Technical Appendix

EPA Climate Pollution Reduction Grant Program

Bay Mills Indian Community (BMIC)
Project Name: BMIC's CPRG Solar Project
April 1, 2024

With EPA support through a Climate Pollution Reduction Grant (CPRG) implementation award, Bay Mills Indian Community (BMIC) will construct an 11 MW solar installation with a 5 MWh battery energy storage system (BESS) on 40 acres of tribal trust land in the Eastern Upper Peninsula (EUP) of Michigan.

5 Lakes Energy (5LE) prepared this analysis of the estimated GHG emissions reductions—and financial, public-health, economic, and other co-benefits—that BMIC's proposed project will deliver. Please note the discrepancies between the BMIC PCAP estimated GHG emission reductions and the estimated GHG emission reductions provided in this Technical Appendix. While the PCAP provided general estimations for this project, the analysis provided by 5LE in this Technical Appendix provides a more realistic set of estimations; therefore, the Cover Letter provided as an attachment to this proposal will reflect the 5LE estimations. A summary of 5LE's energy modeling credentials is provided at the end of this appendix. Please note that we changed the order of the technical appendix prompts, compared to how they were presented in the NOFO, to create a more linear narrative given the specifics of the project and our analytical approach.

A. GHG Reduction Estimate Method. To develop the projections described in this appendix and included in BMIC's application Work Plan, 5LE used the analytical framework or toolkit that we developed with Elevate Energy to a evaluate the net costs and benefits of proposed building electrification and renewable energy projects. Funded by a major grant from the Michigan Public Service Commission through its Renewable Energy and Electrification Infrastructure Enhancement and Development grant program, the toolkit helps users assess a prospective project from the perspectives of various stakeholders. In the case of this project, which will involve BMIC producing renewable energy, selling it to the market, and displacing a portion of the grid's existing fossil-fuel and other generating resources, our model estimates the costs and benefits to BMIC as the project owner and to society as the recipient of environmental, health, and economic co-benefits.

Using the toolkit and the assumptions and methods described below, 5LE calculated the estimated net amount of energy displaced from the grid by BMIC's proposed solar energy and storage project (hourly basis for one year of production). To determine the generating profile or mix of the grid energy resources that the project will displace through that production, 5LE deployed our internally developed, Excel-based STEP8670 tool, which models the grid's resource profile at hourly intervals into the future. It uses a financial-optimization approach which assumes that reality will reflect the least costly available option consistent with applicable policy and other legal requirements (please see the discussion of the "electricity grid" in Section B. for more details).

With the resulting hourly calculations of the amount and generating source of the energy that BMIC's project will displace, 5LE used various publicly available datasets and factors (described below) to estimate the project's net GHG emissions reductions, as well as public-health, economic, and other co-benefits. In addition to estimating GHG emissions in metric tons (MT), those tools and datasets translate emissions reductions and other impacts into their net financial benefit to energy end users, society, and others, thus allowing for direct quantitative comparison of various impacts by expressing them via a common unit of measure (i.e., dollars).

5LE presents the results of our toolkit modeling in a net present value (NPV) table that shows those dollar-value costs/benefits over the projected lifespan of the proposed project. An annual inflation rate of 2% is applied to those values, and they are discounted each year by an established factor that accounts for how the value of the benefits change over time from the perspective of the beneficiary. Those discount factors are provided below for each type of impact that we modeled for this project. A brief layperson's explanation of NPV and the discount factors is provided in Section H.

B. Measure Implementation Assumptions. The following summarizes key assumptions related to BMIC's proposed GHG emission reduction measure as we modelled it.

- **Solar energy production.** Using actual energy production data, provided by Cloverland Electric Cooperative, from a similar project also in the Eastern UP, energy production from the 11 MW solar farm for each of the 8,760 hours in one year was estimated. Based on the application of that hourly energy modeling, the project is estimated to generate an average of 15,472,657 kWh (or 15.5 GWh) of electricity per year.
- **Battery deployment.** Limitations in the time available to complete the modeling for the BMIC project required us to assume that the BESS will charge and discharge energy on a fixed daily schedule (provided for this analysis by Cloverland Electric Cooperative). 5LE's recent modeling of battery deployment has showed that 5-minute pricing can yield as much as twice as much net revenue from battery storage compared to a fixed schedule with one-hour intervals.[1] As such, our net revenue estimates for this project are conservative. By using the latest available software and technologies to time the BESS's charging and discharging interactions with the grid, the project will perform much better financially in practice (and better meet the grid's needs).
- **The electricity grid.** As mentioned above, 5LE deployed our STEP8760 tool to characterize the generation or source profile of the energy that the project will displace from the grid. In doing so, we assumed that amendments adopted in 2023 to the State of Michigan's "Clean and Renewable Energy and Energy Waste Reduction Act" will be fully implemented over time. Under the new laws, Michigan utilities are required to meet a renewable energy standard of 50% by 2030 and 60% by 2035, as well as a clean energy standard of 80% by 2035 and 100% by 2040 (unlike the renewable energy standard, nuclear power and natural gas generation combined with carbon capture count toward the clean energy standard). Again assuming that the utilities will achieve those standards with various energy resources in the most cost-effective manner possible, our STEP8760 modeling adjusts the generating profile of the grid over time in response to those policy requirements and other factors. Starting in 2040 when the last of those legal benchmarks is met, we assume the grid stabilizes.

  <u>NOTE</u>: It is important to recognize that if our modeling did not account for the State of Michigan's mandated increases in renewable energy production, it would estimate greater GHG reductions from the BMIC project, because the Tribe's proposed solar farm and storage system would displace a "dirtier" mix of energy than we predict for the grid's future. To put that into perspective, because our model now assumes that Michigan will ramp up renewable production to meet the State's new, more ambitious clean energy standards, it shows that the BMIC project

[1] https://5lakesenergy.com/integratingbatteriesintoresourceplanning/

will reduce emissions by 7,986.41 mtCO2e in its first year of production but just 725.24 mtCO2e when Michigan's 100% by 2040 clean energy standard is fully implemented, even though the amount of energy that the system will generate annually will only change marginally over that period. Of course, having fewer GHG emissions to reduce from generating electricity is the urgent and desired outcome we are trying to achieve, particularly as we strive to electrify other major energy end uses like buildings and transportation.

- **Construction timeline.** 5LE consulted respected Michigan-based solar contractors, who estimated that it will take 18-24 months to complete the installation of the project from the time it is certain to move forward, given the steps that have already been taken and will be taken between now and EPA's award announcements in October 2024. Based on that feedback, our modeling assumes that the project will begin production in 2027.

- **Project lifespan.** While the latest solar and storage technologies are generally expected to last longer, it is still common in the industry to assume a 25-year lifespan for the solar and battery equipment that the BMIC project will install and operate. Based on that industry standard, we assumed the system will continue generating renewable energy for the full period from 2027 through 2050. Per another standard industry practice, the cost estimates for the project included ongoing operations and maintenance services that will be provided by the turnkey solar contractor, including the replacement of key components at scheduled intervals (i.e., one cycle of inverter replacement in the 25-year period).

- **Electricity and REC sales assumptions.** 5LE used assumptions made by Baker Tilly and Cloverland Electric Cooperative in developing estimates of the financial benefits that BMIC will enjoy by selling energy and renewable energy credits (RECs) to the market. The provided assumptions we modeled were: 3.30 cents per kWh for the energy sales and 0.21 cent per kWh for the RECs. Based on 5LE's deep knowledge of the energy markets, our team considers these assumptions conservative and pegged to a period of low energy prices. In reality, the solar farm and BESS will likely generate significantly greater annual revenue for BMIC.

  Additionally, as mentioned in the Work Plan, BMIC and Cloverland intend to enter a PPA as soon as 2029 for the latter to purchase the energy and RECs from the former. However, given that 2029 remains five years into the future and the details of the prospective PPA have not been determined with certainty, our modeling makes a simplifying assumption that the initial direct-sale-to-market approach will continue through the end of the analysis period (2050). Given that the PPA is expected to be more lucrative for BMIC than that approach, our analysis likely underestimates the financial benefit this project will provide the Tribe. (NOTE: 5LE's methods for estimating the value of the project's energy "capacity" are summarized in the next section).

- **Capital expenditures or stack.** Based on cost estimates provided by its consultants at Baker Tilly, BMIC has budgeted $25.5 million for the 11 MW solar farm and 5 MWh BESS (to be installed/overseen by a single solar developer through a competitively-bid, turnkey contract). As explained in its Work Plan, BMIC conservatively estimates it will qualify for federal renewable investment tax credits (ITCs) representing 40% ($10,200,000) of those total project costs. The remaining 60% ($15,300,000) will be covered by BMIC's proposed CPRG implementation grant. BMIC will secure financing to "bridge" from project completion and its final contractor payment to receipt of its ITCs. For our analysis, we split the overall capital expenditure of $25.5 million over the first two years of the grant period, during which the project will be prepped and constructed. Our cost-benefit modeling assumes that "society" will bear the full cost of the project through grant funds and tax credits.

C. Models/Tools Used. As described in the previous sections, 5LE used actual production data that Cloverland Electric Cooperative provided from a similar project in the EUP to estimate hourly energy production, and our own STEP8760 model to develop an hourly source or generating profile for the energy that the BMIC project will displace from the grid. The following describes the tools and methods 5LE used to translate that energy production and grid energy displacement into projected GHG emissions reductions and other impacts.

- **GHG emissions**. GHG emissions for CO2, N2O, and CH4 were computed using emissions factors from EPA's GHG Emissions Factors Hub. As prescribed by the application guidelines, we applied the Global Warming Potentials (GWPs) in the 2013 IPCC AR5 Fifth Assessment Report as listed in the table included in the NOFO. While the application guidelines suggest estimating reductions for seven different GHGs, the three on which we report—CO2, N2O, and CH4—are the only greenhouse gases that our proposed measures will reduce in significant amounts. They are also the gases for which the tools described throughout this appendix provide reduction estimates for this type of project.
- **Air quality and public health impacts.** Net non-GHG emission reductions were computed using emissions factors from EPA's AP-42 database by fuel type and source. Based on those calculations, 5LE used the EPA's CO–Benefits Risk Assessment (COBRA) screening model to project the health benefits that the proposed project will deliver by reducing fossil-fuel electricity generation and the accompanying emissions of major co-pollutants (particulate matter (PM2.5), sulfur dioxide (SO2), nitrogen oxides (NOX), ammonia (NH3), and volatile organic compounds (VOCs)). Using established factors that assign a dollar value to a variety of health impacts—from avoided deaths to reduced incidence of heart attacks and other ailments—COBRA estimates the benefit to society of reducing those co-pollutant emissions.
- **Net economic benefits.** Net jobs created and net income generated by the project were estimated using data and tools developed by Greenlink Analytics and supported by peer reviewed research from Georgia Tech University. Led by our partner Elevate, this analysis was conducted similarly and with the same underlying data (IMPLAN) as other widely accepted economic impact tools. Limited to the impacts in the years of the project's construction, it considers jobs directly involved in project implementation and indirect jobs spurred by that activity, as well as net jobs lost by displacing existing energy resources. It then estimates the net income to our economy from the net jobs created.
- **Capacity impacts.** Because utilities must demonstrate that they have adequate resources to meet energy demands at peak usage times, the generating capacity that BMIC will develop through this project has an economic value and can be sold on an existing market (or to a utility as part of a PPA). In addition to the assumptions described in the previous section that were used to project BMIC's revenue from energy and REC sales, 5LE computed the project's capacity-related value using an algorithm which assigns a standard factor based on cost of new entry (CONE) during hours of highest demand over the course of a year.

D. GHG Reduction Estimate Assumptions. To summarize and consolidate relevant information provided in the previous sections, 5LE used actual production data from a similar, nearby project to estimate hourly energy production and our STEP8760 model to develop an hourly source or generating profile for the energy that the BMIC project will displace from the grid. To those net energy generation and grid displacement estimates, we applied the Global Warming Potentials (GWPs) in the 2013 IPCC AR5 Fifth Assessment Report, as listed in the NOFO and provided by EPA's GHG Emissions Factors Hub, to calculate our estimated GHG emissions reductions for CO2, N2O, and CH4.

E. Reference Case Scenario. Again, summarizing and consolidating relevant information provided in the previous sections, our case scenario is an 11 MV solar farm with a 5 MWh BESS that will be installed in the EUP of Michigan. It will sell renewable energy to the grid/market (along with RECs and capacity). According to our modeled scenario, the BESS will charge and discharge power to the grid on a fixed hourly schedule (even though, BMIC will deploy advanced technologies and software to implement more lucrative 5-minute pricing, which also more precisely meets the grid's needs).

The BMIC project is estimated to generate an average of 15,472,657 kWh (or 15.5 GWh) of energy per year. That energy will displace a mix of grid generating resources that 5LE modelled using our STEP8760 tool, which projects how that mix of generating resources will evolve over time as Michigan utilities meet the state's new renewable energy standard of 50% by 2030 and 60% by 2035, as well as its clean energy standard of 80% by 2035 and 100% by 2040 (both described above).

F. GHG Emissions Reduced. According to calculations made via the methods described above, 5LE estimates as follows the GHG emission reductions associated with the 62.9% of the total project cost associated with BMIC's requested CPRG grant amount:[2]

- 16,770.42 mtCO2e cumulatively reduced for the period from 2025 through 2030.
- 36,661.78 mtCO2e cumulatively reduced for the period from 2025 through 2050.
- 5,025.85 mtCO2e in annual absolute terms for 2027, the project's expected first year of production. To benchmark for our modeling, which again uses a geographic-specific grid factor and other nuances, the equivalent figure from the EPA Greenhouse Gas Equivalencies Calculator is 6,802.24 mtCO2e.
- 2,795.07 mtCO2e reduced annually (on average) for the period from 2025 through 2030. This average includes the two-year period during which the project will be prepped and constructed, and no energy will be generated (or emissions reduced). The average for the period from 2027 through 2030—the project's first four years of actual production—is 4,192.60 mtC02e.

Given BMIC's requested grant of $17,316,468.44, the above figures translate to $1,032.56 CPRG grant dollars per mtCO2e reduced from 2025 to 2030 and $472.33 CPRG grant dollars per mtCO2e reduced from 2025 to 2050.

Once again, it is **important to note** that all the above figures reflect 5LE's modeling approach which accounts for expected increases in deployment of renewable generating resources, including increases specific to Michigan per the state's new aggressive clean energy standards. As the grid gets "cleaner" and "cleaner" over time, according to our model, the BMIC project will displace energy that is "cleaner" and "cleaner," and, thus, the corresponding GHG emissions associated with the project's solar energy production will drop proportionally. These effects impact our GHG reduction projections immediately (in the 2025 through 2030 period), but they are particularly pronounced in the longer-term view. For perspective, our estimate of the project's CO2e reduction in 2040 is just 14% of our estimate for the project's first year of production (again, because we expect the grid to be so much less carbon intense 15 years from now).

---

[2]As budgeted, the total project investment will also include an estimated $10,200,000 investment tax credit (ITC). That brings the total anticipated investment in the project to $27,516,468.44. The direct investment in the solar farm and BESS is budgeted at $25,500,000.

GHG Emissions Reductions - For share of total project cost to be funded by CPRG grant (62.9% of total project)	CUMULATIVE 2025-2030	CUMULATIVE 2025-2050	ABSOLUTE ANNUAL (Production Year 1)
Change in CO2 Emissions (metric tons)	16,692.57	36,537.62	5,001.30
Change in CH4 Emissions (metric tons)	1.20	1.95	0.38
Change in N2O Emissions (metric tons)	0.17	0.26	0.05
Change in CO2e Emissions (metric tons)	16,770.42	36,661.78	5,025.85
Cost Effectiveness (CPRG grant dollars/mt)	$ 1,032.56	$ 472.33	

When the project is considered as whole—not just the cost share attributed to the proposed CPRG grant—5LE estimates the project's GHG emission reductions as follows:

- 26,649.32 mtCO2e cumulatively reduced for the period from 2025 through 2030.
- 58,259.03 mtCO2e cumulatively reduced for the period from 2025 through 2050.
- 7,986.41 mtCO2e in annual absolute terms for 2027, the project's estimated first year of production. Again, to benchmark for our modeling, which again uses a geographic-specific grid factor and other nuances, the equivalent figure from the EPA Greenhouse Gas Equivalencies Calculator is 10,809.00.
- 4,441.55 mtCO2e reduced annual (on average) for the period from 2025 through 2030. This average includes the two-year period during which the project will be prepped and constructed, and no energy will be generated (or emissions reduced). The average for the period from 2027 through 2030—the project's first four years of production—is 6,662.33 mtCO2e.

GHG Emissions Reductions - Total Project (Grant Request + ITCs)	CUMULATIVE 2025-2030	CUMMULATIVE 2025-2050	ASOLUTE ANNUAL (Production Year 1)
Change in CO2 Emissions (metric tons)	26,525.62	58,060.74	7,947.40
Change in CH4 Emissions (metric tons)	1.90	3.09	0.60
Change in N2O Emissions (metric tons)	0.27	0.42	0.08
Change in CO2e Emissions (metric tons)	26,649.32	58,258.03	7,986.41

G. Social co-benefits. The following summarizes the projected co-benefits that BMIC's proposed project will generate, calculated per the methods described in Sections A-E above. These figures are based on the total BMIC project. In other words, they are not limited to the share of the total project cost provided by BMIC's proposed CPRG grant. All told, through 2050, the project will deliver a net benefit—total benefits minus total costs—of $11,805,190 for a cost/benefit ratio of 1.47.

- **GHG Benefits.** The 5LE toolkit estimates the social value of the GHG emissions reductions shared in the previous section at $6,787,171 from 2025 through 2050 for an annual average benefit of $282,799.
- **Health Benefits.** Using COBRA's modeling of the social value of avoided mortality/disease/illness and other health benefits from the reduction of major harmful air co-pollutants, the project will

deliver estimated health impacts valued at an annual average of $195,426 for an aggregate total of $4,690,229 over the period from 2025 to 2050.

- **Net jobs and income.** The project will create an estimated 185 net jobs and an added net income to our economy of $10,089,491 **(**both through the direct jobs that the construction of the $25.5 million renewable energy installation will create and the indirect jobs/economic activity that will be spurred as a result). The tools we used for this estimate attribute the full value of this economic benefit to the years in which the project is being implemented or constructed.
- **Financial benefits to BMIC.** Through the sale of energy, capacity, and RECs on the market, the project will generate average annual revenues for BMIC of $636,488 for $15,275,713 through 2050. In 5LE's view, this revenue should be considered a social benefit, because BMIC will reinvest that revenue in a variety of services that it provides its community, including additional investments in decarbonization and climate resilience strategies.

COST/BENEFIT CATEGORIES	TOTAL: 2025 – 2050	ANNUAL AVERAGE: 2025 – 2050
PROJECT INVESTMENT CAPITAL EXPENSES (2% annual inflation)	$ (25,037,415)	$ (962,977)
PROJECT OWNER BENEFITS/ENERGY & RECS (2% annual inflation; 4.0% NPV annual discount rate)	$ 10,368,289	$ 432,012
PROJECT OWNER BENEFITS/CAPACITY (2% annual inflation; 4.0 % NPV annual discount rate)	$ 4,907,425	$ 204,476
SOCIETAL GHG BENEFITS (2% annual inflation; 2.5% NPV annual discount rate)	$ 6,787,171	$ 282,799
HEALTH BENEFITS (2% annual inflation; 2.5% NPV annual discount rate)	$ 4,690,229	$ 195,426
NET INCOME/ECONOMIC BENEFITS (2% annual inflation; 2.5% NPV annual discount rate)	$ 10,089,491	$ 388,057
TOTAL BENEFIT:	**$ 36,842,605**	**$ 1,502,770**
TOTAL COST:	**$ (25,037,415)**	**$ (962,977)**
TOTAL NET PRESENT VALUE :	**$ 11,805,190**	**$ 539,793**
BENEFIT/COST RATIO:	**1.47**	

H. Explanation of Net Present Value (NPV). Empirically and according to economic theory, people behave as though they prefer benefits (i.e., money) sooner rather than later. A net present value (NPV) approach to projecting a return on investment takes that into account by decreasing the projected per-unit value of a benefit over time.

In the context of this technical appendix, the projected utility savings from an investment in solar are more valuable per dollar to the customer/applicant in the year that the project is installed than in each successive year. For example, in the case of a hypothetical project that generates annual utility savings of

$50,000 for a given period, that savings may be valued at $50,000 by the customer in Year 1, $40,000 several years later, and as little as $30,000 further down the road. This "time value of money" dynamic also holds for the environmental, economic, and other social costs/benefits associated with an investment, whether it is a solar installation or some other project. Those benefits also decrease per unit over time, relative to today, from the perspective of the entity enjoying the benefit (or incurring the cost).

To calculate how future benefits diminish over time compared to the present (or time of the decision), an annual discount rate is applied. Generally, a small percentage of 2-10%, those rates vary by the extent to which the stakeholder (type of actor) values benefits in the present versus the future. A larger discount rate is used for actors who give less weight to the future compared to the present (and vice versa). As noted above in our NPV table, 5LE applied discount rates in this analysis that we have adopted as convention based on commonly used industry standards: 2.5% for social benefits (i.e., society's discount rate) and 4.0% for BMIC as the project owner.

I. 5LE credentials. 5 Lakes Energy is a Michigan-based policy consulting firm dedicated to mitigating climate change by accelerating clean energy deployment. Since our founding in 2010, we have helped a diverse roster of state and local governments, businesses, trade associations, and environmental and public interest nonprofits pursue clean energy, decarbonization, and climate resilience goals. Our team possesses decades of experience and deep expertise in energy systems, utility regulation, and related policy issues. Highly skilled in conducting quantitative analysis to inform public and private decision-making, the 5LE Lakes Energy team excels at identifying, organizing, and analyzing data from myriad sources, including federal agencies/laboratories, industry trade associations, state agencies and regulatory commissions, and academic experts. It also uses utility company technical, financial, and economic data in many applications, including comparing energy investment options, evaluating cost of service studies, and reviewing utility program effectiveness.

5LE deploys its modeling and data capacity in many forums, including its frequent role providing expert witness testimony in regulatory proceedings, such as those related to 20-year Integrated Resource Plans (IRP), Distribution System Plans, annual renewable energy and energy waste reduction (EWR) plans, cost allocation and rate design, voluntary green pricing (VGP) programs, and various pilots related to electric vehicle charging and other emerging technologies.

Quantitative analysis also serves as the backbone of 5LE's policy and plan development work, and the studies we produce to inform public debates. For example, 5 Lakes Energy recently joined the Michigan Energy Innovation Business Council in authoring *The Michigan Clean Energy Framework*, a comprehensive report which modelled a scenario in which Michigan adopted a suite of policies that reflects the priorities of the MI Healthy Climate Plan (MHCP) and closely resembles legislation that state lawmakers were considering at the time that the report was developed (and that they passed late in 2023). Our analysis showed that these policies would not only achieve the MHCP's short- and long-term emissions reduction targets, but also drive a myriad of other health and economic benefits, such as significant job creation, lower pollution-related mortality rates, and reduced average household energy costs. We have deployed similar modeling capabilities to support Michigan communities, including Ann Arbor, Traverse City, and Grand Haven, in developing models and pathways for achieving their ambitious clean energy goals and GHG emissions reduction targets. Our recent development of the analytic toolkit described above grew out of this work.