning Reserves	650 MW
Quick Start Reserves	600 MW
Load Following Reserves Target	1% of Load

The base case was then simulated for the 2025 study year using 1962-2015 weather years to determine its inherent reliability. To establish the base case reliability at a CAP_{LOLE} of ~0.1 days/year the equivalent of 290 MW of load was added to the system.

2.2. Solar Penetration Cases

Each of the resulting scenarios were created via the following three step process:

1. Creating the solar resources and adding them to the case
2. Creating the intra-hour solar volatility parameters and incorporating them into the appropriate solar group
3. Benchmarking the resulting case back to a CAP_{LOLE} of ~0.1 days/year

The following describes each of those three steps for the seven solar penetration scenarios.

2.2.1. Solar Resource Additions

The base case database provided by Southern Company contained a total of 64 solar resources, which together represented solar scenarios A and B. Several of these modeled resources included an aggregation of a geographically diverse set of distributed generator (DG) solar resources. Several other modeled resources were aggregations of generic future committed solar resources. Scenario A included 61 solar resources representing a total of 2,947 MW. This is consistent with all solar resources built or committed to be built prior to the 2019 IRP. Three additional facilities representing 1,210 MW were added for Scenario B, representing a total of 5,157MW. This is consisted with all solar resources built or committed to be built including new solar resources approved by the 2019 IRP. A list of all modeled solar resources is included in Appendix A.

To establish each of the remaining five scenarios, the capacities of the 64 resources were increased on a pro-rata basis to achieve the desired solar penetration.

To ensure each of the 7 solar scenarios had a starting point capacity reliability that was comparable to the base case, load was added to the system until each scenario case had $LOLE_{CAP}$ values of approximately 0.1 days/year.

2.2.2. Intra-Hour Solar Volatility Parameters

To develop the necessary intra-hour solar volatility parameters, it was necessary to develop a series of aggregate 5-minute solar profiles for one year for each tranche of solar. These profiles were developed by Southern using its own wavelet model and provided to Astrapé. These 5-minute profiles were then imported into SERVM to create associated divergence profile (i.e., the frequency at which a given level of divergence from the smooth profile would occur). SERVM then applies volatility parameters established from those divergence profiles to create intra-hour solar output from the hourly solar profiles for each weather year. The figure below shows the divergence profile for each of the seven solar penetration scenarios.

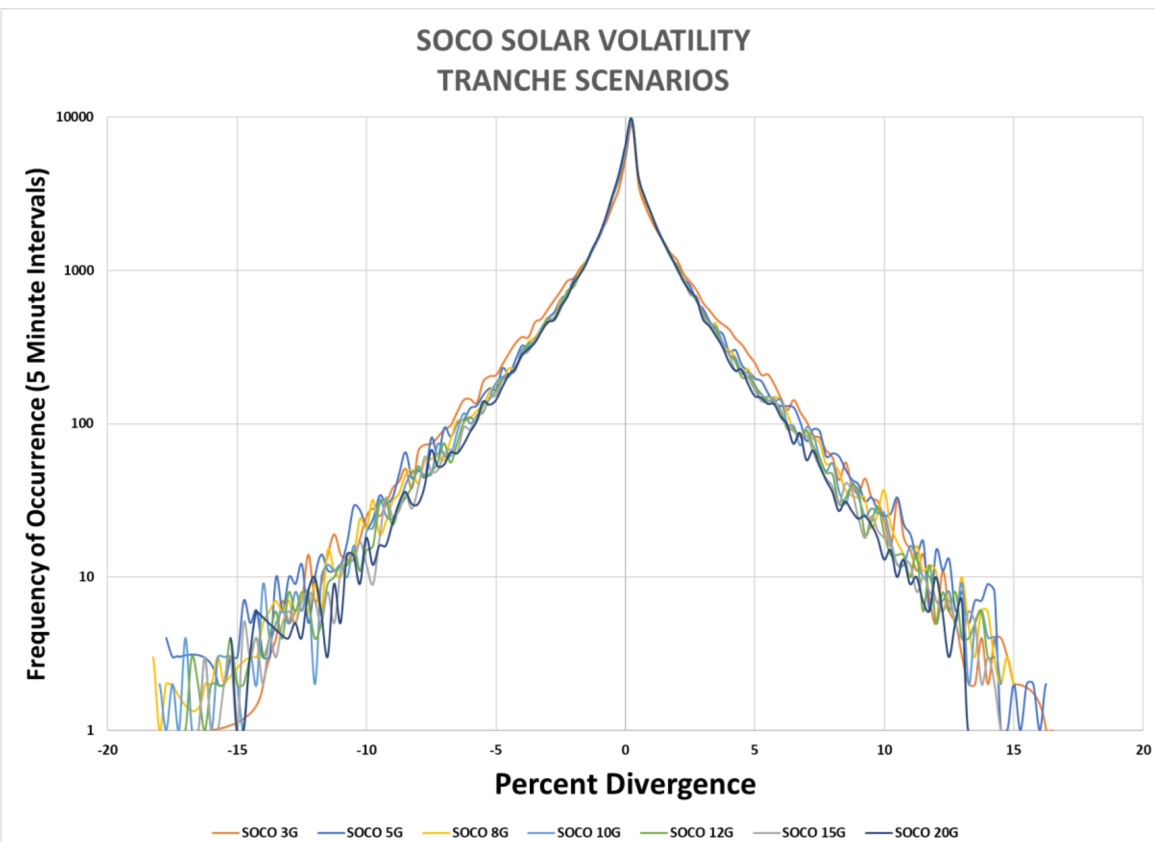

Figure 4. Solar Volatility Divergence Profiles

2.3. Technology Portfolio Cases

For the technology portfolio cases, the addition of BESS or RICE technologies resulted in $LOLE_{CAP}$ values of less than 0.1 days/year.

BESS resources were modeled as a series of 100 MW and 25 MW resources, as necessary to achieve the desired fleet size, each containing the following parameters:

Table 11. BESS Modeling Parameters

Dispatch Capacity	100 MW / 25 MW
Charging Capacity	100 MW / 25 MW
Minimum Dispatch Capacity	0 MW
Minimum Charge Capacity	0 MW
Cycle Efficiency	0.85
Storage Size	2 Hours
Quick Start Capability	Yes
AGC Capability	Yes
Economic Dispatch Threshold[2]	90%
Reliability Dispatch Price[3]	$1000/MWH

RICE resources were modeled as a series of 20 MW resources as necessary to achieve the desired fleet size, each containing the following parameters:

Table 12. RICE Modeling Parameters

Dispatch Capacity	20 MW
Minimum Dispatch Capacity	2 MW
Heat Rate	8.7 MMBTU/KWH
Fuel	Natural Gas
EFOR	3%
Maintenance Rate	3%
Ramp Rate (Up and Down)	20 MW/Min
Start Time	5 Minutes

To ensure each BESS and RICE scenario had a starting point capacity reliability that was comparable to the base case, load was added to the system until each scenario case had $LOLE_{CAP}$ values of approximately 0.1 days/year.

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[2] The Economic Dispatch Threshold represents a value (as percent of net peak load) above which the battery will not be dispatched except to preserve reliability. If the daily net peak load is below this threshold, the battery will be scheduled economically.

[3] The Reliability Dispatch Price is the price at which battery will dispatch to preserve reliability.

3. Study Methodology

The following describes the procedure used to calculate the integration cost for each of the solar penetration scenarios.

3.1. Establish Flexibility Violation Benchmark Target

The flexibility violation benchmark is a measure of the intra-hour flexibility of a given system. Computationally it is calculated based on days in which the system was unable to balance load and resources for 5 minutes or longer. However, because of the frequency bias and response of the interconnect, a flexibility violation event does not likely represent an actual loss of load. Rather, such an event represents negative pressure on the system's ability to meet NERC Reliability Standard BAAL-001-2. Therefore, the flexibility violation metric should not be interpreted as actual outage conditions.

The philosophical approach taken in this analysis was to ensure that the integration of solar resources will not create negative pressure on the Southern Company System's ability to meet NERC Reliability Standard BAAL-001-2 beyond that which would exist in the system without the presence of the solar resources. As such, the flexibility violation benchmark target was established as that which was established in the base case, or a flexibility violation metric 1.85 days/year.[4]

In addition, each intra-hour flexibility violation and its associated energy deficit (measured in MWh) was captured and converted into a 12x24 matrix representing the expected 24-hour profile of intra-hour energy deficit for each of the 12 months of the year (i.e., the weighted summation of all deficient energy in that hour of the month/year). Each instance of energy deficit contributes towards the flexibility violation metric. Thus, mitigating short duration energy deficiencies is the mechanism by which flexibility violations are mitigated. While SERVM does not specifically quantify Area Control Error (ACE), SERVM does balance load and generation on a 5-minute basis in the simulations. Any inability to match load and generation on this basis would correlate with actual violations of ACE limits. Configuring the simulations to maintain the base level of flexibility violations of 1.85 days/year for all future resource mixes ensures the ability to maintain an equivalent level of reliability as solar penetration increases. The 12x24 matrix of intra-hour energy deficiencies described above was therefore used to help establish the time periods in which mitigation was necessary as described in the steps below.

[4] Currently, there is no industry standard regarding acceptable levels of flexibility violations. The only requirement is ongoing compliance with NERC Reliability Standard BAAL-001-2. By setting the benchmark to the base case value, which is presumed to be in compliance with NERC standards, the post-solar system can be presumed to likewise remain in compliance with NERC standards.

3.2. Determine Pre-Mitigation Cost/Reliability Parameters

To determine the integration cost of a given solar penetration scenario, it was first necessary to establish the pre-mitigation cost and reliability parameters of each scenario. Specifically, the pre-mitigation total production cost and the pre-mitigation flexibility violations were established.

In addition, each intra-hour failure to balance load and resource and the associated energy deficiencies were captured and converted into a 12x24 matrix like that established for the base case. Other metrics, such as curtailment (i.e., over generation) and spinning reserves supplied were also captured for reporting purposes. SERVM models curtailment whenever the combined minimum dispatch levels of all online generation, including generation online to provide the required operation reserves, exceed system demand or load. The addition of solar resources can increase the frequency and magnitude of such generation curtailment. Lower net load periods and more volatile net load periods associated with increased solar penetration make committing dispatchable resources to follow net load more challenging and result in curtailment. Also, since mitigating solar volatility can include committing more resources, managing flexibility violations can also contribute to system curtailment. Thus, both the solar resources themselves and the actions taken to mitigate flexibility violations associated with those resources contribute to greater risks of generation curtailment.

3.3. Establish Mitigation Impact Profile

Using the base case and scenario case 12x24 profiles of intra-hour energy deficiencies, a mitigation impact profile was developed by directly comparing the base case intra-hour 12x24 energy deficiency profile to the scenario intra-hour 12x24 energy deficiency profile. Each hour of the base case profile was subtracted from the scenario profile. The resulting differences represented those periods of time in which additional load following reserves would be necessary. The table below is a theoretical example of such a resulting impact profile but does not necessarily represent any specific result of this analysis.

Table 13. Example Mitigation Impact Profile (MWH)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	-0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	-1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	-0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.9	0.1	7.6	4.8	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.3
7	11.3	52.7	29.1	36.3	5.8	0.6	1.1	2.9	24.3	2.9	38.4	38.8
8	5.7	11.3	26.1	17.5	8.8	1.2	1.3	2.5	3.6	5.9	23.9	7.7
9	14.1	13.9	20.3	21.1	9.0	1.8	1.3	3.4	5.2	18.2	26.2	16.1
10	13.4	12.7	14.6	21.8	7.8	2.2	2.6	3.1	6.8	22.1	24.7	18.7
11	10.8	7.8	17.8	19.2	6.7	2.9	3.1	5.3	9.9	18.1	23.9	19.3
12	12.9	9.3	13.9	21.3	5.7	4.8	7.4	11.8	16.1	22.8	19.6	17.8
13	14.0	6.9	14.5	22.0	10.1	10.5	18.0	23.4	32.1	28.8	21.9	15.4
14	13.7	8.1	19.5	22.6	16.4	30.2	45.1	60.3	52.2	35.7	28.8	14.4
15	11.3	7.5	23.1	30.3	33.5	72.3	111.5	114.5	81.7	54.3	37.9	15.7
16	13.5	9.6	34.5	52.1	67.3	142.5	195.4	225.9	151.4	99.0	87.5	30.3
17	119.0	20.1	63.2	98.0	157.5	249.7	329.8	358.3	284.6	204.4	307.8	251.1
18	0.0	16.8	248.2	180.7	259.6	295.0	321.2	313.5	186.4	193.7	21.1	0.0
19	0.0	0.0	96.7	145.1	157.8	161.4	155.3	227.5	167.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	26.3	195.1	108.4	0.5	0.0	0.0	0.0	-0.1
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2
22	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2
23	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

The values in the table are MWH values representing the difference in the intra-hour energy deficiencies between the solar penetration scenario and the base case, and therefore, the table can be understood as the increase in flexibility violations caused by the solar penetration scenario. The magnitude of energy deficiency in the table is correlated to the amount of mitigation that may be necessary to return the system back to base case reliability conditions, which higher levels of energy deficiency requiring greater operating reserves to mitigate the flexibility violations.

3.4. Mitigation Using Load Following Reserves

The three primary types of operating reserves modeled in SERVM are regulating reserves, contingency reserves (including spinning reserves and quick start reserves) and load following reserves.

Regulating reserves are generally used to manage the moment-to-moment fluctuations on the system caused by momentary changes in load but would also include the type of moment-to-moment fluctuations that may be caused by intermittent resources such as solar. Regulating reserves are online and ready to be deployed as needed.

Contingency reserves are used to recover from the sudden loss of a generation resource resulting from a forced outage. Contingency reserves are often split into spinning reserves (i.e., those that are online are ready to dispatch at a moment's notice) and quick start reserves (i.e., those that are not online but can be brought online at a moment's notice).

Load following reserves represent the amount of additional spinning reserves that are brought online on an hourly basis to manage the change in load from hour to hour. For purposes of this analysis, load following reserves were used to determine the amount of mitigation necessary to return the reliability of the system to base case conditions. For this analysis, load following reserve targets for the base case were set at 1% of load.

As solar penetration increases, the level of intra-hour flexibility violations also increases. To mitigate the increase in flexibility violations, load following reserves were increased in hours containing intra-hour energy deficiencies until the system returned as closely as possible to the base case flexibility violation benchmark of 1.85 days/year. This was an iterative process. Each new iteration required the calculation of a new mitigation impact profile and subsequent adjustments to the load following reserve targets in each hour. Hours with higher levels of incremental energy deficiencies would necessarily require higher levels of load following. The figure below demonstrates this iterative process.

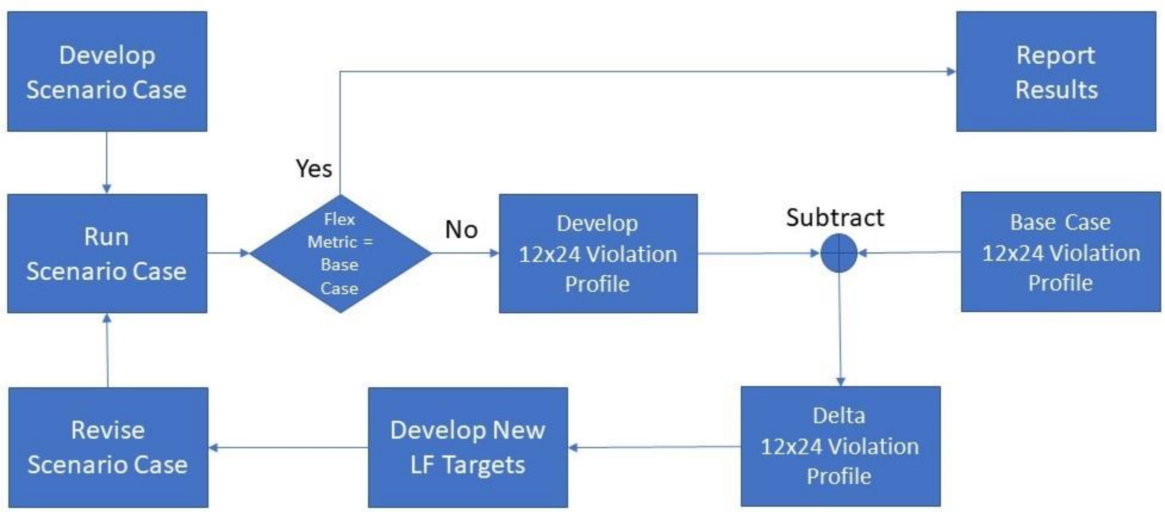

Figure 5. Mitigation Flowchart

The table below shows a theoretical example of the resulting 12x24 load following profile that may result from this process. The table reflects the load following targets (in percent of load) that would need to be followed in each hour of the respective month to ensure adequate intra-hour flexibility.

Table 14. Example Load Following Target Profile (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.0	1.3	1.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1
7	1.9	3.1	4.2	4.6	4.8	4.8	4.7	4.2	2.0	1.8	3.7	2.9
8	2.5	3.6	6.2	5.9	8.1	8.1	7.8	8.6	6.6	3.6	5.3	2.6
9	6.8	6.7	6.8	6.4	6.8	7.4	7.3	7.0	6.9	7.0	5.9	6.2
10	6.5	6.5	6.8	6.1	6.2	6.8	6.2	6.0	6.0	6.2	6.2	6.2
11	6.5	6.3	6.5	6.3	5.9	5.6	5.3	5.4	5.7	6.2	6.2	6.2
12	6.3	6.5	6.2	6.4	5.4	5.4	4.9	5.1	5.5	6.3	6.3	8.0
13	6.4	6.3	6.3	6.3	5.5	5.1	4.7	4.8	5.6	6.0	6.2	6.2
14	6.2	6.2	6.4	6.0	5.3	5.2	4.3	4.9	5.4	5.9	6.4	6.4
15	6.5	6.0	6.4	5.9	5.5	5.2	4.6	4.1	5.2	6.0	6.7	6.4
16	7.0	6.6	6.6	6.1	5.8	5.4	7.0	4.8	5.6	6.4	4.2	4.5
17	4.8	4.6	6.0	6.2	5.8	5.3	8.1	4.2	6.5	5.5	3.5	3.3
18	1.9	2.8	4.2	6.1	5.9	5.1	3.6	6.1	4.9	4.8	1.0	1.0
19	1.0	1.0	3.1	4.4	5.0	4.6	3.9	5.1	6.7	1.0	1.0	1.0
20	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

This mitigation process is applicable to all three technology portfolios. While BESS and RICE technology portfolios are very flexible resources and improve the response of the system, the addition of these technologies do not inherently bring the flexibility violations down to base case levels because SERVM is also using them to meet base case reserve targets. Therefore, load following reserve targets must still be increased with these portfolios to fully return the system to base case flexibility levels.

3.5. Integration Cost Calculations

Once the mitigated system achieved flexibility violations of approximately 1.85 days/year, the mitigation cost could be determined in accordance with the following equation:

$$SMC = (TPC_{post} – TPC_{pre})/MWH_{scenario}$$

Where,

$SMC \equiv$ Scenario Mitigation Cost in \$/MWH,
$TPC_{post} \equiv$ Total Production Cost of the Scenario post mitigation,
$TPC_{pre} \equiv$ Total Production Cost of the Scenario pre mitigation, and
$MWH_{scenario} \equiv$ The megawatt hours of solar generation associated with the scenario.

This SMC value represents the cost of the required increase in load following reserves. The costs associated with increases in curtailment are implicitly included in these calculations since the production costs associated with the additional energy that was generated but did not serve load are included in TPC_{post}.

4. Results

The results from each of the scenarios for each of the three technology portfolios are detailed in the following sections. Following the discussion of the three technology portfolios is a discussion concerning the impact of the solar tranches and the associated mitigation on expected generation curtailments.

4.1. Portfolio 1 – Current System Mix

Portfolio 1 represents integration costs assuming Southern Company's current expectations of system mix (i.e., without any significant dependence upon fast-acting technologies such as BESS or RICE). The table below shows the integration costs for each of the seven solar penetration scenarios.

Table 15. Portfolio 1 Mitigation Costs

Scenario	Solar MW	Mitigation Cost ($/MWH)
A	3,000	2.68
B	5,000	2.88
C	8,000	2.50
D	10,000	3.25
E	12,000	3.19
F	15,000	4.83
G	20,000	6.64

The figure below shows the same information graphically.

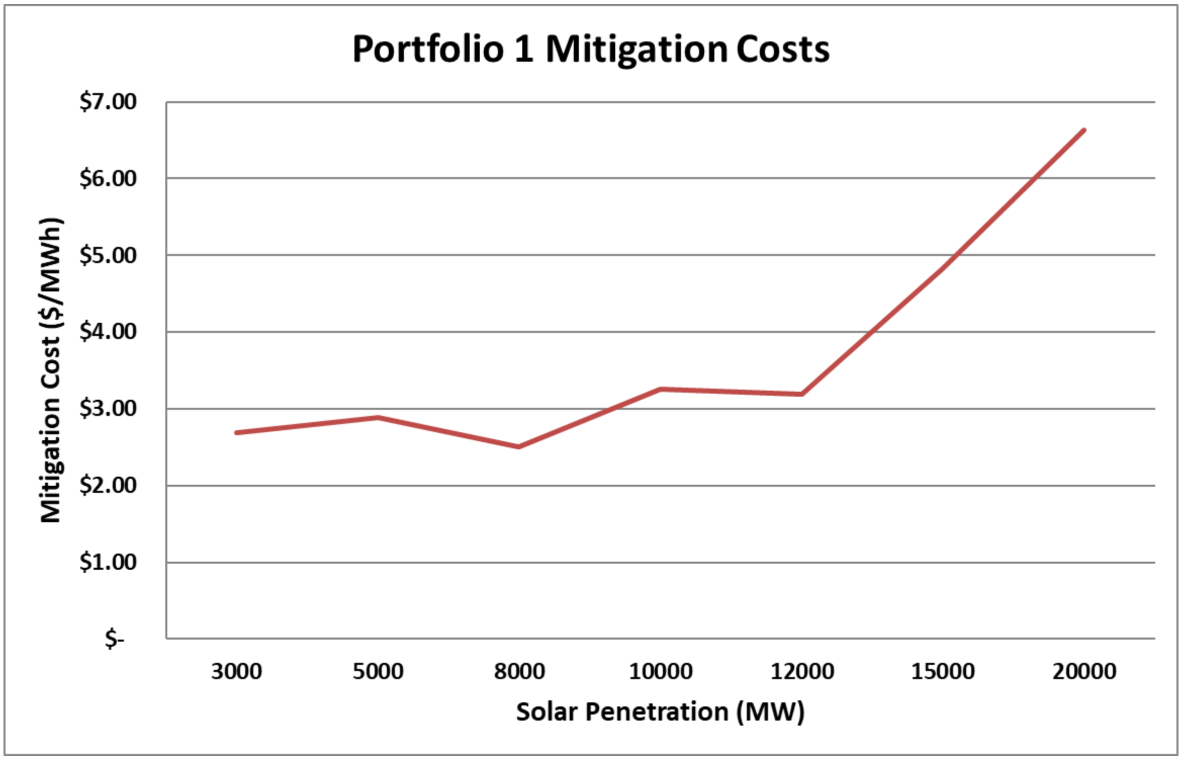

Figure 6. Portfolio 1 Mitigation Costs

The detailed integration cost calculations for the 7 scenarios in Portfolio 1 are included in Appendix B.

As an example of the load following profiles necessary to achieve this level of mitigation, the following table shows a 12x24 heat map of the Scenario A (3,000 MW) Solar Only scenario load following results.

Table 16. Scenario A Solar Only Load Following Requirements (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.1	1.0	1.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.4
7	1.8	1.7	2.2	1.9	2.6	2.3	2.0	2.0	1.1	1.8	1.9	1.3
8	1.6	1.8	2.2	2.4	3.0	2.5	2.0	2.0	2.5	2.2	2.3	1.5
9	2.1	2.2	2.7	2.7	2.5	2.5	2.5	2.5	2.5	2.6	2.5	2.9
10	2.3	2.3	2.6	2.6	2.4	2.5	2.2	2.1	2.4	2.6	2.4	2.1
11	2.4	2.5	3.5	2.8	2.3	2.0	1.9	2.0	2.1	2.7	2.6	2.5
12	2.3	2.5	3.7	3.1	2.5	1.9	2.0	1.9	2.3	2.7	2.7	2.5
13	2.3	2.5	3.7	3.4	2.7	2.2	2.1	1.9	2.3	2.7	2.6	2.6
14	2.4	2.3	3.8	3.4	2.6	2.1	1.5	1.8	2.1	2.7	2.7	2.4
15	2.4	2.1	2.8	3.2	2.4	2.2	1.9	2.6	2.0	2.7	2.7	2.6
16	2.3	2.2	2.8	2.6	2.4	2.4	1.8	1.2	1.8	2.8	2.3	2.1
17	2.0	2.0	2.8	3.0	2.6	2.9	2.1	1.4	2.3	3.1	1.6	2.0
18	1.4	1.9	2.1	3.1	2.8	2.9	3.6	1.4	1.6	2.4	1.0	1.3
19	1.0	1.0	1.1	2.3	2.5	2.7	4.4	4.3	3.7	1.0	1.0	1.1
20	1.0	1.0	1.0	1.0	1.0	1.8	2.1	2.0	1.0	1.0	1.0	1.1
21	1.0	1.0	1.0	1.0	1.0	2.2	2.5	4.8	1.0	1.0	1.1	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Load Following heat maps for the 7 scenarios in Portfolio 1 are included in Appendix C.

4.2. Portfolio 2 – BESS Technology

Portfolio 2 represents integration costs assuming Southern Company's current expectations of system mix contains a significant penetration of BESS resources. The table on the following page shows the integration costs for each of the seven solar penetration scenarios for this technology mix. As previously stated, the addition of the BESS resources reflected a change in the underlying system and were added as a flexible resource used to serve load. While being a more flexible resource class, they did not fully mitigate the flex violations. Thus, the mitigation cost shown represents the cost of the increased load following reserves required to achieve the necessary reductions in flexibility violations and does not reflect the cost of adding the BESS resources.

Table 17. Portfolio 2 (BESS) Mitigation Costs

Scenario	Solar MW	BESS MW	Mitigation Cost ($/MWH)
A	3,000	500	2.78
B	5,000	775	2.83
C	8,000	1,150	1.88
D	10,000	1,500	1.35
E	12,000	1,675	1.85
F	15,000	2,000	1.37
G	20,000	2,500	1.52

The figure below shows the same information graphically.

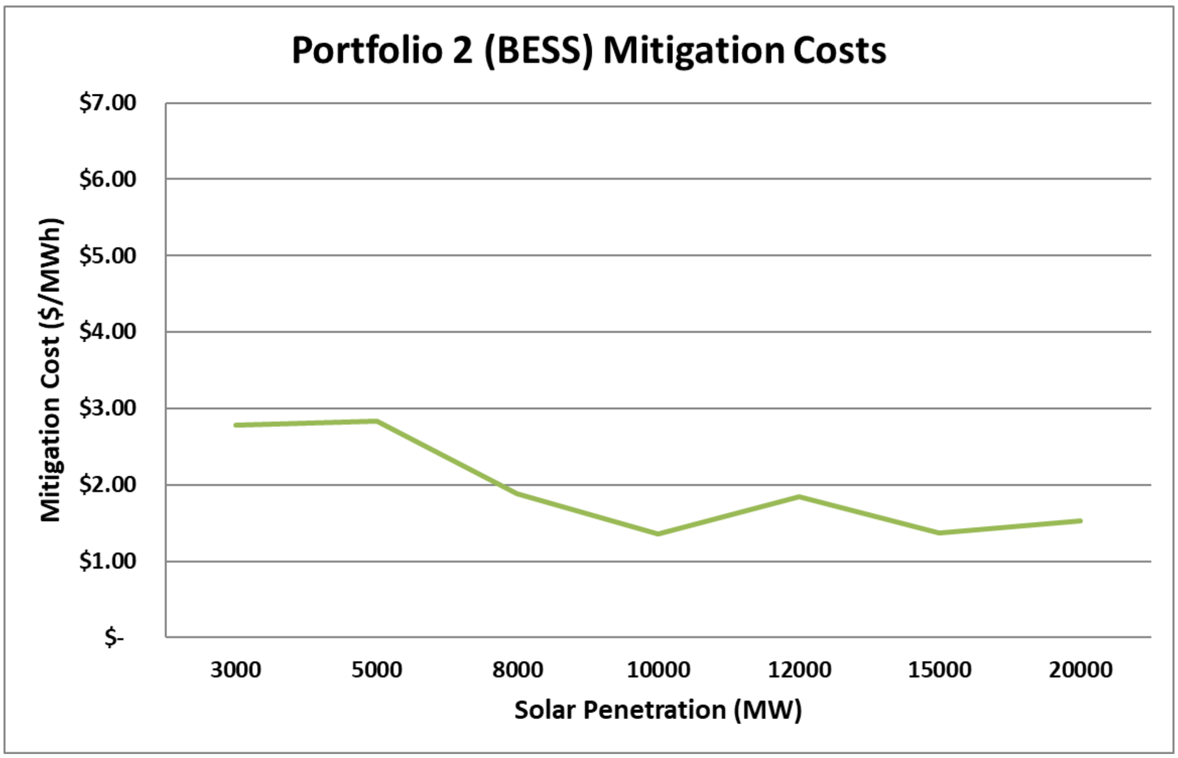

Figure 7. Portfolio 2 (BESS) Mitigation Costs

The detailed integration cost calculations for the 7 scenarios in Portfolio 2 are included in Appendix B.

Load Following heat maps for the 7 scenarios in Portfolio 2 are included in Appendix C.

4.3. Portfolio 3 – RICE Technology

Portfolio 2 represents integration costs assuming Southern Company's current expectations of system mix contains a significant penetration of RICE resources. The table below shows the integration costs for each of the seven solar penetration scenarios for this technology mix. As previously stated, the addition of the RICE resources reflected a change in the underlying system and were added as a flexible resource used to serve load. While being a more flexible resource class, they did not fully mitigate the flex violations. Thus, the mitigation cost shown represents the cost of the increased load following reserves required to achieve the necessary reductions in flexibility violations and does not reflect the cost of adding the RICE resources.

Table 18. Portfolio 3 (RICE) Mitigation Costs

Scenario	Solar MW	RICE MW	Mitigation Cost ($/MWH)
A	3,000	500	2.74
B	5,000	780	2.54
C	8,000	1,160	1.75
D	10,000	1,500	1.68
E	12,000	1,680	1.67
F	15,000	2,000	2.10
G	20,000	2,500	2.56

The figure on the following page shows the same information graphically.

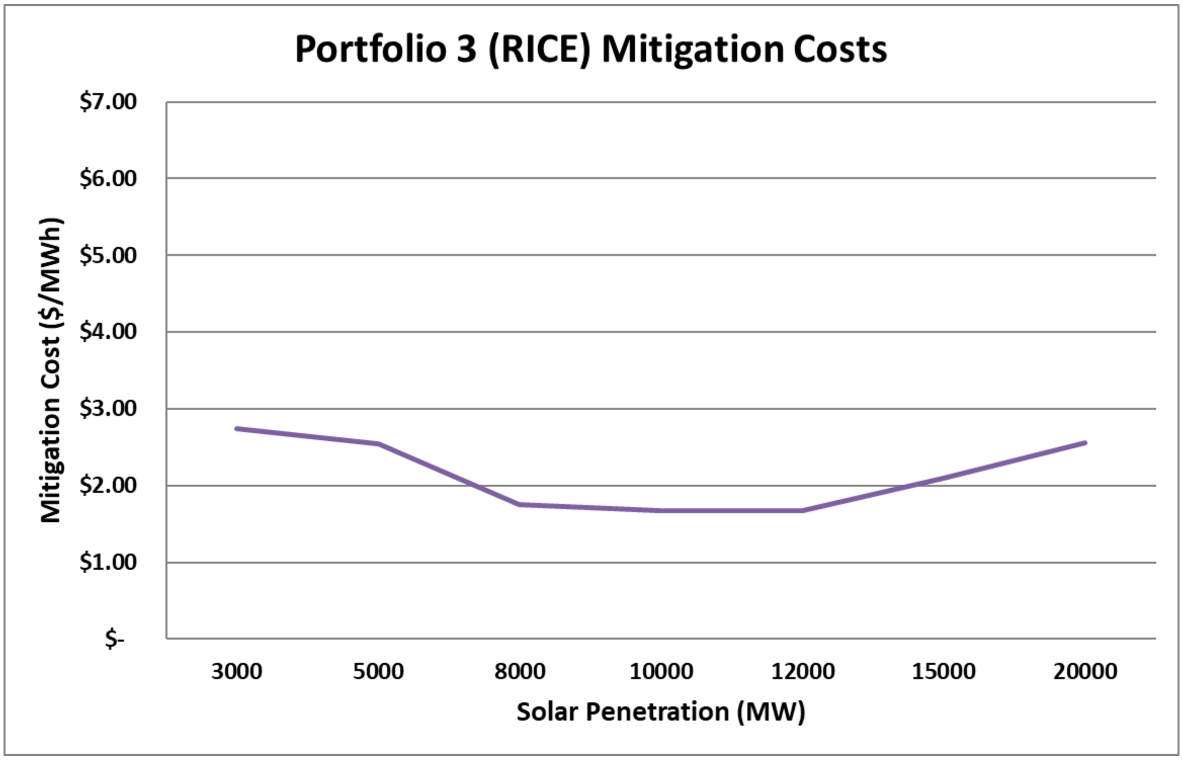

Figure 8. Portfolio 2 (BESS) Mitigation Costs

The detailed integration cost calculations for the 7 scenarios in Portfolio 1 are included in Appendix B.

Load Following heat maps for the 7 scenarios in Portfolio 3 are included in Appendix C.

4.4. Technology Summaries and Observations

The figure on the following page shows a comparative summary of the mitigation costs for all three technology portfolios.

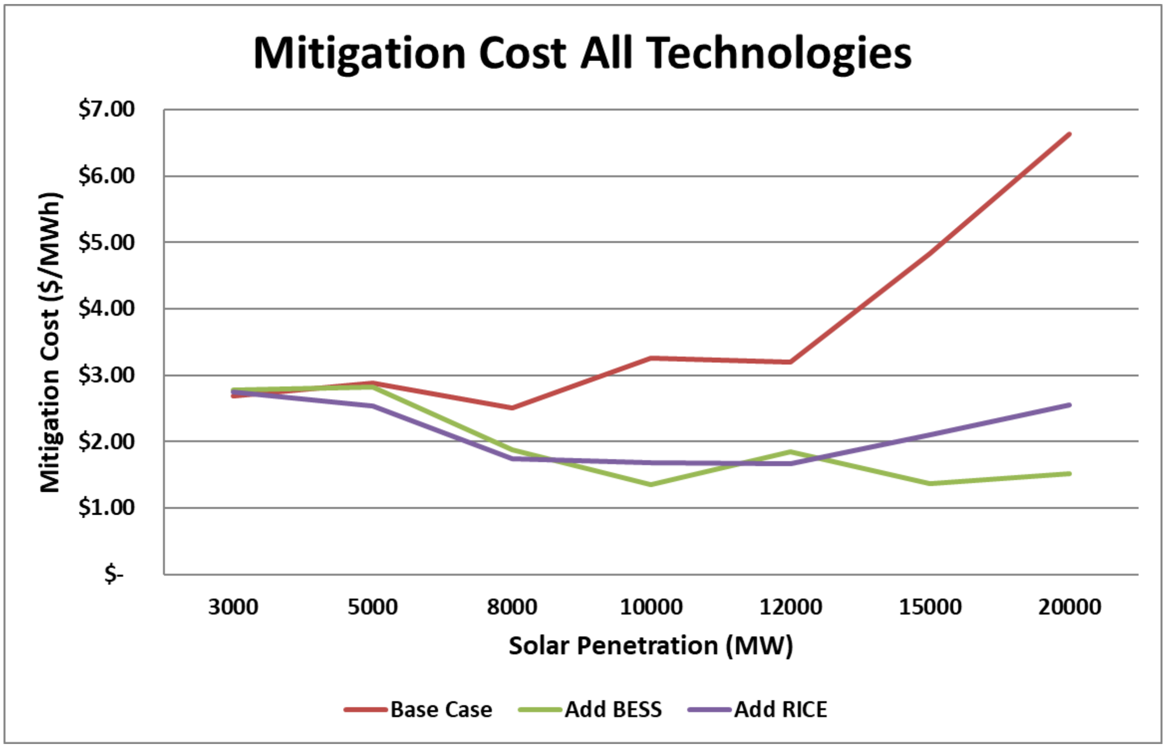

Figure 9. Comparison of Mitigation Costs by Technology Portfolio

The following are some key observations regarding the results of the analysis.

1. The addition of solar has a significant impact on the flexibility needs of the system. The volatility of the net load profile after the addition of solar necessitates mitigation either through increasing load following or adding more flexible capacity or some combination of the two solutions.
2. Southern Company currently operates its fleet with appropriate safety margins and in compliance with NERC balancing standards. There is not spare capability to manage the net load volatility observed in the study.
3. While there is no industry standard for ideal levels of flexibility violations, Southern's current operating practices provide an appropriate benchmark to maintain as the resource mix changes. Adjusting the flexible capacity on the system and increasing operating reserve guidelines along with considerations of the associated costs of such actions to incremental renewable energy as integration costs appropriately balances economic and reliability considerations.
4. In the Current Mix portfolio, there appears to be a significant inflection point at approximately 12,000 MW of solar, above which integration costs increase significantly.
5. BESS and RICE portfolios have similar renewable integration cost scenarios until approximately 12,000 MW of solar, above which the cost of the RICE portfolio diverges with higher cost. This is because at higher penetration levels, the battery provides more flexibility value as it avoids more generation curtailment (i.e., overgeneration). Consequently, it should be noted that the generation curtailment associated with the RICE portfolio also increases more rapidly at that point (see Impacts on Generation Curtailment section below).

6. As indicated above, the size of the BESS and RICE fleets used for this analysis were not fully optimized but were selected based on the underlying volatility of the solar fleet. The levels of BESS and RICE generation relative to solar penetration will likely impact the shape of the integration cost curve.
7. Due to the ancillary services benefit of both BESS and RICE technologies, the reduction in integration costs associated with those technologies is not fully realized until the penetration of BESS and RICE exceed that of the ancillary services requirements.

4.5. Impacts on Generation Curtailment

Generation curtailment is a metric that represents conditions in which load falls below a point at which the online generation is no longer able to reduce output to match load. This phenomenon is sometimes referred to as overgeneration. In the real world, this condition is remedied either by allowing frequency to slightly rise, selling excess generation to a neighboring utility, or decommitting online generation. In this study, an increase in the generation curtailment metric relative to the base case is an indication of the increased risk that such conditions will materialize in the real world as a direct consequence of the additional solar generation.

For this analysis such conditions are presumed to be mitigated by curtailing solar generation and thus not receiving the energy otherwise available from the resource.

Because the cost attributable to the increase in the generation curtailment metric is dependent upon the utility's assessment of the value of the generation curtailed, generation curtailment cost is not included in the previously discussed integration costs. However, there are two ways in which the cost of generation curtailment should be considered.

First, there is the increase in generation curtailment from the pre-mitigated case to the base case, referred to here as the Pre-Mitigated Curtailment Impact. This represents the amount of renewable generation that would not be received simply because the system mix cannot manage the day-to-day swings in net load resulting from the renewable resource. This cost should be considered in the ***initial evaluation*** of the economic value of the resource. The table and figure on the following page show numerically and graphically the magnitude (in MWH) of the Pre-Mitigated Curtailment Impact for each scenario in each of the technology portfolios.

Table 19. Pre-Mitigation Curtailment Impact (MWH)

Solar MW	Solar Only	BESS	RICE
3000	72	0	0
5000	90	0	76
8000	5,473	51	4,752
10000	62,631	631	44,239
12000	278,285	11,661	220,725
15000	1,255,231	151,189	758,255
20000	5,222,657	1,713,614	3,068,090

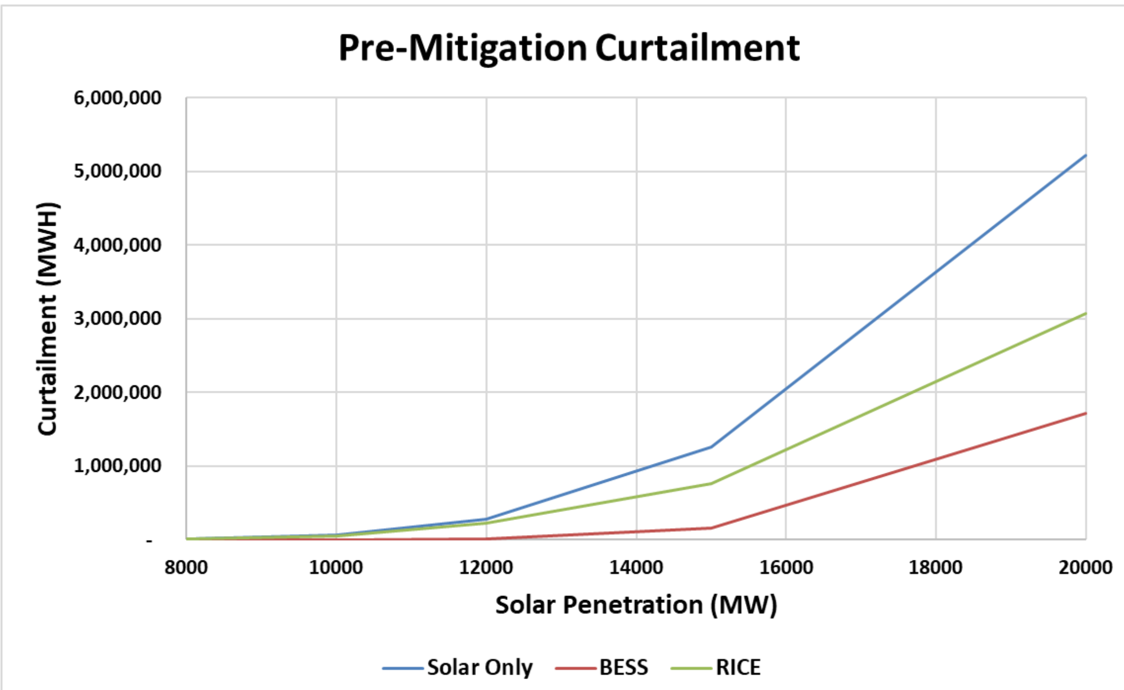

Figure 10. Pre-Mitigated Curtailment Impact

The second way in which generation curtailment costs should be considered is in the difference between the post-mitigated case and the pre-mitigated case for the same scenario, referred to here as the Post-Mitigated Curtailment Impact. The Post-Mitigated Curtailment Impact should be incorporated as part of (i.e., in addition to) the previously identified ***renewable integration costs*** because it represents the additional generation curtailment caused by increasing load following reserves to ensure intra-hour flexibility. The table and figure on the following page show numerically and graphically the magnitude (in MWH) of the total Post-Mitigated Curtailment Impact (i.e., inclusive of the Pre-Mitigated Curtailment Impact) for each scenario in each of the three technology portfolios.

Table 20. Post-Mitigation Curtailment Impact (MWH)

Solar MW	Solar Only	BESS	RICE
3000	208	47	236
5000	572	89	229
8000	14,430	253	9,281
10000	163,716	3,031	75,137
12000	649,582	69,547	346,162
15000	2,781,999	333,138	1,147,722
20000	9,325,828	2,383,882	4,184,069

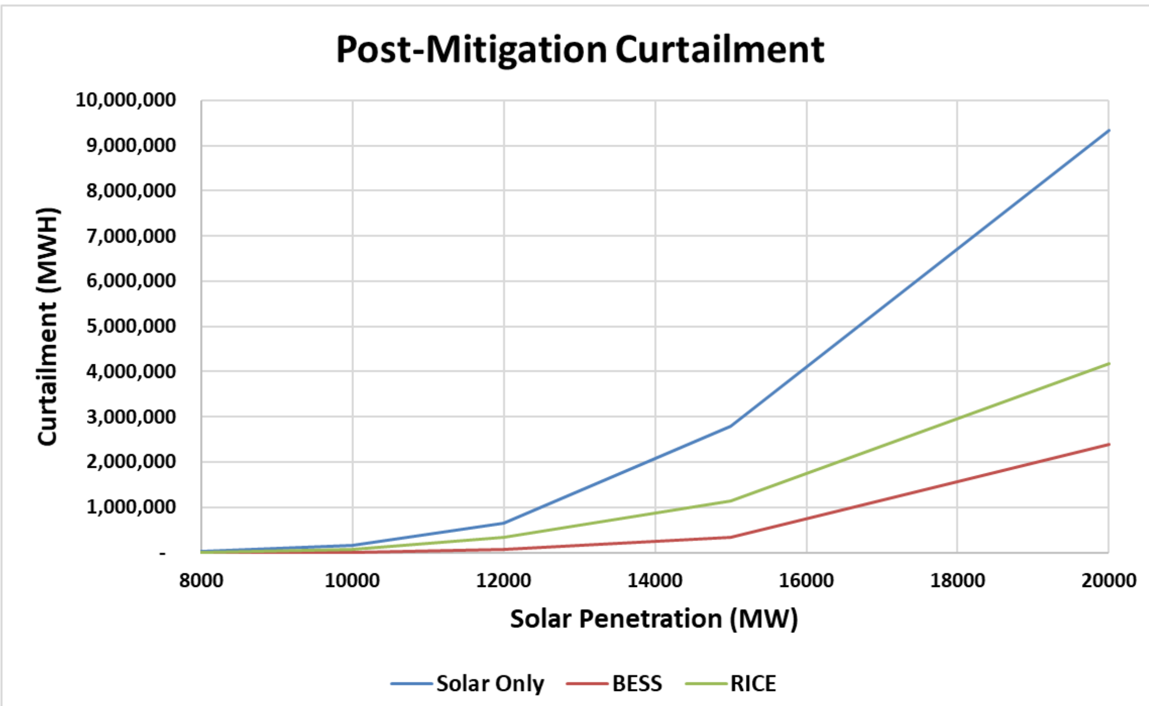

Figure 11. Post-Mitigated Curtailment Impact

As an example of the timing throughout the year of when such curtailment may occur, the table on the following page shows a heat map of the total system curtailment (base case curtailment plus pre-mitigation curtailment plus post-mitigation curtailment) for the 8,000 MW solar only scenario. The table shows the total MWHs of curtailment by hour by month for the scenario. As the heat map shows, the greatest concentration of curtailment occurs during periods of low load combined with periods of high solar output, such as during the middle of the day during spring, fall, and winter months. Other scenarios would be similar, but with varying quantities based on the level of solar penetration.

Table 21. Heat Map of Total MWHs of Curtailment (8,000 MW Solar Only Scenario)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	13	0	3	3	4	1	1	-	1	1	0
2	0	-	-	-	-	-	0	-	-	-	-	0
3	0	0	0	-	-	-	-	-	-	-	-	0
4	1	0	0	0	0	-	-	-	-	-	0	0
5	6	1	0	0	0	-	-	-	0	-	0	0
6	0	0	0	0	0	0	-	-	-	-	-	0
7	0	0	1	0	1	0	0	0	-	-	0	0
8	5	4	16	10	11	4	0	0	0	0	3	2
9	18	8	40	28	69	11	3	1	5	1	9	5
10	59	55	173	101	180	5	2	0	21	4	34	18
11	159	155	294	157	139	1	4	0	19	9	75	29
12	361	300	515	188	64	0	0	-	6	17	136	61
13	898	633	764	226	54	0	0	0	8	25	177	128
14	1,133	798	936	247	57	0	0	0	7	19	120	116
15	672	510	800	230	45	0	4	1	8	6	21	26
16	174	95	427	116	25	3	41	11	3	1	4	7
17	0	7	96	21	2	19	193	25	19	0	0	-
18	-	-	16	2	4	45	144	94	51	0	-	-
19	-	-	-	0	6	66	45	145	158	-	-	-
20	-	-	0	-	2	14	11	4	2	-	-	0
21	0	-	0	-	-	0	0	0	0	-	-	-
22	-	-	-	-	0	0	0	0	-	0	-	-
23	0	-	-	-	-	-	-	-	-	0	-	-
24	0	-	-	-	-	-	-	-	-	-	-	-

Appendix A – Solar Resources Modeled

The following tables indicate the solar resources and associated nominal capacity modeled as part of this solar integration study. The first table reflects the 61 resources included in Scenario A, representing a total of 2,947 MW. This is consistent with all solar resources built or committed to be built prior to the 2019 IRP. The second table reflects three additional facilities representing 1,210 MW that was added for Scenario B, representing a total of 5,157MW. This is consistent with all solar resources built or committed to be built after the 2019 IRP. Several of these modeled resources included an aggregation of a geographically diverse set of aggregated distributed generator (DG) solar resources. Several other modeled resources were aggregations of generic future committed solar resources.

Table 22. Scenario A Solar Facilities

Unit Name	Capacity (MW)
Solar - GPC REDI Twiggs County	200
Solar - GPC REDI Quitman	150
Solar - MPC Meridian III	52
Solar - GPC REDI C&I Daugherty	120
Solar - GPC REDI Camilla	160
Solar - GPC REDI DG 1	53.47
Solar - GPC REDI DG CS	36.27
Solar - GPC Moody AFB	48
Solar - GPC Ft Valley	10.8
Solar - GPC REDI DG 2	72.58
Solar - GPC Ray	1
Solar - APC RGC Lafayette	72
Solar - APC RGC ANAD	7.4
Solar - APC RGC Ft Rucker	10.6
Solar - SPC Sandhills	143
Solar - GPC ASI Classic Butler Farm	20
Solar - GPC ASI Classic Decatur Cty	18.9
Solar - GPC ASI Classic DG1	26
Solar - GPC ASI Classic DG2	49
Solar - GPC ASI Classic Dublin	4
Solar - GPC ASI Classic Rincon	16
Solar - GPC ASI Classic Old Midville	20
Solar - GPC ASI Classic Richland	20
Solar - GPC ASI Classic Glynn Co	17.7
Solar - GPC ASI Prime Butler 100	100
Solar - GPC ASI Prime Decatur Pkwy	79.9
Solar - GPC ASI Prime DG1	39.7
Solar - GPC ASI Prime DG2	39.7
Solar - GPC ASI Prime Live Oak	51

Unit Name	Capacity (MW)
Solar - GPC ASI Prime Paw-Paw	30
Solar - GPC ASI Prime White Oak	76.5
Solar - GPC ASI Prime White Pine	101.07
Solar - GPC LSS Pembrooke	1
Solar - GPC LSS Camilla	16
Solar - GPC LSS Camp	3
Solar - GPC MIL Ft Benning	30
Solar - GPC MIL Ft Gordon	30
Solar - GPC MIL Ft Stewart	30
Solar - GPC 2020 Customer Owned DG BTM	25
Solar - GPC 2025 Customer Owned DG BTM	15
Solar - MPC CB Energy	3.29
Solar - GPC MIL Kings Bay	30
Solar - GPC MIL MCLB	31
Solar - MPC MS Solar 2	52
Solar - GPC LSS Simon	30
Solar - MPC Hattiesburg Farm	50
Solar - GPC REDI 21 A	90
Solar - GPC REDI 21 B	90
Solar - GPC REDI 21 C	90
Solar - GPC REDI 22 A	90
Solar - GPC REDI 22 B	90
Solar - GPC REDI 22 C	90
Solar - GPC MIL Robbins AFB	128
Solar - GPC REDI C&I Tanglewood	57.5
Solar - GPC Vogtle Community Solar	2.4
Solar - GPC Axium	1
Solar - GPC Comer Community Solar	2.16
Solar - GPC Falcons	1
Solar - GPC Savannah Community Solar	3.6
Solar - GPC MIL Self Build	13.5
Solar - GPC GA College	3.5

Table 23. Additional Solar Resources for Scenario B

Unit Name	Capacity (MW)
Solar - GPC 2019 IRP DG	210
Solar - GPC 2019 IRP US 1	1000
Solar - GPC 2019 IRP US 2	1000

Appendix B – Integration Cost Calculation Details

This appendix shows the integration cost details for each of the 21 scenarios evaluated. The integration costs are calculated as the increase in production cost from the pre-mitigation scenario case to the post-mitigation scenario case divided by the solar energy associated with the scenario case. As a point of reference, the no solar base case production cost was $4,957,016,049.

The table below shows the pre-mitigation production cost, post-mitigation production cost, delta production cost, solar generation, and resulting integration cost for each of the 7 scenarios in Portfolio 1 (Solar Only).

Table 24. Table 21. Portfolio 1 (Solar Only) Integration Cost Details

Scenario	Pre-Mitigation Cost (M$)	Post-Mitigation Cost (M$)	Delta (M$)	Solar MWH	Integration Cost ($/MWH)
A	5,031	5,049	17.69	6,596,132	2.68
B	4,898	4,928	29.71	10,309,138	3.20
C	4,840	4,883	43.13	17,254,076	3.81
D	4,712	4,782	70.09	21,564,785	3.87
E	4,594	4,677	82.61	25,878,158	3.41
F	4,444	4,601	156.21	32,344,214	5.02
G	4,261	4,548	286.19	43,130,920	6.83

The table below shows the pre-mitigation production cost, post-mitigation production cost, delta production cost, solar generation, and resulting integration cost for each of the 7 scenarios in Portfolio 2 (BESS).

Table 25. Portfolio 2 (BESS) Integration Cost Details

Scenario	Pre-Mitigation Cost (M$)	Post-Mitigation Cost (M$)	Delta (M$)	Solar MWH	Integration Cost ($/MWH)
A	5,172	5,190	18.33	6,596,411	2.78
B	5,197	5,226	29.15	10,308,476	2.83
C	5,181	5,213	32.44	17,253,830	1.88
D	5,133	5,162	29.15	21,565,169	1.35
E	4,997	5,045	47.78	25,874,835	1.85
F	4,978	5,022	44.25	32,342,571	1.37
G	4,888	4,953	65.69	43,125,873	1.52

The table below shows the pre-mitigation production cost, post-mitigation production cost, delta production cost, solar generation, and resulting integration cost for each of the 7 scenarios in Portfolio 3 (RICE).

Table 26. Portfolio 3 (RICE) Integration Cost Details

Scenario	Pre-Mitigation Cost (M$)	Post-Mitigation Cost (M$)	Delta (M$)	Solar MWH	Integration Cost ($/MWH)
A	5,200	5,219	18.09	6,596,219	2.74
B	5,231	5,257	26.18	10,308,903	2.54
C	5,165	5,195	30.15	17,252,879	1.75
D	5,191	5,227	36.16	21,564,006	1.68
E	5,060	5,103	43.22	25,876,678	1.67
F	5,042	5,110	67.78	32,344,174	2.10
G	4,961	5,071	110.27	43,129,227	2.56

Appendix C – Load Following Heat Maps

The following 7 tables contain heat maps reflecting the load following requirements needed to successfully mitigate the flex violations associated with the 7 scenarios in Portfolio 1 (Solar Only).

Table 27.Scenario A Solar Only Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.1	1.0	1.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.4
7	1.8	1.7	2.2	1.9	2.6	2.3	2.0	2.0	1.1	1.8	1.9	1.3
8	1.6	1.8	2.2	2.4	3.0	2.5	2.0	2.0	2.5	2.2	2.3	1.5
9	2.1	2.2	2.7	2.7	2.5	2.5	2.5	2.5	2.5	2.6	2.5	2.9
10	2.3	2.3	2.6	2.6	2.4	2.5	2.2	2.1	2.4	2.6	2.4	2.1
11	2.4	2.5	3.5	2.8	2.3	2.0	1.9	2.0	2.1	2.7	2.6	2.5
12	2.3	2.5	3.7	3.1	2.5	1.9	2.0	1.9	2.3	2.7	2.7	2.5
13	2.3	2.5	3.7	3.4	2.7	2.2	2.1	1.9	2.3	2.7	2.6	2.6
14	2.4	2.3	3.8	3.4	2.6	2.1	1.5	1.8	2.1	2.7	2.7	2.4
15	2.4	2.1	2.8	3.2	2.4	2.2	1.9	2.6	2.0	2.7	2.7	2.6
16	2.3	2.2	2.8	2.6	2.4	2.4	1.8	1.2	1.8	2.8	2.3	2.1
17	2.0	2.0	2.8	3.0	2.6	2.9	2.1	1.4	2.3	3.1	1.6	2.0
18	1.4	1.9	2.1	3.1	2.8	2.9	3.6	1.4	1.6	2.4	1.0	1.3
19	1.0	1.0	1.1	2.3	2.5	2.7	4.4	4.3	3.7	1.0	1.0	1.1
20	1.0	1.0	1.0	1.0	1.0	1.8	2.1	2.0	1.0	1.0	1.0	1.1
21	1.0	1.0	1.0	1.0	1.0	2.2	2.5	4.8	1.0	1.0	1.1	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 28.Scenario B Solar Only Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
7	2.1	2.0	4.5	2.9	4.4	4.4	4.3	2.6	1.1	1.0	3.5	1.5
8	2.9	3.1	4.1	4.9	6.2	5.9	6.1	5.2	4.2	3.2	3.7	2.2
9	4.9	4.1	4.7	4.8	4.9	5.6	5.6	5.2	5.0	4.6	4.2	4.7
10	4.7	4.8	5.0	4.1	4.2	5.0	4.2	4.6	4.0	4.6	4.5	4.4
11	4.7	4.8	4.7	4.3	4.2	3.9	3.8	3.7	3.9	4.4	4.4	4.3
12	4.6	4.7	4.5	4.3	4.0	3.6	3.7	3.4	3.9	4.3	4.5	4.5
13	4.5	4.4	4.4	4.3	3.9	3.6	3.3	3.2	4.0	4.3	4.5	4.5
14	4.6	4.2	4.6	4.3	3.8	3.7	3.1	3.2	3.8	4.2	4.4	4.3
15	4.4	4.6	4.6	4.4	3.7	3.6	3.0	3.3	3.8	4.2	5.0	4.8
16	4.0	5.0	4.6	4.2	4.2	3.7	3.0	2.9	4.4	4.3	3.3	3.1
17	3.0	3.1	4.6	4.5	4.2	3.8	3.3	3.4	4.7	4.2	2.6	2.2
18	1.3	1.7	2.8	4.6	4.5	3.9	3.3	3.6	4.6	3.3	1.0	1.0
19	1.0	1.0	1.0	3.5	3.1	3.1	2.6	6.1	4.0	1.0	1.0	1.0
20	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 29. Scenario C Solar Only Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.0	1.3	1.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1
7	1.9	3.1	4.2	4.6	4.8	4.8	4.7	4.2	2.0	1.8	3.7	2.9
8	2.5	3.6	6.2	5.9	8.1	8.1	7.8	8.6	6.6	3.6	5.3	2.6
9	6.8	6.7	6.8	6.4	6.8	7.4	7.3	7.0	6.9	7.0	5.9	6.2
10	6.5	6.5	6.8	6.1	6.2	6.8	6.2	6.0	6.0	6.2	6.2	6.2
11	6.5	6.3	6.5	6.3	5.9	5.6	5.3	5.4	5.7	6.2	6.2	6.2
12	6.3	6.5	6.2	6.4	5.4	5.4	4.9	5.1	5.5	6.3	6.3	8.0
13	6.4	6.3	6.3	6.3	5.5	5.1	4.7	4.8	5.6	6.0	6.2	6.2
14	6.2	6.2	6.4	6.0	5.3	5.2	4.3	4.9	5.4	5.9	6.4	6.4
15	6.5	6.0	6.4	5.9	5.5	5.2	4.6	4.1	5.2	6.0	6.7	6.4
16	7.0	6.6	6.6	6.1	5.8	5.4	7.0	4.8	5.6	6.4	4.2	4.5
17	4.8	4.6	6.0	6.2	5.8	5.3	8.1	4.2	6.5	5.5	3.5	3.3
18	1.9	2.8	4.2	6.1	5.9	5.1	3.6	6.1	4.9	4.8	1.0	1.0
19	1.0	1.0	3.1	4.4	5.0	4.6	3.9	5.1	6.7	1.0	1.0	1.0
20	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 30. Scenario D Solar Only Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.0	1.2	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1
7	2.8	4.2	5.0	5.5	7.5	6.0	6.0	5.6	2.9	2.7	5.1	2.8
8	5.5	5.9	8.6	7.8	11.0	11.5	12.0	12.0	9.0	5.5	8.1	5.0
9	9.0	9.0	8.9	8.8	9.0	11.3	9.0	9.0	12.0	10.3	8.9	9.0
10	9.0	8.9	8.9	8.5	8.6	9.0	8.9	8.9	8.7	8.8	8.9	9.0
11	8.9	9.0	9.0	8.8	8.2	8.5	8.2	8.4	8.6	8.8	8.9	9.0
12	9.0	9.0	8.9	8.8	7.6	8.2	6.0	7.1	8.3	8.8	9.0	9.0
13	9.0	9.0	8.9	8.8	8.3	6.0	6.0	6.0	8.5	8.7	8.9	9.0
14	9.0	9.0	9.0	8.7	7.6	7.5	6.0	5.9	7.7	8.7	8.9	9.0
15	9.0	8.9	9.0	8.6	7.9	7.8	5.9	5.6	8.2	8.8	9.0	9.0
16	9.0	9.0	9.0	8.8	8.6	8.1	5.9	5.5	8.5	8.7	6.0	6.0
17	6.0	6.0	8.8	8.9	8.7	8.1	5.9	5.5	8.9	8.6	5.7	2.9
18	1.0	2.2	6.0	8.8	8.8	8.5	6.0	5.7	8.8	7.9	2.0	1.0
19	1.5	1.0	5.3	8.4	8.3	6.0	5.9	6.0	6.0	1.0	1.0	1.0
20	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 31. Scenario E Solar Only Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.2	1.4	1.6	2.2	1.0	1.0	1.0	1.0	1.0	1.0	2.4	1.0
7	1.6	3.5	4.0	4.6	7.0	7.0	8.0	6.0	3.2	1.2	4.8	2.6
8	5.6	5.7	8.6	7.5	11.8	11.8	13.9	11.8	7.9	5.5	6.8	5.4
9	10.0	9.2	9.5	9.6	9.5	10.0	10.3	9.9	10.0	10.5	8.8	9.5
10	8.9	8.8	9.3	8.3	9.1	9.7	8.8	8.8	8.6	8.9	9.2	9.0
11	8.9	9.3	9.5	9.0	8.2	8.5	7.6	8.2	8.5	9.1	9.4	9.6
12	9.0	9.5	9.3	9.1	7.3	8.1	7.3	7.7	8.3	10.3	9.7	8.9
13	9.4	9.5	10.0	9.6	8.5	7.0	6.9	7.5	8.4	10.0	9.8	10.2
14	9.0	9.3	9.9	8.8	7.8	7.8	6.5	7.8	8.0	9.9	10.2	9.4
15	9.1	9.0	10.1	8.9	8.1	7.9	6.7	5.8	8.1	9.4	11.5	10.3
16	8.2	9.7	10.7	9.6	9.1	8.3	7.0	5.9	8.6	10.2	6.5	6.7
17	6.4	6.2	8.8	10.2	8.7	8.1	7.4	6.5	9.6	9.7	5.9	5.5
18	1.9	2.4	6.5	9.4	9.0	8.0	7.1	6.8	7.1	7.2	1.0	1.0
19	1.0	1.0	4.6	7.0	6.5	6.5	5.8	6.8	6.8	1.8	1.9	1.2
20	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 32. Scenario F Solar Only Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.2	1.2	2.8	3.0	1.2	1.0	1.0	1.0	1.0	1.4	2.8	2.0
7	2.8	4.0	3.9	5.0	8.1	8.4	11.1	8.3	3.3	2.9	4.4	2.9
8	4.6	7.7	10.2	7.5	12.8	12.8	10.7	10.5	10.8	6.0	8.1	4.1
9	13.1	11.3	12.8	10.8	12.6	12.8	12.8	12.8	12.8	12.8	11.1	11.2
10	11.3	11.2	11.4	10.3	11.2	11.4	11.1	11.3	10.6	10.7	11.2	11.0
11	11.2	11.3	11.4	11.1	10.4	10.7	8.3	9.8	11.0	11.4	11.3	11.4
12	11.3	11.3	11.2	11.2	8.2	10.5	8.1	10.4	10.8	12.8	12.8	11.3
13	11.3	11.4	11.3	11.2	11.1	8.5	8.4	10.0	11.2	11.2	11.3	13.0
14	11.5	11.3	11.3	10.9	10.4	11.4	8.6	9.1	11.1	11.4	11.5	12.8
15	11.3	11.3	12.8	11.1	10.7	11.0	7.9	7.2	10.9	11.6	12.8	12.8
16	12.8	12.9	12.9	11.4	11.5	11.5	7.9	6.3	10.5	13.0	11.0	11.1
17	11.5	11.3	11.4	12.9	12.9	11.7	8.8	6.6	12.0	13.2	9.9	2.4
18	1.3	1.9	8.7	12.9	13.0	11.2	9.7	7.7	10.5	11.4	1.6	1.0
19	1.0	1.0	6.4	11.1	11.2	8.5	8.2	8.4	9.0	1.0	1.5	1.0
20	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 33. Scenario G Solar Only Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.1	1.2	4.0	2.9	2.1	1.0	1.0	1.0	1.0	1.1	3.0	1.4
7	5.3	6.3	5.5	6.2	9.4	9.7	10.3	9.4	6.8	2.6	4.4	8.2
8	7.7	8.6	11.1	9.2	15.1	17.5	18.9	15.4	10.2	7.6	9.5	8.0
9	13.1	12.7	13.1	12.9	13.9	14.0	14.6	14.4	14.9	15.3	12.6	12.8
10	12.7	13.0	12.7	11.9	12.8	12.9	13.0	12.4	11.4	13.5	12.5	12.7
11	12.5	12.4	13.6	13.5	12.4	12.3	10.8	11.7	13.1	13.9	12.9	13.9
12	12.7	13.3	13.4	13.5	11.4	12.4	11.4	13.0	12.8	14.7	13.2	13.1
13	12.2	12.9	13.8	13.4	12.4	11.7	11.1	12.2	13.7	14.2	13.5	14.8
14	13.2	13.1	14.3	13.2	12.2	13.9	12.2	13.4	13.2	15.6	14.9	13.9
15	12.3	13.1	14.1	13.0	13.1	13.7	12.9	11.7	14.0	15.2	14.3	13.9
16	12.8	13.2	15.3	14.8	14.6	14.4	13.6	11.6	15.4	17.0	11.3	12.2
17	12.9	11.4	12.8	15.4	15.7	15.1	14.6	12.6	17.1	15.8	10.6	10.5
18	2.0	2.8	10.5	14.7	16.0	13.5	12.5	12.1	11.5	14.1	4.4	1.4
19	1.6	1.1	9.3	13.7	10.9	10.2	10.0	11.9	11.4	1.9	2.5	1.8
20	1.0	1.5	2.3	1.9	1.0	4.0	3.5	2.7	1.1	1.7	2.7	2.2
21	1.0	1.3	2.2	2.6	1.7	1.0	1.2	1.5	1.0	1.3	2.1	1.3
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

The following 7 tables contain heat maps reflecting the load following requirements needed to successfully mitigate the flex violations associated with the 7 scenarios in Portfolio 2 (BESS).

Table 34. Scenario A BESS Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.3	1.3	1.4	1.5	1.3	1.0	1.0	1.0	1.0	1.9	1.9	1.6
6	1.2	1.3	1.4	2.1	2.1	1.0	1.2	1.0	1.4	2.2	1.5	1.5
7	1.9	2.0	4.0	2.4	3.1	1.6	1.4	1.2	1.3	1.8	3.8	3.6
8	1.7	2.0	2.4	2.7	3.4	1.9	1.8	1.6	2.5	2.3	2.5	1.4
9	2.4	2.5	2.8	2.8	2.7	2.5	2.5	2.5	2.5	2.7	2.6	2.3
10	2.5	2.5	2.8	2.8	2.5	2.5	2.5	2.5	2.4	2.6	2.6	2.1
11	2.5	2.5	3.0	3.1	2.5	2.0	1.9	1.9	2.1	2.6	2.9	2.6
12	2.5	2.5	3.2	3.6	2.7	2.1	2.1	1.8	2.2	2.7	2.9	2.5
13	2.5	2.6	3.3	4.9	2.8	2.2	2.1	2.6	2.5	2.7	3.0	2.8
14	2.5	2.8	4.1	5.1	2.7	2.4	2.6	2.0	2.4	2.8	3.0	2.8
15	2.8	3.1	4.4	4.5	2.5	2.5	1.7	1.0	2.8	2.8	4.2	4.0
16	3.9	3.3	5.1	4.0	2.5	2.5	2.5	2.1	3.6	3.1	3.6	4.4
17	2.5	2.8	3.7	3.4	2.8	2.5	3.7	1.9	3.6	3.0	1.1	2.5
18	1.9	1.1	2.5	3.2	3.1	3.1	1.8	1.4	2.0	2.5	1.2	1.0
19	1.2	1.2	1.3	2.5	2.5	3.1	2.5	5.2	3.7	1.0	1.2	1.0
20	1.3	1.3	1.6	1.0	1.0	1.9	3.0	2.6	1.0	1.0	1.0	1.0
21	1.1	1.1	1.6	1.1	1.0	2.0	4.6	5.4	1.0	1.0	1.1	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 35. Scenario B BESS Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
7	2.8	2.9	5.4	5.1	5.9	5.9	5.9	2.9	2.9	2.6	4.8	2.6
8	4.7	5.7	5.7	5.9	8.4	8.9	8.9	5.9	5.9	5.5	5.6	2.8
9	5.9	5.9	5.9	5.8	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.8
10	5.8	5.9	5.9	5.8	5.8	5.9	5.9	5.9	5.8	5.8	5.8	5.7
11	5.9	5.9	5.9	5.9	5.8	5.6	5.5	5.7	5.8	5.8	5.9	5.9
12	5.9	5.9	5.9	8.4	5.9	5.1	5.2	5.3	5.8	5.8	5.9	5.9
13	5.9	5.9	5.9	8.7	5.9	5.4	5.0	4.6	5.7	5.9	5.9	5.9
14	5.9	5.9	5.9	8.7	5.9	5.6	2.9	2.9	5.6	5.9	5.9	5.9
15	5.9	5.9	5.9	5.9	5.8	5.5	2.9	2.8	5.2	5.9	8.8	8.9
16	5.9	5.9	5.9	5.9	5.8	5.7	2.9	2.8	4.5	5.9	5.9	5.9
17	5.9	5.8	5.9	5.9	5.9	5.9	2.9	2.8	5.2	5.9	2.9	2.9
18	2.8	2.8	5.7	5.9	5.9	5.9	2.9	2.7	2.9	5.8	2.3	2.7
19	2.6	2.5	2.7	5.7	5.8	5.9	2.9	2.8	2.9	2.5	2.4	2.1
20	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 36. Scenario C BESS Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
7	4.2	5.0	6.6	7.3	8.0	5.0	5.0	5.0	5.0	4.5	5.0	2.7
8	4.7	7.0	7.8	7.8	11.0	8.0	8.0	8.0	7.9	7.6	7.5	3.5
9	8.0	8.0	10.5	7.8	7.9	10.9	8.0	8.0	7.7	7.9	7.8	7.5
10	8.0	8.0	8.0	7.8	7.7	8.0	7.9	7.9	7.6	7.8	8.0	7.2
11	8.0	8.0	8.0	7.9	7.8	7.0	5.0	5.0	7.0	7.8	7.9	8.0
12	8.0	8.0	8.0	8.0	7.9	5.0	5.0	5.0	7.4	7.7	7.9	7.9
13	8.0	8.0	7.9	7.8	7.3	5.0	5.0	5.0	7.1	7.8	8.0	8.0
14	8.0	8.0	8.0	8.0	5.0	5.0	4.9	4.8	5.0	7.9	8.0	8.0
15	8.0	8.0	7.9	7.9	7.3	5.0	4.8	4.4	5.0	7.8	8.0	8.0
16	5.0	8.0	8.0	7.5	5.0	5.0	4.8	4.5	4.9	7.8	5.0	5.0
17	5.0	5.0	7.9	7.8	7.4	5.0	4.9	4.6	5.0	7.7	4.1	1.0
18	1.0	1.0	5.0	7.6	7.8	5.0	4.9	4.5	4.9	5.0	1.0	1.0
19	1.0	1.0	3.6	5.0	5.0	5.0	4.9	4.6	5.0	1.7	1.3	1.0
20	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 37. Scenario D BESS Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
7	3.5	4.4	5.3	5.3	5.5	2.5	2.5	2.5	2.5	3.4	4.9	2.2
8	2.5	4.8	8.1	7.9	11.5	8.5	5.5	8.5	5.5	4.6	7.6	1.1
9	8.1	5.5	8.4	8.4	8.5	5.5	8.5	8.4	8.1	8.3	8.2	5.5
10	5.1	5.4	8.3	8.3	8.2	8.0	8.3	8.4	8.3	8.5	8.4	5.3
11	5.5	5.5	8.4	8.3	7.7	5.5	5.5	8.0	7.8	8.2	8.5	8.4
12	5.5	5.5	8.3	8.5	5.5	5.5	5.5	5.5	7.8	8.2	8.5	5.5
13	8.5	5.5	8.5	8.3	7.8	5.5	5.5	5.5	8.1	8.4	8.4	5.5
14	8.5	5.5	8.5	8.5	7.4	7.7	5.5	5.4	7.9	8.4	8.4	5.5
15	5.5	5.5	8.4	8.4	8.1	8.0	5.4	5.2	6.7	8.4	8.5	5.5
16	5.5	5.5	8.5	8.4	8.3	8.2	5.4	5.3	6.4	8.4	8.4	5.5
17	5.5	5.4	8.4	8.4	8.4	8.4	5.5	5.3	7.0	8.4	4.5	1.0
18	1.0	1.0	5.5	8.4	8.5	8.4	5.5	5.3	5.5	8.4	1.0	4.6
19	1.0	1.0	4.3	8.3	8.4	5.5	5.5	5.4	5.5	2.0	1.0	1.0
20	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 38. Scenario E BESS Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
7	8.1	8.3	9.9	9.9	11.3	8.3	8.3	8.3	11.3	9.9	8.8	7.9
8	8.3	11.3	9.8	11.3	10.2	9.7	9.2	9.6	11.2	11.3	10.1	7.4
9	11.3	9.7	10.0	9.7	9.5	9.5	11.3	9.2	11.3	10.3	11.3	8.3
10	11.1	11.3	11.3	11.2	11.3	11.3	11.3	11.3	11.0	11.2	9.6	10.8
11	11.3	11.3	11.3	9.3	11.3	10.2	8.3	8.3	10.9	11.3	11.3	10.0
12	11.3	11.3	11.3	11.3	8.3	8.3	8.2	8.2	10.8	11.1	11.3	11.3
13	11.3	11.3	11.2	11.3	10.7	8.3	8.3	8.2	10.5	11.3	11.3	11.3
14	11.3	9.5	11.3	11.2	8.3	8.3	7.7	7.4	8.3	11.3	11.3	11.3
15	8.3	11.3	11.3	11.1	10.5	8.3	6.9	5.4	8.2	10.9	11.3	11.3
16	8.3	11.3	11.3	8.3	10.4	8.3	6.5	5.2	7.8	11.0	8.3	11.2
17	8.3	8.1	11.1	11.0	8.3	8.3	7.4	5.2	8.1	10.9	4.4	1.0
18	1.0	1.0	8.0	8.3	11.0	8.3	7.4	5.1	6.3	8.3	1.0	1.0
19	1.0	1.0	4.7	8.3	8.3	8.3	5.3	5.3	8.1	1.5	1.0	1.0
20	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 39. Scenario F BESS Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.2	1.2	2.6	1.6	1.0	1.0	1.0	1.0	1.0	1.1	1.5	1.3
7	4.1	5.2	5.5	5.7	6.0	3.0	3.0	3.0	6.0	4.7	5.3	3.1
8	2.9	5.7	11.0	8.9	11.9	10.7	9.0	12.0	6.0	5.3	9.1	2.6
9	12.0	12.0	12.0	9.6	12.0	10.1	9.2	11.9	11.9	10.0	12.0	8.8
10	9.0	11.8	11.8	11.7	11.5	9.0	9.1	9.0	11.2	11.7	11.7	10.5
11	6.1	11.9	11.9	11.8	9.0	8.8	6.0	9.1	11.6	11.7	9.4	12.0
12	12.0	9.0	12.0	11.9	8.5	8.2	8.5	9.0	9.0	11.7	9.2	12.0
13	9.5	9.0	12.1	12.1	12.0	8.8	8.8	8.8	11.2	11.8	12.0	12.0
14	12.0	9.0	12.0	11.9	9.0	9.1	8.4	7.9	9.1	11.7	12.1	9.0
15	9.0	9.0	12.0	12.0	9.0	9.0	7.5	5.9	8.8	11.9	12.0	9.0
16	6.0	9.0	12.0	12.1	11.2	9.0	7.5	6.3	8.7	11.8	9.0	9.0
17	9.0	8.8	12.0	11.9	11.7	9.0	8.3	6.5	8.8	11.6	6.0	2.9
18	2.9	2.9	9.0	12.0	11.9	9.0	8.6	6.4	8.4	12.0	2.7	2.6
19	2.7	2.5	8.1	11.9	11.9	9.0	8.8	8.3	9.0	2.8	2.8	2.1
20	1.1	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.1
21	1.1	1.1	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 40. Scenario G BESS Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
7	11.0	11.0	11.9	10.9	10.9	11.0	8.0	11.0	14.0	12.5	10.6	10.9
8	7.6	10.5	14.0	13.2	13.2	12.8	12.2	11.8	14.0	10.6	12.8	2.0
9	12.7	13.8	12.9	12.4	12.6	12.0	11.0	12.0	12.4	14.4	13.3	13.2
10	14.1	12.1	12.3	12.5	12.5	11.4	11.7	11.2	11.7	13.0	12.4	12.8
11	14.0	11.9	12.9	12.6	12.4	11.7	13.7	14.0	12.3	13.0	13.0	13.9
12	13.4	14.0	12.4	12.0	13.2	11.0	11.0	13.3	14.0	12.6	14.0	13.1
13	14.6	12.6	12.9	12.0	14.0	10.8	10.9	10.8	13.3	13.5	13.8	14.0
14	13.2	14.0	14.0	14.0	13.7	13.9	10.7	9.9	12.6	14.0	13.0	14.0
15	14.0	14.0	14.0	13.4	13.6	11.0	9.5	8.0	10.9	14.0	14.0	14.0
16	11.0	13.9	14.0	14.0	13.6	13.4	9.0	7.8	10.7	14.0	11.0	11.0
17	8.0	5.0	13.9	14.0	13.7	13.9	10.3	8.0	10.8	13.4	5.0	1.0
18	1.0	1.0	11.0	14.0	13.8	11.0	10.5	7.9	8.0	13.9	1.0	1.0
19	1.0	1.0	7.4	14.0	11.0	11.0	10.3	8.8	13.5	1.0	1.0	1.0
20	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

The following 7 tables contain heat maps reflecting the load following requirements needed to successfully mitigate the flex violations associated with the 7 scenarios in Portfolio 3 (RICE).

Table 41. Scenario A RICE Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.0
7	1.1	1.3	1.8	1.7	1.8	1.0	1.0	1.0	1.0	1.7	2.0	1.0
8	1.2	1.6	1.9	2.1	2.6	1.2	1.1	1.1	2.1	2.3	2.4	1.0
9	1.8	1.8	2.7	2.4	2.1	1.7	1.6	1.6	2.7	2.6	2.7	2.0
10	1.9	1.9	2.8	2.4	2.0	1.8	1.7	2.9	2.5	2.6	2.6	1.9
11	1.9	1.8	2.8	2.7	2.2	1.6	2.0	2.2	2.4	2.7	2.8	2.8
12	1.9	2.9	2.9	3.0	2.3	1.6	1.9	2.0	2.5	2.7	2.9	2.9
13	2.0	1.7	2.9	3.1	2.8	2.4	2.4	2.0	2.6	2.8	2.9	3.0
14	1.8	1.9	2.9	2.9	2.6	2.7	1.5	1.3	2.1	2.9	2.9	1.9
15	1.7	1.7	2.9	2.9	2.6	2.8	1.5	1.8	1.9	2.8	3.0	2.1
16	1.7	1.8	3.0	2.9	2.7	2.8	1.8	2.6	1.8	2.9	3.0	1.6
17	1.2	1.3	2.9	2.9	2.9	3.0	1.9	3.0	2.0	3.0	1.0	1.0
18	1.0	1.0	1.2	2.9	3.0	3.1	3.1	3.8	1.9	2.9	1.0	1.0
19	1.0	1.0	1.1	2.7	2.9	1.3	3.9	6.4	2.0	1.0	1.0	1.0
20	1.0	1.0	1.0	1.0	1.0	1.4	4.4	3.5	1.0	1.0	1.1	1.0
21	1.0	1.0	1.0	1.0	1.0	1.8	3.6	5.9	1.0	1.0	1.1	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 42. Scenario B RICE Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
7	1.8	2.2	2.9	2.7	5.8	1.0	3.0	1.0	1.0	1.5	3.0	1.0
8	2.4	2.7	3.0	4.8	5.9	3.0	3.0	3.0	3.0	3.0	4.6	1.0
9	3.0	3.0	5.6	5.3	5.5	5.9	6.0	5.9	5.9	5.7	5.7	3.0
10	3.0	3.0	5.7	5.1	5.4	5.7	5.7	5.9	5.6	5.7	5.7	3.0
11	3.0	3.0	5.5	5.5	5.1	3.0	3.0	4.9	5.5	5.8	5.9	5.8
12	3.0	3.0	5.6	5.6	4.4	3.0	3.0	3.0	5.6	5.8	5.9	5.9
13	3.0	3.0	5.6	5.7	5.4	3.0	3.0	3.0	5.5	5.8	5.9	6.0
14	3.0	3.0	5.9	5.8	5.5	5.3	3.0	2.9	5.2	5.9	6.0	5.9
15	3.0	3.0	5.9	5.8	5.4	3.0	2.9	2.7	4.2	5.9	6.0	5.9
16	3.0	3.0	6.0	5.8	5.7	5.4	2.9	2.7	3.0	5.9	6.0	3.0
17	3.0	3.0	5.9	5.9	5.9	5.8	2.9	2.7	4.0	6.0	3.0	1.0
18	1.0	1.0	3.0	5.9	5.9	6.0	3.0	2.5	2.9	5.7	1.0	1.0
19	1.0	1.0	1.8	5.5	3.0	3.0	3.0	2.9	3.0	1.0	1.0	1.0
20	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 43. Scenario C RICE Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.1	1.2	1.1
7	2.5	3.0	3.4	4.2	5.9	1.1	3.0	3.0	3.0	2.6	3.9	2.0
8	2.1	2.8	5.2	4.4	6.0	6.0	6.0	6.0	5.7	3.1	5.0	1.3
9	5.6	6.0	6.0	5.7	5.9	6.0	6.0	6.0	6.0	6.3	5.9	5.7
10	5.6	6.0	5.9	5.8	5.9	5.9	6.0	6.0	5.9	6.2	6.0	5.4
11	5.9	6.0	5.9	5.9	5.6	5.5	5.7	5.8	5.9	6.2	6.0	6.0
12	6.0	5.9	5.9	5.9	5.3	5.6	5.7	5.8	5.9	6.1	6.0	6.0
13	6.0	5.9	5.9	6.0	5.9	5.8	5.8	5.8	5.9	6.0	6.0	6.0
14	6.0	6.0	6.0	6.0	5.9	5.9	5.1	4.7	5.9	6.0	6.0	6.0
15	6.0	6.0	6.0	6.0	5.9	6.0	4.3	3.9	5.8	6.1	6.0	6.0
16	6.0	6.0	6.0	6.0	6.0	6.0	4.4	3.9	5.4	6.1	6.0	6.0
17	6.0	3.0	6.0	6.0	6.0	6.0	5.1	4.7	5.6	6.2	5.0	1.0
18	1.0	1.0	5.9	6.2	6.0	6.0	5.5	4.1	5.1	6.0	1.0	1.0
19	1.0	1.0	3.0	6.0	6.0	6.0	5.5	4.8	6.0	1.0	1.0	1.0
20	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1
21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.2	1.0	1.0	1.0	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 44. Scenario D RICE Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.6	1.5	1.8	2.0	1.0	1.0	1.0	1.0	1.0	1.2	1.4	1.7
7	2.5	3.9	4.3	5.2	6.3	1.8	2.0	2.1	3.2	1.9	4.9	2.6
8	2.3	3.5	6.6	5.3	7.6	4.6	6.1	6.0	5.5	3.7	5.7	1.6
9	6.6	6.8	7.2	7.8	7.7	6.6	6.6	6.7	7.3	8.3	6.9	6.4
10	6.4	6.5	7.1	7.5	7.7	6.9	6.8	6.7	7.3	7.6	7.2	6.3
11	6.7	6.8	7.2	7.5	6.5	6.0	6.1	6.4	7.0	7.6	7.5	7.2
12	6.9	6.5	7.0	7.9	5.9	6.2	5.7	6.1	6.9	7.5	7.5	6.9
13	7.1	6.5	7.3	7.5	6.7	6.0	5.9	5.8	7.1	7.8	7.2	7.5
14	6.9	6.5	7.2	7.3	6.7	7.0	5.3	5.4	6.8	8.1	7.5	6.9
15	6.5	6.5	7.6	7.3	7.0	6.8	5.1	4.9	6.4	8.3	7.6	6.9
16	6.2	6.4	9.0	8.3	7.2	6.9	5.5	6.9	6.2	8.6	7.8	6.9
17	6.7	6.2	9.1	8.7	8.5	6.7	5.8	5.6	6.7	9.0	5.1	2.8
18	1.0	1.0	6.0	8.9	8.8	6.2	5.1	6.9	5.0	8.9	1.0	1.4
19	1.5	1.3	5.2	8.3	6.0	6.0	5.5	4.0	6.4	1.2	1.7	1.0
20	1.3	1.3	1.3	1.2	1.0	1.0	1.0	1.0	1.1	1.3	1.2	1.4
21	1.5	1.2	1.3	1.4	1.1	1.0	1.0	1.0	1.0	1.0	1.5	1.2
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 45. Scenario E RICE Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.5	1.4	2.1	2.4	1.3	1.0	1.0	1.0	1.0	1.3	1.2	1.1
7	2.9	4.1	4.1	5.0	6.4	1.8	3.4	3.1	3.5	2.3	4.9	2.3
8	2.3	3.7	7.2	5.8	9.5	7.0	6.8	6.4	5.7	3.5	6.2	1.5
9	6.8	6.8	9.0	9.3	7.8	7.1	7.3	7.2	9.1	9.3	7.5	7.1
10	6.8	7.0	7.5	8.7	8.8	7.3	7.1	9.1	7.9	8.7	8.7	7.5
11	7.0	7.1	8.9	9.0	7.3	6.9	7.0	7.3	8.4	8.8	9.1	9.3
12	7.3	7.3	8.7	9.0	6.8	7.2	6.7	7.3	8.3	8.9	9.0	7.3
13	9.6	7.4	9.0	9.3	8.5	6.8	6.8	6.8	8.7	9.1	8.9	10.0
14	7.5	7.1	9.2	9.1	8.3	8.7	6.6	6.1	8.2	9.0	9.1	7.2
15	6.7	7.2	9.5	8.9	8.8	8.7	5.8	5.9	7.6	9.3	9.2	9.2
16	7.1	7.4	9.6	9.2	8.9	9.1	6.1	6.7	7.2	9.4	9.5	9.3
17	9.5	6.9	9.5	9.7	9.2	9.2	6.5	5.8	8.5	10.0	5.7	2.9
18	1.0	1.0	6.7	9.8	9.2	9.2	6.2	6.3	5.7	9.3	1.0	1.0
19	1.2	1.1	5.9	8.9	8.9	6.0	6.0	6.3	6.7	1.0	1.0	1.0
20	1.2	1.1	1.5	1.3	1.0	1.2	1.0	1.0	1.1	1.3	1.0	1.1
21	1.1	1.1	1.2	1.6	1.0	1.0	1.0	1.0	1.1	1.0	1.1	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 46. Scenario F RICE Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	2.0	2.0	2.9	3.3	2.0	1.0	1.0	1.0	1.0	2.4	2.2	2.0
7	3.1	4.2	3.8	4.8	7.0	4.1	5.6	3.7	4.3	3.0	4.6	2.6
8	2.2	4.5	8.6	6.6	11.1	11.8	9.6	8.5	5.4	4.1	6.7	1.5
9	9.6	9.4	10.0	11.5	10.5	9.8	10.7	9.1	10.3	11.1	10.3	9.0
10	8.9	8.5	10.4	10.7	10.1	9.0	10.3	8.8	9.6	10.3	10.1	9.1
11	9.1	9.2	10.5	10.8	8.9	8.7	8.1	9.1	10.2	10.9	10.6	10.3
12	10.9	9.3	10.0	11.1	8.4	8.7	7.9	9.4	9.5	10.6	10.5	9.8
13	12.8	10.6	10.7	11.4	9.9	9.3	8.5	8.6	10.0	10.6	10.5	12.3
14	10.6	10.0	10.5	10.9	9.5	11.0	8.3	8.1	10.1	10.8	11.0	10.6
15	10.0	9.2	11.1	10.4	10.5	10.8	7.2	6.7	9.3	11.9	11.1	10.7
16	9.5	10.8	12.8	11.3	10.8	10.9	7.7	6.6	9.3	12.9	10.7	10.8
17	12.0	9.9	11.0	13.0	12.9	10.9	8.4	6.6	10.1	13.9	6.2	3.0
18	1.0	1.0	10.2	13.1	12.3	10.3	7.9	6.0	6.9	12.3	1.3	1.0
19	1.2	1.1	6.9	11.4	9.0	9.0	6.6	7.9	9.2	1.0	1.2	1.0
20	1.4	1.4	1.4	1.3	1.0	1.6	1.0	1.0	1.0	1.6	1.1	1.3
21	1.8	1.4	1.3	1.6	1.2	1.0	1.0	1.0	1.1	1.0	1.2	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 47. Scenario G RICE Load Following Heat Map (% of Load)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	2.4	2.2	3.5	3.7	2.2	1.0	1.1	1.0	1.0	2.8	3.0	2.4
7	9.2	4.2	3.4	4.7	6.5	6.7	6.5	4.4	6.0	3.5	4.4	3.3
8	2.5	5.7	9.5	7.4	12.9	13.7	12.7	10.3	5.9	3.8	7.7	1.9
9	10.5	12.2	12.4	13.3	12.5	12.6	13.4	13.2	13.0	13.5	12.7	11.1
10	10.4	12.5	12.5	11.7	11.0	11.0	12.8	10.7	12.1	12.2	11.5	10.4
11	10.6	9.9	12.6	12.8	11.1	10.2	9.9	11.0	12.5	12.7	12.8	12.7
12	12.8	11.1	12.9	13.3	10.2	10.9	9.6	11.9	11.1	12.9	12.8	12.4
13	12.9	12.7	13.0	13.6	12.3	11.1	10.3	10.7	12.5	12.6	13.2	15.0
14	13.1	10.9	13.1	13.2	12.4	13.2	11.1	10.3	13.0	13.1	14.0	13.4
15	12.8	11.3	13.9	13.4	13.1	13.2	9.9	8.8	12.6	14.4	13.8	14.0
16	13.7	13.6	14.5	14.1	14.3	13.6	10.1	9.3	12.9	15.7	13.6	12.9
17	15.7	13.1	14.3	15.6	15.8	13.8	11.6	10.6	15.8	17.3	10.7	3.2
18	1.0	2.7	13.1	16.4	15.8	13.4	11.0	9.5	11.2	13.9	2.6	1.1
19	1.6	1.2	9.9	13.3	12.3	9.0	9.0	10.4	12.3	1.0	1.5	1.0
20	1.5	1.4	1.4	1.0	1.0	1.7	1.1	1.0	1.0	1.6	1.0	2.0
21	1.4	1.3	1.5	1.8	1.2	1.0	1.0	1.0	1.1	1.0	1.2	1.8
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0