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Filer:	Jeffery D. Harris
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**Petition for Modification
Tanager Battery Energy Storage System Project**

Data Response Set 2C

**Los Esteros Critical Energy Facility
03-AFC-02C**

Submitted to
California Energy Commission

Submitted by
Los Esteros Critical Energy Facility, LLC

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LOS ESTEROS CRITICAL ENERGY FACILITY (03-AFC-02C)

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Los Esteros Critical Energy Facility, LLC, on behalf of Tanager Power, LLC, provides the following responses to the California Energy Commission (“CEC”) Staff’s Data Request Set 2. These responses address Data Requests A59 through A62, and supplement *Data Response Set 2A*¹ and *Data Response Set 2B*² for the Tanager Battery Energy Storage System (“BESS”) Project (“Project”).

The responses are grouped by individual discipline or topic area. Within each discipline area, the responses are presented in the same order as presented in CEC Staff’s Data Request Set 2³ and are keyed to the Data Request numbers.

BATTERY ENERGY STORAGE SYSTEM DIRECT AND INDIRECT GREENHOUSE GAS EMISSIONS

DATA REQUESTS

A59. Please estimate the annual indirect GHG emissions (metric tons of CO₂e) resulting from energy losses due to transmission and charging/discharging cycles. Please include assumptions that account for the degradation of round-trip efficiency over the project lifetime in the calculation of indirect GHG emissions.

Response: For the purposes of Data Responses A59 through A62, a BESS Unit is assumed to be comprised of the following:

- A fixed number of racks (6),
- A fixed number of modules per rack (8), and
- A fixed number of cells per module (104).

All of the above will be encased in a protective metal enclosure that contains the necessary electrical charging and discharging management system (“ECDMS”) as well as the temperature management system (“TMS”). There will be a total of 189 battery enclosures.

The Tanager Battery Energy Storage System (“BESS”) Project will be located on the Los Esteros Critical Energy Facility (“LECEF”) parcel. Although the LECEF is located in Santa Clara County within the Silicon Valley Power service area, the Tanager BESS Project will be connected to the grid via a new generation-tie line to the Pacific Gas and Electric Company (“PG&E”) 230 kilovolt (“kV”) bus at the Los Esteros Substation. Therefore, PG&E greenhouse gas (“GHG”) emissions factors will be used in the **indirect** emissions analysis. The Tanager BESS Project will be rated at a nominal 200 megawatts (“MW”) with approximately 800 megawatt hours (“MWh”) of BESS storage capacity.

The Project will **not** have direct GHG emissions. The portion of indirect GHG emissions during operation attributable to utility sources supplying electricity to the grid serving the BESS facility include the following:

¹ TN: 268416.

² TN: 268869.

³ TN: 267573.

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- energy used to charge the BESS facility as part of its storage operations,
- energy losses during grid transmission to the BESS facility,
- onsite efficiency losses from battery charging/discharging cycles (“CDC”), and
- onsite auxiliary loads including BESS unit ECDMS and TMS, supervisory control and data acquisition system, and other energy consuming equipment. (These indirect emissions will be comprised of emissions and losses similar to those outlined in the second and third bullets above.)

The first three bullets above account for activities in response to Data Request A59. The final bullet accounts for activities in response to Data Request A60. Table 2, presented in Data Response A62, documents the calculated indirect GHG emissions attributable to both transmission and charging/discharging cycles (Data Response A59) and auxiliary loads (Data Response A60).

Table A59-1 presents the estimated cumulative emissions from the Tanager BESS for the charging cycle and auxiliary load consumption. These emissions are supported in Attachment DR-A59.

Table A59-1 Tanager BESS Charging Cycle GHG Emissions Compared to Natural Gas Power Plant Emissions

Source of Electricity	GHG Emissions Intensity of PG&E Grid Electrical Supply <i>MTCO_{2e}/MWh</i>	Emissions to Fully Charge BESS Including Eff% Losses ² <i>MTCO_{2e}/Day</i>	Emissions from Production of the Equivalent of a Single Charge Cycle (800 MWh) <i>MTCO_{2e}/Day</i>	Emissions from Production of the Equivalent of 365 Charge Cycles (292,000 MWh) <i>MTCO_{2e}/Yr</i>
PG&E System ¹	0.09344	88.684	88.684	32,369.82
Natural Gas Fired Combined Cycle Power Plant ³	0.385	---	365.405	133,372.88
Natural Gas Fired Advanced Combustion Turbine Power Plant ⁴	0.524	---	497.331	181,525.69
¹ California Air Pollution Control Officers Association (CAPCOA). CalEEMod, User’s Guide. Appendix G, Default Data Tables, Table G-3. April 2022				
² The efficiency loss factor is based on assumed project-level T-line losses, transformer losses, battery internal losses, and auxiliary load consumption to operate the BESS. The efficiency loss factor of 84.29% is based on the proposed design and may differ slightly from the final project-level design. The efficiency loss factor represents the average over the first fifteen years of the project’s life.				
^{3,4} California Energy Commission (CEC), Staff Report. “Estimated Cost of New Utility-Scale Generation in California: 2018 Update.” CEC-200-2019-500. Dated May 2019. See also, Potentia-Viridi Energy Storage System, CEC Staff Assessment, Table 5.3-1.				

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The comparison of electricity supplies in Table A59-1 shows that the emissions related to fully charging the BESS system (88.864 MTCO₂e) from the grid, including round-trip losses, would be much less than the typical emissions that would otherwise be emitted by a natural gas-fired power plant producing the equivalent supply. With up to 365 charging and discharging cycles per year, the displaced GHG emissions would be as follows.⁴

Based on an analysis of emissions from a single charge cycle, and assuming a standard one full charge cycle per day, the Tanager BESS Project would result in net indirect GHG **reductions** of 276.721 MT CO₂e/day compared to a hypothetical combined cycle facility and 408.647 MT CO₂e/day compared to a hypothetical advanced combustion turbine in a simple cycle configuration:

Table A59-2 Net GHG Reductions (Single Day)

	Emissions from the Equivalent of a Single Charge Cycle (800 MWh)	Net GHG Reductions
Tanager BESS Project	88.684 (Indirect)	-
Natural Gas-Fired Combined Cycle Power Plant	365.405 (Direct)	276.721 MT CO ₂ e
Natural Gas-Fired Advanced Combustion Turbine Power Plant	497.331 (Direct)	408.647 MT CO ₂ e

Based on an analysis of emissions from 365 charging cycles per year, the Tanager BESS Project would result in net GHG reductions of 101,003.06 MT CO₂e/Yr compared to a hypothetical combined cycle facility and 149,155.87 MT CO₂e/Yr compared to a hypothetical advanced combustion turbine in a simple cycle configuration:

⁴ We have assumed that Staff comments in Data Request 59 regarding round-trip efficiency degradation are related to transmission line losses during CDC. Based on data presented in Table A59-1 and USDOE, EIA State Electric Profiles, California, 2024 Statistics, degradation of the transmission system is not increasing, but decreasing, resulting in less transmission system losses. (See also, Data Response A61.) Conversely, the displaced GHG emissions would be higher if the project uses non-peak power produced from solar facilities for charging.

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Table A59-3 Net GHG Reductions (365 Cycles / Year)

	Emissions from the Equivalent of 365 Charging Cycles (292,000 MWh)	Net GHG Reductions
Tanager BESS Project	32,369.82 (Indirect)	-
Natural Gas-Fired Combined Cycle Power Plant	133,372.88 (Direct)	101,003.06 MT CO ₂ e
Natural Gas-Fired Advanced Combustion Turbine Power Plant	181,525.69 (Direct)	149,155.87 MT CO ₂ e

A60. Please estimate the annual indirect GHG emissions (metric tons of CO₂e) from auxiliary loads, such as BESS cooling. Please include assumptions that account for the BESS efficiency degradation over the project lifetime in the calculation of indirect GHG emissions.

Response: Each of the Tanager BESS Project’s 189 battery units will also be equipped with a TMS that provides cooling and/or heating of the battery modules as required to maintain the optimal operating temperature conditions. The total facility auxiliary load, including ECDMS, TMS, and other energy consumption is estimated to be 39 MWh/day. Facility BESS auxiliary systems are estimated to utilize approximately 14,235 MWh/yr of grid supplied electric energy. Assumed annual indirect auxiliary load GHG (as CO₂e) emissions are estimated to be 1330.1MT CO₂e/Yr. The support data for the auxiliary load emissions is presented in Attachment DR-A59. It should be noted that the auxiliary load emissions are included in the cumulative emissions total in Table A59-1 above and should not be double-counted.

A61. If the BESS would be charged by the grid, please calculate the indirect GHG emissions associated with charging from the grid and displaced GHG emissions with discharging to the grid. Provide assumptions for the number of hours annually that the BESS could be charged by the grid, the GHG emission intensity factor from the electrical grid during charging and discharging considering carbon neutrality by 2045, and the efficiency degradation over the project lifetime in the calculation of indirect GHG emissions.

Response: Table A61-1 presents the GHG emissions factors and global warming potential (“GWP”) values applicable to the Project site. Table A61-2 presents the estimated indirect GHG emissions during operation of the Project, based on default GHG emission factors provided by California Emissions Estimator Model (“CalEEMod”) for PG&E. Table A61-2 emissions represent the scenario where

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the BESS is charged from, and discharged to, the PG&E grid. It should be noted that the GHG emissions factors for PG&E are the same for the yearly period of 2019 through 2050 per CalEEMod 2022.1.1.3, Appendix G-3. This is a conservative approach, as PG&E GHG emission factors are expected to decrease as Renewables Portfolio Standards increase.

Table A61-1 CalEEMod Utility Carbon Intensity (GHG) Emissions Factors and GWP Values

Electric Utility GHG Emissions Factors	CO₂, lb/MWh	CH₄, lb/MWh	N₂O, lb/MWh
Pacific Gas and Electric Company ¹	203.983	0.033	0.004
Global Warming Potential Value ²	1	25	298
PG&E Carbon Intensity Factor ³	206.0 lbs CO ₂ e/MWh or 0.09344 MTCO ₂ e/MWh		
Charging Cycle Emissions	32,369.82 MT CO ₂ e/Yr ⁴		
¹ CalEEMod 2022.1.1.3, Appendix Table G-3 (for year 2025) ² CalEEMod 2022.1.1.3, Appendix Table G-39 CO ₂ = carbon dioxide, CH ₄ = methane, N ₂ O = nitrous oxide ³ For consistency with comparable analysis of other projects, the calculations here utilized PG&E’s emissions factors from 2019. The carbon intensity assumed in this analysis is significantly higher than the 16 lb CO ₂ e/MWh reported by PG&E in its most recent (2024) power content label disclosure. The displacement effect vis-à-vis marginal gas resources that would otherwise be dispatched during a discharge event would therefore be even greater in light of this and other circumstances noted in this analysis. At the carbon intensity reported by PG&E’s 2024 power content label disclosure (16 lb CO ₂ e/MWh), the indirect emissions from efficiency losses from operating the BESS project for a single cycle would be approximately 6.9 MT CO ₂ e, and for 365 cycles would be approximately 2,514.2 MT CO ₂ e. This would imply a net annual GHG reduction of 130,859 MTCO ₂ e/yr relative to a combined cycle gas-fired facility, and a net annual GHG reduction of 179,012 MTCO ₂ e/yr relative to a simple cycle gas-fired facility. The conservative calculations provided in the body of the document accordingly should not be used and are not offered for any purpose other than to allow the Commission to evaluate the Petition for Modification. ⁴ These emissions assume a standard 365 cycles per year and have been adjusted for losses and incorporate emissions from auxiliary load consumption.			

Table A61-2 Estimated Annual Tanager BESS Indirect Emissions, Using PG&E Default Emissions Factors

Annual Indirect GHG Emissions	MT CO₂e/Yr
Indirect Charging Cycle Emissions ¹	32,369.82
Auxiliary Load Emissions	1392.2
Indirect Discharging Cycle Emissions ²	-
Total Cumulative Indirect Emissions	32,369.82
¹ adjusted for losses and includes auxiliary load emissions ² discharging emissions are understood to be insignificant	

Carbon neutrality refers to balancing the amount of carbon dioxide emitted with an equivalent amount of carbon dioxide removed from the atmosphere, effectively resulting in no net increase in atmospheric CO₂. Carbon neutrality in the power industry means that, over a given period, the CO₂ released from producing electricity is fully balanced by reductions or removals, resulting in no net CO₂ emissions to the atmosphere. Carbon neutrality focuses on balancing carbon dioxide emissions specifically, while “net zero” usually covers all major greenhouse gases from the sector, including methane and nitrous oxide. In power systems, this balance is achieved primarily by cutting emissions at the source and only using offsets or removals for the smaller share of emissions that are hard to eliminate.

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The calculated indirect GHG emissions indicated in Table A61-2 represent a conservatively high estimate of indirect GHG emissions attributable to the Tanager BESS Project. These calculations use the grid-wide annual average within PG&E's service territory to calculate indirect GHG emissions and, as noted above, CalEEMod's default emissions factors for 2019 through 2050 do not change to reflect increasing penetration of renewables and other low-carbon generation resources. Moreover, using this PG&E annual average also does not account for the fact that batteries are more likely to be charged when the grid includes excess renewable energy generation, including peak solar generation, to later be discharged at times when demand is high and fossil fuel generation would likely otherwise be needed to meet demand.⁵ As a consequence, fossil fuels are more effectively displaced by renewable energy through the utilization of a BESS such as will be installed at the Tanager BESS Project.

BESS projects allow for load serving entities to rely upon an increased percentage of renewable energy usage and thereby reduce GHG emissions by storing lower-carbon electricity for use during times when demand exceeds renewable energy generation.⁶ Grid-wide average annual emissions rates are, as a general matter, higher than the grid-wide hourly emissions during the hours when batteries are most likely to be charged.⁷ For this reason, once the displacement of fossil fuel generation that would otherwise be dispatched to meet demand is accounted for, operation of a BESS should result in a significant reduction in system-wide GHG emissions. This displacement effect is not accounted for in CalEEMod's estimates of indirect emissions.

The CAISO's 2024 Special Report on Battery Storage recognized that batteries account for a significant portion of load (14.7 percent) during peak solar hours.⁸ In addition, batteries account for a significant portion of energy and capacity (8.6 percent) during the late afternoon and early evening hours.⁹ Electricity discharged by batteries during these late afternoon and early evening hours

⁵ See Gregory Miller et al., *Hourly accounting of carbon emissions from electricity consumption* Environmental Research Letters, 6-7 (2022), <https://iopscience.iop.org/article/10.1088/1748-9326/ac6147/pdf>; EticaAG, *How Battery Storage Reduces Carbon Emissions* (August 18, 2025), <https://eticaag.com/how-battery-storage-reduces-carbon-emissions/>.

⁶ Corby Battery Energy Storage System Project, *Air Quality and Greenhouse Gas Technical Report 37*.

⁷ See Wouter Schram et al., *On the use of average versus marginal emission factors*, Proceedings of the 8th International Conference on Smart Cities and Green ICT Systems (2019) (stating that average emissions factors assume constant emissions over time, which does not reflect reality, and cannot be used to accurately determine the mitigated CO2 emissions by renewables), <https://www.scitepress.org/Papers/2019/77657/77657.pdf>; see also CanaryMedia, *Open-sourcing the grid emissions data needed for 24/7 clean energy* (2022), <https://www.canarymedia.com/articles/emissions-reduction/open-sourcing-the-grid-emissions-data-needed-for-24-7-clean-energy#:~:text=Why%20accurate%20hourly%20emissions%20data,this%20chart%20from%20Singularity%20indicates>.

⁸ CAISO, *2024 Special Report on Battery Storage 4* (May 29, 2025), <https://www.aiso.com/documents/2024-special-report-on-battery-storage-may-29-2025.pdf>.

⁹ *Id.*

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displaces some fossil fuel generation, and replaces it with renewable energy.¹⁰ One report indicates that, due to deployment of battery storage in California, the amount of solar energy utilized to meet demand has increased and use of gas to meet evening peak demand has been concomitantly reduced to about half of what was needed to meet evening peak demand in April 2021.¹¹ According to some sources, at several points in April 2024, batteries charged by solar became the largest source of power on the CAISO system¹² and displaced consumption of an estimated 30 Bcf of natural gas for electricity generation from January through August 2024.¹³

For all these reasons, the estimates of indirect GHG emissions provided at Tables A59-1 through A59-3, A61-1, and A61-2 for the Tanager BESS Project represent a conservatively high estimate of potential indirect emissions as they do not fully account for the critical role that batteries such as the Project play and will increasingly play in allowing California to rely more on renewable energy, including in periods when fossil generation resources would otherwise be dispatched to meet demand.

Furthermore, as demonstrated by the analysis in Data Response A59, even this conservatively high estimate of potential indirect emissions for a BESS would indirectly reduce GHG emissions at other facilities (by over 75% at a hypothetical combined cycle facility and over 82% at a hypothetical advanced combustion turbine in a simple cycle configuration).

A62. Please provide a copy of the spreadsheet file(s) containing the emissions calculations performed for A59, A60, and A61 with live, embedded calculations.

Response: Please see Attachment DR-A59 for the supporting calculation spreadsheets and information.

¹⁰ See Ember, *US Electricity 2025 – Special Report 22* (March 12, 2025), <https://ember-energy.org/app/uploads/2025/03/US-Electricity-2025-Special-Report.pdf>.

¹¹ *Id.*

¹² S&P Global, *California batteries taking bigger bite out of gas-fueled energy* (December 20, 2024), <https://www.spglobal.com/energy/en/news-research/latest-news/natural-gas/122624-california-batteries-taking-bigger-bite-out-of-gas-fueled-energy>.

¹³ *Id.*

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ATTACHMENT DR-A59

BESS Estimated GHG Emissions - Cumulative Emissions

Facility Data	Calpine Tanager BESS	
BESS Rating, MW:	200	
BESS Rated Output, MWh:	800	
Charge/Discharge Cycle Time, Hrs:	8.7	
Charge Period, Hrs:	4	
Initial MWh per Charge Cycle:	800	
Charge Efficiency, %:	84.29	See Note 1
Charge Efficiency Fraction:	0.8429	
Actual MWhr per Charge Cycle:	949.10	
# of Charge Cycles per Year:	365	
Utility:	PG&E	
Current Utility GHG Data		
CO2 lb/MWh	203.983	
CH4 lb/MWh	0.033	
N2O lb/MWh	0.004	
Current CARB GWP Factors		
CO2	1	
CH4	25	
N2O	298	
CO2e Emissions Factor, lb/MWh	206.00	
MT CO2e/MWh =	0.09344	
MT CO2e per Daily Charge Cycle	88.684	
MT CO2e per Year	32369.82	

Note 1: Efficiency fraction includes line losses, transformer losses, battery internal losses, and auxiliary consumption to operate the BESS.

Source of Electricity	GHG Emissions Intensity of Grid Electrical Supply MTCO2e/MWh	Emissions to Fully Charge BESS Including Eff% Losses MTCO2e/Day	Emissions from Production of a Single Charge Cycle/Day MTCO2e/Day	Emissions from Production of 365 Charge Cycles/Yr MTCO2e/Yr	Compared Technology Emissions Reductions MTCO2e/Yr
PG&E System	0.09344	88.684	88.684	32,369.82 See Note 2	---
Comparative Technologies					
Natural Gas Fired Combined Cycle Power Plant ¹	0.385	---	365.405	133,372.88	101,003.06
Natural Gas Fired Advanced Combustion Turbine Power Plant ²	0.524	---	497.331	181,525.69	149,155.87

^{1,2} Potentia-Viridi Energy Storage System, CEC Staff Assessment, Table 5.3-1.

Note 2: Emissions include line losses, transformer losses, battery internal losses, and auxiliary consumption to operate the BESS.

BESS Estimated GHG Emissions - Aux Load Emissions

FacilityData	Calpine Tanager BESS	
Estimated Aux Load, MW-hr/day:	39	total for all 189 units
MW-hr/Yr:	14235	365 days per year
Utility:	PG&E	
Current Utility GHG Data		
CO2 lb/MWh	203.983	
CH4 lb/MWh	0.033	
N2O lb/MWh	0.004	
Current CARB GWP Factors		
CO2	1	
CH4	25	
N2O	298	
CO2e Emissions Factor, lb/MWh	206.00	
MT CO2e/MWh =	0.09344	
MT CO2e per Year	1330.1	
MT CO2e per Day	3.64	