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Water Pollution Control Plant

Energy Storage System Installation

Project Review

- City of San Leandro, August 2020 -

Contents

Document versioning

Release	File name	Date	Author	Approval	Comment
0.1	DERNetSoft WPCP report v0.1.docx	07/03/2020	G. Hatfield	A. Colombo	First draft for review
0.4	DERNetSoft WPCP report v0.4.docx	08/12/2020	G. Hatfield	A. Colombo	Final draft after vendor feedback
0.5	DERNetSoft WPCP report final deliverable.docx	08/31/2020	G. Hatfield	A. Colombo	Final after customer review

Introduction

The City of San Leandro requested from DERNetSoft a third party evaluation of the energy storage system (ESS) proposal in consideration for the Water Pollution Control Plant (WPCP). The proposal was originally compiled and presented by Climatec and includes several energy efficiencies measures.

OUT OF SCOPE

This report does not include a review of the following sections of the original Climatec report;

- High efficiency digester mixers
- Heat loop pumps
- High efficiency turbo blower

IN SCOPE

The scope of this document is to provide a third party evaluation of the energy storage system (ESS) proposal in consideration for the Water Pollution Control Plant (WPCP).

DERNetSoft reviewed the overall technical project design proposal, along with assumptions and financial analyses to deliver our third-party professional opinion to support the City of San Leandro's vendor selection for the WPCP battery energy storage project. The scope of this report is to review and expand upon the Battery Energy Storage System and Microgrid Control proposal section. Additionally, we will review the assumptions made by Climatec regarding the high strength waste and compressed natural gas production proposal.

Energy Storage Technical Review

The purpose of the technical review is to verify that the energy storage system proposed by Climatec is in compliance with market standards in terms of technology, reliability, control, etc.

Hardware Technology

The selected battery storage system vendor is EnergPort Inc., located at 48660 Kato Road, Fremont, CA 94538. The proposed energy storage system model the L5001100 - 500kW/1,150kWh, which is used for grid-tie energy storage application. The equipment typical lifespan is the following:

- Battery Banks: 15
- Inverters: 15 Years

Privately owned energy storage systems are eligible for the ITC credit (26% of capital costs) if the system were tightly tied to the existing solar PV, where the battery is fully charged by the PV. If the asset is owned by the City of San Leandro, it is not eligible for this incentive.

We have reviewed the vendor website which describes this ESS model as: "*The Energport line of outdoor commercial & industrial and utility scale energy storage systems provides a fully integrated, turnkey energy storage solution. Leveraging lithium iron phosphate batteries utilized in hundreds of thousands of electric vehicles, Energport's solution provides unparalleled degrees of safety and reliability. An integrated inverter provides for plug and play functionality, removing implementation burden and reducing installation costs. The systems are actively cooled and can operate in a wide range of temperature conditions*."

The supported applications are:

- **Resiliency** - The system provides backup power during grid outages and prevents losses.
- **Solar Integration** - The system stores excess solar energy produced during the day for use at another time.
- **Frequency Regulation** - The system can provide frequency regulation in wholesale markets.
- **Demand Charge Management -** The system will intelligently charge and discharge to reduce peak loads.

Issue

In the Climatec package we were not able to find the following information:

- Assumption on the ESS warranty. It is described 10 years on the vendor product description, but it is assumed as 15 years on the Energy Toolbase analysis.

Microgrid control technology

Energy Management System (EMS) will manage and control the whole battery system for demand charge management, PV integration / self-consumption, demand shaving and microgrid / backup power applications.

EMS Software & Control is described on the product sheet as a cloud-based web interface for the WPCP manager to check the main feature such as:

- Real-time running information of energy storage system
- Query the user's electricity consumption with ESS and generate the user's monthly electricity report
- Battery system data gathering and graphical display
- Historical data record of system running
- Running parameters setting of system
- System control and so on
- Modbus
- TCP

Issue

In the Climatec package we have not found any specific feature to control and change the behavior of the microgrid controller. There is a note "System control and so on" which does not describe any specific feature on the control strategy options.

Data Communication Technology

The product sheet on the vendor website describes the energy storage system architecture and data communication which is shown below in Figure 1. In the product description, we have also found the support of Modbus and TCP protocol.

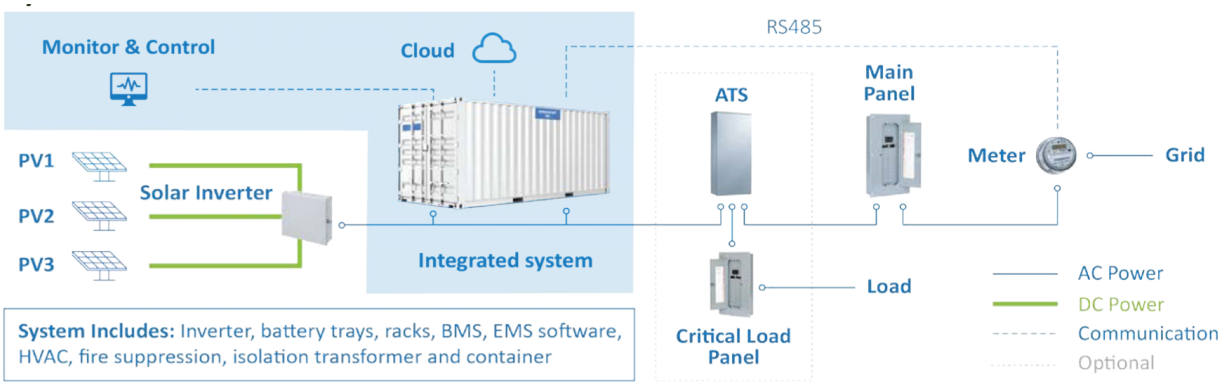

Figure 1 - Energport Energy Storage System architecture

Issue

In the Climatec package and in the product description, we were not able to find the following information:

- Other protocol support for utility grid service provisioning (i.e. DNP3, 2030.5)

Open Points

DERNetSoft would like to access the following information to complete the report:

- Vendor reference for projects similar to WPCP1
- Details for PV Solar and ESS integration management and microgrid control tools and features
- Training for the WPCP operators to manage the microgrid

Energy Storage Financial Review

The purpose of the financial review is to convey the expected impact on WPCP's electric bills upon installation of a battery energy storage system. These findings are based on battery sizings proposed by Climatec, as well as additional sizing optimizations. The operations of the potential battery system, in conjunction with the existing solar PV, were simulated in order to estimate the predicted bills resulting from ESS adoption.

Energy Baseline Assumptions

The current bills were calculated based on the current primary voltage E-19 Option-R tariff and replicating Climatec assumptions. Because the facility recently adopted a solar PV system, the predicted bills after simulated solar generation were determined. Furthermore, DERNetSoft assumes the charges after solar generation on the primary voltage E-19 Option-R tariff to be the baseline costs when analyzing the savings benefits of ESS.

Based on 15-minute interval data spanning from January 1st, 2019 to December 31st, 2019, costs for the following scenarios were determined, where scenario 3 is considered to be the baseline in calculating savings:

1. Charges on load under E19P tariff prior to PV operation
2. Charges on load under E-19P after solar PV operation
3. Charges on load under E-19P Option-R after solar PV operation

Charges on load under E19P tariff prior to PV operation

Running the DERNetSoft rate engine, the pre-solar annual cost is calculated to be $534,620 which is comparable to Climatec's assumption ($531,787, +0.53%). The small difference stems from a more up-to-date data set.

	Energy Charges ($)			Demand Charges ($)			Total Charges ($)			
Month	**Peak**	**Part Peak**	**Off Peak**	**Peak**	**Part Peak**	**Max**	**Customer Charge**	**Energy**	**Demand**	**Total**
Jan.	$0	$14,422	$13,307	$0	$106	$10,931	$1,172	$27,728	$11,037	$39,938
Feb.	$0	$13,702	$13,736	$0	$102	$10,437	$1,059	$27,438	$10,538	$39,035
Mar.	$0	$15,226	$16,045	$0	$102	$10,491	$1,172	$31,272	$10,593	$43,037
Apr.	$0	$14,266	$13,040	$0	$93	$9,560	$1,135	$27,306	$9,653	$38,093
May	$7,921	$6,960	$12,544	$9,288	$2,532	$8,309	$1,172	$27,426	$20,129	$48,727
Jun.	$6,994	$5,949	$12,825	$9,404	$2,604	$8,534	$1,135	$25,767	$20,541	$47,443
Jul.	$8,206	$6,890	$12,410	$9,988	$2,697	$8,934	$1,172	$27,505	$21,619	$50,297
Aug.	$8,195	$6,905	$12,962	$9,833	$2,668	$8,796	$1,172	$28,062	$21,298	$50,532

Sept.	$7,882	$6,847	$13,048	$10,081	$2,762	$9,053	$1,135	$27,777	$21,896	$50,808
Oct.	$8,461	$7,292	$12,560	$10,134	$2,783	$9,123	$1,172	$28,313	$22,040	$51,526
Nov.	$0	$12,313	$12,948	$0	$94	$9,677	$1,135	$25,261	$9,771	$36,166
Dec.	$0	$13,849	$14,709	$0	$90	$9,198	$1,172	$28,558	$9,287	$39,018
Total	**$47,659**	**$124,620**	**$160,134**	**$58,729**	**$16,633**	**$113,041**	**$13,804**	**$332,413**	**$188,403**	**$534,620**

Charges on load under E-19P after solar PV operation

DERNetSoft cost calculation with solar PV is determined under the primary voltage E-19 tariff by simulating the operation of a 1-axis ground mounted solar PV system interacting with the measured facility load for data spanning January 2019 through December 2019. This scenario is presented to inform the facility owner of the benefits of the Option R tariff (see next section). The annual PV generation resulting from this simulation is 1,589,244 kWh. Excess PV generation is assumed to be net metered.

	Energy Charges ($)			Demand Charges ($)			Total Charges ($)				
Month	Peak	Part Peak	Off Peak	Peak	Part Peak	Max	Customer Charge	NBC	Energy	Demand	Total
Jan.	$0	$9,329	$11,231	$0	$106	$10,931	$1,172	$5,192	$20,560	$11,037	$37,962
Feb.	$0	$7,722	$11,327	$0	$95	$9,799	$1,059	$4,949	$19,049	$9,894	$34,952
Mar.	$0	$6,750	$11,230	$0	$102	$10,491	$1,172	$5,057	$17,980	$10,593	$34,802
Apr.	$0	$2,802	$7,983	$0	$93	$9,516	$1,135	$3,888	$10,784	$9,609	$25,415
May	-$3,968	$2,314	$5,930	$7,435	$2,532	$8,298	$1,172	$3,344	$4,276	$18,265	$27,057
Jun.	-$4,751	$1,326	$5,101	$5,859	$2,604	$8,534	$1,135	$2,971	$1,676	$16,997	$22,778
Jul.	-$4,797	$1,944	$5,916	$8,496	$2,675	$8,766	$1,172	$3,193	$3,063	$19,937	$27,365
Aug.	-$3,108	$2,427	$6,758	$6,123	$2,668	$8,745	$1,172	$3,418	$6,078	$17,536	$28,205
Sept.	-$517	$3,246	$7,658	$9,130	$2,762	$9,053	$1,135	$3,823	$10,387	$20,945	$36,290
Oct.	$892	$3,745	$9,204	$9,724	$2,783	$9,123	$1,172	$4,233	$13,841	$21,630	$40,876
Nov.	$0	$6,810	$9,957	$0	$94	$9,677	$1,135	$4,385	$16,767	$9,771	$32,058
Dec.	$0	$9,360	$12,603	$0	$90	$9,198	$1,172	$5,530	$21,963	$9,287	$37,953
Total	**-$16,248**	**$57,773**	**$104,898**	**$46,767**	**$16,604**	**$112,131**	**$13,804**	**$49,984**	**$146,424**	**$175,501**	**$385,714**

Charges on load under E-19P Option-R after solar PV operation

DERNetSoft cost calculation with solar PV is determined under primary voltage E-19 Option-R tariff by simulating the operation of a 1-axis ground mounted solar PV system interacting with the measured

facility load for data spanning January 2019 through December 2019. This scenario represents the baseline in determining the savings associated with additional system investments because the site has integrated solar PV and transitioned to Option R. The annual PV generation resulting from this simulation is 1,589,244 kWh. Excess PV generation is assumed to be net metered.

	Energy Charges ($)			Demand Charges ($)			Total Charges ($)				
Month	**Peak**	**Part Peak**	**Off Peak**	**Peak**	**Part Peak**	**Max**	**Customer Charge**	**NBC**	**Energy**	**Demand**	**Total**
Jan.	$0	$9,772	$4,696	$0	$106	$10,931	$1,172	$5,378	$14,468	$11,037	$32,056
Feb.	$0	$8,089	$4,736	$0	$95	$9,799	$1,059	$5,127	$12,825	$9,894	$28,904
Mar.	$0	$7,070	$4,695	$0	$102	$10,491	$1,172	$5,238	$11,766	$10,593	$28,769
Apr.	$0	$2,935	$3,338	$0	$93	$9,516	$1,135	$4,027	$6,272	$9,609	$21,042
May	-$9,167	$3,432	$6,288	$598	$252	$8,298	$1,172	$3,464	$554	$9,148	$14,338
Jun.	-$10,976	$1,967	$5,409	$471	$259	$8,534	$1,135	$3,078	-$3,600	$9,264	$9,876
Jul.	-$11,081	$2,883	$6,274	$683	$266	$8,766	$1,172	$3,307	-$1,925	$9,715	$12,271
Aug.	-$7,180	$3,601	$7,167	$492	$265	$8,745	$1,172	$3,541	$3,588	$9,503	$17,804
Sept.	-$1,195	$4,815	$8,121	$734	$275	$9,053	$1,135	$3,960	$11,741	$10,062	$26,897
Oct.	$2,061	$5,556	$9,760	$782	$277	$9,123	$1,172	$4,384	$17,377	$10,181	$33,115
Nov.	$0	$7,133	$4,163	$0	$94	$9,677	$1,135	$4,542	$11,297	$9,771	$26,744
Dec.	$0	$9,805	$5,269	$0	$90	$9,198	$1,172	$5,728	$15,074	$9,287	$31,262
Total	**-$37,537**	**$67,058**	**$69,915**	**$3,760**	**$2,173**	**$112,131**	**$13,804**	**$51,773**	**$99,437**	**$118,064**	**$283,079**

Issue

The baseline annual cost calculated by DERNetSoft is assumed to be **$283,079** because this scenario represents operations on the current tariff with the predicted impacts of the solar PV. We tried to reproduce Climatec analysis, but we are missing the following data:

- Missing simulated PV generation data

Energy Storage System Financial Savings

Climatec proposed a 500 kW / 1,150 kWh battery energy storage system. This section will analyze the financial benefits of such a system on our more current dataset. We will also provide an analysis of the following modular battery sizes based on DERNetSoft operational and financial optimizations in order to show the building manager potential reference options:

1. 500 kW / 1,150 kWh
2. 500 kW / 2,000 kWh

3. 300 kW / 750 kWh

In each simulation, we constrain battery charging to come solely from the solar PV generation. Analyses are provided with and without SGIP, as well as with and without ITC. We consider the baseline costs described above when calculating savings.

The following table describes an annualized summary of the facility's billing components corresponding to each system's deployment (See Attachments for more detail). Note that non bypassable per kWh charges (NBC) are included in annualized energy charges. Savings values are compared to the $283,079 baseline charges discussed above. Green highlighted is the Climatec sizing scenario.

ESS Size	New Annual Energy Charges	New Annual Demand Charges	New Annual Fixed Charges	New Annual Total Charges	Annual Savings
Baseline (No ESS)	$151,210	$118,064	$13,804	$283,079	-
500 kW / 1,150 kWh	$150,923	$82,006	$13,804	$246,733	$36,346
500 kW / 2,000 kWh	$160,615	$71,982	$13,804	$246,402	$36,677
300 kW / 750 kWh	$148,174	$89,265	$13,804	$251,243	$31,836
300 kW / 1,250 kWh	$151,681	$80,117	$13,804	$245,602	$37,477

Figure 2 - Energy storage system sizing scenario

Due to the lower demand rates associated with the Option-R schedule, savings corresponding to the battery integration is due to both energy arbitrage and demand shaving. Specific resiliency parameters (i.e. 50 KW for 2 hours backup) were not included in these analyses because no resiliency requirements were specified, so the battery was simulated to achieve common financial goals such as energy arbitrage and demand shaving. Energy savings are low in comparison to demand savings because solar generation that would have served the facility load is allocated to charging the battery. Peak rates are much higher on Option-R, making energy arbitrage a valuable service for an integrated ESS system. This is why we see significant increase in savings as battery energy capacity (kWh capacity) increases.

Issue

In the Climatec package we were not able to find the following information:

- Climatec's dataset is based on data from September 2018 - August 2019
- PV Generation simulations make the baseline different
- Climatec's resiliency limitations on battery operations were not provided

Project Return on Investment

In reference to the list of analyzed battery sizes provided above, this section will provide a financial analysis of each investment case based on standard ESS Cost estimates. Industry standard preliminary battery pricing assumptions, as well as the awarded SGIP ($440,000), were assumed when calculating the

financial metric provided below. These analyses assume the same pricing assumptions for each investment case in order to adequately compare results. The summary table includes 20-year financial estimates for the installation of ESS at the listed sizes. These analyses incorporate the savings described above, as well as estimated energy cost escalation, PV degradation, O&M cost escalation, component replacement costs, and federal and local taxes.

No Self-Generation Incentive Program investment case

The analysis hereby described is based on receiving no Self-Generation Incentive Program (SGIP) incentive. DERNetSoft assumes:

- ESS Pricing: $500 / kW and $250 / kWh installed cost (based on NREL cost benchmarking)
- Discount rate: 5.5%
- SGIP: $0
- ITC: 26% assuming battery may fully charge by PV system (tightly coupled)
- MACRS Schedule: 5-year assuming battery may only be charged by PV system (tightly coupled)

This simulation includes the federal Investment Tax Credit. This project is not eligible for the ITC incentive; however, this investment case is included for customer reference.

	Year-One Savings	**Pre-Incentive Cost**	**Payback Period**	**20-Year ROI**	**20-Year NPV**
500 kW / 1,150 kWh	$36,345	$537,500	8. yr.	21%	-$45,504
500 kW / 2,000 kWh	$36,677	$750,000	> 20 yr.	-0.3%	-$213,304
300 kW / 750 kWh	$31,836	$337,500	6.4 yr.	51%	$73,078
300 kW / 1,250 kWh	$37,477	$462,500	7.4 yr.	36%	$32,544

Self-Generation Incentive Program Investment Case

When applying the awarded SGIP incentive of $440,000, we obtain the following results. Climatec did not specify what SGIP value they assumed in their analysis. We provide an analysis for the potential case in which no SGIP is awarded to help decision makers understand the risks associated with this investment, and an analysis assuming the awarded SGIP incentive is received over a 5-year schedule.

This simulation includes the federal Investment Tax Credit. This project is not eligible for the ITC incentive; however, this investment case is included for customer reference.

DERNetSoft assumptions:

- ESS Pricing: $500 / kW & $250 / kWh installed cost (based on NREL cost benchmarking)
- Discount rate: 5.5%
- SGIP: $440,000

- ITC: 26% assuming battery may fully charge by PV system (tightly coupled)
- MACRS Schedule: 5-year assuming battery may only be charged by PV system (tightly coupled)

	Year-One Savings	Pre-Incentive Cost	Payback Period	20-Year ROI	20-Year NPV
500 kW / 1,150 kWh	$36,345	$537,500	2.3 yr.	62%	$303,419
500 kW / 2,000 kWh	$36,677	$750,000	3.6 yr.	29%	$128,524
300 kW / 750 kWh	$31,836	$337,500	1.8 yr.	98%	$323,383
300 kW / 1,250 kWh	$37,477	$462,500	1.9 yr.	84%	$375,555

We note the similar potential yearly savings associated with a downsized 2-hour system. The 300 kW / 750 kWh battery is shown to provide $31,836 of annual bill savings, $4,509 less than those observed for the Climatec recommended 500 kW / 1,150 kWh system; over an estimated 20 year lifetime, this amounts to $90,180. Thus, the 500 kW / 1,150 kWh system will provide $90,180 more in savings than the 300 kW / 750 kWh system; however, the smaller battery size would cost an estimated $200,000 less before incentives, and $148,000 less after the ITC incentive is applied. This relatively small differential in savings and large differential in system cost explains why the 300 kW / 750 kWh system shows both the highest return on investment and greatest net present value. In addition, the 300 kW / 750 kWh system shows a positive investment case if the SGIP rebate is not rewarded.

Self-Generation Incentive Program without ITC Investment Case

When applying the awarded SGIP incentive of $440,000, we obtain the following results. Climatec did not specify what SGIP value they assumed in their analysis. We provide an analysis for the potential case in which no SGIP is awarded to help decision makers understand the risks associated with this investment, and an analysis assuming the awarded SGIP incentive is received over a 5-year schedule. Climatec claimed that the project is not eligible for the ITC incentive since it will be owned by a public entity (the City). DERNetSoft can confirm this is the case. As such, this simulation excludes the ITC credit and is more reflective of the actual investment scenario.

This investment case represents the most likely scenario.

DERNetSoft assumptions:

- ESS Pricing: $500 / kW & $250 / kWh installed cost (based on NREL cost benchmarking)
- Discount rate: 5.5%
- SGIP: $440,000
- ITC: 0% assuming battery may fully charged by PV system (tightly coupled)
- MACRS Schedule: N/A

	Year-One Savings	Pre-Incentive Cost	Payback Period	20-Year ROI	20-Year NPV
500 kW / 1,150 kWh	$36,345	$537,500	3.7 yr.	49.5%	$188,711
500 kW / 2,000 kWh	$36,677	$750,000	5.5 yr.	17%	-$31,533
300 kW / 750 kWh	$31,836	$337,500	2.9 yr.	86%	$251,357
300 kW / 1,250 kWh	$37,477	$462,500	4.7 yr.	52%	$135,613

Note that eliminating the ITC from this analysis does not make the Climatec proposal or 300 KW proposals inopportune; however, the 500 KW / 2,000 KWH battery demonstrates a negative net present value at year 20 without the ITC retracting its financial feasibility. The 300 KW battery systems still show a higher return on investment, and even a higher net present value, than the system proposed by Climatec.

Open Points

DERNetSoft would like to access the following information to complete the report:

- PV generation simulation dataset
- missing part of the Energy Toolbase analysis shown in the proposal index at page 22 and 23
- if there are any additional facility resiliency requirements (i.e. ESS must serve a critical load for 12 hours, 24 hours); if so, what is considered critical load?

HSW Storage & CNG Vehicle Fuel Production

This section will review the assumptions pertaining to the High Strength Waste Reception and Compressed Natural Gas Production projects proposed by Climatec.

Climatec predicts total Biogas production to be 30,399,298 cubic feet per year coming from two sources: 1) plant loading (8,640,00 cf/year)) and 2) high strength waste (12,039,298 cf/year). The biogas project financial analysis includes additional ongoing costs due to project adoption and various revenue streams.

Costs include:

- Added electric costs: Climatec assumes a flat $0.16/kWh LCOE
- RIN fees: Climatec assumes to be 20% of RIN value
- LCFS fees:Climatec assumes to be 20% of LCSF value
- Maintenance/labor: Climatec estimates $71,000 per year

Revenue streams include:

- Commodity natural gas value: $2.00 per diesel gallon equivalent
- RIN value: $1.50 per diesel gallon equivalent
- LCFS value: $1.00 per diesel gallon equivalent

Climatec also assumes the biogas produced will have a 60% methane content; various sources indicate biogas contains roughly 50-70% methane, making this a safe assumption. The unit commodity, RIN, and LCFS values for RNG used for Climatec's financial analysis all align with moderate values within the estimated average ranges. For example, the RIN price minimum is $0.05 and maximum is $2.00 , and $1.50 was selected for the analysis.

The added electric costs stem from running a 142 KW conditioning load 85% of the time and billed at $0.16/KWH, or $169,173 per year. DERNetSoft conducted a more accurate cost analysis of the added electric charges by considering TOU energy and demand rates and flat demand rates to verify Climatec's LCOE of $0.16/kWH.

Added Energy Charges: $119,457

Added Demand Charge: $34,849

Total Added Electric Charges: $154,306

DERNetSoft conducted an independent verification of Climatec assumptions for the CNG production project proposal and found no outstanding issues.

Market Benchmarking Analysis

DERNetSoft analysis has been run with industry standard tools and updated market reference costs. DERNetSoft has utilized standard market references and its premium network of vendors to obtain rough pre-incentive cost estimates for the battery sizes analyzed above. The pre-incentive costs represent upfront total installation and start-up costs; operation and maintenance costs are included in this value but are considered in the financial analysis based on the most recent national averages. The pre-incentive costs derived by DERNetSoft are as follows:

ESS Size	Pre-Incentive Cost
500 kW / 1,150 kWh	$537,500
500 kW / 2,000 kWh	$750,000
300 kW / 750 kWh	$337,500
300 kW / 1,250 kWh	$462,500

DERNetSoft was able to research reference quotations provided by its premium vendor network to check if the Climatec proposal would be in line with the market. Below you can find two reference quotations for your comparison.

Vendor	ESS Size	Pre-Incentive Cost
DERNetSoft	500 kW / 1,150 kWh	$537,500
Vendor A	500 kW / 1,150 kWh	$688,000
Vendor B	500 kW / 1,150 kWh	$429,999

Conclusion

After review of the Climatec proposal, DERNetSoft has found the installation of battery energy storage at the proposed size to be financially viable and beneficial with the awarded incentives. DERNetSoft has found other battery sizes to serve the facility better financially; however, analysis of the proposed 500 kW battery was included due to interest in a larger size. A smaller capacity battery system proves to demonstrate similar savings but at a significantly lower cost. DERNetSoft has verified assumptions made by Climatec regarding the Biogas production project; however, analyzing the potential flow rates of biogas from the digesters or High Strength Waste is out of scope for this report.

Attachments

DERNetSoft Baseline calculation

Refer to file ESS_System_Billing_Breakdowns.xlsx.

DERNetSoft Energy Storage System analysis

Refer to Modular_ESS_Financial_Analyses.xlsx.