TECHNICAL APPENDIX

CPRG – PROPOSAL TO ADDRESS RURAL ALASKA'S CRITICAL ENERGY CHALLENGES

GHG Reduction Estimate Method

The reduction of diesel fuel consumption is the primary driver of all components proposed in this application to reduce GHG emissions. Before being able to determine the amount of CO_2 equivalent that may be reduced, the first agenda was gathering data of previous projects that were identical in scope and determining how much fuel was saved after implementation of these measures. The main source of data, which will be mentioned often in this section, comes from the Power Cost Equalization (PCE) Program.[1] This program is the number one most-used resource to gather data for all measures listed in this application.

The PCE program was created to provide economic assistance to communities and residents of rural electric utilities where the cost of electricity can be three to five times higher than for customers in more urban areas of the state. AEA, along with the Regulatory Commission of Alaska (RCA), administers the program that serves over 88,000 Alaskans in 193 communities that are largely reliant on diesel fuel for power generation. All communities discussed in this application, whether those used as proxies or the ones to be funded for upgrades if awarded this grant, are all part of the PCE program.

Utilities that are eligible for this program submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA calculates the amount of PCE on a monthly basis and issues payment to the utility. At end of each Alaska fiscal year (1 July – 30 June), the PCE report for that year for all eligible communities is generated and posted to AEA's website.[2]

Although these particular calculations are not used in determining GHG reductions, their results do provide the metrics needed to determine GHG emission reductions proposed in this application. The four main data points used from each PCE report were: 1) Diesel kWh Generated; 2) Fuel Used (gallons); 3) Line Loss (%); and 4) Fuel Efficiency (kWh per gallon of diesel)

Although the calculations are already indicated on each PCE report, the fuel efficiency and line loss data formulas are as follows:

Fuel Efficiency (kWh) = Diesel kWh Generated / Fuel Used (gallons)

Line Loss (%) = 100 - (Total kWh Sold & Powerhouse Consumption / Diesel kWh Generated)

These two metrics that proved valuable in determining if projects funded for distribution and power plant upgrades, reduced GHG emissions.

The methods used for gathering data with respect to the diesel genset replacement was EPA's Diesel Emissions Quantifier (DEQ) tool.[3] Required data was input for the baseline engine (engine model currently utilized at various locations requiring upgrade) as well as data for the upgraded engine. Short tons were then converted to metric tons using a standard calculator.

Models/Tools Used

The models and tools used were the following: EPA Diesel Emissions Quantifier (DEQ); Heat Recovery Simulation Analysis; Power Cost Equalization Reports; EPA GHG Equivalencies Calculator, and multiple excel spreadsheets with formulas

[1] Alaska Energy Authority > What We Do > Power Cost Equalization (akenergyauthority.org)

[2] Alaska Energy Authority > What We Do > Power Cost Equalization > PCE Reports & Publications (akenergyauthority.org)

[3] My Account: Diesel Emissions Quantifier | Diesel Emissions Reduction Act (DERA) | US EPA

The DEQ was the primary tool used when calculating GHG reductions for diesel genset replacements. However, some uncontrolled nonroad engines are to be replaced by Tier 2 or 3 marine engines. The DEQ uses load factors, applied to rated engine horse power to determine average engine horsepower for emission calculations. The nonroad and marine engine load factors are different, and are not representative of actual average engine horsepower. Additionally, the DEQ does not directly support comparing emissions reductions unless the baseline and replacement are of the same category (e.g. nonroad -> nonroad, marine -> marine). Therefore, to determine emissions reductions for different engine types accurately, the DEQ calculator was run for each engine separately and the results were exported to Excel for comparison.

Below is an example of a DEQ study for a nonroad -> marine engine project exported to excel for comparison. The engines used in this model are as follows:

- Baseline Engine – John Deere 4039, Non-Certified, 30kW Prime
- Replacement Engine – John Deere 4045TFM75, Tier 2 Marine, 65kW Prime

Annual Results (metric tons)	*Carbon Dioxide - CO2 (1 diesel engine)*	*Nitrogen Oxide (NOx)*	*PM 2.5*	*Carbon Monoxide (CO)*	*Hydrocarbon (HC)*
Baseline of Entire Project	253.29	1.55	0.64	1.86	0.29
Upgrade of Entire Project	211.01	1.71	0.05	0.25	0.10
Amount Reduced After Upgrades	42.28	-0.16	0.59	1.61	0.19
Percent Reduced After Upgrades	16.7%	-9.9%	91.6%	86.8%	66.7%

Figure 1 Nonroad to Marine Engine Comparison

In addition to the DEQ, a Heat Recovery Simulation Analysis model is used for distribution upgrade projects as needed. This model is commonly used and provided by an engineering firm that works closely with the applicant on many rural projects: Gray Stassel Engineering (GSE), Inc.[4] This firm has supported over 120 communities in Rural Alaska by providing services for many aspects of a project's life cycle. GSE firm has extensive knowledge and experience with the diesel genset replacements and RPSU programs as they have been directly involved in the design and construction of over 65 diesel power plants design/construction and 30 distribution projects which included small-scale interties to connect neighboring communities.

The distribution upgrade projects normally involve heat recovery analysis and implementation in conjunction with upgrading transformers, power lines, and poles. The data required for the heat recovery simulator includes generation metrics from the applicable PCE report, the proposed engine's heat rejection rates, and the estimated annual heating requirements of the end user buildings. The completed results will indicate has shown for Manokotak's study below.

[4] Gray Stassel Engineering (gse.engineering)

Manokotak Heat Recovery Simulation - With Clinic

11/18/2022

PROGRAM RESULTS:

Annual O&M cost:	0	$/year.	
Cost Estimate		$	
Fuel heat value:	134000	Btu/gall.	
Fuel cost	0.00	$/gallon	
Fuel cost escal.	0	/year	
Power increase	0	/year	
Discount rate	0	/year	

[Savings, year 0, gallons 6200]

GEN DATA: Jacket Water Only

Heat rate at kw-load above	55	3079	Btu/kwh
Heat rate at kw-load above	76	2437	Btu/kwh
Heat rate at kw-load above	102	1963	Btu/kwh
Heat rate at kw-load above	128	1756	Btu/kwh
Heat rate at kw-load above	154	1579	Btu/kwh
Heat rate at kw-load above	176	1446	Btu/kwh
Heat rate at kw-load above	200	1364	Btu/kwh
Heat rate at kw-load above	227	1272	Btu/kwh
Heat rate at kw-load above	251	1234	Btu/kwh
Heat rate at kw-load above	278	1204	Btu/kwh
Heat rate at kw-load above	302	1186	Btu/kwh

SYSTEM LOSS DATA:

Constant losses:

Plant piping:	5000	Btu/hr.	Piping Mains Insulated (default heat loss)
Buried Arctic piping:	36990	Btu/hr.	Note 1: North Shop: 150' of 2" @ 22.6 BTU/H-ft); Note 4: New Clinic 1500' of 75mm @ 22
Genset Eng. Preheat:	7000	Btu/hr.	Assume 2kW for engine preheat
Total constant:	48990	Btu/hr.	

Variable losses:

Plant Heating:	50	Btu/hr.xF	Control Room
Exterior piping:	62	Btu/hr.xF	South Shop/VPSO: 440' above-grade arctic pipe @ 0.14 BTU/Hr-ft-F; Note 2

GENERATION DATA: PCE FY20 Kwh/month: Note 3		WEATHER DATA: HDD/Month: Dillingham
January	148833	1516
February	123318	1373
March	106700	1330
April	61972	1008
May	78499	694
June	92279	424
July	97316	312
August	101116	354
September	101116	537
October	134509	989
November	111174	1268
December	136281	1567
	1293113	11372

NOTES:

1 150' Buried - Round Trip from Power Plant to North Shop
2 400' Above Grade from PP to South Shop/VPSO, includes 5' at end of Each Run at Each Building (5' X 4 building
3 Generation Data is average kWh generated from FY18 thru FY20
4
5

BUILDING DATA:

Building in use, 1=yes, 0=no

Fuel use, gallons	Seasonal	Non-Seasonal	Boiler Efficiency	January	February	March	April	May	June	July	August	September	October	November	December		OPER. HDD
North Shop	1200	0	75%	1	1	1	1	1	1	1	1	1	1	1	1	12	11373
South Shop	2000	0	75%	1	1	1	1	1	1	1	1	1	1	1	1	12	11373
VPSO	1000	0	75%	1	1	1	1	1	1	1	1	1	1	1	1	12	11373
Clinic	2000	0	75%	1	1	1	1	1	1	1	1	1	1	1	1	12	11373
building 4	0	0	75%	1	1	1	1	1	1	1	1	1	1	1	1	12	11373
building 5	0	0	75%	1	1	1	1	1	1	1	1	1	1	1	1	12	11373
building 6	0	0	75%	1	1	1	1	1	1	1	1	1	1	1	1	12	11373
building 7	0	0	75%	1	1	1	1	1	1	1	1	1	1	1	1	12	11373
building 8	0	0	75%	1	1	1	1	1	0	0	0	1	1	1	1	9	10283
-	0	0	75%	1	1	1	1	1	0	0	0	1	1	1	1	9	10283

Figure 2 Heat Recovery Simulator

Once the estimated fuel savings are calculated, this number will be converted into CO_2 equivalent by using EPA's equivalencies calculator which uses Intergovernmental Panel on Climate Change's (IPCC) standard below:

$$10{,}180 \text{ grams of } CO_2/\text{gallon of diesel} = 10.180 \times 10^{-3} \text{ metric tons } CO_2/\text{gallon of diesel}$$

<u>Measure Implementation Assumptions</u>

All measures are expected to have a lifetime of at least 20-25 years.

When calculating GHG emissions reductions on the DEQ for one Engine A and one Engine B, the results were used to calculate emissions reductions from 2025 through 2050. See two tables below.

Genset Replacement	# Communities		# Engines	
	A - <1M kWh	B - >1M - 2M kWh	Type A	Type B
Round 1 Q424 – Q426	3	2	6	4
Round 2 Q325 – Q427	3	2	6	4
Round 3 Q226 – Q428	3	1	6	2
Total	14		28	

Table 1 Breakdown of Size Communities/Type Engines Per Round

Engine A		Engine B	
Baseline	**Replacement**	**Baseline**	**Replacement**
John Deere 4039, Non-Certified	John Deere 4045TFM75, Tier 2 Marine	CAT3406C Non-Certified	Detroit Diesel 6063TK35, Tier 1 – Low PM
Emissions Reduced	**42.28 metric tons**	Emissions Reduced	**76.75 metric tons**

Table 2 Engine A and B Results from DEQ

With the data above, formulas were inputted to this spreadsheet which indicate how many metric tons of GHG are reduced each year and as diesel genset projects progress during all three rounds.

Diesel Genset Replacement GHG Reductions 2025 - 2050										
	Round 1			Round 2			Round 3			
Year	6x Engine A	4x Engine B	Total CO_2 (MT)	6x Engine A	4x Engine B	Total CO_2 (MT)	6x Engine A	2x Engine B	Total CO_2 (MT)	Grand Total CO_2 (MT)
2025	Diesel Genset Replacement									
2026	In Progress			Diesel Genset Replacement						
2027	254	307	561	In Progress			Diesel Genset Replacement			561
2028	507	614	1,121	254	307	561	In Progress			1,682
2029	761	921	1,682	507	614	1,121	254	154	407	3,211
2030	1,015	1,228	2,243	761	921	1,682	507	307	814	4,739
2031	1,268	1,535	2,803	1,015	1,228	2,243	761	461	1,222	6,268
2032	1,522	1,842	3,364	1,268	1,535	2,803	1,015	614	1,629	7,796
2033	1,776	2,149	3,925	1,522	1,842	3,364	1,268	768	2,036	9,325
2034	2,029	2,456	4,485	1,776	2,149	3,925	1,522	921	2,443	10,853
2035	2,283	2,763	5,046	2,029	2,456	4,485	1,776	1,075	2,850	12,382
2036	2,537	3,070	5,607	2,283	2,763	5,046	2,029	1,228	3,257	13,910
2037	2,790	3,377	6,167	2,537	3,070	5,607	2,283	1,382	3,665	15,439
2038	3,044	3,684	6,728	2,790	3,377	6,167	2,537	1,535	4,072	16,967
2039	3,298	3,991	7,289	3,044	3,684	6,728	2,790	1,689	4,479	18,496
2040	3,552	4,298	7,850	3,298	3,991	7,289	3,044	1,842	4,886	20,025
2041	3,805	4,605	8,410	3,552	4,298	7,850	3,298	1,996	5,293	21,553
2042	4,059	4,912	8,971	3,805	4,605	8,410	3,552	2,149	5,701	23,082
2043	4,313	5,219	9,532	4,059	4,912	8,971	3,805	2,303	6,108	24,610
2044	4,566	5,526	10,092	4,313	5,219	9,532	4,059	2,456	6,515	26,139
2045	4,820	5,833	10,653	4,566	5,526	10,092	4,313	2,610	6,922	27,667
2046	5,074	6,140	11,214	4,820	5,833	10,653	4,566	2,763	7,329	29,196
2047	5,327	6,447	11,774	5,074	6,140	11,214	4,820	2,917	7,736	30,724
2048	5,581	6,754	12,335	5,327	6,447	11,774	5,074	3,070	8,144	32,253
2049	5,835	7,061	12,896	5,581	6,754	12,335	5,327	3,224	8,551	33,781
2050	6,088	7,368	13,456	5,835	7,061	12,896	5,581	3,377	8,958	35,310

Table 3 Genset Replacement GHG Reductions, 2025-2050

For AEA's proposed distribution projects, the assumptions were that made that a total of four projects would be completed with CPRG funds. AEA used simulations from four proxy communities to determine GHG reductions. This is a conservative estimate; AEA anticipates completing up to five distribution upgrades. For the Native Village of Manokotak, which was briefly mentioned in Section 1 of the application, studies and simulations have indicated that the project will save the community around 7,000 gallons of diesel fuel per year upon completion. The community of Napaskiak's distribution upgrade involves the purchase and installation of high-efficiency transformers. This measure would reduce line loss and save the community 3,000 gallons of diesel per year. Nelson Lagoon, a small community apart of the Aleutian Island chain, is in dire need of distribution and heat recovery upgrades. Simulations for this community have also indicated that 7,000 gallons of diesel fuel would be saved once upgrades are complete. Kipnuk's distribution system is considered in extremely poor condition. Simulations indicate this project would bring the community up to standards, reducing line losses, and saving approximately 9,000 gallons of diesel per year. Due to logistics, funding, and feasibility, the projects would be staggered over the 5-year period of performance. Due to this schedule, the reduction measures were calculated as depicted in the table below.

Year	AEA Distribution Upgrades 2025 - 2050								
	Project 1		Project 2		Project 3		Project 4		Combined Total (MT
	GHG Reductions per Year (MT)	Cumulative Reductions (MT)	GHG Reductions per Year (MT)	Cumulative Reductions (MT)	GHG Reductions per Year (MT)	Cumulative Reductions (MT)	GHG Reductions per Year (MT)	Cumulative Reductions (MT)	
2025	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2026	59.0	59.0	0.0	0.0	0.0	0.0	0.0	0.0	59.0
2027	59.3	118.3	59.0	59.0	0.0	0.0	0.0	0.0	177.3
2028	59.3	177.6	59.3	118.3	61.0	61.0	0.0	0.0	356.9
2029	59.3	236.9	59.0	177.3	61.0	122.0	26.0	26.0	562.2
2030	59.3	296.2	59.3	236.6	61.0	183.0	26.0	52.0	**767.8**
2031	59.3	355.5	59.3	295.9	61.0	244.0	26.0	78.0	973.4
2032	59.3	414.8	59.3	355.2	61.0	305.0	26.0	104.0	1,179.0
2033	59.3	474.1	59.3	414.5	61.0	366.0	26.0	130.0	1,384.6
2034	59.3	533.4	59.3	473.8	61.0	427.0	26.0	156.0	1,590.2
2035	59.3	592.7	59.3	533.1	61.0	488.0	26.0	182.0	1,795.8
2036	59.3	652.0	59.3	592.4	61.0	549.0	26.0	208.0	2,001.4
2037	59.3	711.3	59.3	651.7	61.0	610.0	26.0	234.0	2,207.0
2038	59.3	770.6	59.3	711.0	61.0	671.0	26.0	260.0	2,412.6
2039	59.3	829.9	59.3	770.3	61.0	732.0	26.0	286.0	2,618.2
2040	59.3	889.2	59.3	829.6	61.0	793.0	26.0	312.0	2,823.8
2041	59.3	948.5	59.3	888.9	61.0	854.0	26.0	338.0	3,029.4
2042	59.3	1,007.8	59.3	948.2	61.0	915.0	26.0	364.0	3,235.0
2043	59.3	1,067.1	59.3	1,007.5	61.0	976.0	26.0	390.0	3,440.6
2044	59.3	1,126.4	59.3	1,066.8	61.0	1,037.0	26.0	416.0	3,646.2
2045	59.3	1,185.7	59.3	1,126.1	61.0	1,098.0	26.0	442.0	3,851.8
2046	59.3	1,245.0	59.3	1,185.4	61.0	1,159.0	26.0	468.0	4,057.4
2047	59.3	1,304.3	59.3	1,244.7	61.0	1,220.0	26.0	494.0	4,263.0
2048	59.3	1,363.6	59.3	1,304.0	61.0	1,281.0	26.0	520.0	4,468.6
2049	59.3	1,422.9	59.3	1,363.3	61.0	1,342.0	26.0	546.0	4,674.2
2050	59.3	1,482.2	59.3	1,422.6	61.0	1,403.0	26.0	572.0	**4,879.8**

Table 4 Distribution Upgrades Implementation Assumptions

With the funds requested for VEEP projects, we're anticipating up to 15 projects to be complete during the period of performance. Project lengths would vary from 18 months or as long as 36 months. The number of anticipated projects and assumed timelines were considered when calculating GHG emissions as indicated on the following table. AEA used historical performance and funding, adjusted for inflation, to estimate the impact of CPRG funding for the VEEP program. From 2016 through 2023, 56 communities were awarded $2.7 million under VEEP; this offset 1,189,463 kWh per year, totaling 830.9 metric tons of CO_2 equivalent. AEA adjusted the historical VEEP funding for inflation to determine the amount of kWh reduced per VEEP dollar spent in 2024 dollars, which is shown below, and applied that to the proposed CPRG VEEP budget and then used the EPA's GHG Equivalencies Calculator to determine GHG reductions. AEA anticipates VEEP funding through CPRG will offset 3,002,198 kWh per year and result in a reduction of 8,388 metric tons CO_2 equivalent for 2025 – 2030.

	VEEP	Actual/Budget	Annual kWh reduced	kWh reduced per $ spent	Annual CO2 metric tons reduction**
		(a)	(b)	(c)	(d)
(1)	2016-2023 Actual	$ 2,700,000	1,189,463	0.440541852	831
(2)	2016-2023 ($2024)*	$ 3,308,248	1,189,463	0.35954469	831
(3)	CPRG VEEP *** Subaward Budget	$ 8,350,000	3,002,198	0.35954469	2,097
CPRG VEEP 1 Year Reduction = 3,149 metric tons					

* $2024 calculated using inflation calculator on www.bls.gov

** CO2 metric ton reduction calculated using the EPA's Greenhouse Gas Calculator

*** Calculation CPRG VEEP Subaward Budget kWh annual reduced is (c)(2)*(a)(3)

Year	VEEP Projects 2025 - 2050						
	Group 1 (18 mos)		Group 2 (24 mos)		Group 3 (36 mos)		
	GHG Reductions per Year (MT)	Cumulative Reductions (MT)	GHG Reductions per Year (MT)	Cumulative Reductions (MT)	GHG Reductions per Year (MT)	Cumulative Reductions (MT)	Combined Total (MT)
2025	0	0	0	0	0	0	0
2026	699	699	0	0	0	0	699
2027	699	1,398	699	699	0	0	2,097
2028	699	2,097	699	1,398	699	699	4,194
2029	699	2,796	699	2,097	699	1,398	6,291
2030	699	3,495	699	2,796	699	2,097	8,388
2031	699	4,194	699	3,495	699	2,796	10,485
2032	699	4,893	699	4,194	699	3,495	12,582
2033	699	5,592	699	4,893	699	4,194	14,679
2034	699	6,291	699	5,592	699	4,893	16,776
2035	699	6,990	699	6,291	699	5,592	18,873
2036	699	7,689	699	6,990	699	6,291	20,970
2037	699	8,388	699	7,689	699	6,990	23,067
2038	699	9,087	699	8,388	699	7,689	25,164
2039	699	9,786	699	9,087	699	8,388	27,261
2040	699	10,485	699	9,786	699	9,087	29,358
2041	699	11,184	699	10,485	699	9,786	31,455
2042	699	11,883	699	11,184	699	10,485	33,552
2043	699	12,582	699	11,883	699	11,184	35,649
2044	699	13,281	699	12,582	699	11,883	37,746
2045	699	13,980	699	13,281	699	12,582	39,843
2046	699	14,679	699	13,980	699	13,281	41,940
2047	699	15,378	699	14,679	699	13,980	44,037
2048	699	16,077	699	15,378	699	14,679	46,134
2049	699	16,776	699	16,077	699	15,378	48,231
2050	699	17,475	699	16,776	699	16,077	50,328

Table 5 VEEP Project Implementation Assumptions

TCC and NAB used similar assumptions and considerations for their proposals, relying on diesel offset to determine GHG reduction and 2023 PCE data as a baseline. NAB's diesel reductions are driven, in part, by being able to maximize diesel off time at its water and power plants. TCC is anticipating being 50% complete with their projects by end of 2026 and 100% complete in 2027. NAB is anticipating 50% completion by end of 2027 and fully complete in 2028. These assumptions were then applied to the following spreadsheets to calculate their respective emissions reductions.

NAB Community Diesel Savings and GHG Reductions are below.

Table 2. Community Diesel Savings and GHG Emissions Reductions

Community	Current Alternative Energy (kW-hr, 2023)	Percent of Total	2023 Diesel Offset (gals)	Potential Additional Diesel Reduction (gals)
Kotzebue	3,662,784	19%	268,403	100,000
Kivalina	0	0	12,639	5,745
Deering	145,466	17%	11,566	3,442
Buckland	189,145	10%	18,229	9,528
Selawik	0	0	21,092	9,587
Noatak	0	0	11,701	5,319
Kiana	0	0	9,905	4,502
Noorvik	0	0	14,895	6,771
Ambler	0	0	9,016	4,098
Shungnak	193,423	11%	14,986	6,643
Kobuk	0	0	Note 3	

Notes: (1) Overall data is from 2023 Power Cost Equalization reports produced by AEA. (2) Blue values indicate estimates based on 11% offset of current diesel usage from implementation of solar/BESS. (3) Kobuk receives primary power from Shungnak; additional diesel savings from the proposed project are anticipated to be negligible.

TCC Target Communities								
Year	GHG Reductions per Year (MT)	Cumulative Reductions (MT)	Year	GHG Reductions per Year (MT)	Cumulative Reductions (MT)	Year	GHG Reductions per Year (MT)	Cumulative Reductions (MT)
2025	0	0	**2034**	774	6,581	**2043**	774	13,549
2026	387	387	**2035**	774	7,355	**2044**	774	14,323
2027	774	1,161	**2036**	774	8,129	**2045**	774	15,097
2028	774	1,936	**2037**	774	8,903	**2046**	774	15,871
2029	774	2,710	**2038**	774	9,678	**2047**	774	16,646
2030	774	**3,484**	**2039**	774	10,452	**2048**	774	17,420
2031	774	4,258	**2040**	774	11,226	**2049**	774	18,194
2032	774	5,032	**2041**	774	12,000	**2050**	774	**18,968**
2033	774	5,807	**2042**	774	12,774			

Table 6 TCC Implementation Assumptions

Northwest Arctic Borough Communities								
Year	GHG Reductions per Year (MT)	Cumulative Reductions (MT)	Year	GHG Reductions per Year (MT)	Cumulative Reductions (MT)	Year	GHG Reductions per Year (MT)	Cumulative Reductions (MT)
2025	0	0	**2034**	1,590	11,926	**2043**	1,590	26,237
2026	0	0	**2035**	1,590	13,516	**2044**	1,590	27,827
2027	795	795	**2036**	1,590	15,106	**2045**	1,590	29,417
2028	1,590	2,385	**2037**	1,590	16,696	**2046**	1,590	31,007
2029	1,590	3,975	**2038**	1,590	18,286	**2047**	1,590	32,597
2030	1,590	**5,565**	**2039**	1,590	19,876	**2048**	1,590	34,187
2031	1,590	7,155	**2040**	1,590	21,466	**2049**	1,590	35,777
2032	1,590	8,746	**2041**	1,590	23,056	**2050**	1,590	**37,367**
2033	1,590	10,336	**2042**	1,590	24,647			

Table 7 NAB Implementation Assumptions

GHG Reduction Estimate Assumptions/Measure-Specific Activity Data

The heat recovery simulator is a tool used to calculate potential fuel savings. Additionally, assumptions are based on similar projects that have already been implemented. To keep assumptions as realistic as possible, planned projects are compared with past projects that are similar in project scope, genset type, energy demand, population, and location. Data is pulled from PCE reports to determine GHG reductions before and after an emissions-reduction project is completed.

From the PCE reports, total diesel kWh generated, total diesel fuel used (gallons), and fuel efficiency are the metrics gathered for review. Line loss is also referenced to indicate if energy efficiency projects funded under VEEP had improved for the community. Furthermore, data is gathered from a community's report ***before*** a project is completed, and then again ***after*** it is implemented.

Reference Case Scenario (GHG Emissions or Activity Level)

Nikolai is a good example of how projects funded under the RPSU program have reduced GHG emissions with fuel savings. Nikolai recently had upgrades to its distribution, heat recovery, power plant replacement, and fuel upgrades. The project began in 2021 and was completed in March 2023. Below is a table of vital data pulled from the PCE reports for fiscal years 2021 – 2023 during that timeframe.[5]

Nikolai, AK				
State of Alaska Fiscal Year	Diesel kWh Generated	Total Fuel Used (gal)	Fuel Efficiency (kWh per gal)	Line Loss (%)
2021	355,204	37,474	9.48	17%
2022	532,152	55,378	9.61	19.40%
2023	446,222	38,294	11.65	10.30%

Table 8 Nikolai PCE Data, 2021-2023

The fuel consumption numbers are misleading. Since 2021, Nikolai's upgrades allowed for a total of **10,212 gallons of diesel fuel** to be displaced. 512 gallons of fuel were displaced in 2022 and 9,700 gallons were displaced in 2023. Those amounts were calculated by using the following method:

Fuel efficiency improved with 9.61 kWh per gallon in 2022 versus 2021's efficiency of 9.48 kWh per gallon. If 2021 had the same efficiency as 2022, it would have saved 512 gallons of fuel because:

- ***355,204 kWh (2021 diesel kWh generated) / 9.61 kWh per gal (2022 fuel efficiency) = 36,961.91 gal***
- ***37,474 gal (2021 total fuel used) - 36,961.91 gal (2021 fuel used with 9.61 efficiency) = 512 gal saved***

For comparison between 2023 and 2022:

- ***532,152 kWh (2022 diesel kWh generated) / 11.65 kWh per gal (2023 fuel efficiency) = 45,678.28 gal***
- ***55,378 gal (2022 total fuel used) – 45,678.28 gal (2022 fuel used with 11.65 efficiency) = 9,700 gal saved***

[5] Alaska Energy Authority > What We Do > Power Cost Equalization > PCE Reports & Publications (akenergyauthority.org)

GHG Emissions Reduced

The following tables indicate measure-specific reductions to GHG emissions. Table 5 breaks it down by each specific measure for annual reductions through 2050. Table 6 shows the consolidated amount of GHG reductions from all proposed measures.

Year	AEA Measures							NAB Measures		TCC Measures		
	Genset Replacement		VEEP		Distribution		Combined					
	Reductions/Yr	Cumulative	Reductions/Yr	Cumulative	Reductions/Yr	Cumulative	Cumulative	Reductions/Yr	Cumulative	Reductions/Yr	Cumulative	
2025	0	0	0	0	0	0	0	0	0	0	0	
2026	0	0	699	699	59	59	758	0	0	387	387	
2027	561	561	1,398	2,097	118	178	2,835	795	795	774	1,161	
2028	1,121	1,682	2,097	4,194	180	357	6,233	1,590	2,385	774	1,935	Combined total
2029	1,529	3,211	2,097	6,291	205	563	10,064	1,590	3,975	774	2,710	2025-2030
2030	1,529	4,739	2,097	8,388	205	768	13,895	1,590	5,565	774	3,484	**22,943**
2031	1,529	6,268	2,097	10,485	205	973	17,726	1,590	7,155	774	4,258	
2032	1,529	7,796	2,097	12,582	205	1,178	21,557	1,590	8,746	774	5,032	
2033	1,529	9,325	2,097	14,679	205	1,384	25,387	1,590	10,336	774	5,806	
2034	1,529	10,853	2,097	16,776	205	1,589	29,218	1,590	11,926	774	6,581	
2035	1,529	12,382	2,097	18,873	205	1,794	33,049	1,590	13,516	774	7,355	
2036	1,529	13,910	2,097	20,970	205	2,000	36,880	1,590	15,106	774	8,129	
2037	1,529	15,439	2,097	23,067	205	2,205	40,711	1,590	16,696	774	8,903	
2038	1,529	16,967	2,097	25,164	205	2,410	44,542	1,590	18,286	774	9,678	
2039	1,529	18,496	2,097	27,261	205	2,616	48,372	1,590	19,876	774	10,452	
2040	1,529	20,025	2,097	29,358	205	2,821	52,203	1,590	21,466	774	11,226	
2041	1,529	21,553	2,097	31,455	205	3,026	56,034	1,590	23,056	774	12,000	
2042	1,529	23,082	2,097	33,552	205	3,231	59,865	1,590	24,647	774	12,774	
2043	1,529	24,610	2,097	35,649	205	3,437	63,696	1,590	26,237	774	13,549	
2044	1,529	26,139	2,097	37,746	205	3,642	67,527	1,590	27,827	774	14,323	
2045	1,529	27,667	2,097	39,843	205	3,847	71,358	1,590	29,417	774	15,097	
2046	1,529	29,196	2,097	41,940	205	4,053	75,188	1,590	31,007	774	15,871	
2047	1,529	30,724	2,097	44,037	205	4,258	79,019	1,590	32,597	774	16,645	
2048	1,529	32,253	2,097	46,134	205	4,463	82,850	1,590	34,187	774	17,420	Combined total
2049	1,529	33,781	2,097	48,231	205	4,669	86,681	1,590	35,777	774	18,194	2025-2050
2050	1,529	35,310	2,097	50,328	205	4,874	90,512	1,590	37,367	774	18,968	**146,846**

Table 9 Individual Breakdown of Coalition Measures' GHG Reduction

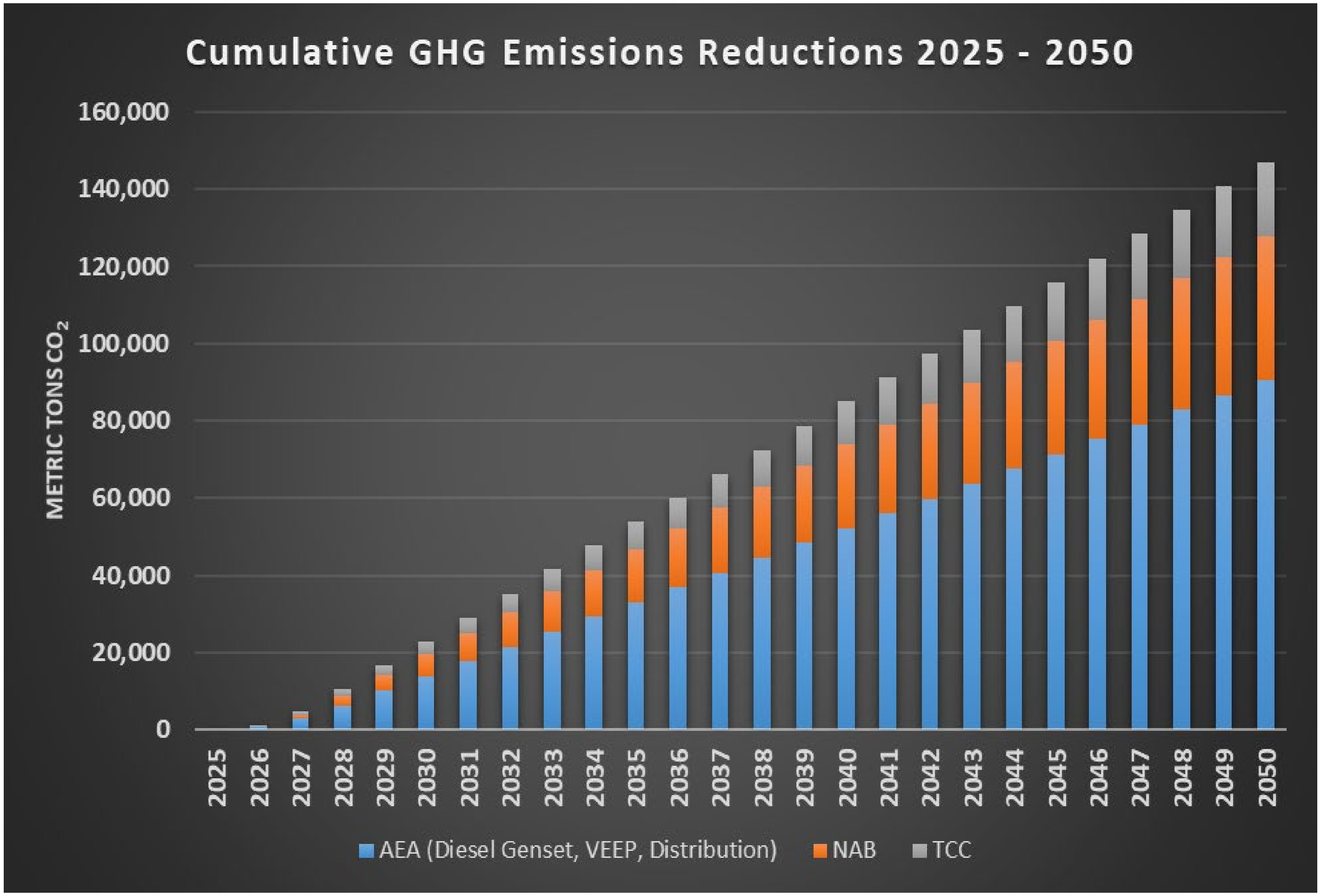

Table 6 Cumulative GHG Emissions Reduction for Coalition Partners 2025-2050

<u>Consolidated Amounts:</u>

Annual Reductions – **6,196 metric tons CO_2 equivalent**

2025-2030 – **22,943 metric tons CO_2 equivalent**

2025-2050 – **146,846 metric tons CO_2 equivalent**