EXECUTIVE SUMMARY

Demonstrating the Benefits of Long-Duration, Low-Cost Flow Battery Storage in a Renewable Microgrid

ESTCP Project EW19-5312

DECEMBER 2019

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ACRONYMS AND ABBREVIATIONS

$\$/kW_c$	Cost of critical load coverage
AESOP	Ameresco Energy Storage Optimization Platform
BESS	Battery Energy Storage System
CLCPC	Critical Load Coverage Probability Curve
DCM	Demand Charge Management
DG	Diesel Generator
DoD	Department of Defense
ESTCP	Environmental Security Technology Certification Program
HIL	Hardware In the Loop
HVAC	Heating, Ventilation and Air Conditioning
kW	Kilowatt
kWh	Kilowatt-hour
Li-Ion	Lithium ion
MTBF	Mean Time Between Failure
P_{fs}	Probability of Failure to Start
PV	Photovoltaic
TOU	Time of Use
VRF	Vanadium Redox Flow

ACKNOWLEDGEMENTS

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We would also like to thank Eric Winkler, a key Ameresco team member, who provided insightful guidance and information related to the research and understanding of wholesale market products, rules, regulations, and opportunities for battery storage participation. This effort has significantly advanced our understanding of the opportunities and limitations for battery storage to realize value from multiple value streams, which is a key focus area in today's energy storage industry.

Finally, Ameresco thanks the following Ameresco Federal Solutions business unit team members who played a significant role in support, planning, and execution of this project: Nicole Bulgarino, Executive Vice President; Anthony Colonnese, Vice President; Paul Molta, Associate Project Development Engineer; Krystian Nowak, Associate Project Development Engineer, and Benjamin Lavoie, Project Development Engineer and Principal Investigator.

1.0 INTRODUCTION

Ameresco Inc., with its partner 2ndPath Energy, completed this ESTCP-funded project to investigate and advance the state of the art of flow battery energy storage—a promising new storage technology. The purpose of this project is to study the reliability and operational effectiveness of flow battery storage and quantify the extent to which this new storage technology could reduce reliance on diesel generators (DGs) in a military microgrid.

The team is completing this Phase 1 work as part of what we intend to be a three-phase effort. This Phase 1 work provides an in-depth study into the technology with a scope of work focused on technology research, analytical modeling, and analysis. We believe the conclusions of this Phase 1 work support future investigation to conduct Phase 2 Hardware in the Loop (HIL) testing of the technology to validate the findings of this Phase 1 work. Finally, if justified, we look forward to conducting Phase 3 work whereby we would complete a field installation and demonstration of the flow technology, demonstrate its capabilities and effectiveness in a microgrid, and validate the revenue generating opportunities this technology can offer during grid tied conditions as compared to how our team projected them in Phase 1 through analytical modeling.

Our team has specific interest in investigating Vanadium Redox Flow (VRF) Battery Energy Storage Systems (BESSs). We cross-compare its techno-economic performance with DG technology, a proven and widely deployed backup generation technology, and with Lithium ion (Li-Ion) BESS technology, the predominant advanced storage technology at this time. We are interested in investigating how battery storage could perform as a replacement for a DG within a microgrid and determining what technical and economic barriers exist that need to be mitigated to foster adoption. DG technology is a reliable, low cost established generation technology that is deployed at scale throughout virtually every DoD installation. However, fundamentally, DGs are uni-directional in that they only discharge power and cannot store energy. Also, they are often limited in the value they can provide during normal, utility grid connected situations, as they typically cannot operate continuously because of emissions limitations. Finally, there is widespread interest throughout the energy industry to develop methods to reduce emissions and reliance on fossil fuel powered equipment. Long duration, reliable energy storage offers promise as one technology that can work towards this goal, especially when paired with low or no emission generation technology such as solar photovoltaics and combined heat and power. As such, investigating the opportunity to reduce reliance on DGs offers value to the DoD and energy industry at large.

As discussed in detail in this technical report, VRF storage offers attractive differentiators that could provide an alternative to Li-Ion storage technology—which is the most common technology being deployed today. These differentiators include the ability to store 10 to 12 hours of rated energy capacity, little to no degradation in retained energy capacity over time, and inherently safer chemistry characteristics as compared with Li-Ion storage—all of which reduce the need for costly auxiliary systems. Despite some commercial VRF product offerings in the market, the technology is still a nascent technology with very few large-scale deployments throughout the world. Thus, the technology is still at a high cost relative to what it could be at scaled production levels. Further, this investigation quantified the impacts of some of the less desirable technical characteristics of VRF storage, namely lower round trip efficiency and higher auxiliary system loads attributable to the mechanical pumping systems of the system architecture.

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2.0 OBJECTIVES

The work herein studied five DoD installations across the continental United States. At each site, the technical objectives aimed to quantify how large-scale battery energy storage can add technical and economic value to a baseline microgrid. The baseline microgrid at each site contains a series of DGs sized to meet critical load with N+1 redundancy and uninterruptible power systems to provide ride-through power supply to a subset of critical loads. There is no large-scale battery energy storage in the baseline microgrid. This report describes the methodology, simulations, results, and conclusions of how a VRF BESS should be sized to replace a single DG asset and how that replacement impacts statistical reliability of operation, grid tied operation, and economic cost of serving critical load. Table 1 summarizes the discrete objectives of the project that were investigated for each site.

Table 1. Project Objectives

Objective	Category of Interest	Description of Objective
Objective 1	*Reliability*	Calculate hourly probability of serving ***100%*** of the critical load requirement during a utility outage of up to 168 hours in duration that could start at any hour of the year.
Objective 2	*Reliability*	Calculate hourly probability of serving ***130%*** of the critical load requirement during a utility outage of up to 168 hours in duration that could start at any hour of the year.
Objective 3	*Reliability*	With no diesel fuel supply, calculate hourly probability of serving ***30%*** of critical load during a utility outage of up to ***24 hours*** that could start at any hour of the year.
Objective 4	*Reliability*	With no diesel fuel supply, calculate hourly probability of serving ***10%*** of critical load during a utility outage of up to ***24 hours*** that could start at any hour of the year.
Objective 5	*Reliability*	Determine the minimum amount of power and energy the BESS needs to provide the microgrid such that the Objective 1 outcome meets or exceeds the fixed load baseline performance.
Objective 6	*System Design*	Identify the full system rated power and energy capacity sizing of the optimally sized BESS.
Objective 7	*Economic Feasibility*	Quantify annual value proposition of BESS through retail and wholesale use cases, based on ***current and future volatile market conditions.***
Objective 8	*Economic Feasibility*	Calculate the cost of securing critical load for the BESS enabled microgrid as a function of 20-year Net Present Value and how this compares to the baseline, DG only microgrid.
Objective 9	*Reliability & Economic Feasibility*	Identify if VRF or Li-Ion is the preferred technology for the proposed BESS.

A detailed explanation of assumptions that were made are provided throughout this report. There are certain key assumptions notable for this summary that are important to recognize when assessing the context and conclusions of this study. First, each installation was analyzed assuming the site's electric distribution system was a perfectly functioning, single-feeder electrical system. This means that all generation assets and critical and non-critical loads are modeled to be on a single circuit.

This guidance was prescribed by the ESTCP program. It is recognized that this is an unrealistic condition, however, and would be an important area of differentiation for future investigation.

Second, a key assumption was the allowance of a BESS to be charged from surplus DG generation capacity within the storage enabled microgrid. In reality, an installation may not want to do this if they preferred to run only the necessary DG capacity and conserve diesel fuel supplies. Also, this operation would use more fuel for the same amount of served electric energy because of the BESS round trip efficiency, which is notably lower for VRF technology than Li-Ion technology. However, allowing the BESS to charge from DG capacity only within an outage period helps prolong the usability of the BESS as a dispatchable asset to serve more critical load during high demand times.

Third, determination of reliability probability statistics for the VRF Storage technology heavily influenced reliability results. Our team worked to collect as much relevant and useful information and feedback as we could gather about the technology to inform this decision. However, there is limited field experience and vendor testing that provides the ability to publish these parameters. This highlighted an area where vendor testing is lacking and further ESTCP investigation would significantly benefit the industry. Thus, it is possible that the probability of failure to start (P_{fs}) and mean time between failure (MTBF) metrics used in this Phase 1 work are not reflective of true long-term field performance. Validation of the metrics used for this study will be an important aspect of Phase 2 HIL and Phase 3 field demonstration scopes of work. For this study, our team concluded that P_{fs} and MTBF metrics of 1.0% and 1095 hours, respectively, were reasonable assumptions based on the data and information in hand and reasonable engineering judgement. This compares to the ESTCP provided DG metrics of 0.2% and 1700 hours, respectively.

Since calculation of hourly probability curves are a critical technical objective of this work, it is important to briefly introduce that concept and clearly establish the baseline for performance. A large portion of the analysis of this project worked toward defining a Critical Load Coverage Probability Curve (CLCPC) under various scenarios and conditions. The CLCPC provides expected probability of serving 100% of the hourly critical load for each site as a function of outage duration, from 1 to 168 hours. Our team developed a Monte Carlo based simulation method to calculate CLCPC curves. This utilized 100 discrete iterations of simulation analysis across 8760 outage blocks, each 168 hours in duration. Hourly calculations from each of the 100 iterations were averaged to compile a single hourly CLCPC curve.

CLCPC data for the DG only baseline microgrid was provided by ESTCP. This was provided for the case where the amount of critical load was fixed and equal to the site's annual peak critical load (referred to elsewhere in this report as the fixed load baseline). This was also provided for the scenario where the amount of critical load varied hourly and equaled a fixed percentage of the site's hourly electric load, as determined by ESTCP and the installation (referred to elsewhere in this report as the variable load DG-only scenario). It is worth noting that the fixed hourly peak critical load scenario is the worst-case scenario to analyze, as much of the time the amount of critical load to serve is overstated and requires more generation capacity from the DG assets. Ameresco validated its reliability model by re-creating the fixed load baseline and variable load DG-only scenarios to ensure results aligned with ESTCP provided figures. Figure 1 shows this comparison for one example site (Westover Air Reserve Base).

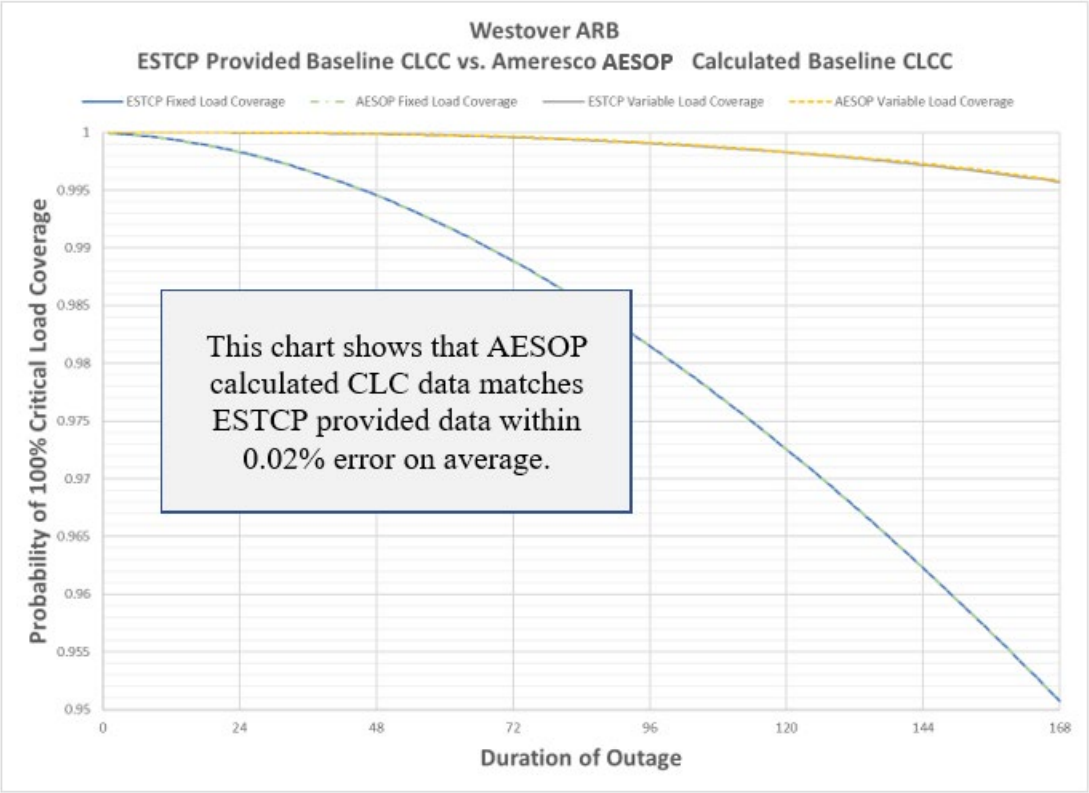

Figure 1. Example Critical Load Coverage Probability Curve

Finally, it is important to clearly state that the basis for "successful" reliability performance of the BESS enabled microgrid is the fixed, peak critical load curve and not the variable load DG-only curve. This was directed by ESTCP. However, it is important to note that this yields an indirect comparison since the BESS enabled load coverage curves analyze the variable critical load data profile.

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3.0 TECHNOLOGY DESCRIPTION

There are three generation and storage equipment types and two simulation programs that comprise the core technologies being analyzed and utilized within the scope of this project. The three equipment types being compared include DGs, VRF batteries, and Li-Ion batteries. The baseline technology for assessment is the DG. The new technology t is the primary focus for investigation through this work is the VRF battery. Since VRF storage technology is a nascent technology with very little field deployment experience, the project team felt it was prudent to compare analysis results of the VRF technology to that of Li-Ion storage technology. Li-Ion storage is the primary technology being deployed for megawatt scale energy storage systems, comprising greater than 90% of all distributed storage deployments over the last several years. A major technical objective was to determine if the equipment reliability of VRF technology is sufficient to serve as a replacement technology for a DG asset within a microgrid. However, even if that proves to be true, a critical secondary objective of the project team was to determine if there is a viable business case for VRF technology over Li-Ion technology, and what project screening metrics and equipment price points are required to enable VRF technology to be a better business choice for deployment. To investigate these objectives, Python-based statistical simulation and time-series software programs were developed and used.

A detailed description of the VRF battery technology is provided in the body of this technical report. Fundamentally, VRF batteries produce or absorb electrical current by pumping a vanadium-based electrolyte solution through a power stack across a membrane. VRF batteries differentiate themselves from Li-Ion in that the power (kW) and energy (kWh) components can be adjusted independently of one another without impacting performance. By increasing the volume of electrolyte, VRF batteries can provide a 12-hour or longer solution. Further, the claimed lack of energy capacity degradation over time ensures a consistent level of performance over the life of the project while reducing maintenance and replacement costs associated with today's Li-Ion batteries. VRF battery manufacturers report negligible energy capacity degradation after 10,000 full cycles, whereas Li-Ion energy capacity degradation can range from 2-4% or more annually, depending on use cases. Also, VRF storage typically has a broader ambient operating temperature range, requiring less active thermal management and could more easily serve a wider array of geographic regions without additional heating, ventilation and air-conditioning (HVAC) cost. These benefits create opportunity to solve the problems noted above and could serve as a key building block to achieving a renewable based microgrid that can sustain load for days or weeks with reduced reliance on DGs. Table 2 below provides a summary of the key technology assumptions used for the VRF and Li-Ion battery equipment.

Table 2. Assumed Battery Specifications

	Units	VRF	Li-Ion
Round Trip Charge/Discharge Efficiency	%	76%	85%
Auxiliary Power Draw	kW/MW Rated	11 - 72	0.75 - 5
Controls Auxiliary Load	kWh/day	0.3	0.3
AC Equipment Cost	$/kW	$ 250	$ 250
DC Equipment Cost	$/kWh	$ 480	$ 350
Balance of Plant Installation Cost	$/kWh	$ 275	$ 275
Annual Energy Capacity Degradation	%/Year	0 - 0.5%	2-4%

The overarching objective of this project is to determine what configuration of battery system(s) provide adequate reliability performance at equal or lower cost of critical load support as compared to a DG-only baseline microgrid. This configuration is defined by the quantity of unique BESS units (1 or more) and the amount of total power and energy required from a BESS within a microgrid to maintain the stated reliability performance over an outage of up to 168 hours duration.

To determine the target configuration, our team completed a sequenced series of modeling efforts for each site which included baseline DG characterization, Monte Carlo based statistical reliability modeling, modeling of expected BESS hourly operation in grid tied settings to quantify value creation opportunities, and economic analysis. All three of these modeling tools leveraged Python programming language and were integrated into Ameresco's internally developed energy storage modeling tool, referred to as the Ameresco Energy Storage Optimization Platform (AESOP). This tool existed prior to the completion of this phase of ESTCP work, however, a significant achievement of this ESTCP work is the expansion of the tool to include all of the required modeling capabilities described above. This allowed for a centralized tool to be used to complete all required analysis. This ESTCP effort has also allowed advancement of the grid tied modeling capabilities of the tool, allowing for more value stacking use cases to be analyzed. This effort not only enhanced our analysis of the five installations under investigation but also supports improved energy storage analysis for other Ameresco developed Federal Government energy projects that include battery measures.

4.0 PERFORMANCE ASSESSMENT

Ameresco conducted statistical reliability and time series grid tied modeling across the five installations to assess microgrid and BESS performance. This included reliability modeling of multiple scenarios of critical load to serve, ranging from 10% to 130% of nominal critical load, scenarios with and without diesel fuel availability, and multiple market condition scenarios. Across all scenarios, Ameresco calculated probability curves for no photovoltaic (PV) production and expected PV production conditions. We felt this was justified since it is likely PV would not be operational in a severe weather induced outage for potentially multiple days. We recognize PV may be available to an intermediate extent, but our approach characterizes the full range of reliability performance into which any of these scenarios would fall. Prior to running the Monte Carlo based reliability models, Ameresco characterized ideal operation of the DG assets across all five sites to inform power and energy microgrid requirements of the storage system aimed at replacing the least running DG. This provided an initial input of the storage power and energy available for microgrid reliability modeling as shown in Table 3. For clarity, this is not the total BESS system size, but the amount of power and energy a BESS needs to provide to the microgrid for acceptable reliability performance. This analysis showed that the least running DG for Westover only had one hour of projected operation under ideal conditions, whereas the remaining sites had between 12 and 56 hours within a single outage block.

Table 3. BESS Power and Energy Requirements for Passing Critical Load Coverage

	Units	Westover	Patuxent River	NAS CC	Fort Bliss	March ARB
Microgrid Minimum Power Requirement	kW	207	514	659	507	250
Microgrid Minimum Energy Requirement	kWh	207	6958	7264	3574	3509
Number of BESS Units Required	#	1	1	1	1	2

Once the microgrid requirements of the BESS were established, Monte Carlo based reliability simulations were completed to quantify the probability of critical load coverage when replacing a single DG with a BESS with the above stated power and energy capacity. As previously mentioned, the model was configured to allow the BESS to charge from surplus DG capacity. Table 4 summarizes the results, providing the calculated probability of critical load coverage under all requested conditions.

Table 4. Summary of Critical Load Coverage Modeling Results

Critical Load %	Reliability Modeling Results Summary	Westover ARB	NAS Patuxent River	NAS Corpus Christi	Fort Bliss	March ARB
100%	Critical Load CLC Baseline Req. at 168 Hrs	0.95076	0.67376	0.85815	0.82253	0.95076
100%	BESS Enabled Variable Load CLC at 168 Hours	0.97170	0.90028	0.92551	0.95656	0.98326
130%	BESS Enabled CLC Probability at 168 Hours	0.81173	0.29558	0.45154	0.66019	0.81098
30%	No DG BESS Only CLC Probability at 1 Hour	0.03167	0.00000	0.00000	0.00000	0.99481
30%	No DG BESS Only CLC Probability at 24 Hour	0.00000	0.00000	0.00000	0.00000	0.00000
10%	No DG BESS Only CLC Probability at 1 Hour	0.99003	0.00000	0.00000	0.06930	0.99990
10%	No DG BESS Only CLC Probability at 24 Hour	0.00000	0.00000	0.00000	0.00000	0.00000
30%	No DG PV+BESS CLC Probability at 1 Hour	0.41085	0.06815	0.09932	0.35519	0.99932
30%	No DG PV+BESS CLC Probability at 24 Hour	0.00000	0.00000	0.00000	0.00000	0.00000
10%	No DG PV+BESS CLC Probability at 1 Hour	0.99431	0.27192	0.30639	0.47862	0.99995
10%	No DG PV+BESS CLC Probability at 24 Hour	0.00000	0.00000	0.00321	0.00000	0.90949

Once reliability modeling was complete, the next step was to quantify how much value a BESS could generate through utility billing savings and wholesale energy market opportunities. Ameresco studied each site's utility rate conditions as well as the rules and regulations of available wholesale market products where relevant. This allowed us to determine a use case stack for each site. This stack is summarized in Table 5. The available value creation use cases that were identified included Retail Demand Charge Management (DCM), Retail Time of Use (TOU) Energy Savings, Wholesale Energy market participation co-optimized with Wholesale Synchronous Reserves, and Wholesale Regulation. We then worked to enhance the modeling capabilities of the AESOP tool to be capable of simulating those use cases. This primarily involved expanding our existing DCM and Regulation modeling functionality and adding the new use cases of Retail TOU, and Wholesale Energy coupled with Reserves.

Table 5. Grid Tied Use Case Stacks for Each Site

Site	ISO	Retail DCM	Retail TOU	Wholesale Energy	Wholesale Reserves	Wholesale Regulation
Westover ARB	ISO-NE	•	• (1)	•	•	•
NAS Patuxent River	PJM	•		•	•	•
NAS Corpus Christi	ERCOT	•				
Fort Bliss	N/A	•	•			
March ARB	CAISO	•	•	•	•	

1 Requires 80% RTE to be economically justified. Applicable to Li-Ion, not Flow.

Next, we determined the appropriate battery system sizes to model under grid-tied conditions to quantify the value each system could generate for each site, considering both VRF and Li-Ion equipment solutions. We approached sizing of possible configurations by making sure the full BESS rated power and energy capacity met the microgrid requirements, had a power capacity appropriate to replace one DG for each site, and assessed rated durations from 1 to 10 hours. It should be noted that systems with durations of 1 to 4 hours are Li-Ion technology and those with 6 to 10 hours of duration are VRF technology. Though there are not rigid limits on durations for each technology, these bounds are aligned with the strengths of each technology and the commercially available products on the market today.

We then completed grid tied modeling simulations for a total of 30 unique BESS systems sizes across the five installations. This allowed for determination of expected annual value (savings and revenue) for each BESS option. For each system size, we estimated implementation cost and annual operation expenses based on Ameresco's experience developing and operating these battery systems. This allowed for assessment of economic viability of each option to determine the BESS size that provided the best opportunity for economic viability at each installation. Our team selected the optimal system size for a VRF and Li-Ion BESS at each site to allow comparison of each storage technology.

5.0 COST ASSESSMENT

As further described in the Technical Report, multiple levels of economic assessment were completed to determine the optimal VRF and Li-Ion BESS sizing for each microgrid. Of the six BESS sizes considered for each site, a single VRF and Li-Ion BESS was selected for each site based on estimated simple payback. Then, a detailed 20-year economic pro-forma was created for each system, in both current and future market and cost scenarios. The 20-year net present value of each microgrid was then calculated and normalized by the amount of each site's critical load. This identified the cost of critical load coverage for each site's DG only baseline and battery enabled microgrid systems. A summary of these results is provided in Table 6. These results show that there are scenarios where the BESS enabled microgrid can reduce the site's cost of critical load support now or in the future. However, the VRF BESS technology in all cases provides a higher cost of critical load support—primarily due to higher capital costs, lower round trip efficiency, and significantly higher auxiliary loads which reduce the operating value of the VRF storage systems.

Table 6. Cost of Critical Load Support Results Summary

Installation	# of DG Assets	DG Capacity Per Asset (kW)	# of BESS Assets	BESS Total Power Capacity	BESS Total Energy Capacity	BESS Lower SOE	Grid Tied Use Case Stack	Cost of Critical Load Support ($/kW-c)
				kW	kWh	kWh		
March ARB	4	250	0	N/A	N/A	N/A	None	$416
	3	250	2 VRF	875	7,000	3509	DCM+WH E&R	$317 (f) to $519 (c)
	3	250	2 Li-Ion	3,500	7,000	3509	DCM+WH E&R	$229 (f) to $525 (c)
NAS Corpus Christi	7	750	0	N/A	N/A	N/A	DR + PS	$89
	6	750	1 VRF	1,217	7,300	0	DCM	$109 (f) to $132 (c)
	6	750	1 Li-Ion	3,650	7,300	0	DCM	$90 (f) to $115 (c)
Fort Bliss	8	2000	0	N/A	N/A	N/A	None	$83
	7	2000	1 VRF	2,000	12,000	0	DCM	$104 (f) to $117 (c)
	7	2000	1 Li-Ion	2,000	4,000	0	DCM	$88 (f) to $93 (c)
Westover ARB	4	750	0	N/A	N/A	N/A	DR	$166
	3	750	1 VRF	750	4,500	0	FR	$196 (f) to $251 (c)
	3	750	1 Li-Ion	750	750	0	FR	$129 (f) to $156 (c)
NAS Patuxent River	12	750	0	N/A	N/A	N/A	DR	$98
	11	750	1 VRF	1,167	7,300	0	DCM+WH E&R	$111 (f) to $128 (c)
	11	750	1 Li-Ion	3,500	7,000	0	DCM+WH E&R	$96 (f) to $121 (c)

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6.0 CONCLUSIONS

This work offered significant insight into the viability of replacing a DG with a BESS in a microgrid. First, based on assessment of the reliability modeling results and critical load coverage curves produced, we can conclude that a VRF battery enabled microgrid can provide satisfactory reliability performance at all five sites by meeting the baseline performance requirement over a 168-hour outage that could occur at any time. However, we can also conclude for all five sites that critical load coverage at 168 hours was below the variable load DG-only coverage by between 1.6% to 3.0%. This is to be expected since the newer VRF technology is assumed to have lower reliability factors that the DG technology. This result indicates that there is significant justification for the further investigation of the VRF technology as to be explored in follow-on Phase 2 testing, with a focus on testing and validating the true reliability metrics of the technology.

From an economic standpoint, results show that there is also opportunity for large scale storage to provide a lower cost of critical load coverage ($/kWc) under certain conditions. However, due to today's VRF BESS equipment pricing higher operating costs, there is not a clearly established case for a VRF BESS providing a preferable technology solution to Li-Ion BESS technology. It is important to recognize that VRF BESS technology is early on in its development and deployment lifecycle and has not yet appreciated the vast cost reductions due to economy of scale that Li-Ion has enjoyed. Should costs of the VRF technology decrease in the future, there may very likely be conditions where a VRF BESS would provide a more attractive solution than Li-Ion. This may be the case, for example, in markets where wholesale products, which are more lucrative for higher power systems, are not viable and where there are high retail demand rates with sites that have relatively flat load profiles and a need for longer duration energy storage.

In conclusion, the work herein has made a significant contribution to the body of knowledge of VRF storage technology. We feel the conclusion that the reliability of VRF BESS technology is sufficient against the baseline for performance is a major observation of this project and one that warrants further investigation through a Phase 2 HIL simulation and potentially a follow-on Phase 3 field demonstration. There is also the potential for VRF battery technology to provide important benefits to a project as compared with Li-Ion technology while improving safety and reducing long term replacement requirements. Continuing to investigate the technology through follow-on phases will further the state of the art of this new storage technology and provide critical feedback to the industry of technical and economic aspects of the technology that need to be improved. Ameresco and its team looks forward to furthering our work to investigate advanced energy storage and its impacts to resiliency and reliability of military installations.