Houlton Band of Maliseet Indians
Priority Climate Action Plan

Natural Resource Department's mission:
"*to sustain and manage HBMI's natural resources for the continuing benefit of Maliseet human, cultural and ecosystem health*".

Photo: Installed Aquatic Habitat Structure
HBMI Meduxnekeag River Restoration Program.

Prepared for:

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Prepared by:

The Houlton Band of Maliseet Indians,

in conjunction with Larsen & Toubro Ltd,
the Tribe's contracted technical service provider.

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Martin Dana and Trevor White for sharing Passamaquoddy/Indian Township's Draft PCAP

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1 Introduction

1.1 Tribe Background

The Houlton Band of Maliseet (HBMI) gained federal recognition on October 10, 1980. Federal recognition gave HBMI a unique government-to-government trust relationship with the United States.

HBMI established governmental offices at 88 Bell Road in Littleton, Maine and Maliseet Riverside Village on the Foxcroft Road in Houlton, Maine. The nearest population center is Houlton, approximately 5 miles southeast of the trust lands. The Town of Houlton is one focus of activity as this municipality provides drinking and waste water services to HBMI and is a source of upstream urban storm water, legacy oil contamination seeping into a tributary, and a POTW discharge. Houlton is served by I-95 and U.S. Route 1 and is near the U.S./Canada border.

1.2 History and Culture

Before contact with Europeans, the Maliseet or Wolastoqewiyik peoples occupied much of what is now considered the eastern border of the U.S. and Canada in northern New England extending into the Province of New Brunswick and throughout the Wolastoq-St John River Basin to its outlet in the Bay of Fundy. After the Jay Treaty in 1794, Maliseets obtained free border crossing rights between the two countries because their villages spanned both countries.

A smaller band of the larger Maliseet Nation of New Brunswick, Canada, the Houlton Band or Metahksonikewiyik, calls the Meduxnekeag River home. We Maliseets are river people who have traditionally been hunters and gatherers in the St. John River basin of which the Meduxnekeag is a tributary.

1.3 Natural Resources

Maliseets or Wolastoqewiyik, People of the Beautiful River, fish, trap, hunt and gather in and around the land and water of the Wolastoq-St. John Watershed. The Houlton Band of Maliseet has camped along the Meduxnekeag, a tributary of the Wolastoq-St. John and harvested its resources for generations. The banks of the Meduxnekeag provide edible plants such as fiddleheads, brown ash for basket-making; and plants such as sweet flag (what we call muskrat root), for traditional medicine. The river offers cedar for purification ceremonies and steam for sweat lodges. The river provides a place to canoe and swim and catch brook and brown trout for food. Historically the Meduxnekeag supplied the bountiful sustenance of sea run salmon.

HBMI cares for 1443.5 acres of farm, wetland, wood, and commercial land holdings in Aroostook County, Maine. Much of the land borders a significant amount of the Meduxnekeag River. The remaining 181 acres is fee land, with 3.5 acres pending trust status. Tribal trust lands total approximately 1263 acres with another 3.4-acre parcel soon to be taken into trust. About half of HBMI's trust acres are forested. Much of this forest has been heavily harvested by "high grading" techniques, prior to acquisition by the Band.

Initially HBMI purchased lands along the Meduxnekeag River as it was part of the tribe's historic territory. The lands along the Meduxnekeag provide a link to the cultural and traditional needs of the tribal community by providing access to traditional foods, materials, and medicines. The Band continues to purchase lands along the Meduxnekeag to establish a contiguous land base as well as to better to protect, preserve and enhance habitats critical to cultural survival.

In the early 1990's when HBMI established a natural resources department, staff was charged with two overarching goals: (1) sea run Atlantic salmon spawning in Tribal waters (with a corollary objective of restoring the whole North Atlantic guild of sea run fish); and (2) American bald eagles nesting on Tribal land.

Wetlands are also a highly valued and significant resource for our Tribe. Many medicinal plants such as muskrat root (Acorus americanus) grow in wetland areas as do Ostrich Fern (Matteuccia struthiopteris), locally known as "fiddleheads" a traditional food gathered by tribal members in great abundance from the riverbanks along tribal land every spring. Basket Ash (Fraxinus nigra) also grow in riparian wetlands; the source of material for basket making, a very important cultural tradition.

Climate Change Impacts: Current climate model scenarios for the Meduxnekeag River watershed predict increases in precipitation and temperature, and changes in snowmelt-related winter-spring hydrology. The vulnerability of wetland plants in the Meduxnekeag watershed to the hydrological consequences of predicted changes is not known. HBMI is collaborating with USGS to develop plant inventories benefitting from Maliseet traditional plant gatherer knowledge with a watershed model already developed by USGS and HBMI for the Meduxnekeag river watershed to develop a wetland plant vulnerability index.

Forests: In 2014, HBMI amended it's 2012 a Forest Management Plan (FMP) for its existing trust land "to establish an Extractive Reserve for Culturally Significant Resources. The objective is to perpetuate the production of these traditional resources through the use of silvicultural techniques that will enhance the biodiversity within the forest. This plan is intended to be custodial in nature and is therefore focused on management activities that ensure the long-term health and viability of the forest resources on the HBMI forestlands."

"Existing wetlands and riparian corridors on the parcels provide high value wildlife habitat and serve as travel pathways between habitats fragmented by agricultural fields and development. They are the cornerstone of biodiversity at both the stand and landscape levels. Maintaining these features is essential to meeting biodiversity objectives. Several RTE [Rare/Threatened/Endangered] plant species were also identified on the HBMI forestlands. Management activities should be planned to minimize disturbance in areas where rare plants are known to occur."

2 Tribal Organization and Considerations

The Tribe is governed by a six-member Council and headed by a Chief. The Tribal Administrator oversees the daily business of the administration. Currently, we have 1801 registered tribal members. Our programs service the 691 members who live in Aroostook County, Maine, our designated service area.

2.1 Housing

Adequate, safe, warm homes are a major public health issue on the reservation. The Tribe's Housing Authority owns and administers 82 low-income housing units (56 single family homes, 12 duplex units, and 2 apartment buildings an 8-unit and a 6-unit).

All families living in tribally owned housing would benefit from improved air circulation, improved insulation, waterproofing systems, and increased energy efficiency.

2.2 Governmental/Public Facilities

include Administration, Gymnasium, Elders Center, Family Services, Health Clinic, Housing Authority, Maintenance, Natural Resources, and a Water Resources Laboratory.

2.3 LIDAC statement

The Tribe is considered a Low Income Disadvantaged Community (LIDAC). As such, any activities to improve lives through improved living conditions, reduced cost of living, quality employment, and health directly benefit a LIDAC community.

2.4 The Changing Climate

The Houlton Band of Maliseet Indians, according to their oral history, traced their roots back to the last ice age over 12,000 years ago. As such, the tribe has seen vast climate changes since then as the ice retreated, but today these changes are concentrated and coming at a much faster pace.

These climate changes threaten the cultural lifeways and economic livelihoods of Tribal members. *For example, Temperature rises negatively impact the health and geographical range of brown ash and sweet grass. As the Brown Ash's range moves further north, this impacts the ability of our basket makers to gather these materials and continue a traditional craft. Both the ash and the sweet grass are pivotal to the making of ash baskets.*

Climate Change: [*excerpt from our 2022 EPA Tribal Environmental Plan (ETEP*)]

Generally, we have addressed climate change on an ad hoc basis, incorporating climate change mitigation and adaptation principles into things like commenting on state environmental rule changes, housing and governmental building design, research proposals, watershed restoration, and nonpoint source management. In 2014 we obtained BIA funds to engage in the conversation at the federal level around landscape conservation in the Northeast. In 2019 and 2020 we applied for additional BIA funds to engage in regional oceans planning. In future we would like to develop a more integrated and holistic approach to climate change. We are considering options such as a climate change strategy and a comprehensive plan for natural resource concerns and a master plan for Maliseet Riverside Village.

A comprehensive plan could address, among other issues, approaches to developing 1) watershed resiliency by reducing water temperature and improving aquatic habitat (e.g., restoring instream habitat structures and riparian buffers; further reducing the acres of fallow farm fields); and enhancing upland wildlife habitat (e.g., investigating impacts from surrounding forestry practices, supporting habitat conservation) and 2) tribal cultural resiliency through a better understanding of climate change impacts on culturally important natural resources and stronger, more sustained efforts to engender an interest in TEK and science-based natural resource management in tribal youth.

A Master Plan would address needed investments in renewable energy and energy efficiency upgrades and reducing our carbon footprint in other ways: HBMI has begun working at a government and community level to reduce our carbon footprint. In the past few years we completed three facilities (health clinic and two apartment buildings) designed with energy and resource efficiency in mind. In 20xx our Housing Authority completed upgrading housing built in the early 1990s with much of the effort – consistent with an energy audit - devoted to the most effective energy efficiency upgrades. In 2014 we established *carbon/energy use reduction goals and a strategy and action plan* toward achieving these goals with CAA 103 funds. The grant allowed us to begin assessing our energy efficiency performance with an energy audit of tribal governmental offices and facilities in 2010. Based on this audit, we implemented a number of energy efficiency retrofits. An updated audit would better support more informed energy efficiency decision-making.

Woli-litu - living sustainably (in balance)[Excerpts in boxes from *Wolankeyutomuk: Wabanaki Inter-tribal Climate Change Adaptation Guidebook, Tribal Culture and Adaptation*]

Tribal communities are becoming increasingly more vulnerable to climate change with the combined impact of past anthropogenic changes and limited access to the resources. Native American views of health include the ability to interconnect with the land, culturally significant food sources and water bases of ancestral origins. Separation from these aspects of wellness have had their negative implications to socio-ecological systems, socio-psychological and spiritual development within Native society and subsistence way of life over the generations.

The Wabanaki have identified the Loss of Economic Security both traditional and nontraditional and the Loss of Cultural Resilience as most urgent in environmental changes within the next decade. For the Wabanaki, cultural resilience is an urgent concern emerging from challenges imposed by the anthropogenic impacts of climate change and access to culturally significant resources. Thus, the need for a culturally responsive approach to adaptation includes planning mechanisms of social-ecological and socio-cultural relevance using indigenous perspectives that will empower cultural resilience and guide future generations.

Ancestrally, Wabanaki cosmology has been a central way of life that includes a paradigm as co-participant amid the ever changing ecology and involves sharing the land and water with others - both human and non-human, referred to conceptually as holism.

For over 500 years of colonization, our access to our original territories, language, cultural practices and belief systems have been met with numerous challenges during the profit driven challenges to the environment. In the interim, the carrying capacity of our lands have been compromised. It is incumbent upon our generation to provide the path forward by ensuring the continuance of the next 7 generations for human and non-human species.

Adaptation Strategies:

Strategy 5: Reduce the impact of biological and anthropogenic stressors. Climate change will cause stress and changes within native ecosystems. These climate-driven stressors can interact with other stressors that may already be occurring on the landscape. Reducing the effects of biological stressors such as (non-local beings) and human-caused stressors like water pollution and soil disturbance can be an important part of a climate adaptation plan. The Approaches that follow describe different ways of maintaining clean air, clean water, and clean land.

5.4. Reduce negative impacts from anthropogenic disturbances. Respectful and purposeful human interactions in ecosystems can leave minimal effects or even benefit an environment. However, some human-caused disturbances from recreation, infrastructure, development, or pollution can cause negative impacts. Reducing the negative impacts can form part of a climate adaptation plan.

Assess, Monitor, and Reduce Climate Pollution.

Although air pollution is a global problem, ***local efforts to reduce climate pollution****, improve air quality, and alert community members of air quality issues are important. Monitoring the air quality in your region will allow you to reduce ambient air pollution and its negative effects when possible and communicate these issues with the local population.*

3 PCAP Elements

3.1 Greenhouse Gas (GHG) Inventory (required)

3.1.1 Scope

The scope of this GHG inventory exercise was kept to the boundaries of the tribal trust land adjacent to the Meduxnekeag River (see Map on page . Specifically, GHG inventory was estimated for:

- Tribal government service buildings (ongoing); and
- Tribal residential households;

3.1.2 Data Sources

Data used for the GHG inventory are sourced from reputable U.S. government agencies and organizations highlighted below.

3.1.2.1 U.S. Environmental Protection Agency (EPA)

The GHG inventory exercise used the emission factors from the **2024 GHG Emission Factors Hub** as part of the data inputs. The document provides specific CO_2, CH_4, and N_2O emission factors for various fuels, including coal, natural gas, petroleum products, and biomass fuels.

These factors, (e.g., kg CO_2 per mmBtu, g CH_4 per mmBtu) along with data on fuel consumed, enable precise calculations of GHG emissions from combustion sources (see image below).

Blue text indicates an update from the 2023 version of this document.

Emission Factors for Greenhouse Gas Inventories
Last Modified: 13 February 2024

Table 6 Electricity

eGRID Subregion Acronym	eGRID Subregion Name	Total Output Emission Factors		
		CO_2 Factor ($lb\ CO_2$ / MWh)	CH_4 Factor ($lb\ CH_4$ / MWh)	N_2O Factor ($lb\ N_2O$ / MWh)
AKGD	ASCC Alaska Grid	1,052.1	0.088	0.012
AKMS	ASCC Miscellaneous	495.8	0.023	0.004
AZNM	WECC Southwest	776.0	0.051	0.007
CAMX	WECC California	497.4	0.030	0.004
ERCT	ERCOT All	771.1	0.049	0.007
FRCC	FRCC All	813.8	0.048	0.006
HIMS	HICC Miscellaneous	1,155.5	0.124	0.019
HIOA	HICC Oahu	1,575.4	0.163	0.025
MROE	MRO East	1,479.6	0.133	0.019
MROW	MRO West	[illegible]	[illegible]	[illegible]
NEWE	NPCC New England	536.4	0.063	0.008

	mmBtu per gallon	$kg\ CO_2$ per mmBtu	$g\ CH_4$ per mmBtu	$g\ N_2O$ per mmBtu	$kg\ CO_2$ per gallon	$g\ CH_4$ per gallon	$g\ N_2O$ per gallon
Petroleum Products							
Asphalt and Road Oil	0.158	75.36	3.0	0.60	11.91	0.47	0.09
Aviation Gasoline	0.120	69.25	3.0	0.60	8.31	0.36	0.07
Butane	0.103	64.77	3.0	0.60	6.67	0.31	0.06
Butylene	0.105	68.72	3.0	0.60	7.22	0.32	0.06
Crude Oil	0.138	74.54	3.0	0.60	10.29	0.41	0.08
Distillate Fuel Oil No. 1	0.139	73.25	3.0	0.60	10.18	0.42	0.08
Distillate Fuel Oil No. 2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Distillate Fuel Oil No. 4	0.146	75.04	3.0	0.60	10.96	0.44	0.09
Biomass Fuels - Solid							
Agricultural Byproducts	8.25	118.17	32	4.2	975	264	35
Peat	8.00	111.84	32	4.2	895	256	34
Solid Byproducts	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Wood and Wood Residuals	17.48	93.80	7.2	3.6	1,640	126	63

Figure 1: GHG Excerpt showcasing the various emission factors (GHG produced per MWh/gal/mmBtu) depending on the region of interest.

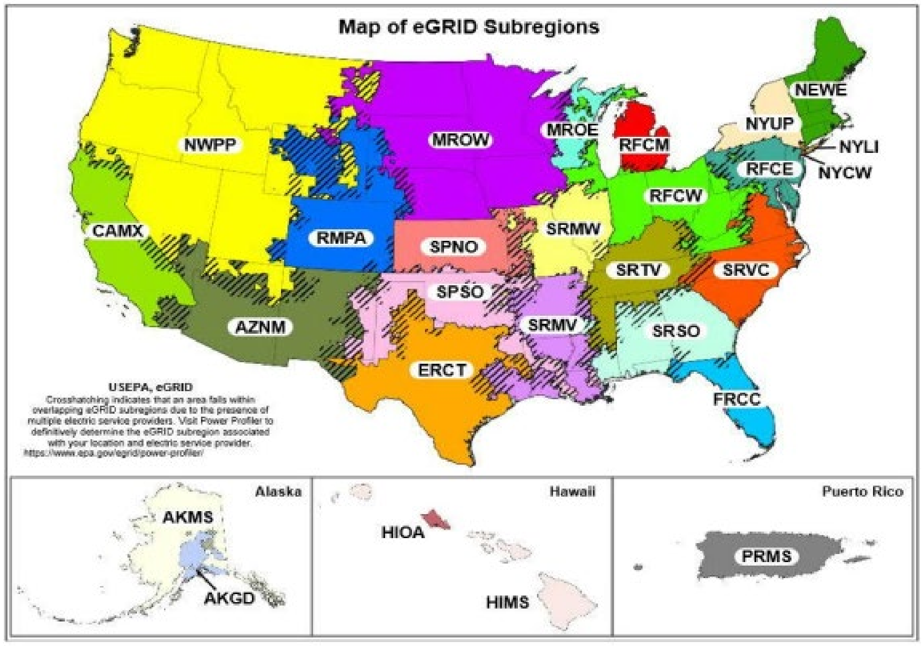


Figure 2: This is an illustration of the eGrid map. The community is located within the NPCC New England (NEWE) subregion. The image is reproduced from the U.S. EPA's GHG inventory tool.

Petroleum Products	mmBtu_per_gal	kg_CO2_per_mmBtu	kg_CH4_per_mmBtu	kg_N2O_per_mmBtu	kg_CO2_per_gallon	kg_CH4_per_gallon	kg_N2O_per_gallon
Fuel Oil No. 4	0.138	75.04	3	0.6	10.21	0.41	0.08
Biomass		93.8	7.2	3.6			
Propane	0.091	62.87	3	0.6	5.72	0.27	0.05

Electricity Emission Factor	lb CO2_per_MWh	lb CH4_per_MWh	lb N2O_per_MWh
NEWE (NPCC New England)	536.4	0.063	0.008
	kg_CO2_per_kWh	kg_CH4_per_kWh	kg_N2O_per_kWh
	0.243818182	2.86364E-05	3.63636E-06

Conversion

~~lb~~ / ~~MWh~~	kg / 2.2~~lb~~	~~MWh~~ / 1000 kWh	=	**536.4 kg / 2,200 kWh**
	3412 ~~Btu~~ / kwh	1 mmBtu / 1000000 ~~Btu~~	=	**0.003412 mmBtu**

Figure 3: Emission Factors Acquired from EPA

3.1.2.2 U.S. Census Bureau

Tribal demographic data was acquired via the U.S. Census Bureau's "My Tribal Area" platform, which provides detailed demographic, social, economic, and housing statistics for the nation's communities every year. These statistics are acquired via the American Community Survey (ACS).[1]

[1] U.S. Census Bureau. (n.d.). Tribal Resources. Retrieved from https://www.census.gov/tribal/

Pertinent data gathered are the number of households per tribe.

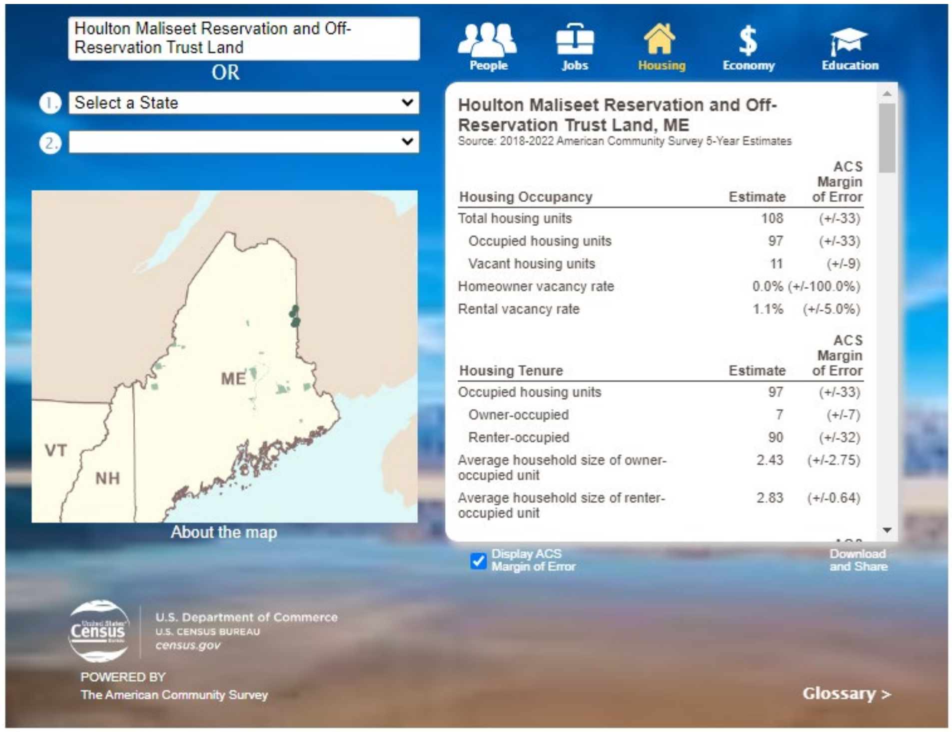


Figure 4: Community demographic data acquired from the U.S. Census Bureau

3.1.2.3 Lawrence Livermore National Laboratory (LLNL)

The study leveraged LLNL's Maine-specific Energy Consumption Sankey Diagram to estimate the distribution of energy source types that a typical Maine residential home uses.

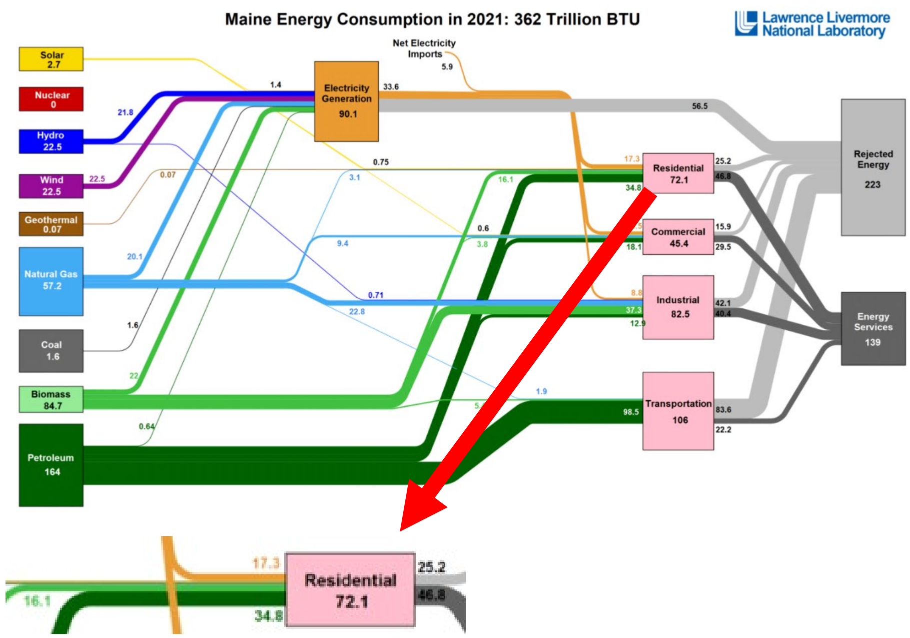


Figure 5: LLNL Sankey diagram, showcasing energy flow from various sources such as biomass, petroleum, natural gas, and geothermal towards electricity generation and end-use sectors, including residential, commercial, industrial, and transportation. Image reproduced from LLNL website.

For example, out of the arbitrary 72.1 units of energy used in a Maine household, 16.1 units come from Biomass highlighted as light green in the diagram (wood pellets and wood-derived fuel). 17.3 energy units come from electricity, 34.8 from petroleum, etc.

If we summarize the distribution of energy type use per home, we will have the following table of percentages.

Table 1: Breakdown of residential energy consumption in British thermal units (Btu)

Source	Trillion Btu	Percentage
Biomass	16.10	22%
Electricity	17.30	24%
Petroleum	34.80	48%
Natural Gas	3.10	4%
Geothermal	0.75	1%
TOTAL	**72.05**	

This also aligns with another diagram provided by the EIA and confirms that the share of each energy type hasn't changed much since 2016

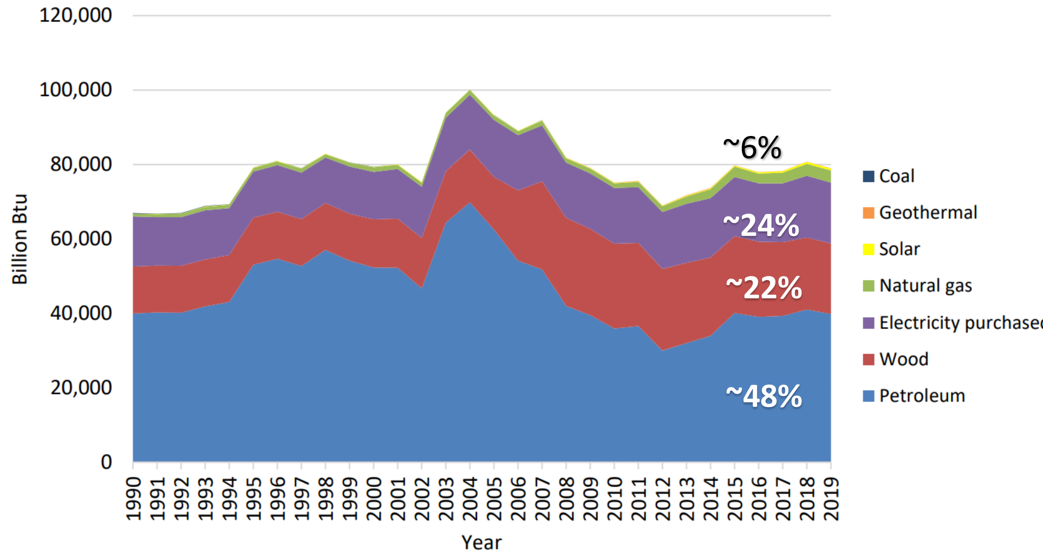


Figure 6: Maine residential energy consumption trend shows that the usage share of each energy type has remained the same since 2016. Image reproduced from the U.S. Energy Information Agency.

3.1.2.4 Versant Power and In-house Data

Versant Power, an established utility serving loads within MN, PPP, and near HBMI, has a dataset of typical residential load profiles. These profiles were used as assumptions on how much a typical tribal household consumes annually. The dataset acquired was for calendar year 2023.

Table 2: Versant Energy's Typical Residential Load Profile

VERSANT POWER						
Residential Profiles		**Hourly Demand (kW)**				
Hour		1	2	3	...	24
JAN	WEEKDAY	0.58	0.55	0.52	...	0.62
	WEEKEND	0.59	0.55	0.53	...	0.63
FEB	WEEKDAY	0.52	0.50	0.49	...	0.57
	WEEKEND	0.53	0.51	0.49	...	0.57
MAR	WEEKDAY	0.51	0.47	0.45	...	0.55
	WEEKEND	0.51	0.42	0.46	...	0.55
APR	WEEKDAY	0.44	0.41	0.39	...	0.48
	WEEKEND	0.44	0.41	0.39	...	0.48
MAY	WEEKDAY	0.42	0.38	0.36	...	0.47
	WEEKEND	0.42	0.38	0.37	...	0.47
JUN	WEEKDAY	0.42	0.37	0.35	...	0.50
	WEEKEND	0.42	0.38	0.36	...	0.50
JUL	WEEKDAY	0.49	0.44	0.41	...	0.56
	WEEKEND	0.48	0.43	0.41	...	0.56
AUG	WEEKDAY	0.48	0.44	0.42	...	0.57
	WEEKEND	0.49	0.45	0.42	...	0.57

SEP	WEEKDAY	0.41	0.38	0.36	…	0.47
	WEEKEND	0.42	0.38	0.36	…	0.47
OCT	WEEKDAY	0.45	0.42	0.39	…	0.50
	WEEKEND	0.46	0.47	0.40	…	0.50
NOV	WEEKDAY	0.48	0.45	0.43	…	0.53
	WEEKEND	0.49	0.45	0.44	…	0.50
DEC	WEEKDAY	0.60	0.56	0.54	…	0.70
	WEEKEND	0.61	0.57	0.55	…	0.71

Table 3: Derived Electric Energy Consumption Data

Avg_hourly kW	Avg_daily kWh	Subtotal_monthly kWh	Total_monthly kWh
0.82	19.62	431.65	
0.83	19.86	178.78	610.44
0.75	18.01	360.13	
0.76	18.19	145.53	505.66
0.71	17.03	357.53	
0.72	17.24	172.40	529.93
0.62	14.96	299.22	
0.63	15.15	151.52	450.74
0.61	14.56	334.80	
0.62	14.82	118.59	453.39
0.60	14.42	317.20	
0.61	14.62	116.98	434.19
0.67	15.97	335.38	
0.66	15.94	159.38	494.76
0.68	16.25	373.75	
0.68	16.36	130.88	504.63
0.61	14.53	305.19	
0.62	14.88	133.90	439.10
0.67	16.13	354.89	
0.68	16.41	147.69	502.58
0.71	17.07	375.65	
0.72	17.32	138.53	514.18
0.86	20.52	430.98	
0.86	20.74	207.44	638.42
		Avg_monthly_kwh	**506.50**
		Total_annual_kwh	**6077.99**

As shown in the table, a typical tribal home, according to Versant Power data, consumes 6077 kWh of electricity annually (506.5 kWh monthly average). This is a close estimate to the State of Maine Governor's Energy Office estimates that the average electrical use for a 1,000-square-foot home is 550 kWh.

3.1.2.5 Actual Tribal Data

3.1.2.5.1 Number of Residential Households

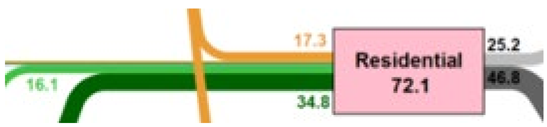
Census data was then compared to data collected from HBMI, MN, and PPP.

Table 4: Household Count of U.S. Census Bureau and Tribal Data

Data Source	Residential Household Count		
	HBMI	MN	PPP
U.S. Census Bureau	97	107	213
Tribal Data	82	111	236

Tribal data was used for the GHG inventory exercise.

3.1.2.5.2 Tribal-Specific Energy Source Use



According to Lawrence Livermore National Laboratory (LLNL), the residential sector in Maine consumed 72.1 Trillion Btus of energy in 2021. Of this, 17.3 Trillion Btus (24%) were consumed as electricity, 16.1 Trillion Btus (22%) as biomass, 34.8 Trillion Btus (48%) as fossil fuel, mostly petroleum, 3.1 Trillion Btus (4%) as natural gas, and 0.75 Trillion Btus (1%) as geothermal (see Table 1).

This 2021 Maine residential energy consumption model is used as the **base model** for determining the distribution of energy source consumption. Adjustments were made based **on tribal-specific practices**.

HBMI households are **not** equipped to use firewood or pellets and don't use natural gas or geothermal energy.

Given these tribe-specific practices, the Maine residential energy consumption model is adjusted to assume that the energy usage from geothermal, biomass, and natural gas is transferred to petroleum. The distribution then is shown below.

The same process is applied to the HBMI municipal buildings. From inspection, it is seen that the share of electric energy use is dominant in **Table 6**. This is due to the fact that data gathering for the municipal fossil fuel consumption data is ongoing and requires more time to complete. This shall be accomplished in the CCAP.

Table 5: HBMI Residential Energy Consumption

Source	perc_Btu
Biomass	0%
Electricity	24%
Petroleum	76%
Natural Gas	0%
Geothermal	0%

Table 6: HBMI Municipal Energy Consumption

Source	Total mmBtu	perc_Btu
Biomass		0%
Electricity	609.04	73%
Petroleum	220.02	27%
Propane		0%
Geothermal		0%

3.1.3 GHG Inventory Study

3.1.3.1 Overview

The methodologies employed to infer the GHG emissions data involved the following steps:

Data Acquisition: The data mentioned in the previous sections were leveraged to establish a baseline on energy consumption sources and their corresponding magnitudes.

Data Transformation: The gathered energy consumption data was converted into GHG units given as follows:

- kilograms of CO2
- grams of NO2
- grams of CH4

Assumptions and Limitations Acknowledgment: The group acknowledges the challenges and limitations of the methodology selected. Having more time and resources in the CCAP phase will help improve the accuracy of the GHGI overall.

3.1.3.2 Inferring Data from Electricity Use Using EIA and LLNL Data

Using LLNL's Sankey diagram and cross-referencing it with a typical household's estimated annual electric energy use, we can derive the mmBtu equivalent of the other residential energy sources, as shown in Table 4 (highlighted in yellow).

Table 7: *HBMI - mmBtu Use per Household*

Source	perc_BTU	kWh	mmBTU_equivalent
Biomass	0%		0.00
Electricity	24%	6077.99	20.74
Petroleum	76%		65.63
Natural Gas	0%		0.00
Geothermal	0%		0.00

No. of Households
82

$$\frac{3412\ \cancel{\text{Btu}}}{\text{kwh}} \quad \frac{1\ \text{mmBtu}}{1000000\ \cancel{\text{Btu}}} = \frac{\mathbf{0.003412\ mmBtu}}{\mathbf{kWh}}$$

As for the **TOTAL** municipal (commercial/institutional category) data, actual gathered data was used below.

Table 8: *HBMI – Total Municipal Btu Use*

Source	Total mmBtu
Biomass (wood/wood residuals)	0.00
Electricity	609.04
Petroleum	220.02
Propane	0.00
Geothermal	0.00

3.1.3.3 Extracting EPA Emission Factors

To determine the corresponding CO2, CH4, and N2O emitted from consuming an energy source, we refer to the table below, which converts mmBtu or kWh to kg/g of CO2, CH4, and N2O.

Table 9: EPA Emission Factors for each energy source

Residential Use	CO2_EF (kg/unit)	CH4_EF (g / unit)	N2O_EF (g / unit)	Unit
Biomass	93.80	7.20	3.60	mmBtu
Electricity	0.24	0.00	0.00	kWh
Petroleum (Fuel Oil No.4)	75.04	3	0.6	mmBtu
Natural Gas	53.06	1.00	0.10	mmBtu
Propane	62.87	3	0.6	mmBtu

3.1.3.4 Apply Calculations to EIA, LLNL, and EPA variables

We then perform the simple operations in the next section and acquire the Total Residential GHG emission in metric tons (MT), as shown in the table below. By inspection, we can see that wood and petroleum are the key sources of GHG emissions in all three categories (CO2, CH4, and N2O).

$$Total_{kg_{CO2}} = Energy\ Use\ (mmBtu) \times Emission\ Factor\ (kg_{CO2}\ per\ mmBtu)$$

$$Total_{g_{CH4}} = Energy\ Use\ (mmBtu) \times Emission\ Factor\ (g_{CH4}\ per\ mmBtu)$$

$$Total_{g_{N2O}} = Energy\ Use\ (mmBtu) \times Emission\ Factor\ (g_{N2O}\ per\ mmBtu)$$

or

$$Total_{kg_{CO2}} = Energy\ Use\ (mmBtu) \times Emission\ Factor\ (kg_{CO2}\ per\ kWh)$$

$$Total_{g_{CH4}} = Energy\ Use\ (mmBtu) \times Emission\ Factor\ (g_{CH4}\ per\ kWh)$$

$$Total_{g_{N2O}} = Energy\ Use\ (mmBtu) \times Emission\ Factor\ (g_{N2O}\ per\ kWh)$$

3.1.3.5 Results

Table 11 below shows the total GHG emissions calculated for the residential sector using these energy sources. The total CO_2 emissions for electricity are 121.52 metric tons of CO_2, with CH_4 emissions at 0.01 kilograms and no N_2O emissions. For petroleum, the CO_2 emissions are significantly higher at 403.84 metric tons, accompanied by 16.15 kilograms of CH_4 and 3.23 kilograms of N_2O emissions.

A notable amount of CH_4 and N_2O emissions is also associated with petroleum consumption. This indicates HBMI households have a high dependency on petroleum as an energy source, which poses potential risks due to price volatility, environmental impact, and health impact.

According to the table's data, petroleum contributes to 77% of CO_2 emissions, 100% of CH_4 emissions, and 100% of N_2O emissions. This highlights the high GHG emissions intensity of petroleum as an energy source.

On the other hand, electricity represents 24% of energy usage and contributes 23% to CO_2 emissions. In this case, the emissions of CH_4 and N_2O from electricity usage are negligible. This GHG emission share can be reduced as renewable generation serving households increases.

Given the disproportionately high emissions from petroleum, electrification and adopting renewable energy could significantly reduce the community's carbon footprint.

Table 10: Total GHG emission per household highlighted in green (kg and g units)

HBMI - Residential							Total GHG Emission per Household					
Source	**kwH**	**mmBTU_equivalent**	**CO2_factor (kg / unit)**	**CH4_factor (g / unit)**	**N2O_factor (g / unit)**	**Units**	**kg_CO2**	**g_CH4**	**g_N2O**	**perc_CO2**	**perc_CH4**	**perc_N2O**
Biomass		0.00	93.80	7.20	3.60	mmBTU	0.0	0.0	0.0	0%	0%	0%
Electricity	6077.99	20.74	0.24	0.00	0.00	kWh	1481.9	0.2	0.0	23%	0%	0%
Petroleum		65.63	75.04	3.00	0.60	mmBTU	4924.9	196.9	39.4	77%	100%	100%
Natural Gas		0.00	53.06	1.00	0.10	mmBTU	0.0	0.0	0.0	0%	0%	0%
Geothermal		0.00	0.00	0.00	0.00	mmBTU	0.0	0.0	0.0	0%	0%	0%

Table 11: Total Residential GHG emission in HBMI highlighted in green (metric tons and kg units)

		Total Residential GHG		
No. of Households	**Source**	**MT_CO2**	**kg_CH4**	**kg_N2O**
82	Biomass (wood/wood residuals)	-	-	-
	Electricity	121.52	0.01	0.00
	Petroleum	403.84	16.15	3.23
	Propane	-	-	-
	Geothermal	-	-	-

As for the institutional sector of HBMI, the total municipal GHG emissions reflect the impact of these sources in the **tables below**:

- **Electricity**: With a total consumption of 178,499 kWh, electricity contributes the following GHG emissions: 72% CO2, 1% CH4, and 0% N2O, equivalent to 43.52 metric tons of CO2.
- **Petroleum**: Contributes to 28% CO2, 99% CH4, and 100% N2O emissions, amounting to 16.51 metric tons of CO2, which is substantial and indicates a high emissions factor.

It should be noted that this distribution does not fully represent the energy consumption model for HBMI due to ongoing data gathering for fossil fuel consumption.

Table 12: Total Municipal GHG emission in HBMI highlighted in green (kg and g units)

HBMI - Commercial / Institutional			Total Municipal GHG Emission					
Source	Total mmBtu	Units	kg_CO2	g_CH4	g_N2O	perc_CO2	perc_CH4	perc_N2O
Biomass (wood/wood residuals)		mmBTU	-	-	-	0%	0%	0%
Electricity	609.04	kWh	43,521.30	5.11	0.65	72%	1%	0%
Petroleum	220.02	mmBTU	16,510.45	660.07	132.01	28%	99%	100%
Propane		mmBTU	-	-	-	0%	0%	0%
Geothermal		mmBTU	-	-	-	0%	0%	0%

Table 13: Total Municipal GHG emission in HBMI highlighted in green (metric tons and kg units)

	Total Municipal GHG Emission		
Source	MT_CO2	kg_CH4	kg_N2O
Biomass (wood/wood residuals)	-	-	-
Electricity	43.52	0.01	0.00
Petroleum	16.51	0.66	0.13
Propane	-	-	-
Geothermal	-	-	-

3.2 GHG Reduction Measures

The GHGI exercise shows that **fossil fuel** use are the predominant contributors to CO2 emissions in the residential sector. Therefore, the following GHG reduction measures are considered in the following subsections. Recommendations for the municipality sector are likely similar but inconclusive for now due to the ongoing data gathering process.

3.2.1 Increase Residential Energy Efficiency

Home Electrification: Transition home energy systems from fossil fuels to electricity. This includes **replacing** oil-based heating systems, water heaters, and stoves with more **efficient electric** heat pumps, electric water heaters, and induction cooktops, which can be powered by renewable energy.

Comprehensive Energy Audits: Conduct home energy audits to identify opportunities for energy-saving improvements and to prioritize actions that yield the best energy savings.

Insulation Enhancement: To reduce heating and cooling costs, upgrade the **insulation** in walls, roofs, and floors. This also includes sealing air leaks around doors, windows, and other openings.

High-Efficiency Windows and Doors: Install energy-efficient windows and doors to minimize heat loss in winter and heat gain in summer.

Energy-Efficient Appliances: Encourage using Energy Star-rated appliances and electronics to lower energy consumption.

3.2.2 Adopt Distributed Renewable Energy

Adopting distributed energy resources (DER) such as solar panels and small-scale wind turbines **goes well** with the residential electrification initiative. Installing solar and wind:

- generates renewable energy locally;
- aligns with the community's cultural values of environmental stewardship;
- reduces GHG emissions;
- potentially creates jobs within the tribe; and
- yields long-term cost savings;

The community can also consider larger-scale solar that will serve the entire community, such as community solar programs. Adding battery systems to these DER portfolios will increase system resilience when the sun and wind are out.

Here are the individual recommendations for adopting DERs:

Solar Panel Installations: Encourage the installation of rooftop solar panels on residential buildings to increase the production of renewable energy and reduce reliance on the grid.

Battery Storage Systems: Solar installations can be paired with home battery storage systems, allowing residents or the community to store excess solar energy for use during peak demand times or outages.

Community Solar Programs: Develop community solar projects that allow households without suitable roofs for solar panels to benefit from solar energy.

3.2.3 Comprehensive Residential and Governmental Facility Energy Audit

Although sourced from established organizations, the current methodologies for estimating the residential GHG inventory could be improved further. Municipal data gathering efforts should also be continued to have a more comprehensive GHG inventory.

Acquiring *actual* residential electricity bills and gallons of petroleum consumed shall be part of the comprehensive energy audit, which will be a time-intensive activity and will be addressed in the CCAP phase.

These gathered data shall provide a more accurate GHG inventory, leading to a better quantitative benefits analysis.

Sample methodology involved once actual electricity and fossil fuel consumptions are acquired are as follows:

Petroleum Heat Content: Start with petroleum's energy content. Petroleum products, such as heating oil, typically have a heat content value expressed in British thermal units (Btu) per gallon. The exact value can vary, but a common figure is about 138,690 Btu per gallon, which aligns with the EPA emission factor table.

Total Btu Consumption: Multiply the household's annual consumption in gallons by the heat content in Btu/gallon to get the total annual Btu consumption.

Conversion to mmBTU: Since 1 million Btu (mmBTU) is a standard unit for large energy quantities, convert the total Btu to mmBTU.

CO2 Emission Factor: The EPA's CO2 emission factor for petroleum is commonly provided in kg CO2 per mmBTU.

Calculate CO2 Emissions: Multiply the total mmBTU by the CO2 emission factor to estimate the total annual CO2 emissions from the household's petroleum usage.

The final figure shall provide the estimated annual CO2 emissions from the residential home's petroleum usage in kilograms.

3.3 Benefits Analysis

Overall, adopting the GHG reduction measures outlined in the previous section can provide social, economic, and environmental benefits that extend beyond monetary savings. This effectively fosters a holistic approach to community development and well-being.

Home electrification, when coupled with the **adoption of DERs** like solar panels, can lead to a sustainable energy model that respects the cultural values of environmental stewardship and positions the community as a leader in green energy initiatives.

Energy audits and subsequent **efficiency enhancements** would lower energy demand, reducing energy costs and decreasing energy production needs. This, in turn, minimizes the community's carbon footprint and mitigates its impact on climate change.

Enhancing insulation and installing high-efficiency windows and appliances would reduce energy consumption and improve home comfort, a benefit that would be felt directly by the residents daily.

3.4 Review of Authority to Implement

The Houlton Band of Maliseet Indians as a federally recognized Indian Tribe has the authority to make decisions for the health and wellbeing for its community and to accept funds from the Federal government and expend said funds for the benefit of the community. This includes entering into agreements and contracts with private entities to build community improvements on Tribal Trust Lands for the benefit of the Tribe's citizens.

Mi'kmaq Nation Priority Climate Action Plan

Prepared for:

U.S. Environmental Protection Agency
Climate Pollution Reduction Grant Program

Prepared by: Shannon Hill, Mi'kmaq Environmental Director

The Mi'kmaq Nation,

in conjunction with Larsen & Toubro Ltd,
the Tribe's contracted technical service provider.

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Table of Contents

1 Introduction

1.1 Tribe Background

The Mi'kmaq Nation (formerly known as the Aroostook Band of Micmacs) is a Federally Recognized Tribe with the main office for administration located in central Aroostook County (Presque Isle, Maine). The Mi'kmaq Environmental Health Department is also located in Presque Isle. The total Tribal roll consists of 1,300 members, of which approximately 750 reside within Aroostook County, the service area designated by the Bureau of Indian Affairs.

Current Tribal land holdings in Northern Maine total approximately 2,711 acres, including 69 housing units and 24 acres of land in Presque Isle, 16 housing units and 4 acres of land in the unorganized township of Connor, 8 housing units and 533 acres of land in Caribou, 11 housing units and 104 acres of land in Littleton, an 18 acre parcel of land in Bridgewater, a 658 acre parcel of land at the former Loring Air Force Base in Limestone, 1,200 forested acres in Winterville Plantation, 160 forested acres in Island Falls, and an 8 acre parcel of land in Mount Vernon, Maine.

The Tribe is governed by a Tribal Council consisting of a Tribal Chief, Vice-Chief, and nine (9) Tribal Council members. The governing document is comprised of bylaws, given the fact that a Tribal Constitution has not yet been adopted.

Since the Mi'kmaq Nation has only been federally recognized since 1991, the Tribe has only recently begun to re-establish a land base in Aroostook County. Agricultural and forestry activities on former aboriginal land holdings of the Tribe have resulted in major impacts to the environmental resources on those lands, including severe degradation of some natural habitats. Maintenance of healthy ecosystems on Tribal lands whether used for agriculture, forestry, or other natural resource management activities are extremely important to the Tribe for cultural, spiritual, and economic concerns.

1.2 History and Culture

The Micmac lived in the provinces of Nova Scotia, New Brunswick, Newfoundland, Prince Edward Island and Quebec in Canada and in Maine. The area was not called Canada or Maine then. The Micmac did not control all of what is today Maine. The Passamaquoddy, Penobscot and Maliseet lived there too. These four tribes made up the Wabanaki Confederacy. The Micmac had territory that ranged from the Eastern Maritimes to Southern Maine.

The French arrived in the area in the 1500s. They sent Catholic missionaries to live with the Micmac and other tribes. The French learned their languages and taught them about Catholicism. The Native Americans blended the Catholic teachings with their own culture.

The British arrived in the area in the 1600s. The British and French fought many wars over who controlled the area where the Wabanaki Confederacy tribes lived. The British made "Indian deeds" with the tribes to buy their land. The British and the members of the Wabanaki Confederacy had different ideas about land use and ownership. Native Americans had no concept of private ownership of property. They believed land was to be used but not owned. Land use of an area passed through the generations and could be granted to other tribes for periods of time. The Europeans thought that individuals owned land. They thought that land could be sold or inherited. This meant that Native Americans thought they were giving Europeans the right to use their land when deeds were signed. Europeans thought they bought the land.

These deeds reduced the size of the territories controlled by members of the Wabanaki Confederacy. The tribes in the area could not win a fight against the British, especially when the French left in 1763. This meant that the members of the Wabanaki Confederacy settled permanently in smaller areas of their former territories. Many Micmac settled in smaller areas in Quebec and the Maritime Provinces in Canada. A small number stayed in Maine.

2.1 Natural Resources

The Mi'kmaq Environmental Health Department (MEHD) is dedicated to protecting and restoring the health and well-being of the Mi'kmaq tribal community and environment. This will be accomplished through the many programs and enterprises currently established under the MEHD.
As we continue to add programs and staff to benefit the Tribal community, the need for a larger space has become apparent in order to accomplish goals set forth in this strategic plan. Therefore, a goal of obtaining funding to build a new facility to house most MEHD programs and the Mi'kmaq has become a priority.

3 Tribal Organization and Considerations

3.1 Housing

Adequate, safe, warm homes are a major public health issue on the reservation. The Tribe owns and operates 111 housing units. All families living in tribally owned housing would benefit from improved air circulation, improved insulation, waterproofing systems, and increased energy efficiency.

3.2 Public Facilities

Assets and buildings that are vulnerable to climate events include the tribal office, health center, wellness, youth center, elderly community center and apartments, housing department building and tribal roads on reserve, and tribal roads on trust lands.

3.3 LIDAC statement

The Tribe is considered a Low Income Disadvantaged Community (LIDAC). As such, any activities to improve lives through improved living conditions, reduced cost of living, quality employment, and health directly benefit a LIDAC community.

3.4 The Changing Climate

The [Tribe], according to their oral history, traced their roots back to the last ice age over 12,000 years ago. As such, the tribe has seen vast climate changes since then as the ice retreated, but today these changes are concentrated and coming at a much faster pace.

These climate changes threaten the cultural lifeways and economic livelihoods of Tribal members. *For example, Temperature rises negatively impact the health and geographical range of brown ash and sweet grass. As the Brown Ash's range moves further north, this impacts the ability of our basket makers to gather these materials and continue a traditional craft. Both the ash and the sweet grass are pivotal to the making of ash baskets.*

Woli-litu - living sustainably (in balance)

[Excerpts in boxes from *Wolankeyutomuk: Wabanaki Inter-tribal Climate Change Adaptation Guidebook, Tribal Culture and Adaptation*]

Tribal communities are becoming increasingly more vulnerable to climate change with the combined impact of past anthropogenic changes and limited access to the resources. Native American views of health include the ability to interconnect with the land, culturally significant food sources and water bases of ancestral origins. Separation from these aspects of wellness have had their negative implications to socio-ecological systems, socio-psychological and spiritual development within Native society and subsistence way of life over the generations.

The Wabanaki have identified the Loss of Economic Security both traditional and nontraditional and the Loss of Cultural Resilience as most urgent in environmental changes within the next decade. For the Wabanaki, cultural resilience is an urgent concern emerging from challenges imposed by the anthropogenic impacts of climate change and access to culturally significant resources. Thus, the need for a culturally responsive approach to adaptation includes planning mechanisms of social-ecological and socio-cultural relevance using indigenous perspectives that will empower cultural resilience and guide future generations.

Ancestrally, Wabanaki cosmology has been a central way of life that includes a paradigm as co-participant amid the ever changing ecology and involves sharing the land and water with others - both human and non-human, referred to conceptually as holism.

For over 500 years of colonization, our access to our original territories, language, cultural practices and belief systems have been met with numerous challenges during the profit driven challenges to the environment. In the interim, the carrying capacity of our lands have been compromised. It is incumbent upon our generation to provide the path forward by ensuring the continuance of the

Adaptation Strategies:

Strategy 5: Reduce the impact of biological and anthropogenic stressors. Climate change will cause stress and changes within native ecosystems. These climate-driven stressors can interact with other stressors that may already be occurring on the landscape. Reducing the effects of biological stressors such as (non-local beings) and human-caused stressors like water pollution and soil disturbance can be an important part of a climate adaptation plan. The Approaches that follow describe different ways of maintaining clean air, clean water, and clean land.

5.4. Reduce negative impacts from anthropogenic disturbances.

Respectful and purposeful human interactions in ecosystems can leave minimal effects or even benefit an environment. However, some human-caused disturbances from recreation, infrastructure, development, or pollution can cause negative impacts. Reducing the negative impacts can form part of a climate adaptation plan.

Assess, Monitor, and Reduce Climate Pollution.

*Although air pollution is a global problem, **local efforts to reduce climate pollution**, improve air quality, and alert community members of air quality issues are important. Monitoring the air quality in your region will allow you to reduce ambient air pollution and its negative effects when possible and communicate these issues with the local population.*

4 PCAP Elements

4.1 Greenhouse Gas (GHG) Inventory (required)

4.1.1 Scope

The scope of this GHG inventory exercise was kept to the boundaries of each tribe's tribal trust land. Specifically, GHG inventory was estimated for:

- Tribal government service buildings; and
- Tribal residential households;

4.1.2 Data Sources

Data used for the GHG inventory are sourced from reputable U.S. government agencies and organizations highlighted below.

4.1.2.1 U.S. Environmental Protection Agency (EPA)

The GHG inventory exercise used the emission factors from the **2024 GHG Emission Factors Hub** as part of the data inputs. The document provides specific CO_2, CH_4, and N_2O emission factors for various fuels, including coal, natural gas, petroleum products, and biomass fuels.

These factors, (e.g., kg CO_2 per mmBtu, g CH_4 per mmBtu) along with data on fuel consumed, enable precise calculations of GHG emissions from combustion sources (see image below).

Blue text indicates an update from the 2023 version of this document.

Emission Factors for Greenhouse Gas Inventories
Last Modified: 13 February 2024

Table 6 Electricity

eGRID Subregion Acronym	eGRID Subregion Name	Total Output Emission Factors		
		CO_2 Factor ($lb\ CO_2$ / MWh)	CH_4 Factor ($lb\ CH_4$ / MWh)	N_2O Factor ($lb\ N_2O$ / MWh)
AKGD	ASCC Alaska Grid	1,052.1	0.088	0.012
AKMS	ASCC Miscellaneous	495.8	0.023	0.004
AZNM	WECC Southwest	776.0	0.051	0.007
CAMX	WECC California	497.4	0.030	0.004
ERCT	ERCOT All	771.1	0.049	0.007
FRCC	FRCC All	813.8	0.048	0.006
HIMS	HICC Miscellaneous	1,155.5	0.124	0.019
HIOA	HICC Oahu	1,575.4	0.163	0.025
MROE	MRO East	[illegible]	[illegible]	[illegible]
MROW	MRO West	936.5	0.102	[illegible]
NEWE	NPCC New England	[illegible]	[illegible]	[illegible]

	mmBtu per gallon	kg CO_2 per mmBtu	g CH_4 per mmBtu	g N_2O per mmBtu	kg CO_2 per gallon	g CH_4 per gallon	g N_2O per gallon
Petroleum Products							
Asphalt and Road Oil	0.158	75.36	3.0	0.60	11.91	0.47	0.09
Aviation Gasoline	0.120	69.25	3.0	0.60	8.31	0.36	0.07
Butane	0.103	64.77	3.0	0.60	6.67	0.31	0.06
Butylene	0.105	68.72	3.0	0.60	7.22	0.32	0.06
Crude Oil	0.138	74.54	3.0	0.60	10.29	0.41	0.08
Distillate Fuel Oil No. 1	0.139	73.25	3.0	0.60	10.18	0.42	0.08
Distillate Fuel Oil No. 2	0.138	73.96	3.0	0.60	10.21	0.41	0.08
Distillate Fuel Oil No. 4	0.146	75.04	3.0	0.60	10.96	0.44	0.09

Biomass Fuels - Solid						
Agricultural Byproducts	8.25	118.17	32	4.2	975	264
Peat	8.00	111.84	32	4.2	895	256
Solid Byproducts	10.39	105.51	32	4.2	1,096	332
Wood and Wood Residuals	17.48	93.80	7.2	3.6	1,640	126

Figure 1: GHG Excerpt showcasing the various emission factors (GHG produced per MWh) depending on the region of interest.

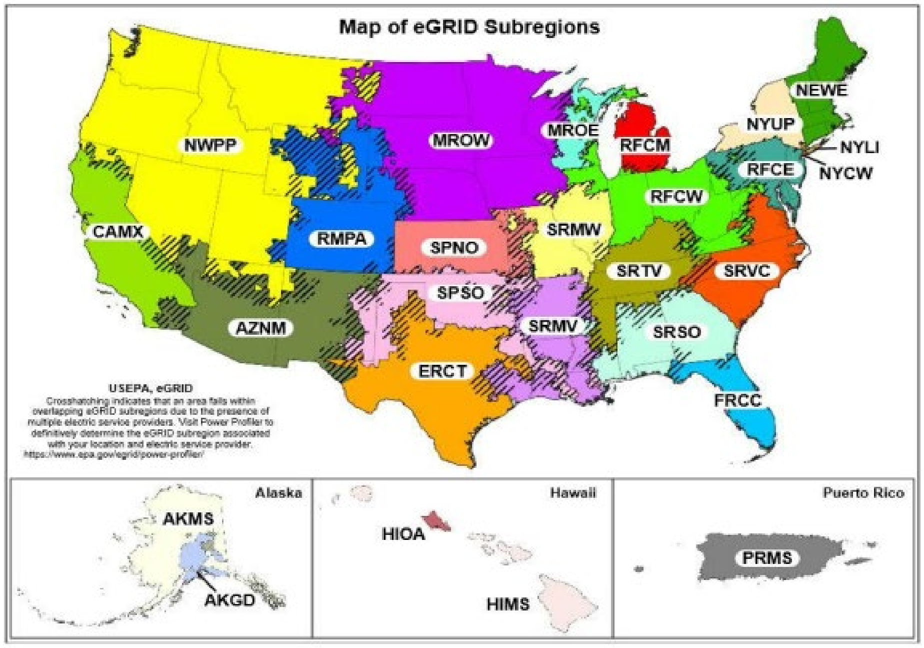


Figure 2: This is an illustration of the eGrid map. The community is located within the NPCC New England (NEWE) subregion. The image is reproduced from the U.S. EPA's GHG inventory tool.

Petroleum Products	mmBtu_per_gal	kg_CO2_per_mmBtu	kg_CH4_per_mmBtu	kg_N2O_per_mmBtu	kg_CO2_per_gallon	kg_CH4_per_gallon	kg_N2O_per_gallon
Fuel Oil No. 4	0.138	75.04	3	0.6	10.21	0.41	0.08
Biomass		93.8	7.2	3.6			
Propane	0.091	62.87	3	0.6	5.72	0.27	0.05

Electricity Emission Factor	lb CO2_per_MWh	lb CH4_per_MWh	lb N2O_per_MWh
NEWE (NPCC New England)	536.4	0.063	0.008
	kg_CO2_per_kWh	kg_CH4_per_kWh	kg_N2O_per_kWh
	0.243818182	2.86364E-05	3.63636E-06

Conversion

lb / MWh	kg / 2.2lb	MWh / 1000 kWh	=	536.4 kg / 2,200 kWh
	3412 Btu / kwh	1 mmBtu / 1000000 Btu	=	0.003412 mmBtu

Figure 3: Emission Factors Acquired from EPA

4.1.2.2 U.S. Census Bureau

Tribal demographic data was acquired via the U.S. Census Bureau's "My Tribal Area" platform, which provides detailed demographic, social, economic, and housing statistics for the nation's communities every year. These statistics are acquired via the American Community Survey (ACS).[1]

[1] U.S. Census Bureau. (n.d.). Tribal Resources. Retrieved from https://www.census.gov/tribal/

Pertinent data gathered are the number of households per tribe.

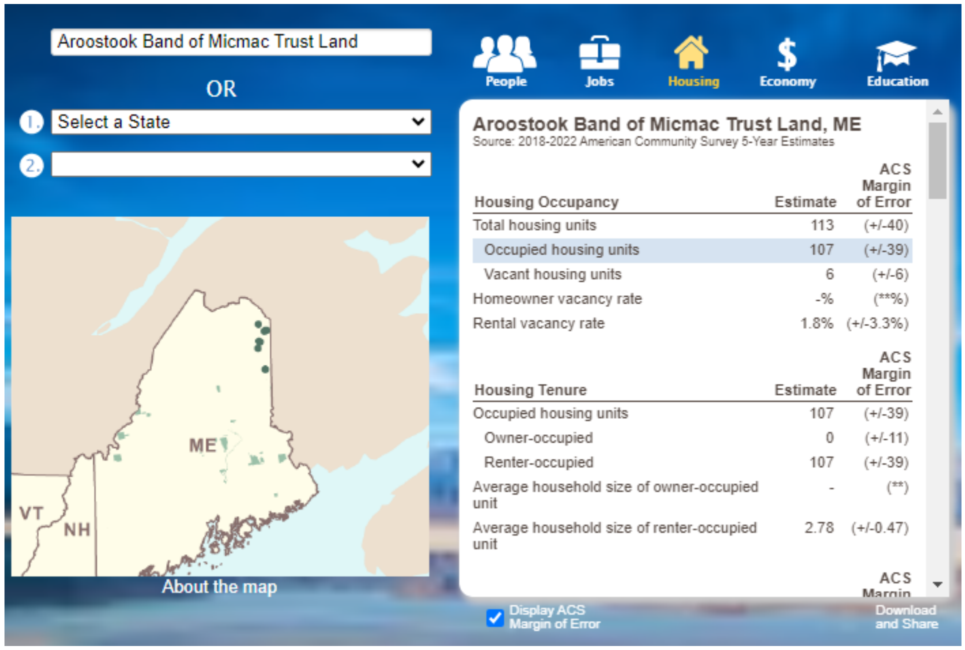


Figure 4: Community demographic data acquired from the U.S. Census Bureau

4.1.2.3 Lawrence Livermore National Laboratory (LLNL)

The study leveraged LLNL's Maine-specific Energy Consumption Sankey Diagram to estimate the distribution of energy source types that a typical Maine residential home uses.

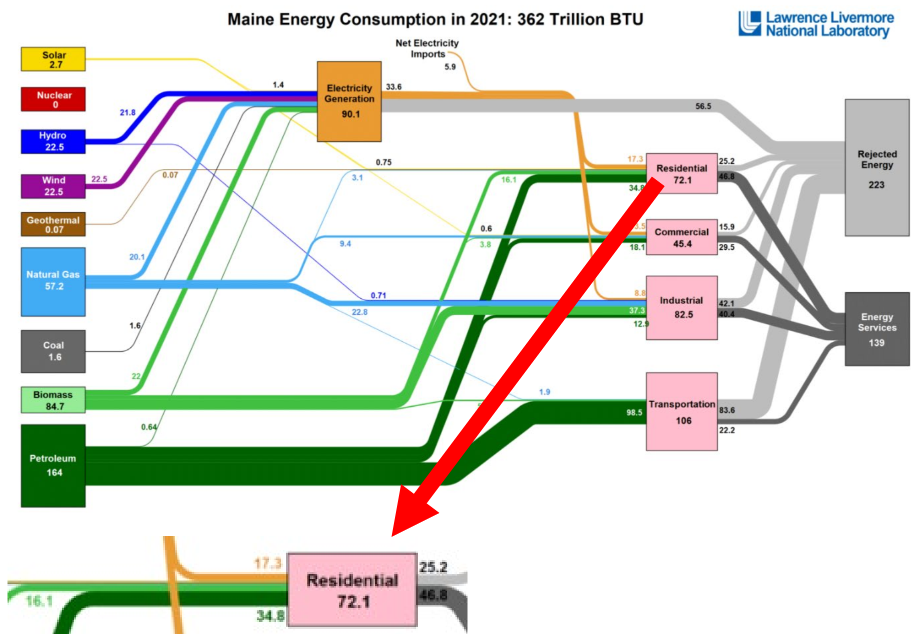


Figure 5: LLNL Sankey diagram, showcasing energy flow from various sources such as biomass, petroleum, natural gas, and geothermal towards electricity generation and end-use sectors, including residential, commercial, industrial, and transportation. Image reproduced from LLNL website.

For example, out of the arbitrary 72.1 units of energy used in a Maine household, 16.1 units come from Biomass highlighted as light green in the diagram (wood pellets and wood-derived fuel). 17.3 energy units come from electricity, 34.8 from petroleum, etc.

If we summarize the distribution of energy type use per home, we will have the following table of percentages.

Table 1: Breakdown of residential energy consumption in British thermal units (Btu)

Source	Trillion Btu	Percentage
Biomass	16.10	22%
Electricity	17.30	24%
Petroleum	34.80	48%
Natural Gas	3.10	4%
Geothermal	0.75	1%
TOTAL	**72.05**	

This also aligns with another diagram provided by the EIA and confirms that the share of each energy type hasn't changed much since 2016

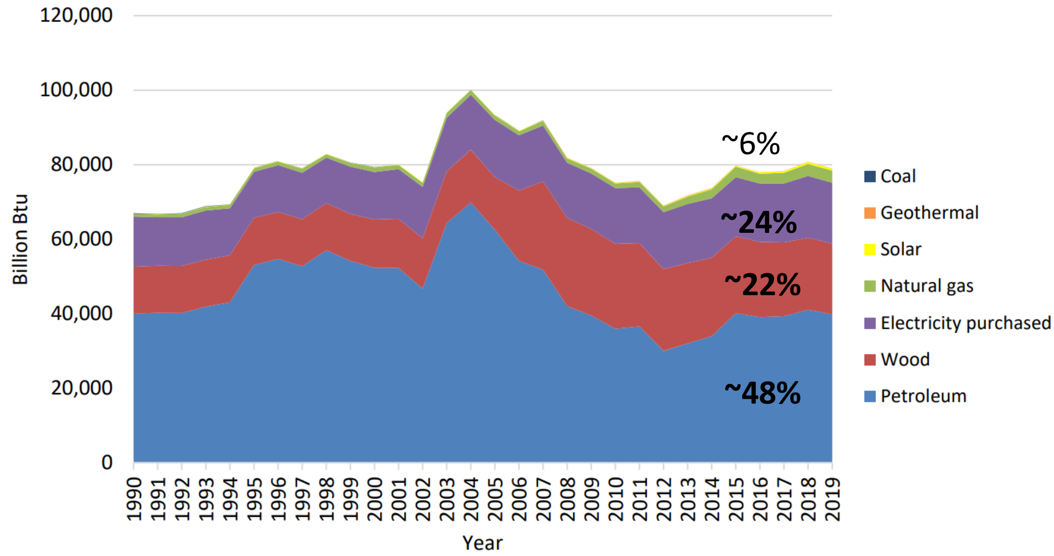


Figure 6: Maine residential energy consumption trend shows that the usage share of each energy type has remained the same since 2016. Image reproduced from the U.S. Energy Information Agency.

4.1.2.4 Versant Power and In-house Data

Versant Power, an established utility serving loads within MN, PPP, and near HBMI, has a dataset of typical residential load profiles. These profiles were used as assumptions on how much a typical tribal household consumes annually. The dataset acquired was for calendar year 2023.

Table 2: Versant Energy's Typical Residential Load Profile

VERSANT POWER						
Residential Profiles		**Hourly Demand (kW)**				
Hour		1	2	3	...	24
JAN	WEEKDAY	0.58	0.55	0.52	...	0.62
	WEEKEND	0.59	0.55	0.53	...	0.63
FEB	WEEKDAY	0.52	0.50	0.49	...	0.57
	WEEKEND	0.53	0.51	0.49	...	0.57
MAR	WEEKDAY	0.51	0.47	0.45	...	0.55
	WEEKEND	0.51	0.42	0.46	...	0.55
APR	WEEKDAY	0.44	0.41	0.39	...	0.48
	WEEKEND	0.44	0.41	0.39	...	0.48
MAY	WEEKDAY	0.42	0.38	0.36	...	0.47
	WEEKEND	0.42	0.38	0.37	...	0.47
JUN	WEEKDAY	0.42	0.37	0.35	...	0.50
	WEEKEND	0.42	0.38	0.36	...	0.50
JUL	WEEKDAY	0.49	0.44	0.41	...	0.56
	WEEKEND	0.48	0.43	0.41	...	0.56
AUG	WEEKDAY	0.48	0.44	0.42	...	0.57
	WEEKEND	0.49	0.45	0.42	...	0.57

SEP	WEEKDAY	0.41	0.38	0.36	…	0.47
	WEEKEND	0.42	0.38	0.36	…	0.47
OCT	WEEKDAY	0.45	0.42	0.39	…	0.50
	WEEKEND	0.46	0.47	0.40	…	0.50
NOV	WEEKDAY	0.48	0.45	0.43	…	0.53
	WEEKEND	0.49	0.45	0.44	…	0.50
DEC	WEEKDAY	0.60	0.56	0.54	…	0.70
	WEEKEND	0.61	0.57	0.55	…	0.71

Table 3: Derived Electric Energy Consumption Data

Avg_hourly kW	Avg_daily kWh	Subtotal_monthly kWh	Total_monthly kWh
0.82	19.62	431.65	
0.83	19.86	178.78	610.44
0.75	18.01	360.13	
0.76	18.19	145.53	505.66
0.71	17.03	357.53	
0.72	17.24	172.40	529.93
0.62	14.96	299.22	
0.63	15.15	151.52	450.74
0.61	14.56	334.80	
0.62	14.82	118.59	453.39
0.60	14.42	317.20	
0.61	14.62	116.98	434.19
0.67	15.97	335.38	
0.66	15.94	159.38	494.76
0.68	16.25	373.75	
0.68	16.36	130.88	504.63
0.61	14.53	305.19	
0.62	14.88	133.90	439.10
0.67	16.13	354.89	
0.68	16.41	147.69	502.58
0.71	17.07	375.65	
0.72	17.32	138.53	514.18
0.86	20.52	430.98	
0.86	20.74	207.44	638.42
		Avg_monthly_kwh	**506.50**
		Total_annual_kwh	**6077.99**

As shown in the table, a typical tribal home, according to Versant Power data, consumes 6077 kWh of electricity annually (506.5 kWh monthly average). This is a close estimate to the State of Maine Governor's Energy Office estimates that the average electrical use for a 1,000-square-foot home is 550 kWh.

4.1.2.5 Actual Tribal Data

4.1.2.5.1 Number of Residential Households

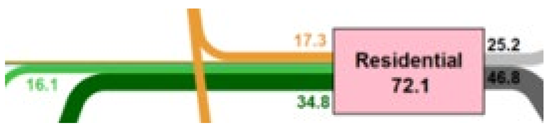
Census data was then compared to data collected from HBMI, MN, and PPP.

Table 4: Household Count of U.S. Census Bureau and Tribal Data

Data Source	Residential Household Count		
	HBMI	MN	PPP
U.S. Census Bureau	97	107	213
Tribal Data	82	111	236

Tribal data was used for the GHG inventory exercise.

4.1.2.5.2 Tribal-Specific Energy Source Use



According to Lawrence Livermore National Laboratory (LLNL), the residential sector in Maine consumed 72.1 Trillion Btus of energy in 2021. Of this, 17.3 Trillion Btus (24%) were consumed as electricity, 16.1 Trillion Btus (22%) as biomass, 34.8 Trillion Btus (48%) as fossil fuel, mostly petroleum, 3.1 Trillion Btus (4%) as natural gas, and 0.75 Trillion Btus (1%) as geothermal (see Table 1).

This 2021 Maine residential energy consumption model is used as the **base model** for determining the distribution of energy source consumption. Adjustments were made based **on tribal-specific practices**.

MN households are **not** equipped to use firewood or pellets and don't use natural gas or geothermal energy.

Given these tribe-specific practices, the Maine residential energy consumption model is adjusted to assume that the energy usage from geothermal, biomass, and natural gas is transferred to petroleum. The distribution then is shown below.

The same process is applied to the MN municipal buildings but with the addition of **propane** use.

Table 5: MN Residential Energy Consumption

Source	perc_Btu
Biomass	0%
Electricity	24%
Petroleum	76%
Natural Gas	0%
Geothermal	0%

Table 6: MN Municipal Energy Consumption

Source	perc_Btu
Biomass	0%
Electricity	4%
Petroleum	62%
Propane	34%
Geothermal	0%

4.1.3 GHG Inventory Study

4.1.3.1 Overview

The methodologies employed to infer the GHG emissions data involved the following steps:

Data Acquisition: The data mentioned in the previous sections were leveraged to establish a baseline on energy consumption sources and their corresponding magnitudes.

Data Transformation: The gathered energy consumption data was converted into GHG units given as follows:

- kilograms of CO_2
- grams of NO_2
- grams of CH_4

Assumptions and Limitations Acknowledgment: The group acknowledges the challenges and limitations of the methodology selected. Having more time and resources in the CCAP phase will help improve the accuracy of the GHGI overall.

4.1.3.2 Inferring Data from Electricity Use Using EIA and LLNL Data

Using LLNL's Sankey diagram and cross-referencing it with a typical household's estimated annual electric energy use, we can derive the mmBtu equivalent of the other residential energy sources, as shown in Table 4 (highlighted in yellow).

Table 7: *MN - mmBtu Use per Household*

Source	perc_BTU	kWh	mmBTU_equivalent
Biomass	0%		0.00
Electricity	24%	6077.99	20.74
Petroleum	76%		65.63
Natural Gas	0%		0.00
Geothermal	0%		0.00

No. of Households
111

$$\frac{3412\ \text{Btu}}{\text{kwh}} \quad \frac{1\ \text{mmBtu}}{1000000\ \text{Btu}} = \frac{\mathbf{0.003412\ mmBtu}}{\mathbf{kWh}}$$

As for the **TOTAL** municipal (commercial/institutional category) data, actual gathered data was used below.

Table 8: *MN – Total Municipal Btu Use*

Source	Total mmBtu
Biomass (wood/wood residuals)	0.00
Electricity	77.09
Petroleum	1131.46
Propane	627.17
Geothermal	0.00

4.1.3.3 Extracting EPA Emission Factors

To determine the corresponding CO2, CH4, and N2O emitted from consuming an energy source, we refer to the table below, which converts mmBtu or kWh to kg/g of CO2, CH4, and N2O.

Table 9: EPA Emission Factors for each energy source

Residential Use	CO2_EF (kg/unit)	CH4_EF (g / unit)	N2O_EF (g / unit)	Unit
Biomass	93.80	7.20	3.60	mmBtu
Electricity	0.24	0.00	0.00	kWh
Petroleum (Fuel Oil No.4)	75.04	3	0.6	mmBtu
Natural Gas	53.06	1.00	0.10	mmBtu
Propane	62.87	3	0.6	mmBtu

4.1.3.4 Apply Calculations to EIA, LLNL, and EPA variables

We then perform the simple operations in the next section and acquire the Total Residential GHG emission in metric tons (MT), as shown in the table below. By inspection, we can see that wood and petroleum are the key sources of GHG emissions in all three categories (CO2, CH4, and N2O).

$$Total_{kg_{CO2}} = Energy\ Use\ (mmBtu) \times Emission\ Factor\ (kg_{CO2}\ per\ mmBtu)$$

$$Total_{g_{CH4}} = Energy\ Use\ (mmBtu) \times Emission\ Factor\ (g_{CH4}\ per\ mmBtu)$$

$$Total_{g_{N2O}} = Energy\ Use\ (mmBtu) \times Emission\ Factor\ (g_{N2O}\ per\ mmBtu)$$

or

$$Total_{kg_{CO2}} = Energy\ Use\ (mmBtu) \times Emission\ Factor\ (kg_{CO2}\ per\ kWh)$$

$$Total_{g_{CH4}} = Energy\ Use\ (mmBtu) \times Emission\ Factor\ (g_{CH4}\ per\ kWh)$$

$$Total_{g_{N2O}} = Energy\ Use\ (mmBtu) \times Emission\ Factor\ (g_{N2O}\ per\ kWh)$$

4.1.3.5 Results

The table below shows the total GHG emissions calculated for an **average household** using these energy sources. The total CO2 emissions for electricity are 1481.9 kilograms, with CH4 emissions at 0.2 grams and no N2O emissions. For petroleum, the CO2 emissions are significantly higher at 4924.9 kilograms, accompanied by 196.9 grams of CH4 and 39.4 grams of N2O emissions.

A notable amount of CH4 and N2O emissions is also associated with petroleum consumption. This indicates MN has a high dependency on petroleum as an energy source, which poses potential risks due to price volatility, environmental impact, and health impact.

According to the table's data, petroleum contributes to 77% of CO_2 emissions, 100% of CH_4 emissions, and 100% of N_2O emissions. This highlights the high GHG emissions intensity of petroleum as an energy source.

On the other hand, electricity represents 24% of energy usage and contributes 23% to CO_2 emissions. In this case, the emissions of CH_4 and N_2O from electricity usage are negligible. This GHG emission share can be reduced as renewable generation serving households increases.

Given the disproportionately high emissions from petroleum, electrification and adopting renewable energy could significantly reduce the community's carbon footprint.

Table 10: Total GHG emission per household highlighted in green (kg and g units)

MN - Residential							Total GHG Emission per Household					
Source	kwH	mmBTU_equivalent	CO2_factor (kg / unit)	CH4_factor (g / unit)	N2O_factor (g / unit)	Units	kg_CO2	g_CH4	g_N2O	perc_CO2	perc_CH4	perc_N2O
Biomass		0.00	93.80	7.20	3.60	mmBTU	0.0	0.0	0.0	0%	0%	0%
Electricity	6077.99	20.74	0.24	0.00	0.00	kWh	1481.9	0.2	0.0	23%	0%	0%
Petroleum		65.63	75.04	3.00	0.60	mmBTU	4924.9	196.9	39.4	77%	100%	100%
Natural Gas		0.00	53.06	1.00	0.10	mmBTU	0.0	0.0	0.0	0%	0%	0%
Geothermal		0.00	0.00	0.00	0.00	mmBTU	0.0	0.0	0.0	0%	0%	0%

Table 11: Total Residential GHG emission in MN highlighted in green (metric tons and kg units)

		Total Residential GHG		
No. of Households	**Source**	**MT_CO2**	**kg_CH4**	**kg_N2O**
111	Biomass (wood/wood residuals)	-	-	-
	Electricity	164.49	0.02	0.00
	Petroleum	546.67	21.86	4.37
	Natural Gas	-	-	-
	Geothermal	-	-	-

As for the institutional sector of the Mi'kmaq Nation (MN), The total municipal GHG emissions reflect the impact of these sources in the **tables below**:

- **Electricity**: With a total consumption of 22,594 kWh, electricity contributes a relatively small percentage of GHG emissions: 4% CO2, 0% CH4, and 0% N2O, equivalent to 5.51 metric tons of CO2. This suggests a cleaner profile for electricity usage, which will improve as more renewable energy enters the system.
- **Petroleum**: It remains the **primary source of GHG emissions**, contributing to 67% CO2, 66% CH4, and 66% N2O emissions, amounting to 89.83 metric tons of CO2, which is substantial and indicates a high emissions factor.
- **Propane**: This source also has a **significant impact**, with 29% CO2, 34% CH4, and 34% N2O emissions, translating into 39.43 metric tons of CO2. The high emissions from propane suggest it is an area where emission reduction could be targeted.

Table 12: Total Municipal GHG emission in MN highlighted in green (kg and g units)

MN - Commercial / Institutional			Total Municipal GHG Emission					
Source	**Total mmBtu**	**Units**	**kg_CO2**	**g_CH4**	**g_N2O**	**perc_CO2**	**perc_CH4**	**perc_N2O**
Biomass (wood/wood residuals)	0.00	mmBTU	-	-	-	0%	0%	0%
Electricity	22594.00	kWh	5,508.83	0.65	0.08	4%	0%	0%
Petroleum	1197.05	mmBTU	89,826.93	3,591.16	718.23	67%	66%	66%
Propane	627.17	mmBTU	39,430.30	1,881.52	376.30	29%	34%	34%
Geothermal	0.00	mmBTU	-	-	-	0%	0%	0%

Table 13: Total Municipal GHG emission in MN highlighted in green (metric tons and kg units)

	Total Municipal GHG Emission		
Source	**MT_CO2**	**kg_CH4**	**kg_N2O**
Biomass (wood/wood residuals)	-	-	-
Electricity	5.51	0.00	0.00
Petroleum	89.83	3.59	0.72
Propane	39.43	1.88	0.38
Geothermal	-	-	-

4.2 GHG Reduction Measures

Fossil fuel and propane use are the predominant contributors to CO_2 emissions in the residential and institutional sector, so the following GHG reduction measures are considered.

4.2.1 Increase Residential and Municipal Energy Efficiency

Home Electrification: Transition home energy systems from fossil fuels to electricity. This includes **replacing** oil-based heating systems, water heaters, and stoves with more **efficient electric** heat pumps, electric water heaters, and induction cooktops, which can be powered by renewable energy.

Comprehensive Energy Audits: Conduct home energy audits to identify opportunities for energy-saving improvements and to prioritize actions that yield the best energy savings.

Insulation Enhancement: To reduce heating and cooling costs, upgrade the **insulation** in walls, roofs, and floors. This also includes sealing air leaks around doors, windows, and other openings.

High-Efficiency Windows and Doors: Install energy-efficient windows and doors to minimize heat loss in winter and heat gain in summer.

Energy-Efficient Appliances: Encourage using Energy Star-rated appliances and electronics to lower energy consumption.

4.2.2 Adopt Distributed Renewable Energy

Adopting distributed energy resources (DER) such as solar panels and small-scale wind turbines **goes well** with the residential electrification initiative. Installing solar and wind:

- generates renewable energy locally;
- aligns with the community's cultural values of environmental stewardship;
- reduces GHG emissions;
- potentially creates jobs within the tribe; and
- yields long-term cost savings;

The community can also consider larger-scale solar that will serve the entire community, such as community solar programs. Adding battery systems to these DER portfolios will increase system resilience when the sun and wind are out.

Here are the individual recommendations for adopting DERs:

Solar Panel Installations: Encourage the installation of rooftop solar panels on residential buildings to increase the production of renewable energy and reduce reliance on the grid.

Battery Storage Systems: Solar installations can be paired with home battery storage systems, allowing residents or the community to store excess solar energy for use during peak demand times or outages.

Community Solar Programs: Develop community solar projects that allow households without suitable roofs for solar panels to benefit from solar energy.

4.2.3 Comprehensive Energy Audit

Although sourced from established organizations, the current methodologies for estimating the residential GHG inventory could be improved further.

Acquiring *actual* residential electricity bills and gallons of petroleum consumed shall be part of the comprehensive energy audit, which will be a time-intensive activity and will be addressed in the CCAP phase.

These gathered data shall provide a more accurate GHG inventory, leading to a better quantitative benefits analysis.

Sample methodology involved once actual electricity and fossil fuel consumptions are acquired are as follows:

Petroleum Heat Content: Start with petroleum's energy content. Petroleum products, such as heating oil, typically have a heat content value expressed in British thermal units (Btu) per gallon. The exact value can vary, but a common figure is about 138,690 Btu per gallon, which aligns with the EPA emission factor table.

Total Btu Consumption: Multiply the household's annual consumption in gallons by the heat content in Btu/gallon to get the total annual Btu consumption.

Conversion to mmBTU: Since 1 million Btu (mmBTU) is a standard unit for large energy quantities, convert the total Btu to mmBTU.

CO2 Emission Factor: The EPA's CO2 emission factor for petroleum is commonly provided in kg CO2 per mmBTU.

Calculate CO2 Emissions: Multiply the total mmBTU by the CO2 emission factor to estimate the total annual CO2 emissions from the household's petroleum usage.

The final figure shall provide the estimated annual CO2 emissions from the residential home's petroleum usage in kilograms.

4.3 Benefits Analysis

Overall, adopting the GHG reduction measures outlined in the previous section can provide social, economic, and environmental benefits that extend beyond monetary savings. This effectively fosters a holistic approach to community development and well-being.

Home electrification, when coupled with the **adoption of DERs** like solar panels, can lead to a sustainable energy model that respects the cultural values of environmental stewardship and positions the community as a leader in green energy initiatives.

Energy audits and subsequent **efficiency enhancements** would lower energy demand, reducing energy costs and decreasing energy production needs. This, in turn, minimizes the community's carbon footprint and mitigates its impact on climate change.

Enhancing insulation and installing high-efficiency windows and appliances would reduce energy consumption and improve home comfort, a benefit that would be felt directly by the residents daily.

4.4 Review of Authority to Implement

The Mi'kmaq Nation as a federally recognized Indian Tribe has the authority to make decisions for the health and wellbeing for its community and to accept funds from the Federal government and expend said funds for the benefit of the community. This includes entering into agreements and contracts with private entities to build community improvements on Tribal Trust Lands for the benefit of the Tribe's citizens.

Passamaquoddy at Pleasant Point (Sipayik)

Priority Climate Action Plan

Prepared for:

U.S. Environmental Protection Agency
Climate Pollution Reduction Grant Program

Prepared by:

Passamaquoddy Pleasant Point's Environmental Department,

in conjunction with Larsen & Toubro Ltd,
the Tribe's contracted technical service provider.

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Table of Contents

1 Introduction

1.1 Tribe Background

The Passamaquoddy (Peskotomuhkati) are a Native American people who live in northeastern North America. Their traditional homeland, Peskotomuhkatik, straddles the Canadian province of New Brunswick and the U.S. state of Maine in a region called Dawnland. They are one of the constituent nations of the Wabanaki Confederacy.

The Passamaquoddy Pleasant Point Reservation (Sipayik) is one of two reservations of the federally recognized Passamaquoddy Tribe and is located in Washington County, Maine. There are 633 enrolled tribal members at the Pleasant Point Reservation. The total population of the Pleasant Point Reservation is 750. Of the 750 people within Reservation boundaries, about 51 are under the age of five, 71 are over the age of 65, 163 have access and functional needs, and 265 are economically challenged.

Sipayik (Pleasant Point) is located in Northeast Maine near the Canadian – U.S. border on a peninsula, west of the Little River and Passamaquoddy Bay and east of Cobscook Bay. The Reservation is bisected by County Road 190 and bordered by the Town of Perry to the north and the City of Eastport to the south. According to the U.S. Census, the Reservation has a total area of 0.6 mi2 (1.6 km2).

Passamaquoddy Bay and neighboring West Isles Archipelago traditionally provided an abundance of salt-water food fish due to the productivity of the deep, cold, strong upwelling currents. The productivity and diversity of fish within the Passamaquoddy Bay region was truly magnificent, fitting the description of a Garden of Eden. Nature provided everything the Passamaquoddy people needed to thrive. In this environment we developed a vibrant Indigenous Economy.

Pleasant Point: Located about one mile from the US-Canada international boundary the Pleasant Point Reservation aka "Sipayik" is a small 300-acre rocky peninsula and serves as home to about 1,000 Passamaquoddy citizens. It is nestled within a group of islands known as the "Quoddy Region Archipelago" and sits where the Cobscook and Passamaquoddy Bays converge. Today Pleasant Point is a modern community with a rich history emerging from the seat of an ancient Passamaquoddy fishing village.

1.2 History and Culture

Passamaquoddy have lived and flourished within our homeland at the least since the time when the Laurentide Ice Glaciers melted away from this part of North America, about 10 to 14 thousand years ago.

For those millennia, the Passamaquoddy way of life was to hunt, fish, trap and gather food and medicine and to employ the natural resources of the environment to sustain our communities. The Pleasant Point peninsula is a traditional seasonal fishing village to the Passamaquoddy. Because of its unique location at the confluence of the Passamaquoddy and Cobscook Bays it was the perfect place to harvest salt water resources such as shell fish and other fish.

Over the past 400 years the encroachment and degradation of the resources in our homeland forced Passamaquoddies to adapt, forcing a shift away from our traditional indigenous economy. We had to find alternative ways to survive and to feed our families.

The Passamaquoddy Tribe of Pleasant Point, Maine (Sipayik) currently lives on a 319-acre reservation. The Tribe shares population, lands and waters with the politically distinct Passamaquoddy Tribe of Indian Township, Maine, and the Schoodic Band of Passamaquoddy in New Brunswick Canada. The Passamaquoddy Tribe currently has an estimated 3,611 people on the tribal census rolls. The Passamaquoddy tribe still lives in its ancestral homelands. The relationship the tribe's culture, language and traditions have with the surrounding environment goes back for more than 500 generations. The Tribe has adapted to environmental changes as can be learned in tribal stories and folklore. There is also archaeological evidence of tribal climate adaptations. These deep relationships with the lands and waters of the St. Croix River Watershed, the Passamaquoddy Bay and other waterbodies in the Passamaquoddy homeland cannot be understated. Therefore it is of utmost importance to the Passamaquoddy Tribe that tribal lands and waters are protected from all sources of degradation and changes to the land planned for and addressed properly.

The Passamaquoddy ancestral homeland is about 6,277 square miles in size. The Passamaquoddy homeland is made up of a number of watersheds in between, the Penobscot River in Maine and the St. John River in NB Canada. Currently, the tribe has about 118,000 acres of land held in trust by the United States and about 10,000 acres of fee land in the State of Maine. The lands held by Passamaquoddy are in the tribe's traditional homeland and also in western Maine where the tribe has maple syrup trees and prime moose hunting grounds near current day Jackman, Maine.

1.3 Natural Resources

Passamaquoddy Bay and neighboring West Isles Archipelago also provided an abundance of salt-water food fish due to the productivity of the deep, cold, strong upwelling currents. The productivity and amount of diversity of fish within the Passamaquoddy Bay region was truly magnificent, fitting the description of a "Garden of Eden." Nature provided everything the Passamaquoddy people needed to thrive. In this environment we developed an Indigenous Economy. The Quoddy Region is a unique ecosystem with diverse habitats for a variety of feeding, resting, spawning and nursing migratory fish and wildlife species. The Pleasant Point Reservation was chosen by the Passamaquoddy Ancestors because of its direct and immediate access to the rich and abundant resources of the marine environment. (See map below)

It is the Sipayik Environmental Department's mission statement "to preserve, protect, restore, and enhance all tribal lands, waters, air and human health and to develop means to monitor and enforce tribal environmental policies." This mission assists the Passamaquoddy Tribe of Pleasant Point (Sipayik) Maine to protect, restore, and conserve culturally significant places, species and practices for future generations. As climatic conditions become uncertain, the development of a living document to address impacts and concerns related to natural and cultural resources will build tribal resilience and adaptation strategies throughout the Ancestral Homelands.

Passamaquoddy Ancestral Homelands extend from the Lepreau River, New Brunswick, Canada, to the Union River, Maine, and back to the Chiputneticook Lakes, Maine. Passamaquoddy Tribe currently has three reservations, each with their own governing body, in Maine and New Brunswick. In addition, the tribe holds ~118,000 acres of land held in trust by the United States Government, and ~10,000 acres of fee land in the State of Maine.

The Sipayik Environmental Department currently monitors tribal lands, waters, fisheries, and air for restoration and conservation of culturally important places, species, and practices. Environmental staff as documented changes to natural resources, including water quality and biodiversity, from a scientific and traditional ecological knowledge (TEK) perspective. The efforts of the department and the Tribe to understand these changes in light of climatic uncertainty are constantly evolving, as capacity builds.

2 Tribal Organization and Considerations

Pleasant Point Passamaquoddy Reservation is a Passamaquoddy Indian Reservation governed by the elected Chief, Vice Chief and Council from Pleasant Point a public body corporate and political subdivision of the Passamaquoddy Tribe. Pleasant Point is responsible for management of matters which pertain to the Pleasant Point Reservation as well as management of the tribally owned fee lands nearby located in the near the reservation in the towns of Perry and Robbinston, and may assume responsibility over other tribal trust or fee lands within the state of Maine through agreement or understanding with either Indian Township or the Joint Tribal Council.

Tribal Vision Statement

To live in peace and harmony as one family within an affectionate, healthy and united band deeply rooted in the cultural values and traditions of the ancestors with access to resources providing stability and prosperity with the freedom to determine our own destiny.

Tribal Mission Statement

To protect tribal sovereignty and our freedom of self-determination, to preserve our heritage and culture for our future generations, to insure equal rights for all members of the tribe, to create fair opportunities for the economic and domestic well-being of all members of the Passamaquoddy Tribe.

2.1 Housing

Adequate, safe, warm homes are a major public health issue on the reservation. The Tribe owns and administers 73 apartment units and there are 200 privately owned residences on the reservation. All families living in tribally owned housing would benefit from improved air circulation, improved insulation, waterproofing systems, and increased energy efficiency.

2.2 Public Facilities

Assets and buildings that are vulnerable to climate events include the tribal office, health center, fire station, police department, youth center, museum, business center, wastewater facility, elderly community center and apartments, housing department building, Passamaquoddy water co., tribal roads on reserve, and tribal roads on trust lands.

2.3 LIDAC statement

The Tribe is considered a Low Income Disadvantaged Community (LIDAC). As such, any activities to improve lives through improved living conditions, reduced cost of living, quality employment, and health directly benefit a LIDAC community.

2.4 The Changing Climate

The Gulf of Maine is one of the fastest warming regions of the ocean. The influence of the cold, deep-water currents from North and the warmer Gulf Stream current from the South creates a unique, temperate water ecosystem with high biodiversity. Historically, the Gulf of Maine, including Passamaquoddy Bay and Cobscook Bay, was home to abundant groundfish populations, including cod, haddock, and Pollock - the namesake of the Passamaquoddy Tribe.

The Passamaquoddy Tribe at Pleasant Point is a coastal reservation located between Passamaquoddy and Cobscook Bays. Tribal members have hunted, fished, and lived here since time immemorial. Their culture and identity is deeply rooted in the natural environment. They harvested Pollock by hand from the shore and operated fish weirs in the coves. Groundfish stocks supported the economy of the tribe and the larger Downeast region of Maine. In the wake of their decline, the fishing community increased pressure on alternate resources, including lobster and shellfish, for sustenance and economic viability.

Despite the reservation's coastal location, Passamaquoddy Ancestral Homelands encompass multiple freshwater ecosystems with connections to the Gulf of Maine. These freshwater resources also provide the tribe with cultural, economic, and sustenance resources. Given the vital connectivity between the two ecosystems and their deeply rooted connection the environment, tribal members have felt the effects of climate change for generations. The community will continue to be one of the first affected, providing them with an opportunity to stand on the forefront of adaptation planning. The Passamaquoddy Tribe's coastal location on the Gulf of Maine and its freshwater connections creates a unique situation with the potential for multiple environmental stressors and the need for adaptation and resilience under future climatic scenarios. At Pleasant Point, local level effects of climate change may include sea level rise, rising air temperatures, more extreme and more frequent weather events, increased precipitation, ocean acidification, rising sea surface temperatures and coastal erosion.

Woli-litu - living sustainably (in balance)

[Excerpts in boxes from *Wolankeyutomuk: Wabanaki Inter-tribal Climate Change Adaptation Guidebook,Tribal Culture and Adaptation*]

Tribal communities are becoming increasingly more vulnerable to climate change with the combined impact of past anthropogenic changes and limited access to the resources. Native American views of health include the ability to interconnect with the land, culturally significant food sources and water bases of ancestral origins. Separation from these aspects of wellness have had their negative implications to socio-ecological systems, socio-psychological and spiritual development within Native society and subsistence way of life over the generations.

The Wabanaki have identified the Loss of Economic Security both traditional and nontraditional and the Loss of Cultural Resilience as most urgent in environmental changes within the next decade. For the Wabanaki, cultural resilience is an urgent concern emerging from challenges imposed by the anthropogenic impacts of climate change and access to culturally significant resources. Thus, the need for a culturally responsive approach to adaptation includes planning mechanisms of social-ecological and socio-cultural relevance using indigenous perspectives that will empower cultural resilience and guide future generations.

Ancestrally, Wabanaki cosmology has been a central way of life that includes a paradigm as co-participant amid the ever changing ecology and involves sharing the land and water with others - both human and non-human, referred to conceptually as holism.

For over 500 years of colonization, our access to our original territories, language, cultural practices and belief systems have been met with numerous challenges during the profit driven challenges to the environment. In the interim, the carrying capacity of our lands have been compromised. It is incumbent upon our generation to provide the path forward by ensuring the continuance of the next 7 generations for human and non-human species.

Adaptation Strategies:

Strategy 5: Reduce the impact of biological and anthropogenic stressors. Climate change will cause stress and changes within native ecosystems. These climate-driven stressors can interact with other stressors that may already be occurring on the landscape. Reducing the effects of biological stressors such as (non-local beings) and human-caused stressors like water pollution and soil disturbance can be an important part of a climate adaptation plan. The Approaches that follow describe different ways of maintaining clean air, clean water, and clean land.

5.4. Reduce negative impacts from anthropogenic disturbances. Respectful and purposeful human interactions in ecosystems can leave minimal effects or even benefit an environment. However, some human-caused disturbances from recreation, infrastructure, development, or pollution can cause negative impacts. Reducing the negative impacts can form part of a climate adaptation plan.

Assess, Monitor, and Reduce Climate Pollution.

*Although air pollution is a global problem, **local efforts to reduce climate pollution**, improve air quality, and alert community members of air quality issues are important. Monitoring the air quality in your region will allow you to reduce ambient air pollution and its negative effects when possible and communicate these issues with the local population.*

3 PCAP Elements

3.1 Greenhouse Gas (GHG) Inventory (required)

3.1.1 Scope

The scope of this GHG inventory exercise was kept to the boundaries of the tribal trust land. Specifically, GHG inventory was estimated for:

- Tribal government service buildings (ongoing); and
- Tribal residential households;

3.1.2 Data Sources

Data used for the GHG inventory are sourced from reputable U.S. government agencies and organizations highlighted below.

3.1.2.1 U.S. Environmental Protection Agency (EPA)

The GHG inventory exercise used the emission factors from the **2024 GHG Emission Factors Hub** as part of the data inputs. The document provides specific CO2, CH4, and N2O emission factors for various fuels, including coal, natural gas, petroleum products, and biomass fuels.

These factors, (e.g., kg CO2 per mmBtu, g CH4 per mmBtu) along with data on fuel consumed, enable precise calculations of GHG emissions from combustion sources (see image below).

Blue text indicates an update from the 2023 version of this document.

Emission Factors for Greenhouse Gas Inventories
Last Modified: 13 February 2024

Table 6 Electricity

eGRID Subregion Acronym	eGRID Subregion Name	Total Output Emission Factors: CO_2 Factor (lb CO_2 / MWh)	CH_4 Factor (lb CH_4 / MWh)	N_2O Factor (lb N_2O / MWh)
AKGD	ASCC Alaska Grid	1,052.1	0.088	0.012
AKMS	ASCC Miscellaneous	495.8	0.023	0.004
AZNM	WECC Southwest	776.0	0.051	0.007
CAMX	WECC California	497.4	0.030	0.004
ERCT	ERCOT All	771.1	0.049	0.007
FRCC	FRCC All	813.8	0.048	0.006
HIMS	HICC Miscellaneous	1,155.5	0.124	0.019
HIOA	HICC Oahu	1,575.4	0.163	0.025
MROE	MRO East	1,479.6	0.133	0.019
MROW	MRO West	[illegible]	[illegible]	[illegible]
NEWE	NPCC New England	536.4	0.063	0.008

	mmBtu per gallon	kg CO_2 per mmBtu	g CH_4 per mmBtu	g N_2O per mmBtu	kg CO_2 per gallon	g CH_4 per gallon	g N_2O per gallon
Petroleum Products							
Asphalt and Road Oil	0.158	75.36	3.0	0.60	11.91	0.47	0.09
Aviation Gasoline	0.120	69.25	3.0	0.60	8.31	0.36	0.07
Butane	0.103	64.77	3.0	0.60	6.67	0.31	0.06
Butylene	0.105	68.72	3.0	0.60	7.22	0.32	0.06
Crude Oil	0.138	74.54	3.0	0.60	10.29	0.41	0.08
Distillate Fuel Oil No. 1	0.139	73.25	3.0	0.60	10.18	0.42	0.08
Distillate Fuel Oil No. 2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Distillate Fuel Oil No. 4	0.146	75.04	3.0	0.60	10.96	0.44	0.09

	mmBtu per gallon	kg CO_2 per mmBtu	g CH_4 per mmBtu	g N_2O per mmBtu	kg CO_2 per gallon	g CH_4 per gallon	g N_2O per gallon
Biomass Fuels - Solid							
Agricultural Byproducts	8.25	118.17	32	4.2	975	264	35
Peat	8.00	111.84	32	4.2	895	256	34
Solid Byproducts	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Wood and Wood Residuals	17.48	93.80	7.2	3.6	1,640	126	63

Figure 1: GHG Excerpt showcasing the various emission factors (GHG produced per MWh/gal/mmBtu) depending on the region of interest.

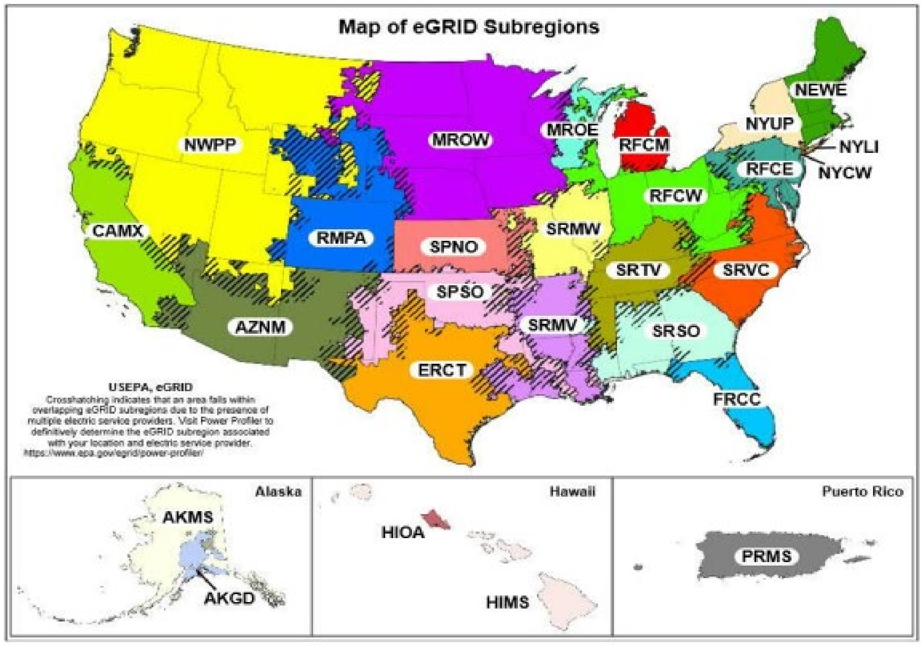


Figure 2: This is an illustration of the eGrid map. The community is located within the NPCC New England (NEWE) subregion. The image is reproduced from the U.S. EPA's GHG inventory tool.

Petroleum Products	mmBtu_per_gal	kg_CO2_per_mmBtu	kg_CH4_per_mmBtu	kg_N2O_per_mmBtu	kg_CO2_per_gallon	kg_CH4_per_gallon	kg_N2O_per_gallon
Fuel Oil No. 4	0.138	75.04	3	0.6	10.21	0.41	0.08
Biomass		93.8	7.2	3.6			
Propane	0.091	62.87	3	0.6	5.72	0.27	0.05

Electricity Emission Factor	lb CO2_per_MWh	lb CH4_per_MWh	lb N2O_per_MWh
NEWE (NPCC New England)	536.4	0.063	0.008
	kg_CO2_per_kWh	kg_CH4_per_kWh	kg_N2O_per_kWh
	0.243818182	2.86364E-05	3.63636E-06

Conversion

~~lb~~ / ~~MWh~~	kg / 2.2~~lb~~	~~MWh~~ / 1000 kWh	=	**536.4 kg / 2,200 kWh**
	3412 ~~Btu~~ / kwh	1 mmBtu / 1000000 ~~Btu~~	=	**0.003412 mmBtu**

Figure 3: Emission Factors Acquired from EPA

3.1.2.2 U.S. Census Bureau

Tribal demographic data was acquired via the U.S. Census Bureau's "My Tribal Area" platform, which provides detailed demographic, social, economic, and housing statistics for the nation's communities every year. These statistics are acquired via the American Community Survey (ACS).[1]

[1] U.S. Census Bureau. (n.d.). Tribal Resources. Retrieved from https://www.census.gov/tribal/

Pertinent data gathered are the number of households per tribe.

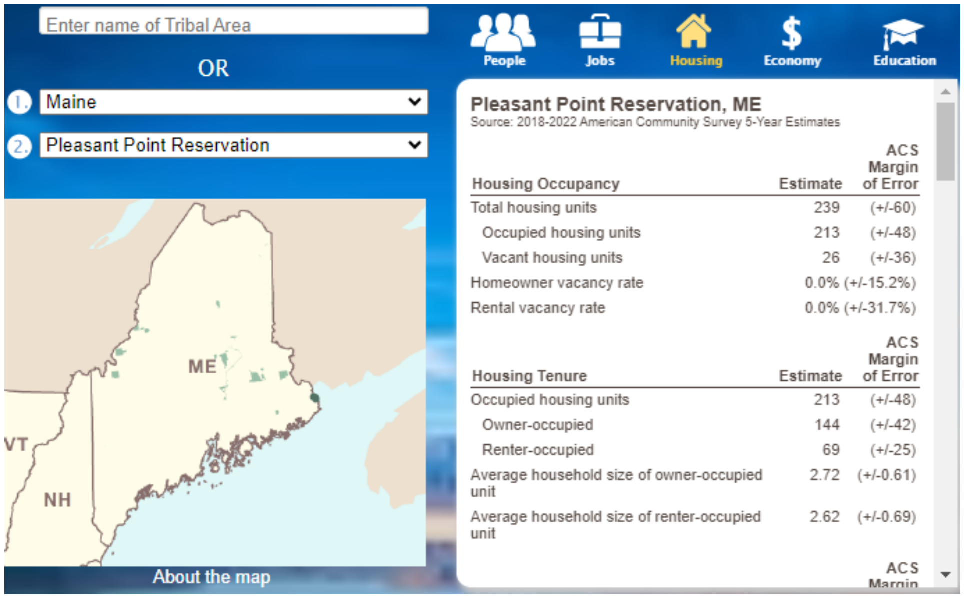


Figure 4: Community demographic data acquired from the U.S. Census Bureau

3.1.2.3 Lawrence Livermore National Laboratory (LLNL)

The study leveraged LLNL's Maine-specific Energy Consumption Sankey Diagram to estimate the distribution of energy source types that a typical Maine residential home uses.

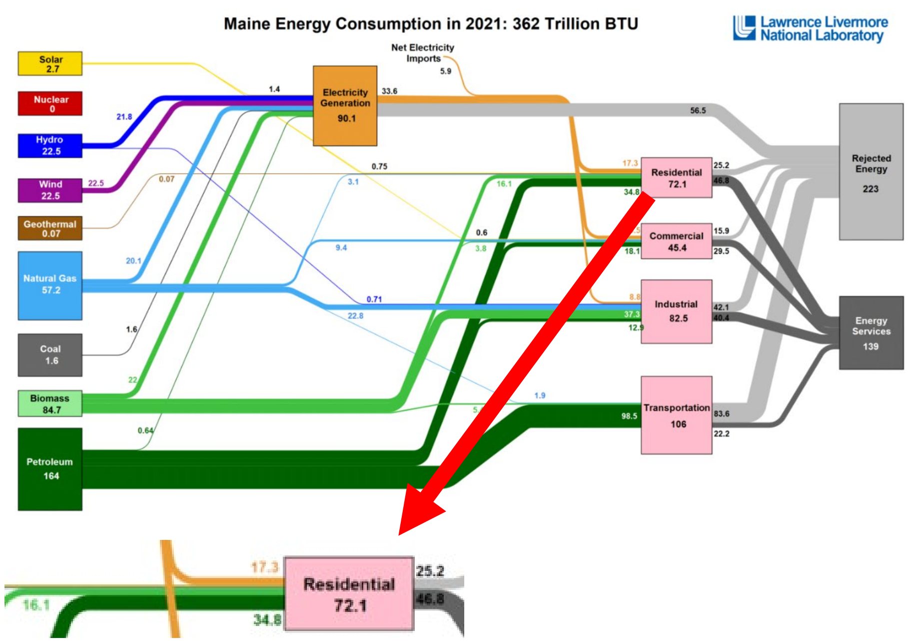


Figure 5: LLNL Sankey diagram, showcasing energy flow from various sources such as biomass, petroleum, natural gas, and geothermal towards electricity

generation and end-use sectors, including residential, commercial, industrial, and transportation. Image reproduced from LLNL website.

For example, out of the arbitrary 72.1 units of energy used in a Maine household, 16.1 units come from Biomass highlighted as light green in the diagram (wood pellets and wood-derived fuel). 17.3 energy units come from electricity, 34.8 from petroleum, etc.

If we summarize the distribution of energy type use per home, we will have the following table of percentages.

Table 1: Breakdown of residential energy consumption in British thermal units (Btu)

Source	Trillion Btu	Percentage
Biomass	16.10	22%
Electricity	17.30	24%
Petroleum	34.80	48%
Natural Gas	3.10	4%
Geothermal	0.75	1%
TOTAL	**72.05**	

This also aligns with another diagram provided by the EIA and confirms that the share of each energy type hasn't changed much since 2016

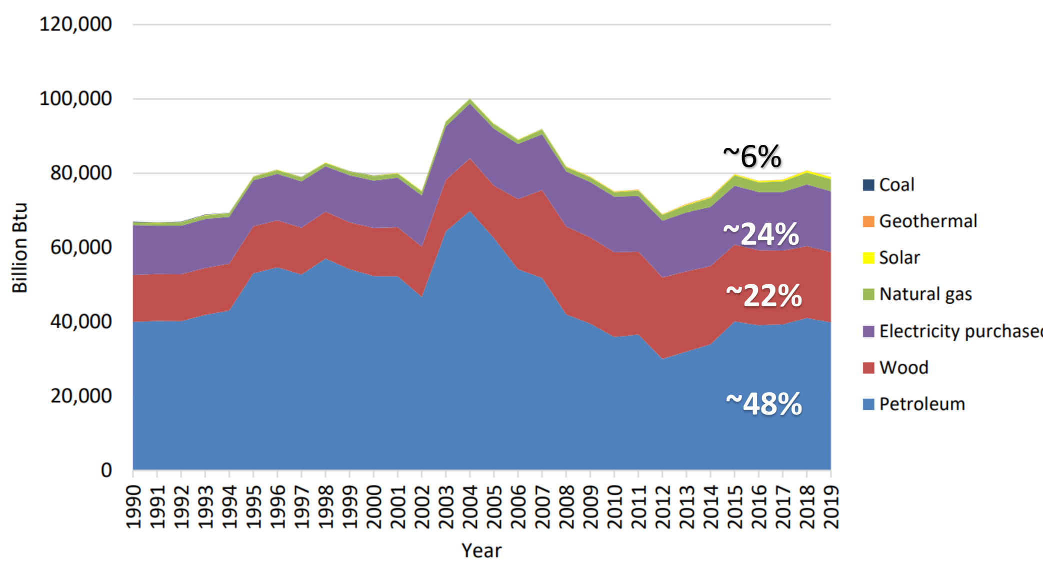


Figure 6: Maine residential energy consumption trend shows that the usage share of each energy type has remained the same since 2016. Image reproduced from the U.S. Energy Information Agency.

3.1.2.4 Versant Power and In-house Data

Versant Power, an established utility serving loads within MN, PPP, and near HBMI, has a dataset of typical residential load profiles. These profiles were used as assumptions on how much a typical tribal household consumes annually. The dataset acquired was for calendar year 2023.

Table 2: Versant Energy's Typical Residential Load Profile

VERSANT POWER						
Residential Profiles		**Hourly Demand (kW)**				
Hour		1	2	3	…	24
JAN	WEEKDAY	0.58	0.55	0.52	…	0.62
	WEEKEND	0.59	0.55	0.53	…	0.63
FEB	WEEKDAY	0.52	0.50	0.49	…	0.57
	WEEKEND	0.53	0.51	0.49	…	0.57
MAR	WEEKDAY	0.51	0.47	0.45	…	0.55
	WEEKEND	0.51	0.42	0.46	…	0.55
APR	WEEKDAY	0.44	0.41	0.39	…	0.48
	WEEKEND	0.44	0.41	0.39	…	0.48
MAY	WEEKDAY	0.42	0.38	0.36	…	0.47
	WEEKEND	0.42	0.38	0.37	…	0.47
JUN	WEEKDAY	0.42	0.37	0.35	…	0.50
	WEEKEND	0.42	0.38	0.36	…	0.50
JUL	WEEKDAY	0.49	0.44	0.41	…	0.56
	WEEKEND	0.48	0.43	0.41	…	0.56
AUG	WEEKDAY	0.48	0.44	0.42	…	0.57
	WEEKEND	0.49	0.45	0.42	…	0.57
SEP	WEEKDAY	0.41	0.38	0.36	…	0.47
	WEEKEND	0.42	0.38	0.36	…	0.47
OCT	WEEKDAY	0.45	0.42	0.39	…	0.50
	WEEKEND	0.46	0.47	0.40	…	0.50
NOV	WEEKDAY	0.48	0.45	0.43	…	0.53
	WEEKEND	0.49	0.45	0.44	…	0.50
DEC	WEEKDAY	0.60	0.56	0.54	…	0.70
	WEEKEND	0.61	0.57	0.55	…	0.71

Table 3: Derived Electric Energy Consumption Data

Avg_hourly kW	Avg_daily kWh	Subtotal_monthly kWh	Total_monthly kWh
0.82	19.62	431.65	
0.83	19.86	178.78	610.44
0.75	18.01	360.13	
0.76	18.19	145.53	505.66
0.71	17.03	357.53	
0.72	17.24	172.40	529.93
0.62	14.96	299.22	
0.63	15.15	151.52	450.74

0.61	14.56	334.80	
0.62	14.82	118.59	453.39
0.60	14.42	317.20	
0.61	14.62	116.98	434.19
0.67	15.97	335.38	
0.66	15.94	159.38	494.76
0.68	16.25	373.75	
0.68	16.36	130.88	504.63
0.61	14.53	305.19	
0.62	14.88	133.90	439.10
0.67	16.13	354.89	
0.68	16.41	147.69	502.58
0.71	17.07	375.65	
0.72	17.32	138.53	514.18
0.86	20.52	430.98	
0.86	20.74	207.44	638.42
		Avg_monthly_kwh	**506.50**
		Total_annual_kwh	**6077.99**

As shown in the table, a typical tribal home, according to Versant Power data, consumes 6077 kWh of electricity annually (506.5 kWh monthly average). This is a close estimate to the State of Maine Governor's Energy Office estimates that the average electrical use for a 1,000-square-foot home is 550 kWh.

3.1.2.5 Actual Tribal Data

3.1.2.5.1 Number of Residential Households

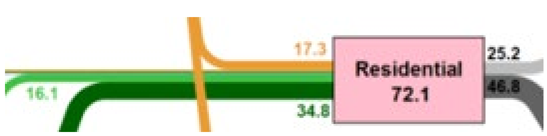
Census data was then compared to data collected from HBMI, MN, and PPP.

Table 4: Household Count of U.S. Census Bureau and Tribal Data

Data Source	Residential Household Count		
	HBMI	**MN**	**PPP**
U.S. Census Bureau	97	107	213
Tribal Data	82	111	236

Tribal data was used for the GHG inventory exercise.

3.1.2.5.2 Tribal-Specific Energy Source Use



According to Lawrence Livermore National Laboratory (LLNL), the residential sector in Maine consumed 72.1 Trillion Btus of energy in 2021. Of this, 17.3 Trillion Btus (24%) were consumed as electricity, 16.1 Trillion Btus (22%) as biomass, 34.8 Trillion Btus (48%) as fossil fuel, mostly petroleum, 3.1 Trillion Btus (4%) as natural gas, and 0.75 Trillion Btus (1%) as geothermal (see Table 1).

This 2021 Maine residential energy consumption model is used as the **base model** for determining the distribution of energy source consumption. Adjustments were made based **on tribal-specific practices**.

Specifically, PPP households don't use natural gas or geothermal energy.

In line with this, the generic Maine residential energy consumption model is adjusted to assume that the energy usage from geothermal and natural gas is transferred proportionally to petroleum and biomass. The distribution then is shown below.

The same process shall be applied to the PPP municipal buildings. Data gathering is ongoing and requires more time to complete. This activity shall be accomplished in the CCAP.

Table 5: PPP Residential Energy Consumption

Source	perc_Btu
Biomass	24%
Electricity	24%
Petroleum	52%
Natural Gas	0%
Geothermal	0%

Table 6: PPP Municipal Energy Consumption

Source	Total mmBtu	perc_Btu
Biomass	Ongoing	Ongoing
Electricity	Ongoing	Ongoing
Petroleum	Ongoing	Ongoing
Propane	Ongoing	Ongoing
Geothermal	Ongoing	Ongoing

3.1.3 GHG Inventory Study

3.1.3.1 Overview

The methodologies employed to infer the GHG emissions data involved the following steps:

Data Acquisition: The data mentioned in the previous sections were leveraged to establish a baseline on energy consumption sources and their corresponding magnitudes.

Data Transformation: The gathered energy consumption data was converted into GHG units given as follows:

- kilograms of CO2
- grams of NO2
- grams of CH4

Assumptions and Limitations Acknowledgment: The group acknowledges the challenges and limitations of the methodology selected. Having more time and resources in the CCAP phase will help improve the accuracy of the GHGI overall.

3.1.3.2 Inferring Data from Electricity Use Using EIA and LLNL Data

Using LLNL's Sankey diagram and cross-referencing it with a typical household's estimated annual electric energy use, we can derive the mmBtu equivalent of the other residential energy sources, as shown in Table 4 (highlighted in yellow).

Table 7: *PPP - mmBtu Use per Household*

Source	perc_BTU	kWh	mmBTU_equivalent
Biomass	24%		20.76
Electricity	24%	6077.9	20.74
Petroleum	52%		44.87
Natural Gas	0%		0
Geothermal	0%		0

No. of Households
236

$$\frac{3412\ \cancel{Btu}}{kwh} \quad \frac{1\ mmBtu}{1000000\ \cancel{Btu}} = \frac{\mathbf{0.003412\ mmBtu}}{\mathbf{kWh}}$$

3.1.3.3 Extracting EPA Emission Factors

To determine the corresponding CO2, CH4, and N2O emitted from consuming an energy source, we refer to the table below, which converts mmBtu or kWh to kg/g of CO2, CH4, and N2O.

Table 8: EPA Emission Factors for each energy source

Residential Use	CO2_EF (kg/unit)	CH4_EF (g / unit)	N2O_EF (g / unit)	Unit
Biomass	93.80	7.20	3.60	mmBtu
Electricity	0.24	0.00	0.00	kWh
Petroleum (Fuel Oil No.4)	75.04	3	0.6	mmBtu
Natural Gas	53.06	1.00	0.10	mmBtu
Propane	62.87	3	0.6	mmBtu

3.1.3.4 Apply Calculations to EIA, LLNL, and EPA variables

We then perform the simple operations in the next section and acquire the Total Residential GHG emission in metric tons (MT), as shown in the table below. By inspection, we can see that wood and petroleum are the key sources of GHG emissions in all three categories (CO2, CH4, and N2O).

$$Total_{kg_{CO_2}} = Energy\ Use\ (mmBtu) \times Emission\ Factor\ (kg_{CO2}\ per\ mmBtu)$$

$$Total_{g_{CH_4}} = Energy\ Use\ (mmBtu) \times Emission\ Factor\ (g_{CH4}\ per\ mmBtu)$$

$$Total_{g_{N2O}} = Energy\ Use\ (mmBtu) \times Emission\ Factor\ (g_{N2O}\ per\ mmBtu)$$

or

$$Total_{kg_{CO_2}} = Energy\ Use\ (mmBtu) \times Emission\ Factor\ (kg_{CO2}\ per\ kWh)$$

$$Total_{g_{CH_4}} = Energy\ Use\ (mmBtu) \times Emission\ Factor\ (g_{CH4}\ per\ kWh)$$

$$Total_{g_{N2O}} = Energy\ Use\ (mmBtu) \times Emission\ Factor\ (g_{N2O}\ per\ kWh)$$

3.1.3.5 Results

Table 10 below shows the total GHG emissions calculated for the residential sector using these energy sources. The total CO_2 emissions for electricity are 349.73 metric tons of CO_2, with CH_4 emissions at 0.04 kilogram and 0.01 kilogram N_2O emissions. For petroleum, the CO_2 emissions are significantly higher at 794.63 metric tons, accompanied by 31.77 kilograms of CH_4 and 6.35 kilograms of N_2O emissions.

Lastly, biomass usage significantly contributed to GHG emissions due to its high emission factors. Total CO_2 emission 495.54 metric tons, with 35.27 kg of CH_4 and 17.64 kg of N_2O.

A notable amount of CH_4 and N_2O emissions are observed from petroleum and biomass consumption. This indicates PPP households have a high dependency on:

- **Petroleum** which poses potential risks due to price volatility, environmental impact, and health impact.
- **Biomass** which only accounts 24% of energy usage but contributes to 29%, 53% and 74% of CO_2, CH_4 and N_2O emissions respectively. However, it is acknowledged that properly-sourced wood pellets **in general** are carbon neutral sources of energy.

According to the table's data, petroleum contributes to 50% of CO_2 emissions, 47% of CH_4 emissions, and 26% of N_2O emissions. This highlights the high GHG emissions intensity of petroleum as an energy source along with biomass.

On the other hand, electricity represents 24% of energy usage and contributes 22% to CO_2 emissions. In this case, the emissions of CH_4 and N_2O from electricity usage are negligible. This GHG emission share can be reduced as renewable generation serving households increases.

Given the disproportionately high emissions from petroleum and biomass, shying away from burning wood, electrification, and adopting renewable energy could significantly reduce the community's carbon footprint.

Table 9: Total GHG emission per household highlighted in green (kg and g units)

PPP - Residential							Total GHG Emission per Household					
Source	kwH	mmBTU_equivalent	CO2_factor (kg / unit)	CH4_factor (g / unit)	N2O_factor (g / unit)	Units	kg_CO2	g_CH4	g_N2O	perc_CO2	perc_CH4	perc_N2O
Biomass (wood/wood residuals)		20.76	93.80	7.20	3.60	mmBTU	1947.2	149.5	74.7	29%	53%	74%
Electricity	6077.9	20.74	0.24	0.00	0.00	kWh	1481.9	0.2	0.0	22%	0%	0%
Petroleum		44.87	75.04	3.00	0.60	mmBTU	3367.1	134.6	26.9	50%	47%	26%
Natural Gas		0	53.06	1.00	0.10	mmBTU	0.0	0.0	0.0	0%	0%	0%
Geothermal		0	0.00	0.00	0.00	mmBTU	0.0	0.0	0.0	0%	0%	0%

Table 10: Total Residential GHG emission in PPP highlighted in green (metric tons and kg units)

		Total Residential GHG		
No. of Households	Source	MT_CO2	kg_CH4	kg_N2O
236	Biomass (wood/wood residuals)	459.54	35.27	17.64
	Electricity	349.73	0.04	0.01
	Petroleum	794.63	31.77	6.35
	Propane	-	-	-
	Geothermal	-	-	-

3.2 GHG Reduction Measures

The GHGI exercise shows that **fossil fuel and biomass** use are the predominant contributors to CO2 emissions in the residential sector. Therefore, the following GHG reduction measures are considered in the following subsections. Recommendations for the municipality sector are likely similar but inconclusive for now due to the ongoing data gathering process.

3.2.1 Increase Residential Energy Efficiency

Aim for Sustainable Wood Pellet Practices: It is acknowledged that wood pellets are generally considered carbon-neutral at the point of combustion because the CO2 emitted is roughly equal to the CO2 absorbed by the trees from which the pellets are made, over their growth cycle. However, if the goal is to decarbonize rather than to aim for net-zero carbon, then adhering to sustainable biomass standards such as the Forest Stewardship Council (FSC), can ensure that wood pellet production does not lead to deforestation.

Home Electrification: Transition home energy systems from fossil fuels and biomass to electricity. This includes **replacing** oil/wood-based heating systems, water heaters, and stoves with more **efficient electric** heat pumps, electric water heaters, and induction cooktops, which can be powered by renewable energy.

Comprehensive Energy Audits: Conduct home energy audits to identify opportunities for energy-saving improvements and to prioritize actions that yield the best energy savings.

Insulation Enhancement: To reduce heating and cooling costs, upgrade the **insulation** in walls, roofs, and floors. This also includes sealing air leaks around doors, windows, and other openings.

High-Efficiency Windows and Doors: Install energy-efficient windows and doors to minimize heat loss in winter and heat gain in summer.

Energy-Efficient Appliances: Encourage using Energy Star-rated appliances and electronics to lower energy consumption.

3.2.2 Adopt Distributed Renewable Energy

Adopting distributed energy resources (DER) such as solar panels and small-scale wind turbines **goes well** with the residential electrification initiative. Installing solar and wind:

- generates renewable energy locally;
- aligns with the community's cultural values of environmental stewardship;
- reduces GHG emissions;
- potentially creates jobs within the tribe; and
- yields long-term cost savings;

The community can also consider larger-scale solar that will serve the entire community, such as community solar programs. Adding battery systems to these DER portfolios will increase system resilience when the sun and wind are out.

Here are the individual recommendations for adopting DERs:

Solar Panel Installations: Encourage the installation of rooftop solar panels on residential buildings to increase the production of renewable energy and reduce reliance on the grid.

Battery Storage Systems: Solar installations can be paired with home battery storage systems, allowing residents or the community to store excess solar energy for use during peak demand times or outages.

Community Solar Programs: Develop community solar projects that allow households without suitable roofs for solar panels to benefit from solar energy.

3.2.3 Comprehensive Residential and Municipal Energy Audit

Although sourced from established organizations, the current methodologies for estimating the residential GHG inventory could be improved further. Municipal data gathering efforts should also be continued to have a more comprehensive GHG inventory.

Acquiring *actual* residential electricity bills and gallons of petroleum consumed shall be part of the comprehensive energy audit, which will be a time-intensive activity and will be addressed in the CCAP phase.

These gathered data shall provide a more accurate GHG inventory, leading to a better quantitative benefits analysis.

Sample methodology involved once actual electricity and fossil fuel consumptions are acquired are as follows:

Petroleum Heat Content: Start with petroleum's energy content. Petroleum products, such as heating oil, typically have a heat content value expressed in British thermal units (Btu) per gallon. The exact value can vary, but a common figure is about 138,690 Btu per gallon, which aligns with the EPA emission factor table.

Total Btu Consumption: Multiply the household's annual consumption in gallons by the heat content in Btu/gallon to get the total annual Btu consumption.

Conversion to mmBTU: Since 1 million Btu (mmBTU) is a standard unit for large energy quantities, convert the total Btu to mmBTU.

CO2 Emission Factor: The EPA's CO2 emission factor for petroleum is commonly provided in kg CO2 per mmBTU.

Calculate CO2 Emissions: Multiply the total mmBTU by the CO2 emission factor to estimate the total annual CO2 emissions from the household's petroleum usage.

The final figure shall provide the estimated annual CO2 emissions from the residential home's petroleum usage in kilograms.

3.3 Benefits Analysis

Overall, adopting the GHG reduction measures outlined in the previous section can provide social, economic, and environmental benefits that extend beyond monetary savings. This effectively fosters a holistic approach to community development and well-being.

Home electrification, when coupled with the **adoption of DERs** like solar panels, can lead to a sustainable energy model that respects the cultural values of environmental stewardship and positions the community as a leader in green energy initiatives.

Energy audits and subsequent **efficiency enhancements** would lower energy demand, reducing energy costs and decreasing energy production needs. This, in turn, minimizes the community's carbon footprint and mitigates its impact on climate change.

Enhancing insulation and installing high-efficiency windows and appliances would reduce energy consumption and improve home comfort, a benefit that would be felt directly by the residents daily.

3.4 Review of Authority to Implement

The Passamaquoddy Tribe at Pleasant Point (Sipayik) as a federally recognized Indian Tribe has the authority to make decisions for the health and wellbeing for its community and to accept funds from the Federal government and expend said funds for the benefit of the community. This includes entering into agreements and contracts with private entities to build community improvements on Tribal Trust Lands for the benefit of the Tribe’s citizens.