LUMMI NATION
STRATEGIC ENERGY PLAN
2016-2026

Prepared for:
Lummi Indian Business Council
(LIBC)

Funded by:
U.S. Environmental Protection Agency
Performance Partnership Grant
(Grant No. BG-00J13401-0,-1,-2)

Prepared by:
Water Resources Division
Lummi Natural Resources Department

Contributors:
Kara Kuhlman CFM, Natural Resources Analyst
Monika Lange, Natural Resources Analyst (former)
Jeremy Freimund P.H., Water Resources Manager
Gerald Gabrisch GISP, GIS Manager

Date:
February 2016

This project has been funded wholly or in part by the United States Environmental Protection Agency under Performance Partnership Grant BG-00J13401-0,-1,-2 to the Lummi Nation. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

TABLE OF CONTENTS

List of Figures

List of Tables

Appendices

EXECUTIVE SUMMARY

The purpose of the Lummi Nation Strategic Energy Plan: 2016-2026 (SEP) is to evaluate current and future energy needs and resources on the Lummi Indian Reservation (Reservation) and to identify options for improving energy efficiency and developing renewable energy resources over the 2016-2026 planning period. Successful implementation of the SEP will help attain the Lummi Nation's stated goals of (1) improved economic and energy self-sufficiency and (2) reduced emissions from energy production and use that contribute to global climate change, air quality degradation, and other adverse environmental and human health impacts.

Tribal energy self-sufficiency has been a goal of the Lummi Nation since at least 1993 when the Lummi Indian Business Council (LIBC – the governing body of the Lummi Nation) passed a resolution (No. 1993-121) directing the Community Development Director to explore a proposal for a tribally owned and operated gas-fired cogeneration facility on the Reservation. Ultimately, development of the cogeneration facility was not recommended, but pursuit of the option started the Lummi Nation moving toward a now long-standing goal to become more energy self-sufficient. In recent years, progress toward energy self-sufficiency has focused on reducing energy use by improving energy efficiency and producing energy from renewable sources, driven largely by increasing awareness of the economic and environmental costs of nonrenewable energy production and use.

In addition, LIBC Resolution No. 2014-084 *Guiding Principles to Address Climate Change* recently directed the LIBC administration to undertake efforts as soon as practicable to reduce the Lummi Nation's contribution to global climate change. Climate change is caused, in large part, by the combustion of carbon-based fossil fuels (e.g., petroleum, natural gas, coal), which releases carbon dioxide (CO_2), a heat-trapping greenhouse gas, into the atmosphere. Climate change affects not only air temperature (i.e., global warming), but also sea surface temperature, sea level, ocean pH (i.e., ocean acidification), precipitation patterns, storm events, and other physical systems. Based on the SEP, the Lummi Nation finds that failure to improve energy self-sufficiency and reduce greenhouse gas emissions has a direct, serious, and substantial adverse effect on the political integrity, economic security, health, and welfare of the Lummi Nation, its treaty rights, its members, and all persons present on the Reservation.

The goals of the Lummi Nation Strategic Energy Plan: 2016-2026 will be attained through achievement of the following objectives:

1. Provide a summary of potential energy resources (nonrenewable and renewable) and the costs and benefits associated with each resource;

2. Identify current energy supplies and suppliers used on the Reservation;

3. Conduct a load assessment to evaluate the current and future energy needs of the Reservation;

4. Evaluate energy efficiency practices and opportunities on the Reservation including an assessment of energy efficiency technology options and associated costs and benefits;

5. Evaluate potential renewable energy resources on the Reservation in terms of economic and environmental costs and benefits;

6. Recommend an action plan and associated budget to increase energy self-sufficiency on the Lummi Indian Reservation.

Based on the assessment of current energy resources, baseline energy use, anticipated future energy demand, and current and potential future energy efficiency practices and renewable energy development on the Reservation, this Strategic Energy Plan recommends that the following action items be implemented in the 2016-2026 planning period:

1. Adopt a Lummi Indian Business Council resolution that establishes an achievable but ambitious goals for reducing energy use on and carbon emissions from the Lummi Indian Reservation. Goals should provide clear direction and set specific standards against which improvements may be measured (e.g., "reduce emissions by 15 percent from 2010 levels by 2025").

2. Create a permanent, full-time Energy Management Specialist position within the Lummi Planning and Public Works Department. See Table 8.1 for the estimated annual budget.

3. Implement all of the energy efficiency practices recommendations presented in Table 6.1 and the renewable energy sources recommendations presented in Table 7.2, focusing initial efforts on the following high priority items:

    a. Conduct energy audits at tribal facilities and prioritize the implementation of energy efficiency practices based on the findings of these energy audits.

    b. Institutionalize the Residential Energy Efficiency Pilot Program as funding allows.

    c. Encourage walking, biking, carpooling, and public transportation on the Reservation through employer incentives and infrastructure improvements.

    d. Mandate high energy efficiency standards in new construction.

    e. Purchase green power to offset some or all electricity use at selected tribal institutions.

    f. Continue to pursue photovoltaic (solar) electricity production and geothermal heating/cooling in new or substantially improved tribal facilities.

4. Provide community education and outreach to increase awareness of the issues surrounding energy and climate change and increase participation in energy conservation programs.

5. Identify and obtain funding to implement energy efficiency improvements and development of renewable energy resources. See Table 8.2 for a partial list of potential external funding sources.

1. INTRODUCTION

This section describes the goals and objectives of the Lummi Nation Strategic Energy Plan: 2016-2026 (SEP), details the importance of strategic energy planning to the Lummi Nation and within a broader regional context, and summarizes how the plan is organized. This SEP has been prepared by the Lummi Nation as a guide to develop and implement effective, integrated environmental programs specific to the needs of the Lummi Nation. This SEP was developed by the Water Resources Division of the Lummi Natural Resources Department (LNR).

1.1. Goals and Objectives of the Strategic Energy Plan

The purpose of the Lummi Nation Strategic Energy Plan: 2016-2026 (SEP) is to evaluate current and future energy needs and resources on the Lummi Indian Reservation (Reservation) and to identify options for improving energy efficiency and developing renewable energy resources over the 2016-2026 planning period. Successful implementation of the SEP will help attain the Lummi Nation's stated goals of (1) improved economic and energy self-sufficiency and (2) reduced emissions from energy production and use that contribute to global climate change, air quality degradation, and other adverse environmental and human health impacts.

The goals of the Lummi Nation Strategic Energy Plan: 2016-2026 will be achieved through the following objectives:

1. Provide a summary of potential energy resources (nonrenewable and renewable) and the costs and benefits associated with each resource;

2. Identify current energy supplies and suppliers used on the Reservation;

3. Conduct a load assessment to evaluate the current and future energy needs of the Reservation;

4. Evaluate energy efficiency practices and opportunities on the Reservation including an assessment of energy efficiency technology options and associated costs and benefits;

5. Evaluate potential renewable energy resources on the Reservation in terms of economic and environmental costs and benefits;

6. Recommend an action plan and associated budget to increase energy self-sufficiency on the Lummi Indian Reservation.

1.2. Why the Lummi Nation is Planning for Energy

The Lummi Nation has identified several reasons for undertaking strategic energy planning, the top two are (1) to improve economic and energy self-sufficiency of the tribe and (2) to reduce emissions from energy use on the Reservation.

Tribal energy self-sufficiency has been a goal of the Lummi Nation since at least 1993 when the Lummi Indian Business Council (LIBC) passed a resolution (No. 1993-121) directing the

Community Development Director to explore a proposal for a tribally owned and operated gas-fired cogeneration facility on the Reservation. The cogeneration facility was intended to meet the growing electrical energy needs of the Reservation and surrounding region and to generate steam to facilitate commercial and industrial development. Ultimately, development of the cogeneration facility was not recommended because it was determined not be economically feasible at that time. Regardless, pursuing the option started the Lummi Nation moving toward a now long-standing goal to become more energy self-sufficient.

Over the past 20 years, it has become increasingly evident that implementation of energy efficiency practices and development of renewable energy resources (e.g., solar, geothermal, wind) are preferable alternatives for attaining energy self-sufficiency, rather than energy production using carbon-based fossil fuels (e.g., petroleum, natural gas, coal). Fossil fuel sources are finite and human demand for these resources will eventually deplete accessible reserves. As such, the costs of fossil fuels and secondary sources of energy (e.g., electricity) derived from fossil fuels are growing and becoming increasingly volatile. Reducing energy use by improving energy efficiency and/or producing energy from renewable sources can not only provide a higher level of energy reliability and security, save money on energy bills, and minimize adverse environmental impacts from energy production and use, but also offers ample opportunity for economic development and job creation.

More recently, LIBC Resolution No. 2014-084 *Guiding Principles to Address Climate Change* directed the LIBC administration to undertake efforts as soon as practicable to reduce the Lummi Nation's contribution to global climate change (Appendix A). Climate change is caused, in large part, by the combustion of carbon-based fossil fuels (e.g., petroleum, natural gas, coal), which releases carbon dioxide (CO_2), a heat-trapping greenhouse gas (GHG), into the atmosphere. Human activities since the mid-17th century have increased the atmospheric concentrations of CO_2 and other GHGs (i.e., methane, nitrous oxide, chloroflurocarbons), thereby enhancing the process that mediates the Earth's energy budget, called the greenhouse effect. Greenhouse gasses serve as the Earth's blanket, without which the Earth would be too cold to be habitable by humans. Increasing the concentration of GHGs in the atmosphere is like using a thicker blanket; the greenhouse effect is enhanced and additional warming occurs. This is referred to as global warming, though it is important to note that changes in climate affect not only air temperature, but also sea surface temperature, sea level, ocean pH (i.e., ocean acidification), precipitation patterns, storm events, and other physical systems. A detailed account of potential climate change impacts on the Reservation is provided in the *Lummi Nation Climate Change Mitigation and Adaptation Plan: 2016-2026*. Generally, impacts are expected to exacerbate some existing natural hazards on the Reservation (e.g., riverine and coastal flooding, coastal erosion, drought, wildfire) and introduce new hazards (e.g., spread of diseases and pests, ocean acidification).

Addressing the causes of climate change requires taking action to reduce anthropogenic greenhouse gas emissions, the quantity of which will determine the extent and severity of climate change over the coming decades-to-centuries. For Reservation residents, this means reducing energy use from nonrenewable, carbon-based energy sources (e.g., gasoline and diesel for transportation, propane and natural gas for heating, electricity generated at coal-fired power plants). Other environmental and human health benefits realized by reducing fossil fuel consumption may include improved air quality and a reduced risk of oil spills, which could have a devastating impact on the ability of Lummi tribal members to exercise their treaty rights.

1.3. Adoption of the Strategic Energy Plan

The Lummi Indian Business Council passed Resolution No. 2016-041 on February 16, 2016 to formally adopt the Lummi Nation Strategic Energy Plan: 2016-2026 (Appendix B). In adopting the plan, the LIBC considered not only the merits of the plan, but also the recommendation of the Lummi Natural Resources Department Director and Deputy Director (meeting held on December 1, 2015), the Lummi Fisheries and Natural Resources Commission (meeting held December 3, 2015), and the Lummi Planning Commission (meeting held on December 8, 2015) that the plan be adopted by the LIBC.

1.4. Planning in a Regional Context

Strategic energy planning is becoming an increasingly evident priority among federal, state, local, and tribal governments and agencies. At the national level, several new energy and climate policies have emerged over the past decade. Recent federal legislation that promotes energy efficiency, low-carbon technologies, and renewable energy development include the Energy Policy Act of 2005, the Energy Independence and Security Act of 2007, and the American Recovery and Reinvestment Act of 2009, among others. Also new within the past ten years, the Environmental Protection Agency (EPA) is now regulating greenhouse gases as "air pollutants" pursuant to the Clean Air Act. In 2009, the EPA finalized the Mandatory Greenhouse Gas Reporting Rule, which requires large greenhouse gas emitters to monitor and report their emissions annually. In 2010, the EPA finalized more protective greenhouse gas emissions standards for light vehicles (effective beginning model year 2016). Currently, the EPA is working to finalize the proposed Clean Power Plan, which is intended to introduce standards that will cut carbon pollution from power plants. National awareness of projected climate change impacts on the United States has also been bolstered by the release of President Barak Obama's Climate Action Plan (2013) and Executive Order No. 13653 – Preparing the United States for the Impacts of Climate Change (2013), as well as publication of the U.S. Global Change Research Program (USGCRP) Third National Climate Assessment (2014). The key messages of these federal efforts are clear: (1) climate change is occurring now, (2) we need to cut carbon pollution, and (3) we need to prepare for the impacts of climate change.

Washington State is also taking action on energy use and climate change. Beginning in earnest in 2007, then Governor Christine Gregoire directed state agencies to work toward reducing greenhouse gas emissions in the state (Executive Order No. 07-02 – Washington Climate Change Challenge). As a result, statutory limits on carbon emissions were signed into law in 2008 (Revised Code of Washington [RCW] 70.235.020), which required a reduction of greenhouse gas emissions to 1990 levels by 2020. In 2012, the Washington State Department of Ecology (Ecology) published the state's climate change action plan, *Preparing for a Changing Climate: Washington State's Integrated Climate Response Strategy* (Publication No. 12-01-004).

Building on this framework, Governor Jay Inslee recently signed Executive Order No. 14-04 – Washington Carbon Pollution Reduction and Clean Energy Action, which is aimed at reducing carbon emissions and developing and implementing renewable energy and energy efficiency technologies. A Carbon Emissions Reduction Taskforce (CERT) is currently considering market-based mechanisms for reaching the carbon emission reduction goals established in RCW 70.235.020, including a carbon tax, carbon cap-and-trade, or a hybrid system, that were introduced to the state legislature in 2015. The efforts of Washington State to mitigate and prepare for climate change continue to provide a model for state-level planning that is just beginning in some other areas of the country.

Indian Tribes are also providing leadership on energy and climate policy. As summarized by the Affiliated Tribes of Northwest Indians (ATNI):

> Energy development and transmission should honor our sovereign governmental status. Our land rights should not be adversely affected by changes in the energy industry. Our cultural resources and fish, wildlife, and treaty resources should not be harmed by energy operations. Indian people are energy consumers. Tribes are also owners of energy resources and are seeking to use those resources, whether renewable or non-renewable, to generate electricity and economic development and need access to transmission. Lastly, tribes seek a continued voice in public processes regarding energy matters.

Among the 20 member tribes of the Northwest Indian Fisheries Commission (NWIFC) there are already several energy and climate change programs underway. In 2007, the Upper Skagit Indian Tribe was one of the first tribes in the region to complete a strategic energy plan that included recommendations for energy efficiency and renewable energy. The Swinomish Indian Tribe has a well-developed climate change program, called the Swinomish Climate Change Initiative. Through the initiative, the tribe has published a climate change impact assessment and a climate change adaptation plan, and has started implementing action items recommended in the reports. Several other tribes are currently in the process of developing their own climate change impact assessments. There is also a diverse range of climate change research being piloted by tribal governments. For instance, the Nooksack Indian Tribe is conducting research on glacier ablation rates in the Nooksack River watershed and the subsequent effect of glacier melt on stream temperature and flow. Meanwhile, the Tulalip Tribes recently commissioned a study to develop baseline carbon budgets in the Snohomish River basin. These are but a few of the many examples of the tribal commitment to climate change planning in the Pacific Northwest.

Some local governments have also taken steps to plan for climate change. Notably, Whatcom County and the City of Bellingham have each adopted climate protection plans that recognize the need for action. The City of Bellingham in particular set substantial greenhouse gas emissions reduction targets for the city government operations and the community and has initiated an aggressive program to meet these targets.

1.5. Assessment Organization

This Assessment is organized into the following sections:

- Section 1 is this introductory section.

- Section 2 describes the climate, land use, and socioeconomic conditions of the Reservation and the government of the Lummi Nation.

- Section 3 summarizes of the past, present, and future energy sources, uses, and costs in the United States, as well as a description of the current energy supplies and suppliers on the Reservation.
- Section 4 is a baseline assessment of the energy load on the Reservation in 2010.
- Section 5 is a description of the future energy needs of the Reservation.
- Section 6 evaluates current and potential future energy efficiency practices on the Reservation and the costs and benefits of improving these practices.
- Section 7 evaluates current and potential future renewable energy sources on the Reservation and the costs and benefits of developing these resources.
- Section 8 presents the recommended 2016-2026 action plan.
- Section 9 presents a summary and conclusion.
- Section 10 is the list of references cited in this plan.

The list of acronyms and abbreviations and appendices follow Section 10.

(This page intentionally left blank)

2. DESCRIPTION OF THE LUMMI INDIAN RESERVATION

The Lummi Indian Reservation (Reservation) is located in northwest Washington State, approximately eight miles west of Bellingham, Washington (Figure 2.1). The Reservation is located along the western border of Whatcom County and at the southern extent of Georgia Strait and the northern extent of Puget Sound. Approximately 38 miles of highly productive marine shoreline surround the Reservation uplands on all but the north and northeast borders. The Reservation includes approximately 12,500 acres of uplands and 7,000 acres of tidelands. The Nooksack River drains a watershed of approximately 786 square miles, flows through the Reservation near the mouth of the river, and discharges to Bellingham Bay (and partially to Lummi Bay during high flows). The Reservation is comprised of a five-mile long peninsula (Lummi Peninsula), which separates Lummi Bay on the west and Bellingham Bay on the east; a northern upland area (Northwest Uplands) and the smaller Sandy Point peninsula that separates Georgia Strait on the west and Lummi Bay on the east; the floodplains and deltas of the Lummi River and the Nooksack River; Portage Island; and associated tidelands (Figure 2.2). The remainder of this section briefly describes the climate, land use, and socioeconomic conditions of the Reservation, as well as the Lummi Nation's government structure.

2.1. Climate

The Pacific Northwest climate and ecology are largely shaped by the interactions that occur between seasonally varying precipitation patterns and the region's mountain ranges. Approximately 75 percent of the regions precipitation occurs in just half the year (October – April) when the Pacific Northwest is on the receiving end of the Pacific storm track. Based on climate data collected at the nearby Bellingham International Airport, the average annual precipitation on the Reservation is approximately 36 inches. On average, November, December, and January are the wettest months; June, July, and August are the driest months.

Temperature on the Reservation is relatively mild year round. Temperature data collected at the Bellingham Airport from 1949-2005 indicate that the warmest months are July and August. During these months the average maximum daily temperature is approximately 71 degrees Fahrenheit (^{o}F). December and January are the coldest months when the average minimum daily temperatures are about 32^{o}F. The growing season is "the portion of the year when soil temperature (measured 20 inches below the surface) is above biological zero (5° Celsius [°C] or 41°F)". May through September is the approximate growing season for agricultural crops in the area (Gillies 1998).

Wind data for Bellingham indicate that the prevailing wind direction on the Reservation is from the south and southeast with gusts upward of 80 miles per hour. Winds from the west are not as common and generally not as strong (ACOE 1997). Wind roses developed from meteorological data collected at two locations on the Reservation as part of a wind energy development feasibility assessment over the January 2011 through January 2012 period indicate that the wind direction is from the south-southeast or south about 50 percent of the time and from the north or northeast about 15 percent of the time (DNV KEMA 2012).

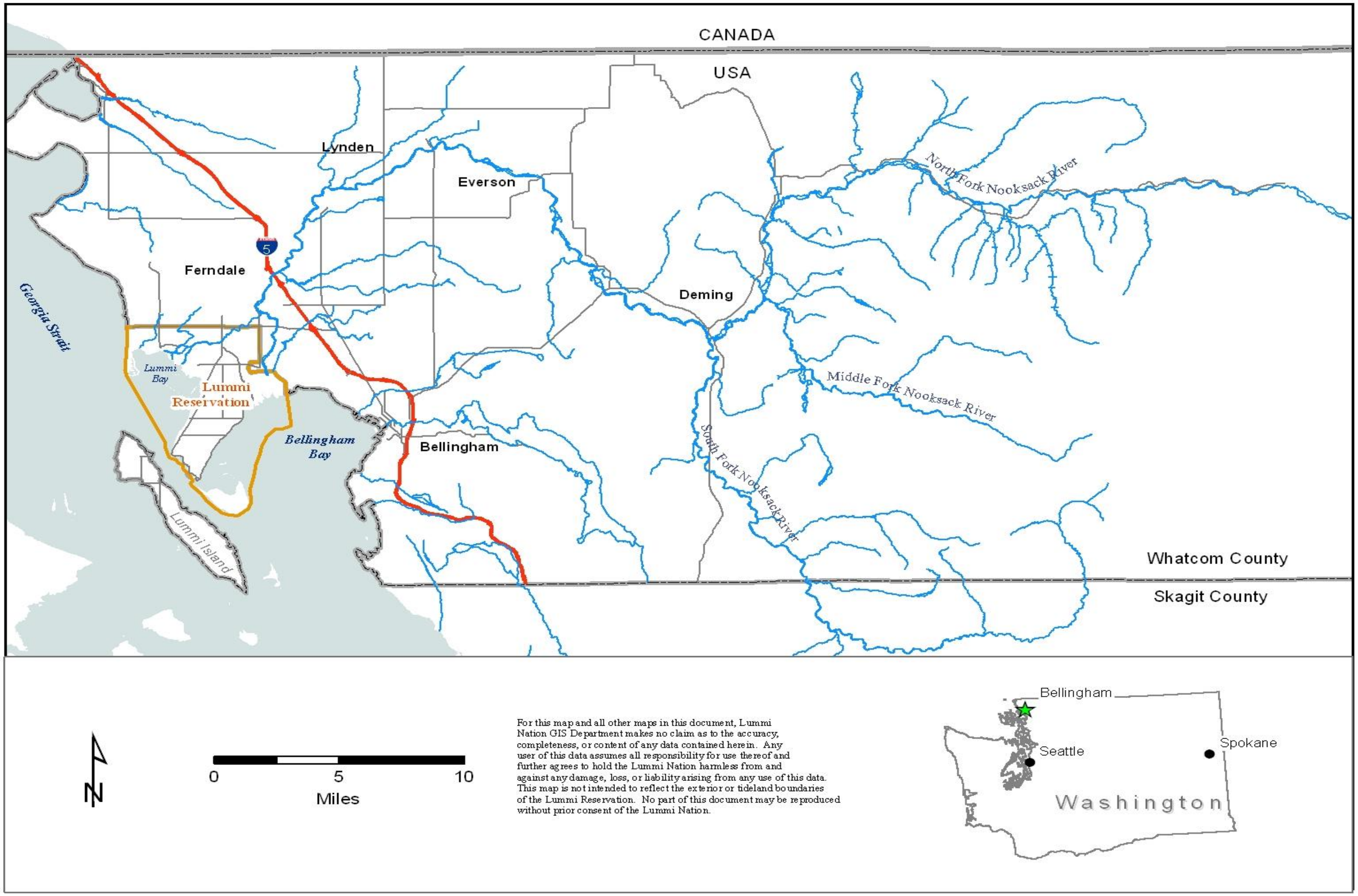


Figure 2.1 Regional Location of the Lummi Indian Reservation

The Reservation experiences a variety of infrequent weather patterns. A typical but infrequent weather pattern is generated from the northeast by cold air masses moving down the Fraser River valley. Strong winds from this pattern, blowing across the Fraser and Nooksack river basins, have caused damage to the residences and businesses of the Reservation (USDA 1992). Another typical but infrequent weather pattern involves continental air masses from the east that bring unusually dry weather that can last a few days or weeks (USDA 1992). During the summer, these air masses bring unusually warm temperatures (mid to upper 90s Fahrenheit). During the winter, these air masses bring unusually cold temperatures (0°F and colder).

2.2. Land Use and Socioeconomic Conditions

Like most places, land use changes on the Reservation have been associated with changes in vegetation types, decreases in the areas covered by vegetation, changes in natural drainage patterns, and increases in impervious surfaces. With the arrival of Euro-Americans, forested land was logged, cleared, and drained for agriculture development, homes, municipal development, and commercial enterprises. Historical and current land uses in the Reservation watersheds and socioeconomic conditions on the Reservation are described below. Much of the information about historical land uses and socioeconomic conditions comes from the *Lummi Nation Comprehensive Environmental Land Use Plan: Background Document* (LIBC 1996).

2.2.1. Historical Land Use

Before the arrival of Euro-Americans, the Lummi People were a fishing, hunting, and gathering society. Based on the accounts of Lummi Elders, early European explorers, and early photographs of the region, before 1850 old-growth forests of massive Douglas fir, western hemlock, Sitka spruce, and western red cedar dominated what was to become the Lummi Indian Reservation. Deciduous trees such as western big leaf maple, black cottonwood, red alder, and western paper birch were also likely present along the rivers, streams, and open areas. Understory vegetation probably included vine maple, Oregon grape, several different willows, ocean spray, salmonberry, thimbleberry, soapberry, and many others. Wetlands, streams, and rivers supported a unique array of plants adapted to wet environments. The marine shoreline was also a unique environment, where only plants adapted to a saltwater-influenced environment thrived.

The forces that shaped vegetation patterns in the Northwest before the arrival of Euro-Americans were forest succession, fires, windstorms, ice storms, floods, and traditional use of natural vegetation by the indigenous peoples. Native American uses of vegetation included the gathering of medicinal plants, the use of willows and other shrubs for fishing, and the extensive use of western red cedar trees for many things, including clothing, baskets, buildings, and canoes. Many plants were also sources of food to complement the traditional diet of fish, shellfish, elk, and deer. Native Americans cultivated some of these plants, such as ferns, camas, and wapato, in prairies along the Nooksack River.

Figure 2.2 Lummi Indian Reservation Overview

Similar to most areas in the lower Nooksack River watershed downstream from Everson, conversion of forestland to agricultural land occurred on the Lummi Indian Reservation following the arrival of Euro-Americans. In 1896, approximately 1,222 acres were reportedly under cultivation on the Reservation. Along with clearing the forested land for agriculture, Euro-Americans constructed ditches, drained wetland areas, cleared logjams, diverted the Nooksack River to drain into Bellingham Bay, built a levee that cut off the Lummi River delta from the Nooksack River, and built a seawall along Lummi Bay. These changes in the natural hydrology of the Lummi Reservation changed the distribution and patterns of watercourses and of wetland- and riparian-associated plant communities

Much of the cedar on the Reservation was cut into shingle bolts and shipped to local shingle mills. The old-growth trees on Portage Island were cut down to fuel steamboats traveling the Nooksack River. One or more large fires swept through the Reservation area between 1850 and 1900. These fires destroyed nearly all of the remaining old-growth forests. Since reforestation was not practiced during the early logging period and did not begin until approximately 1980, pioneer tree species, such as alder, willows, and cottonwood, soon replaced the conifer forests and dominated the landscape (Leckman 1990).

Historically, the Nooksack River flowed (alternately or simultaneously) to both Lummi and Bellingham bays (effectively making the Lummi Peninsula an "island"). Before 1860, the Nooksack River discharged primarily into Lummi Bay by way of the present Lummi River channel, with smaller distributaries flowing into Bellingham Bay (WSDC 1960; Deardorff 1992). In 1860, the mainstem of the river was diverted into what was then a small stream flowing into Bellingham Bay (WSDC 1960). Since that time, considerable effort has been expended to keep the Nooksack River discharging into Bellingham Bay because of the increased commercial value of the river that resulted from its proximity to sawmills along Bellingham Bay (Deardorff 1992). Until the early 1900s, the Nooksack River was also the primary transportation corridor to as far upstream as present day Lynden. The water body remaining in the old channel of the Nooksack River has been called the Lummi River or the Red River (WSDC 1960).

In the 1920s, a reclamation project was initiated both to construct a dike/seawall to keep back the saltwater along the shore of Lummi Bay and to construct a levee along the west side of the Nooksack River (Deardorff 1992). This project, which was started in 1926 and completed in 1934, initially resulted in the nearly complete separation of the Lummi River from the Nooksack River. However, when saltwater intrusion onto the newly reclaimed farmlands and damage to the dam at the head of the Lummi River occurred during flooding, the dam was replaced with a dam and spillway structure (Deardorff 1992). This spillway structure was also damaged over the years during high-flow conditions and was replaced in 1951 by a five-foot-diameter culvert that allowed flow from the Nooksack River into the Lummi River (FEMA 2004). Currently a partially collapsed four-foot diameter culvert allows flow to the Lummi River only during relatively high-flow conditions (approximately 9,600 cubic feet per second [cfs]) (Deardorff 1992). Levees were also constructed along the Lummi River to prevent saltwater from Lummi Bay from flowing onto adjacent farmlands during higher tides. The dike and levee construction activities were accompanied by agricultural ditching to drain fields and wetland areas. Based on 1887-88 topographic surveys, Bortleson et al. (1980) estimated that wetlands located landward of the general saltwater shoreline in the lower Lummi River watershed have decreased from approximately 2.0 square miles to 0.1 square miles (95 percent) over the 1888-1973 period.

Between 1920 and 1960 several new public roads providing access to Ferndale and Bellingham as well as a toll ferry to Lummi Island were constructed and led to an increase in development on the Reservation. Since 1960 there has been a significant increase in the total population on the Reservation and the number of tribal members living on the Reservation. The increase in the number of enrolled Lummi tribal members living on the Reservation has been attributed to a number of factors including improved economic conditions within the community, the beginning of tribal self-governance, the increased rate of house construction, the development of a water distribution and a wastewater collection and treatment system, and a renewed sense of Lummi cultural identity.

2.2.2. Current Land Use

Over the last century, the increase in population, the construction of extensive road networks, development of wastewater collection and treatment systems, the construction of the Sandy Point Marina, and several tribal housing projects have fostered a trend towards higher density neighborhoods throughout the Reservation. Several distinct residential neighborhoods now exist, mainly along the shores of the Reservation including Sandy Point, Neptune Beach, Sandy Point Heights, and Gooseberry Point. Higher density residential neighborhoods can also be accessed from the numerous spur roads along Haxton Way and Lummi Shore Road, which are the primary roads along the perimeter of the Lummi Peninsula. A Lummi Nation Geographic Information Systems (GIS) analysis identified 1,975 addressed structures on the Reservation in 2009. Although increased residential and commercial development has occurred on the Reservation in the last few decades, the majority of the Reservation remains rural.

An approximation of the current land cover and land use in the Reservation watersheds is shown in Figure 2.3. This map was derived from the 2006 National Oceanic and Atmospheric Administration (NOAA) database, Classification of Coastal Washington, which is part of the Coastal Change Analysis Program (C-CAP) of the NOAA Coastal Services Center (NOAA 2006). The map gives an overview of the extent of forest and agricultural lands, residential areas, and wetlands in these watersheds. The estimated distribution of land cover/land use types within the Reservation boundaries is summarized in Table 2.1.

The majority of the forested areas are on the Lummi Peninsula, Portage Island, and the Northwest Uplands. Although there are some conifer groves and Douglas fir plantations, the 2007 inventory of Reservation forests showed that present day forests are largely comprised of deciduous trees, with some mixed deciduous/conifer stands (International Forestry Consultants, Inc. 2007). Wetlands are underrepresented on the C-CAP map, as the remote sensing analysis did not recognize big swathes of forested and scrub-shrub wetlands, but counted them towards forests and scrub-shrub. Based on the 1999 Reservation-wide wetland inventory (LWRD 2000), the percentage of the Reservation land base that is wetland is closer to 40 percent than the 3.46 percent listed in Table 2.1.

Table 2.1 Current Land Cover/Land Use Types on the Lummi Indian Reservation

Land Cover/Land Use	Percent of Area[1]
Residential	2.59
Forest	20.88
Scrub-Shrub	47.79
Wetlands	3.46
Cultivated Land/Grassland	25.28

[1] Does not include the off-Reservation portions of the Lummi Watersheds or tribal tidelands

The floodplains of the Lummi and Nooksack Rivers are sparsely developed. The most important commercial enterprise in the floodplains is the Silver Reef Hotel, Casino & Spa and the adjacent Lummi Mini Mart and gas station. This commercial center is located at the intersection of Haxton Way and Slater Road. The floodplains are dominated by agricultural lands and wetlands, both freshwater and estuarine. The tribal governmental offices are mostly located along Kwina Road; the Northwest Indian College (NWIC) is also located along Kwina Road.

Based on estimates of land cover in Whatcom County, land cover/use in the Nooksack River watershed is generally dominated by forested areas upstream from the town of Deming and agricultural lands downstream from Deming (Whatcom County 2005). The agricultural lands in the lowlands were largely forested before the arrival of Euro-Americans and had been largely denuded of trees by 1925 (Pierson 1953, as cited in Smelser 1970). Population centers such as Ferndale, Lynden, Everson, and Deming are located adjacent to the Nooksack River.

2.2.3. Future Land Use

Future development on the Reservation is guided by a number of tribal laws (Lummi Nation Code of Laws [LCL]) and associated regulations including:

- LCL Title 15: Land Use, Development, and Zoning Code
- LCL Title 15A: Flood Damage Prevention Code
- LCL Title 16: Sewer and Water District Code
- LCL Title 17: Water Resources Protection Code
- LCL Title 22: Building Code
- LCL Title 40: Cultural Resources Preservation Code

Figure 2.4 shows the current official zoning map of the Lummi Reservation. This zoning map was revised and adopted by the LIBC in 2004 as part of the comprehensive planning effort currently underway by the Planning and Public Works Department. The zoning update incorporated comments from tribal departments and commissions and from public comments received during four community meetings.

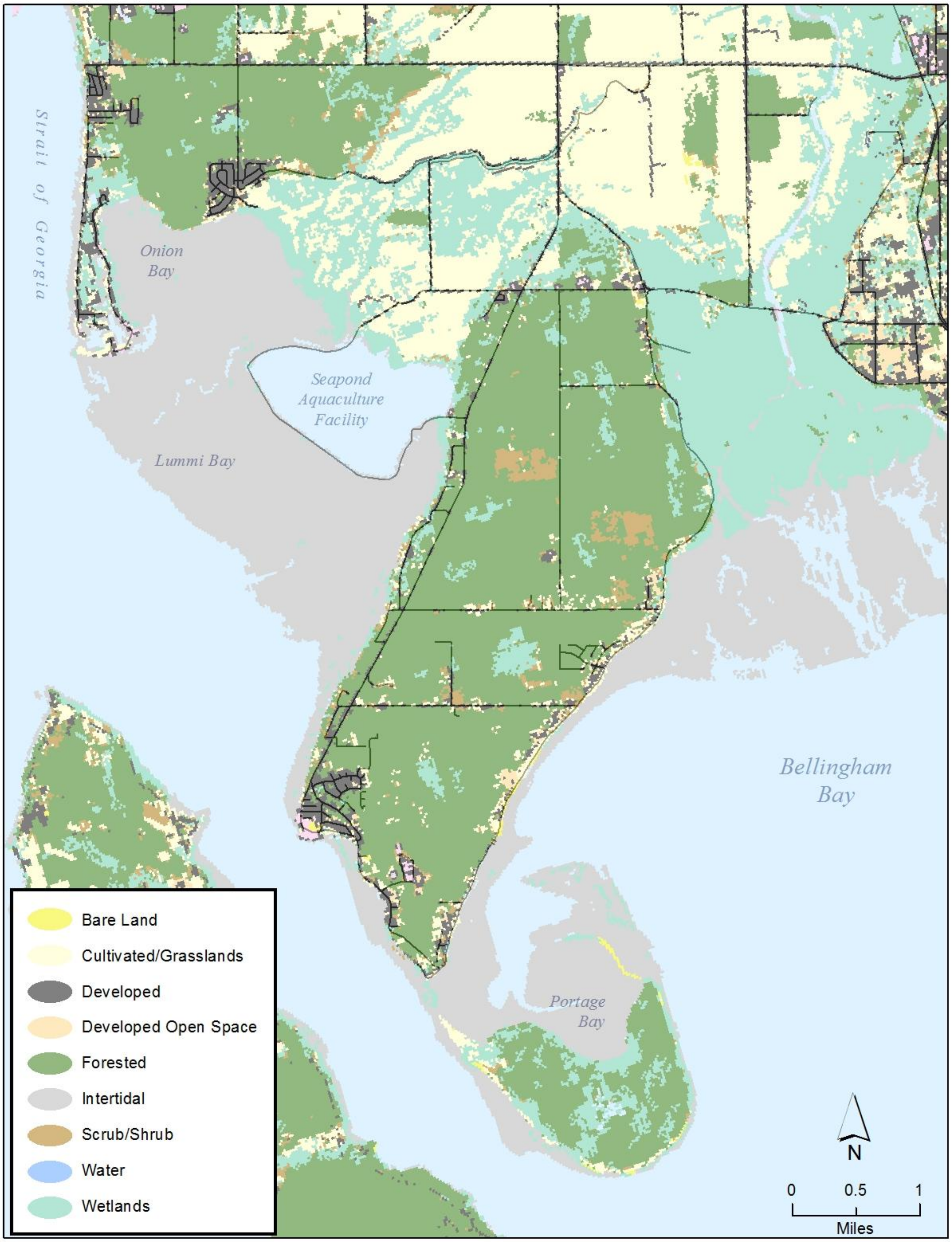


Figure 2.3 Upland Use/Land Cover of the Lummi Indian Reservation Watersheds

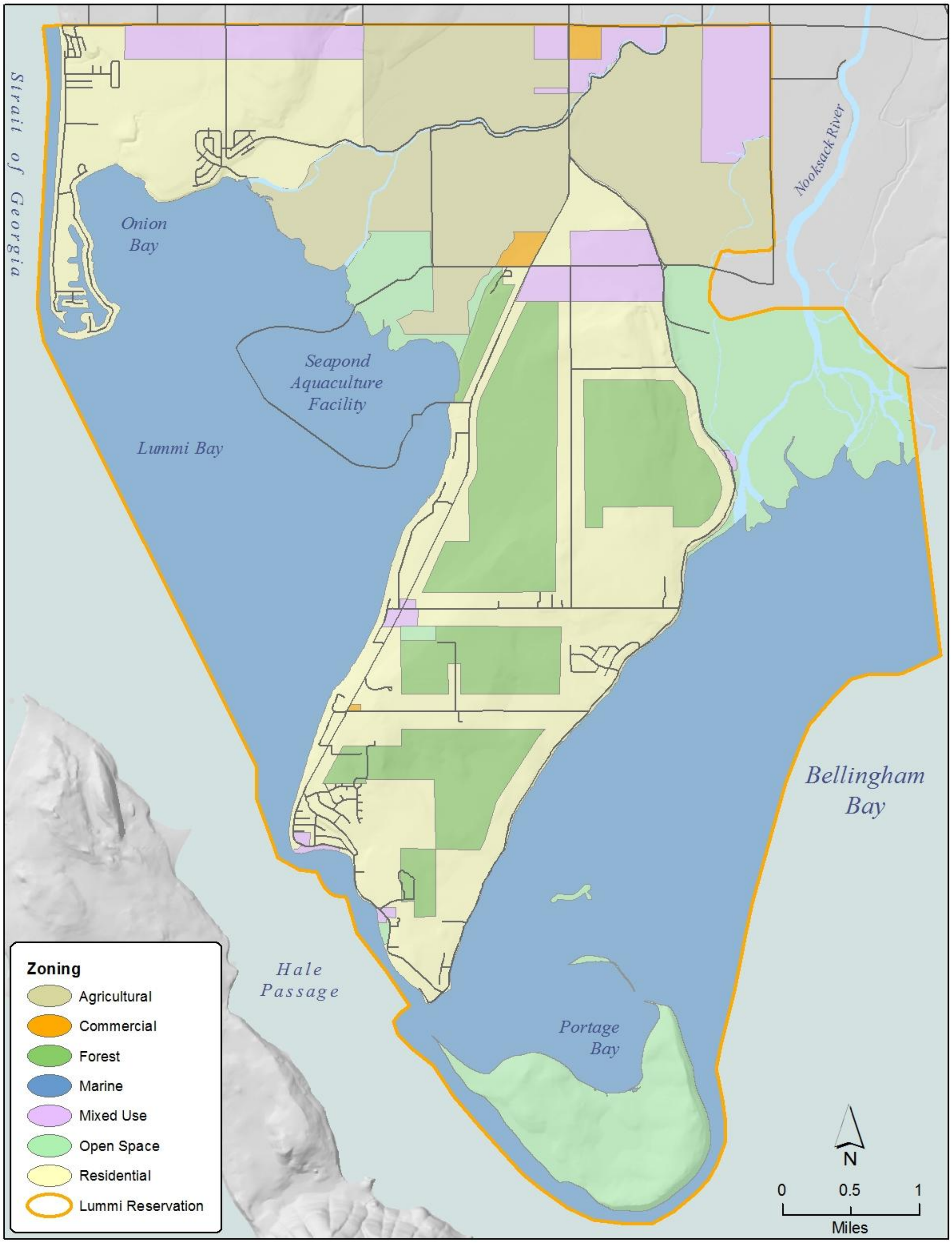


Figure 2.4 Current Land Use Zones on the Reservation

The Lummi Planning and Public Works Department is developing a Comprehensive Plan for the Lummi Reservation. The plan will show, in general, how land on the Reservation will be used over the next 20 years. The Comprehensive Plan will identify areas that will be developed for residential, commercial, mixed uses, industrial, and agricultural purposes, as well as show areas that require protection (e.g., Special Flood Hazard Areas, wetlands, and aquifer recharge zones). To date, a technical background document (LIBC 1996) has been developed, public opinion surveys conducted, drafts of the Comprehensive Plan and maps developed, and focused planning workshops and meetings with commissions and community groups have occurred. The Comprehensive Plan is codified in LCL Title 15 (Land Use, Development, and Zoning Code). Title 15 also formalized an environmental review process that had been already largely in place since 1997 pursuant to LIBC resolutions.

2.2.4. Population

According to the 2010 Census, a total of 4,706 people lived on the Reservation during 2010, which is an 11 percent increase from the 2000 Census population of 4,193. In the 2010 Census, 2,643 people (56.2 percent) identified themselves as American Indian and Alaska Native (Indian) alone or in combination with other races. Corrected by the 2010 undercount rate (4.9 percent), approximately 2,772 American Indians or Alaska Natives are currently living on the Reservation. Population projections from a 2003 study by Northwest Economic Associates suggest that the number of American Indians living on the Reservation would increase from 2,346 persons in 2000 to 3,767 persons in 2020 and to 15,451 persons in 2100. Including the non-Indian population, which was predicted to grow at a slower rate, the Reservation population was projected to reach 5,800-6,800 persons by 2020. In 2011, the Lummi Enrollment Office reported that there were approximately 4,650 enrolled Lummi tribal members living on- and off-Reservation (Kamkoff 2011).

2.2.5. Socioeconomic Conditions

Fishing, logging, farming, and other natural resource related work have historically provided most of the jobs for Lummi tribal members. Until the 1974 Boldt Decision, Lummi tribal members were systematically precluded from the profitable salmon fishery in Puget Sound. Once the treaty fishing right was upheld by the U.S. Supreme Court, commercial fishing and fish processing began to expand on the Reservation resulting in increasing numbers of fishermen, fish processing, and increased overall tribal revenue from the salmon fisheries.

The Lummi Nation is the largest fishing tribe in the Puget Sound in terms of pounds of fish landed and number of species fished (NWIFC 2012). However, the recent declines in salmon stocks have dramatically altered the tribal reliance on salmon fishing as an economic mainstay. In 1985, the average Lummi fisherman made $22,796 ($49,000 in 2011 dollars). In 1993, the average income from fishing was only $5,555 ($8,500 in 2011 dollars). During this period, about 30 percent of the tribal work force relied on fishing for their sole source of income (LIBC 1996). In the 10 year period between 1995 and 2005, there was an average of 592 fishing registrations and 126 crabbing registrations each year. During the 2012-2013 harvest management year (July 1 – June 30) there were 404 vessels registered with the Lummi Nation.

Over the last 15 years, the crab fishery has provided the largest percentage of the yearly fishery revenue followed by sockeye salmon and manila clams. Since 1993, further reductions in salmon stocks have resulted in closure of some fisheries and a further reduction in tribal fishery incomes (LIBC 1996). During 1999, 2007, 2009, and 2013 the sockeye salmon fishery was closed entirely due to low fish runs. The loss or reduction of a fishery increases the importance of the other fisheries to the Lummi economy. Although there are annual variations, 2001 is representative of the most recent 10 years. In 1985, the Lummi Fishing Fleet landed about 15.3 million pounds of finfish and shellfish. In 2001, the combined harvest was about 3.9 million pounds of finfish and shellfish.

In addition to catching fish and harvesting shellfish, the Lummi Nation owns and operates three salmon hatchery facilities. These facilities produce millions of young salmon each year and help offset the decline of fish stocks due to loss of natural habitat and historic overfishing. The tribe also owns an on-Reservation shellfish hatchery, producing approximately 23 million oyster and clam seeds and 2.5 million geoduck seed annually. The tribe owns 7,000 acres of tidelands, much of which is suitable for productive shellfish beds (LIBC 1996). All of these tidelands are held in trust by the United States for the exclusive use of the Lummi Nation.

The tribal commercial shellfish enterprise and the commercial, subsistence, and ceremonial harvest of shellfish by the Lummi Nation and individual tribal members was severely impacted by the closure of 60 acres of tidelands in 1996 and 120 additional acres in 1997. These closures occurred in Portage Bay and were largely attributed to poor dairy waste management practices in the Nooksack River watershed (DOH 1997). Not considering the multiplier effects on the economy, the lost value of the shellfish products alone was estimated to be approximately $825,000 per year. In response to the 1996 closure, the EPA conducted compliance enforcement inspections of dairy operations in the Nooksack River watershed starting in 1997, the State of Washington passed the 1998 Dairy Nutrient Management Act (RCW 90.64), and dairy farmers developed and implemented nutrient management plans (a.k.a. farm plans). As a result of these reactions and additional compliance inspections by the Washington State Department of Ecology, water quality in the Nooksack River improved. In November 2003, approximately 75 percent of the previously closed shellfish beds in Portage Bay were reopened to commercial harvest. In May 2006, the remaining closed shellfish growing areas were reclassified as “approved” for harvest.

Although Nooksack River water quality improved dramatically during the 1997 through 2004 period and resulted in the re-opening of the shellfish beds in 2006, deteriorating water quality trends started to become apparent again in 2005. Despite efforts to proactively prevent another shellfish bed closure due to poor water quality, portions of the Portage Bay shellfish beds no longer achieved the National Shellfish Sanitation Program (NSSP) standards during 2014. In order to protect public health, the Lummi Nation voluntarily closed 335 acres of shellfish growing areas to harvest in September 2014. Continuing poor water quality over the growing area resulted in nearly 500 acres of shellfish bed being closed to harvest by the end of December 2014.

A Lummi Casino project began in 1983 in an effort to diversify the Reservation economy. The casino operation was upgraded significantly in 1994 with the opening of the Lummi Casino at Fisherman’s Cove. The casino flourished initially, employing approximately 400 people, 65 percent of whom were Native American (LIBC 1996). However, competition and changing economic conditions resulted in the closure of the casino on August 26, 1997. With 238 workers losing their jobs, the Lummi unemployment rate grew to approximately 50 percent.

A new casino opened in April 2002 at a new location (the corner of Haxton Way and Slater Road) closer to the Interstate 5 highway. The new casino (the Silver Reef Casino) initially was 28,000 square feet and employed approximately 200 people. The casino was expanded in 2004 (Phase II) to a total of 55,000 square feet with the addition of additional gaming space, a restaurant, and a 400 seat pavilion. The casino was expanded again in 2006 (Phase III) to 135,000 square feet with the addition of a restaurant, additional gaming space, a spa and fitness room, and a six floor, 109 room hotel (NEI 2005). Following this expansion, the Silver Reef Casino was renamed the Silver Reef Hotel, Casino & Spa. A smaller expansion (Phase IV) of approximately 9,000 square feet occurred in 2008 to add gaming space and an additional restaurant. The Phase V expansion was additional parking only. The Phase VI expansion was completed in 2013 and included the addition of 50,000 square feet of additional gaming area, a new restaurant, theater, and event center. The Phase VII expansion, construction of a second hotel tower, was completed in November 2015. In 2005, after the first expansion, the casino employed 382 workers of which 274 were full-time employees and 108 were part-time employees (NEI 2005). In 2007, after the addition of the hotel and spa, the casino employed 500 people (Werner 2007). By 2010, the Silver Reef Hotel, Casino & Spa employed 550 people; following the opening of the Phase VI expansion in 2013 there were 675 employees. The LIBC operates a gas station and mini mart adjacent to the Silver Reef Hotel, Casino & Spa.

Other employment opportunities for Reservation residents exist at the two oil refineries and the aluminum smelter just north of the Reservation and nearby in the communities of Ferndale and Bellingham. In 2004, 40.8 percent (131) of the 321 businesses licensed to operate on the Reservation were owned by enrolled tribal members (NEI 2005). These businesses included fireworks sales, food preparation and retail, wholesale, and trade businesses. In 2010, 251 businesses were licensed to operate on the Reservation according to the LIBC Accounting Department. These businesses range from large employers (Silver Reef Hotel, Casino & Spa) to long established fish buying and processing enterprises, trades, native arts, and food catering.

In 2013, the LIBC was the 9th largest employer in Whatcom County and the Silver Reef Hotel, Casino & Spa was the 14th largest employer; with all tribal institutions combined, the tribe is the 3rd largest employer in the county (WWU 2011). Most of the LIBC and Northwest Indian College (NWIC) employees are tribal members. In 2003, native employees made up 70 percent of LIBC staff (55 percent enrolled Lummi tribal members) and 61 percent of NWIC staff (33 percent enrolled Lummi tribal members) (Valz 2003). The LIBC provides community, administrative, education, natural and cultural resources protection, and health services to the tribal population in order to help achieve the tribal economic and social development goals. These goals include job creation for tribal members, income generation to fund community development programs, and diversification and stabilization of the local economy by creating alternatives to fishing. Revenue generation is needed in order for the Lummi Nation to develop economic self-sufficiency.

In 1993, 56 percent of the 2,500 working-age Lummi tribal members were unemployed, under employed, full-time students, or no longer seeking work (LIBC 1996). Since 1993, the combined effect of the decline in the fishery and the closure of the original casino have had a substantial negative impact on the Lummi economy. The BIA reported that the unemployment rate on the Reservation in 1999 was 21 percent (BIA 1999). Table 2.2 presents the results of a survey of 2,054, over the age of 18, enrolled tribal members conducted by the LIBC Statistics Office in 2003. This survey indicates that 28 percent of adult tribal members were unemployed and up to 14 percent may have been underemployed (part-time, seasonally employed) (LIBC 2003). In 2004, 74.6 percent of enrolled Lummi tribal members in Whatcom County ages 18 through 64 were employed and 15.9 percent were unemployed (NEI 2005).

Table 2.2 Employment Status of Lummi Tribal Members, 2003

Employment Status	Number in Status[1]	Percentage of Survey Individuals
Employed Full-Time	825	40.2
Employed Part-Time	156	7.6
Employed Seasonally	133	6.5
Self-Employed	84	4.1
Retired	127	6.2
Unemployed	567	28.0
Not Available for Employment	153	7.4

[1]LIBC 2003

2.3. Lummi Nation Government

The United States government has a unique legal relationship with tribal governments based on the U.S. Constitution, treaties, statutes, executive orders, and court decisions. Indian tribes have sovereign powers separate and independent from federal and state governments. Tribal sovereignty refers to the inherent authority of indigenous tribes to govern themselves, thus tribal governments have the same power as the federal and state governments to regulate their internal affairs, with a few exceptions. For example, tribes have the inherent power to form a government, to decide their own membership, the right to regulate property, the right to maintain law and order, and the right to regulate commerce. As a result of tribal sovereignty, specific federal legislation, and the trust responsibility of the United States that resulted from treaties, various federal government agencies are involved in assisting Indian tribal governments.

The Lummi Nation is a signatory of the 1855 Treaty of Point Elliot, and is a federally recognized sovereign Indian Tribe organized pursuant to an order approved on November 13, 1947 by the Acting Commissioner of Indian Affairs. The Lummi Nation is governed by an elected 11-member council, the Lummi Indian Business Council (LIBC), and the General Council, which consists of all enrolled Lummi tribal members of voting age (18 years old). The LIBC is supported by several administrative departments including Planning and Public Works, Economic Development, Police, Office of the Reservation Attorney, Cultural Resources, and Natural Resources. The LIBC is responsible for the protection, restoration, enhancement, and management of the natural resources within the boundaries of the Lummi Indian Reservation (Reservation) and throughout the Lummi Nation's usual and accustomed (U&A) hunting, fishing, and gathering grounds and stations. The Lummi Natural Resources Department (LNR) is the caretaker of the Lummi Nation natural resources and is responsible for developing and implementing LIBC policies related to Lummi resources.

3. ENERGY SOURCES, USES, COSTS, AND SUPPLIERS

On the Lummi Indian Reservation (Reservation), residents and visitors consume energy everyday to power their homes, workplaces, businesses, and motor vehicles for uses including, but not limited to, space heating, air conditioning, lighting, water heating, appliances (e.g., stoves, refrigerators, washing machines, dryers), electronics (e.g., televisions, computers, radios, office equipment), machinery, and transportation. The purpose of this chapter is to summarize where this energy comes from (i.e., energy sources), where it is used (i.e., energy end-uses), and how the demand for and cost of energy is expected to increase in the future. This chapter will also identify current energy supplies and suppliers on the Reservation.

3.1. Energy Sources in the United States

According to the U.S. Energy Information Administration (EIA), the statistical and analytical agency within the U.S. Department of Energy (DOE), approximately 97.5 quadrillion British Thermal Units (BTU) of energy were used in the United States in 2011. Over 90 percent of this energy came from nonrenewable energy sources (Figure 3.1; EIA 2012). Nonrenewable energy sources are those that cannot be easily replenished, including fossil fuels (e.g., petroleum, natural gas, coal) and uranium. Fossil fuels are mined from geologic deposits that developed from organic materials (e.g., dead plants, bacteria) that accumulated over millions of years and were subject to conditions of intense heat and pressure. The combustion of fossil fuels releases energy, which may be used directly (e.g., heating, transportation, manufacturing) or for electricity production. Additionally, the combustion of fossil fuels releases carbon dioxide (CO_2) and other polluting gasses (e.g., carbon monoxide, nitrogen oxides, sulfur oxides) into the atmosphere. As discussed in Section 1.2 – Why the Lummi Nation is Planning for Energy, anthropogenic emissions of CO_2 and other greenhouse gasses (i.e., methane, nitrous oxide, chloroflurocarbons) are driving global climate change, which affects air temperatures (i.e., global warming), sea surface temperatures, sea level, ocean pH (i.e., ocean acidification), precipitation patterns, storm events, and other physical systems. Uranium is used in the production of nuclear energy; whereby the uranium atom is split (i.e., nuclear fission), releasing heat that is then used for electricity production. Despite the fact that nuclear power is a low carbon technology, spent nuclear fuel is high-level radioactive waste and disasters at nuclear power plants can have devastating effects on humans and the environment.

The remainder of energy used in the United States during 2011, approximately 9 percent, was generated from renewable energy sources, or those that can easily be replenished. Renewable energy production and use results in little to no carbon emissions and is sometimes referred to as "green energy" or "clean energy." Renewable energy sources include hydroelectric, wood, biofuels (e.g., fuel ethanol, biodiesel), wind, biomass waste (e.g., municipal solid waste, landfill gas, agricultural byproducts), geothermal, and solar (e.g., photovoltaics [PV]). Information pertaining to current (e.g., solar, geothermal) and potential future (e.g., wind, biofuels) renewable energy development on the Reservation and/or Lummi Nation trust lands is the subject of Chapter 7 – Renewable Energy Sources.

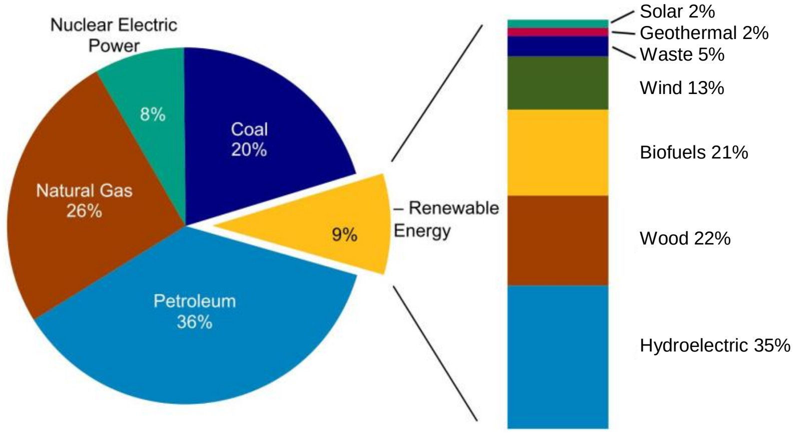


Figure 3.1 U.S. Energy Consumption by Energy Source, 2011

3.2. Energy Use in the United States

Although there is some annual variability in total energy consumption, an increasing trend in energy use across all economic sectors (i.e., industrial, commercial, residential, transportation) in the United States has persisted since at least the mid-20th century. As depicted in Figure 3.2, energy consumption in the United States has nearly tripled since 1950 (EIA 2012). The industrial sector continues to be the largest energy user in the U.S. In 2011, the industrial sector accounted for 31 percent of energy use nationwide, followed by the transportation sector (28 percent), the residential sector (22 percent), and the commercial sector (19 percent) (EIA 2012). In the coming decades, total energy use is expected to continue increasing. However, energy intensity, or the energy consumption per unit of gross domestic product, in the United States is on the decline. For example, residential sector energy use has increased over the past ten years, but there are also many more homes now than there were a decade ago. On average, the amount of energy used per home has decreased as a result of more effective insulation and weatherization and improved energy efficiency of many household appliances.

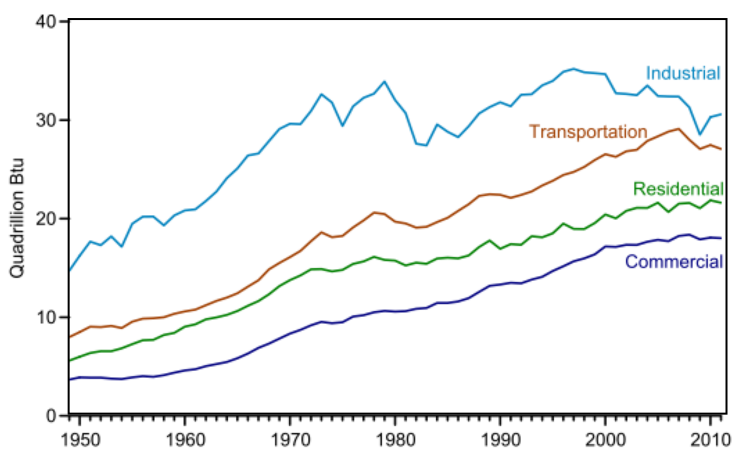


Figure 3.2 U.S. Energy Consumption by Sector, 1949-2011

Within each economic sector, energy use can be further divided into distinctive end-use patterns, which helps to provide a context for understanding energy use on the Reservation.

3.2.1. Industrial Sector

The industrial sector encompasses activities such as processing and manufacturing goods, construction, agriculture, mining, and forestry. There are currently no industrial-scale facilities in operation on the Reservation. Nonetheless, it is noted that the petroleum refining industry has the highest energy expenditure of all the industries in the United States, followed by those that produce chemicals, paper products, and metals (Figure 3.3; EIA 2015). Two of these industries are currently represented in Whatcom County and are located near the Reservation, including the Phillips 66 Ferndale Refinery, the BP Cherry Point Refinery, and the Alcoa Intalco Works aluminum smelter.

3.2.2. Transportation Sector

The transportation sector includes the energy used to move people, goods, and services from place to place. Light trucks, cars, and motorcycles consistently account for over half of the transportation sector fuel expenditure in a given year. In 2012, energy use in light trucks (30 percent) and cars and motorcycles (28 percent) conformed to this pattern (EIA 2015). Meanwhile, large trucks (20 percent), planes (8 percent), boats and ships (4 percent), trains and busses (3 percent), and other (6 percent) accounted for smaller proportions of fuel use. Gasoline continues to be the primary source of fuel for transportation in the United States. In 2013, gasoline accounted for over half of fuel used in transportation, followed by diesel, jet fuel, biofuels, natural gas, and other fuels (i.e., liquefied petroleum gas [LPG], lubricants, residual fuel oil) (Figure 3.4; EIA 2015).

3.2.3. Residential Sector

Energy use in the residential sector is predominantly building-related. Characteristically, space heating accounts for the largest portion of energy consumption in the residential sector, followed by lighting and other appliances, water heating, air conditioning, and refrigeration (Figure 3.5; EIA 2015). Given regional estimates, it is reasonable to expect that the average residence on the Reservation will consume approximately 80 million BTU annually. Household size, type, and condition are also important determinants of residential energy use. Typically, single-family homes use more energy than small apartment buildings (2-4 units), mobile homes, and large apartment buildings (>5 units), listed in decreasing order of energy consumption.

3.2.4. Commercial Sector

The commercial sector encompasses a wide variety of activities, including not only private businesses but also municipal and non-profit organizations (e.g., schools, offices, healthcare facilities, places of religious worship). Similar to the residential sector, the majority of energy use in the commercial sector is building-related and end-use patterns for space heating, lighting and other appliances, water heating, air conditioning, and refrigeration roughly mirror those presented in Figure 3.5. However, the commercial sector also includes many non-building-related uses such as street and outdoor lighting, water and sewage treatment, and other miscellaneous uses.

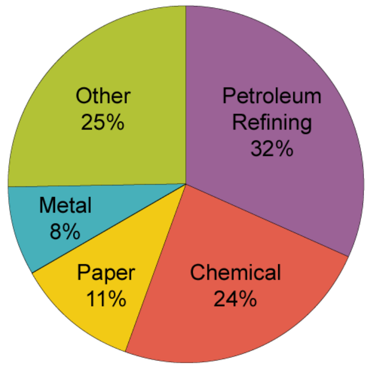


Figure 3.3 U.S. Energy Consumption by Industry Type, 2006

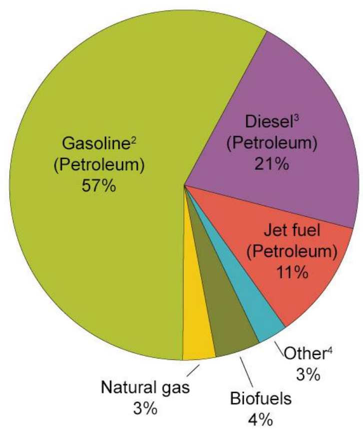


Figure 3.4 U.S. Fuel Consumption for Transportation, 2013

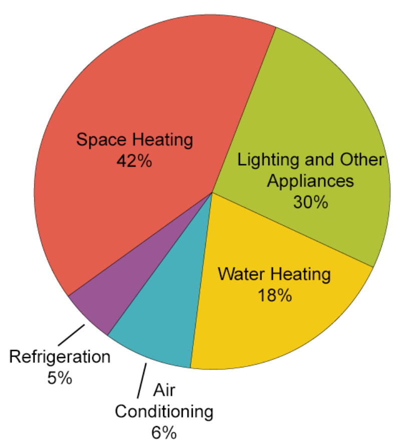


Figure 3.5 U.S. Energy Consumption in the Home, 2009

3.3. Future Energy Demand in the United States

Future energy demand is modeled by the U.S. Energy Information Administration (EIA) using a business-as-usual energy use scenario informed by known market, demographic, and technological trends. Based on model projections, total energy demand in the United States is expected to rise over the coming decades, increasing from 97.5 quadrillion BTU in 2011 to an estimated 107.6 quadrillion BTU by 2040 (Figure 3.6; EIA 2013). Energy use is expected to increase in all economic sectors, but the magnitude of change varies between sectors. From 2011-2040, the largest increase is energy use is expected in the industrial sector (5.1 quadrillion BTU), followed by the commercial sector (3.1 quadrillion BTU), residential sector (1.6 quadrillion BTU), and the transportation sector (0.14 quadrillion BTU). The projected increase in energy use in the industrial sector is attributed to recovery from the 2007-2009 Great Recession and increasing use of natural gas (rather than other fossil fuels). Despite improvements in energy efficiency, energy use in the commercial and residential sectors is expected to grow as additional homes and commercial spaces are developed. By comparison, energy use in the transportation sector is expected to remain relatively stable, as a result of improved vehicle fuel economy standards.

Energy sources will also change over the coming decades. The EIA anticipates that energy use by fuel type in 2040 will be 32 percent petroleum, 28 percent natural gas, 19 percent coal, 9 percent nuclear, and 13 percent renewables (EIA 2013). Compared to 2011, this suggests that petroleum and coal use will decrease, while the use of natural gas, nuclear, and renewables will increase.

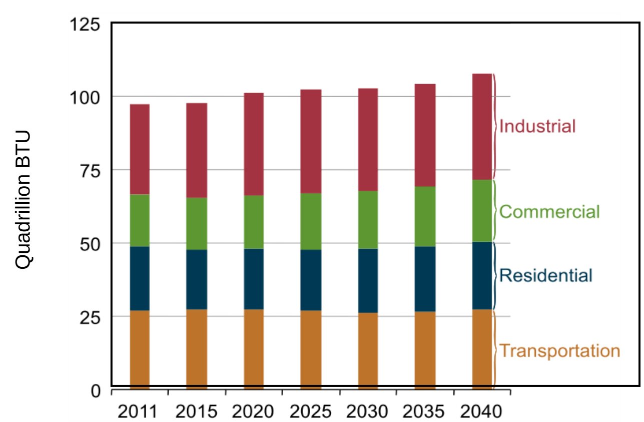


Figure 3.6 Projected U.S. Energy Consumption by Sector, 2011-2040

3.4. Energy Cost in the United States

The cost of energy across the United States continues to increase. For instance, the average residential price of electricity in Washington State increased from 4.39 cents per kilowatt hour (kWh) in 1990 to 8.28 cents per kWh in 2011, an increase of 89 percent over two decades (EIA 2013b). According to the U.S. Energy Information Administration (EIA), energy costs will continue increasing into the foreseeable future. From 2011-2040, the EIA anticipates that the residential price of electricity, natural gas, propane, gasoline, and diesel will increase at a rate of

0.3-1.4 percent annually (Table 3.1; EIA 2013). Again, these estimates are based on a business-as-usual energy use scenario and known trends in energy markets, demographics, and technology. Actual energy prices may be higher or lower based on changes in economic growth and other factors such as the development of the Bakken oil reserves.

Table 3.1 Energy Costs in the United States, 2011 and 2040

Energy Source	2011 Cost ($/million BTU)	2040 Cost[1] ($/million BTU)	Annual Growth 2011-2040 (%)
Electricity	34.34	37.10	0.3
Natural Gas	10.80	16.36	1.4
Propane	25.06	27.99	0.4
Gasoline	28.70	36.18	0.8
Diesel	26.15	36.05	1.1

[1]Cost estimates are in real dollars (i.e., adjusted for inflation) relative to 2011

3.5. Energy Supplies and Suppliers on the Reservation

Energy consumption on the Reservation includes the use of electricity, natural gas, liquefied petroleum gas (a.k.a., propane), wood, and gasoline and diesel. This section describes where or from whom these energy supplies are obtained.

3.5.1. Electricity

Puget Sound Energy (PSE) is an Investor Owned Utility (IOU) with headquarters located in Bellevue, Washington; PSE is the primary supplier of electricity in the Puget Sound region, including the Reservation. The electricity provided by PSE is generated from a mixture of fuels. In 2013, the fuel mix was comprised of hydropower (41 percent), natural gas (25 percent), coal (24 percent), wind (7 percent), nuclear (2 percent), and other sources (1 percent) (PSE 2015). Electricity is delivered through the local transmission system (i.e., “the grid”) owned by PSE. It should be noted that the Bonneville Power Administration (BPA) and Public Utility District No. 1 of Whatcom County (PUD No. 1) also operates transmission lines in the area.

3.5.2. Natural Gas

Cascade Natural Gas Corporation (CNGC), headquartered in Kennewick, Washington, is the natural gas provider in western Whatcom County. There is only a limited area of the Reservation along Slater Road and Haxton Way that is currently served by natural gas lines. Consequently, the Silver Reef Hotel, Casino & Spa and neighboring Lummi Mini Mart and gas station are the only CNGC customers on the Reservation at this time. Tribally-owned facilities located in nearby urban areas (e.g., the Gateway Center in Ferndale) will also be served by Cascade Natural Gas if they are plumbed for natural gas.

3.5.3. Liquefied Petroleum Gas

Liquefied petroleum gas (a.k.a., propane), is delivered by truck to tribal facilities, residences, and private businesses on the Reservation by any of several independent propane providers. The two largest providers in the area are Propane Gas Industries located in Ferndale and Vander Yacht Propane, Inc. located in Lynden.

3.5.4. Heating Oil

When the Reservation energy baseline assessment was conducted in 2010 there was only one tribally-owned facility, the old Natural Resources Building (2616 Kwina Road), heated with No. 2 Heating Oil. At that time, heating oil was delivered by truck by McEvoy Oil Company, which is based out of Bellingham. Following completion of the new tribal administrative facility, the Natural Resources Building was demolished in 2013.

3.5.5. Wood

Wood for heating is available from several local sources, including trees on private property, some tribally-owned forests, and state forests managed by the Department of Natural Resources (DNR), driftwood on the tribally-owned beaches, through tribal programs (e.g., the Community Services Department Energy Assistance Program), or for purchase from various independent suppliers. Collecting firewood on tribally-owned forests and beaches and state managed forests requires proper permitting.

3.5.6. Gasoline and Diesel

Gasoline and diesel for vehicles, fishing boats, generators, and other equipment is available on the Reservation at the Lummi Mini Mart (formerly a Shell Station), the Fisherman's Cove Mini Mart, or at gas stations in nearby cities and throughout Whatcom County. Large quantities of gasoline and diesel fuel are also available from local fuel companies such as McEvoy Oil Company or Yorkston Oil Company, Inc., both located in Bellingham.

3.6. Units of Energy

For practical, everyday purposes, it is sometimes easier to discuss energy in the units that are used on energy invoices, rather than British Thermal Units (BTU). Table 3.2 provides these conventional units and their BTU equivalents. It is noted that kilowatt hours (kWh) may also be expressed as Megawatt hours (MWh), where 1,000 kWh equals 1 MWh, and that British Thermal Units (BTU) may also be expressed as one thousand BTU or one million BTU, which are abbreviated as kBTU and MMBTU respectively.

Table 3.2 Units of Energy

Energy Source	Conventional Unit	BTU Equivalent
Electricity	Kilowatt Hour (kWh)	3,412 BTU/kWh
Natural Gas	Cubic Feet (ft^3)	1,050 BTU/ft^3
Propane	Gallon (gal)	91,330 BTU/gal
Heating Oil	Gallon (gal)	138,690 BTU/gal
Wood	Cord	20,000,000 BTU/cord
Gasoline/Diesel	Gallon (gal)	131,500 BTU/gal

(This page intentionally left blank)

4. ENERGY BASELINE ASSESSMENT

The purpose of the energy baseline assessment was to quantify energy use on the Lummi Indian Reservation (Reservation) and trust properties located off-Reservation (e.g., Skookum Creek Hatchery) during 2010. Determining where, when, and how much energy is being consumed currently not only allows the Lummi Nation to identify areas where energy conservation may be needed or particularly successful, but also establishes a baseline against which future energy use can be measured. The energy baseline assessment is divided into three areas of interest: (1) tribal institutions, (2) private businesses, and (3) residences. Analysis in each area of interest is further differentiated by energy source (i.e., electricity, propane, natural gas, heating oil, wood, and gasoline and diesel). This sector specific analysis is followed by a Reservation-wide energy use summary and emissions estimate.

4.1. Tribal Institutions

For the purpose of this assessment, a tribal institution is considered to be any municipal government institution, educational institution, or commercial organization that is officially affiliated with Lummi Nation and was operational in 2010. Municipal government institutions include the Lummi Indian Business Council (LIBC) offices, schools, hatcheries, and other facilities, the Lummi Tribal Sewer and Water District (LTSWD) facilities, and the Lummi Housing Authority (LHA) facilities. The educational institution is the Northwest Indian College (NWIC). Commercial organizations include the Lummi Commercial Company (LCC) Silver Reef Hotel, Casino & Spa and the LCC mini marts and gas stations.

4.1.1. Methods

All tribal institutions use electricity and petroleum (i.e., gasoline and diesel fuel), some institutions also use propane, natural gas, or heating oil. Because each tribal institution has distinct energy needs and is uniquely organized and managed, a broad array of methods were employed for data collection. The methods for electricity, propane, natural gas, heating oil, and gasoline and diesel data collection are described below in the order that they are presented in the analysis.

Electricity data were compiled for the 2010 calendar year using several methods. For all LIBC, most LCC, and all LHA facilities, hard copies of monthly electricity invoices were collected from the respective institutions. For the LCC's Silver Reef Hotel, Casino & Spa, LTSWD, and NWIC, monthly electricity consumption was independently reported by each institution. The data recorded included the amount of electricity consumed (kilowatt hours [kWh]) and the cost to the institution. At times, independently reporting institutions provided the dollar amount charged on the electricity bill, but not the quantity of electricity consumed. In such cases, electricity use was calculated by multiplying the monthly cost and the average electricity rate for that month. The average electricity rate for a given month was derived from data in the other accounts.

Propane and natural gas utilization data were complied for the 2010 calendar year using similar methods, either recorded directly from invoices or furnished by an institution. The data recorded included the amount of propane or natural gas consumed (gallons or cubic feet [ft^3], respectively) and the cost to the institution. Again, some institutions retained records of energy costs, but not energy usage. When this occurred, estimates of energy use were derived from costs as described above.

The former Lummi Natural Resources (LNR) building (demolished in 2013) located on the former LIBC Central Campus was the only tribally-owned building on the Reservation heated with No. 2 Heating Oil in 2010. Total heating oil usage (gallons) and cost for the 2010 calendar year was reported by the provider (McEvoy Oil).

It should be noted that buildings and facilities that do not appear in the sections on propane, natural gas, or heating oil are heated using electricity (e.g., LCC Fisherman's Cove Mini Mart, LHA Community Hall) or do not require heating (e.g., LTSWD pump stations).

Gasoline and diesel fuel use data were collected for 2012, rather than 2010. This was due to the LIBC's adoption of the Voyager fleet fuel card system, which made fuel expenditures in 2012 more readily accessible and reliable than data available for 2010. It is recognized that fuel prices increased substantially between 2010-2012 (and dropped substantially during 2015); however, annual fuel use was assumed to remain relatively stable. Annual fuel consumption (gallons), fuel costs, and/or vehicle mileage was reported by each tribal institution. As necessary, fuel consumption was calculated from the reported cost by using the average price of fuel in Washington State in 2012 ($3.85/gallon) provided by the U.S. Energy Information Administration or from the reported mileage by using fuel economy data (miles per gallon [mpg]) available from the U.S. Environmental Protection Administration (available at www.fueleconomy.gov). It should be noted that the Silver Reef Hotel, Casino & Spa and LCC did not maintain records of gasoline or diesel fuel costs or use or vehicle mileage in 2012. Instead, annual fuel cost estimates were generated by managers ("best-estimate") and fuel consumption was then calculated as above. This analysis is not restricted to vehicle use within the borders of the Reservation and does not include fuel consumption by tribal employees commuting to and from work.

To evaluate total energy use by tribal institutions, energy provided by different energy sources was converted to British Thermal Units (BTU) using the standard conversion factors provided in Table 3.2.

4.1.2. Electricity Consumption

In 2010, the amount of electricity used by tribal institutions was approximately 15,516 MWh and cost over $1.3 million (Table 4.1, Figure 4.1). The highest electricity consumption among the tribal institutions in 2010 was by the Silver Reef Hotel, Casino & Spa (6,688 MWh, $514,132). In order of decreasing consumption, electricity use for the remaining tribal institutions is as follows: LIBC used 4,670 MWh ($449,631), LTSWD used 1,984 MWh ($171,804), NWIC used 1,079 MWh ($93,399), other LCC facilities used 572 MWh ($55,663), and LHA used 523 MWh ($47,857). The data provided by the LIBC, LTSWD, LCC, and LHA were also analyzed at the building (e.g., the *Wex li em*) or facility (e.g., West Campus offices) scale. Because account-specific data were not available from the Silver Reef Hotel, Casino & Spa or the Northwest Indian College, more refined assessment of annual electricity use at these institutions was not possible. Figures of monthly energy use are presented in Appendix C.

Table 4.1 Electricity Use by Tribal Institutions in 2010

Tribal Institution	Tribal Facility	Electricity Use (MWh)	Cost ($)
LCC – Silver Reef Hotel, Casino & Spa	**All**	**6,688**	**514,132**
LIBC	Lummi Nation School	1,184	118,113
	Clinic and Fitness Center	632	61,126
	Shellfish Hatchery	560	46,824
	Central Campus Offices	544	53,104
	East Campus Offices	482	48,826
	Lummi Bay Salmon Hatchery	338	31,765
	Skookum Creek Hatchery[1]	179	15,987
	Head Start	145	14,020
	West Campus Offices	143	13,920
	Se'eye'chen (Youth Shelter)	128	12,537
	Wex li em (Community Building)	124	13,290
	Lighting (Outdoor and Streets)	111	9,615
	Miscellaneous[2]	100	10,504
	LIBC Total	**4,670**	**449,631**
LTSWD	Sewage Treatment and Offices	1,296	112,207
	Pump Stations	387	33,528
	Wells	301	26,069
	LTSWD Total	**1,984**	**171,804**
NWIC	**All**	**1,079**	**93,399**
Other LCC	Lummi Mini Mart and Gas Station	296	28,137
	Fisherman's Cove Mini Mart	120	12,224
	Billboard[1]	94	8,676
	Offices	58	6,255
	Lighting	4	371
	LCC Total	**572**	**55,663**
LHA	Little Bear Creek	242	20,899
	Lighting	80	6,901
	Recreation Center	69	6,889
	West Campus Offices	68	6,700
	Maintenance	42	4,246
	Transition Recovery	13	1,315
	Community Hall	9	907
	LHA Total	**523**	**47,857**
Tribal Institutions Total		**15,516**	**1,332,486**

[1] Off-Reservation

[2] Miscellaneous includes: Gateway Center[1], Lummi Island Rental Homes[1], All–Hazard Alert Broadcast (AHAB) towers, Ventures, Victims of Crime Shelter, Safehouse, Stommish/Veterans, and Well Alarms

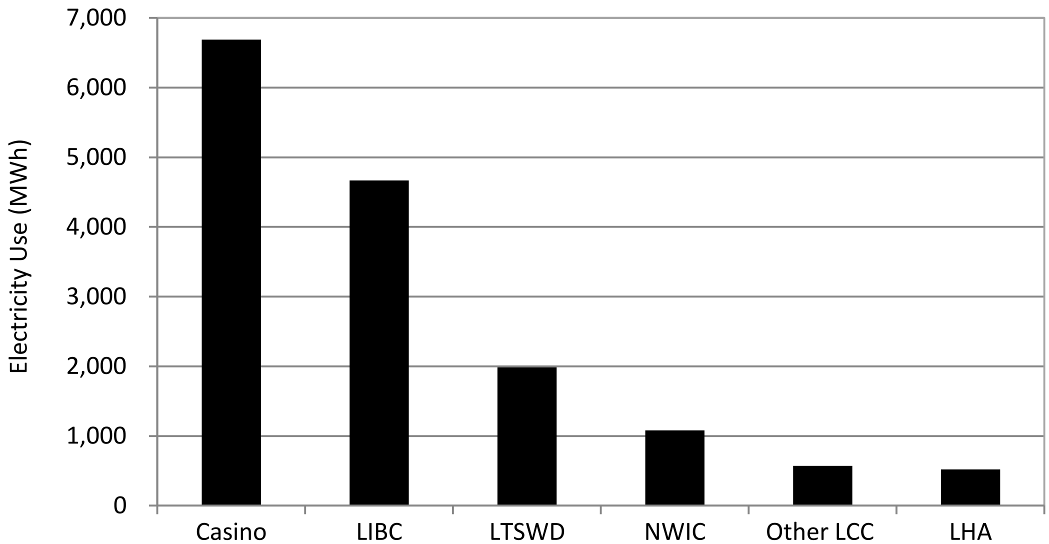


Figure 4.1 Electricity Use by Tribal Institutions in 2010

Lummi Indian Business Council (LIBC): Among LIBC facilities, the highest electricity consumption in 2010 was by the Lummi Nation School (1,184 MWh), which accounted for 25 percent of LIBC electricity use (Table 4.1, Figure 4.2). The school was followed by the Lummi Health Clinic and affiliated Fitness Center (632 MWh), the Shellfish Hatchery (560 MWh), the Central Campus offices (544 MWh), the East Campus offices (482 MWh), and the Lummi Bay Salmon Hatchery (338 MWh), all of which used over 200 MWh of electricity in 2010. Other LIBC facilities, including the Skookum Creek Hatchery, Head Start, West Campus offices, the Se'eye'chen (Youth Shelter), the *Wex li em* (Community Building), and outdoor and street lighting, each used less than 200 MWh of electricity in 2010.

Lummi Tribal Sewer and Water District (LTSWD): At the LTSWD, the highest electricity consumption was by the three sewage treatment facilities and the administrative offices (1,296 MWh), which accounted for 65 percent of LTSWD electricity consumption in 2010 (Table 4.1, Figure 4.3). It should be noted that although the LTSWD offices share electricity meters with the sewage treatment facilities, the offices account for only a small portion of total electricity use. Also operated by the LTSWD were 28 pump stations, which used 387 MWh of electricity, and 10 supply wells, which used 301 MWh of electricity in 2010.

Other Lummi Commercial Company (LCC): Among the LCC facilities other than the Silver Reef Hotel, Casino & Spa, over 50 percent of electricity use was by the Lummi Mini Mart and gas station (296 MWh) located at the intersection of Haxton Way and Slater Road (Table 4.1, Figure 4.4). Next, was the Fisherman's Cove Mini Mart, which used 120 MWh of electricity in 2010. The electronic billboard along Interstate 5 became operational in February 2010 and used 94 MWh of electricity during the following 10 months of operation. The LCC offices and outdoor lighting consumed 58 MWh and 4 MWh of electricity respectively.

Lummi Housing Authority (LHA): In 2010, the Little Bear Creek Elder Home used 242 MWh of electricity, accounting for 46 percent of LHA electricity consumption (Table 4.1, Figure 4.5). Other LHA electricity uses were for outdoor lighting (80 MWh), the Recreation Center (69 MWh), administrative offices (68 MWh), maintenance shops (42 MWh), Transition Recovery homes (13 MWh), and the Kwina Apartments Community Hall (9 MWh). Additionally, LHA paid for electricity consumption in unoccupied LHA rental homes and apartments. Because electricity in rental units is billed to the tenant(s) during occupancy and LHA is only temporarily responsible for electricity costs, these accounts are analyzed in Section 4.2 – Residences.

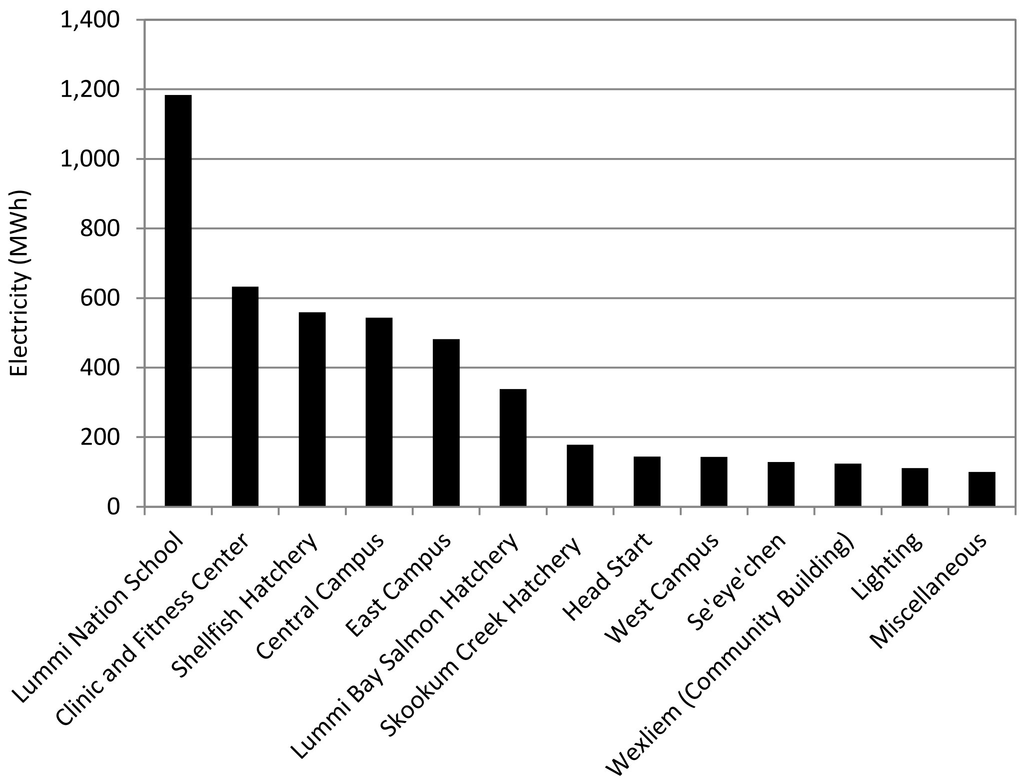


Figure 4.2 Electricity Use by LIBC Facilities in 2010

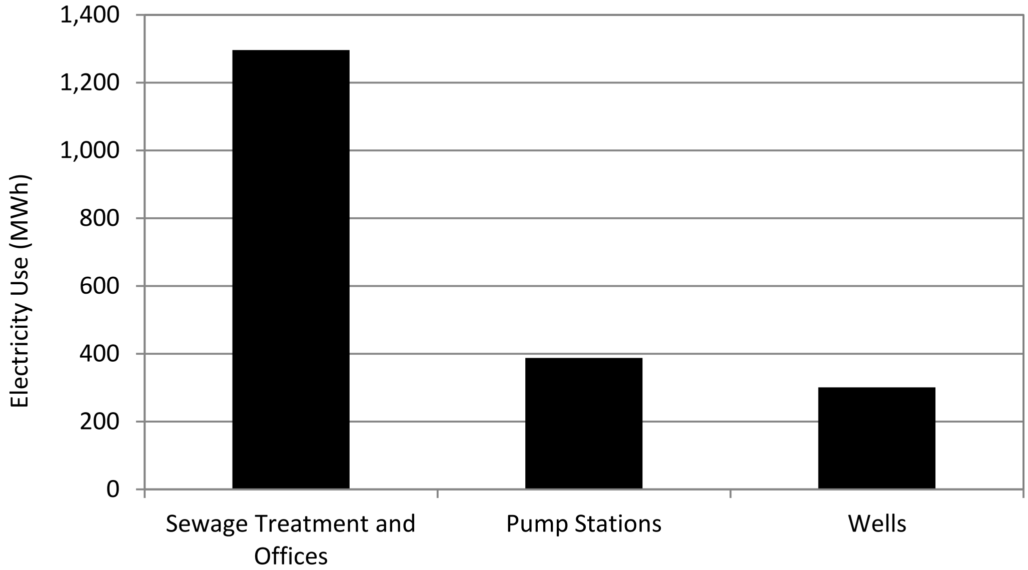


Figure 4.3 Electricity Use by LTSWD Facilities in 2010

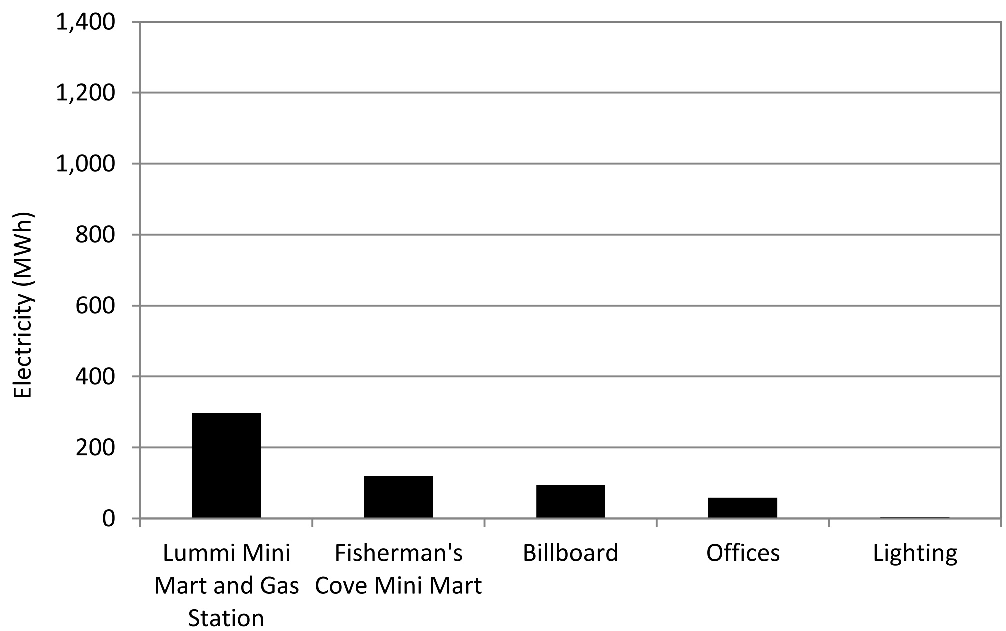


Figure 4.4 Electricity Use by LCC Facilities other than the Silver Reef Hotel, Casino, & Spa in 2010

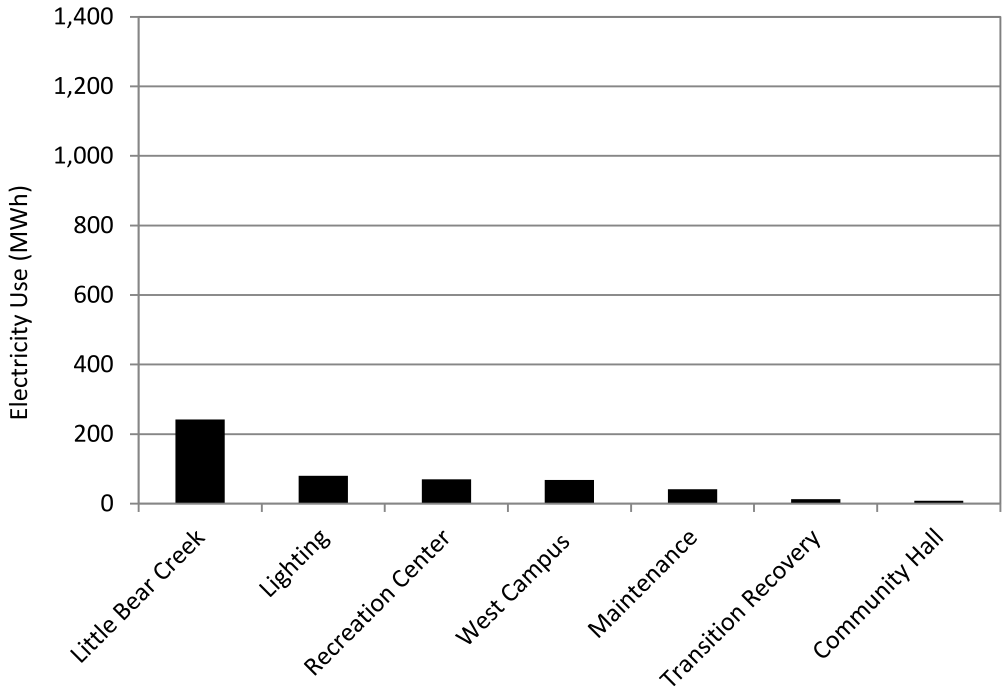


Figure 4.5 Electricity Use by LHA Facilities in 2010

4.1.3. Propane Consumption

The LIBC, NWIC, LHA, and LTSWD operate facilities that utilize propane for space heating, water heating, and/or cooking. In 2010, the total propane consumption by tribal institutions was 107,188 gallons at a cost of $186,321 (Table 4.2, Figure 4.6). Propane consumption by institution was as follows: LIBC used 66,616 gallons ($113,842), NWIC used 21,736 gallons ($39,501), LHA used 18,557 gallons ($32,496), and LTSWD used 279 gallons ($482). Propane use at the LIBC and LHA was also analyzed at the facility-scale.

Lummi Indian Business Council (LIBC): Among the LIBC facilities, the highest propane consumption was by the Shellfish Hatchery (21,723 gallons), which accounted for 33 percent of LIBC propane use in 2010 (Table 4.2, Figure 4.7). Other LIBC facilities with high propane use were the Lummi Nation School (10,800 gallons), the *Wex li em* (7,497 gallons), the Central Campus offices (7,277 gallons), the East Campus offices (7,166 gallons), the Skookum Creek Hatchery (3,238 gallons), and the West Campus offices (2,959 gallons). Meanwhile lower propane consumption was reported by the *Se'eye'chen* (Youth Shelter), the Clinic and Fitness Center, Head Start, the Lummi Bay Salmon Hatchery, and other facilities.

Lummi Housing Authority (LHA): In 2010, 83 percent of the LHA's propane was used in the Little Bear Creek Elder Home (15,343 gallons) (Table 4.2, Figure 4.8). Other LHA facilities used significantly less propane: the Recreation Center (1,544 gallons), the maintenance shop (1,010 gallons), and the Transition Recovery homes (659 gallons). The LHA West Campus offices share a propane account with the LIBC West campus offices. This account is paid by the LIBC and is reported in the previous section.

Table 4.2 Propane Use by Tribal Institutions in 2010

Tribal Institution	Tribal Facility	Propane Use (Gallons)	Cost ($)
LIBC	Shellfish Hatchery	21,723	36,490
	Lummi Nation School	10,800	18,438
	Wex li em (Community Building)	7,497	15,555
	Central Campus Offices	7,277	12,836
	East Campus Offices	7,166	9,559
	Skookum Creek Hatchery[1]	3,238	5,422
	West Campus Offices	2,959	5,453
	Se'eye'chen (Youth Shelter)	2,078	3,664
	Clinic and Fitness Center	1,322	2,381
	Head Start	1,153	1,485
	Lummi Bay Salmon Hatchery	1,122	2,023
	Marietta Facilities[1]	281	536
	LIBC Total	**66,616**	**113,842**
NWIC	**All**	**21,736**	**39,501**
LHA	Little Bear Creek	15,343	26,741
	Recreation Center	1,544	2,743
	Maintenance	1,010	1,832
	Transition Recovery	659	1,180
	LHA Total	**18,557**	**32,496**
LTSWD	**Sewage Treatment and Offices**	**279**	**482**
Tribal Institutions Total		**107,188**	**186,321**

[1]Off-Reservation.

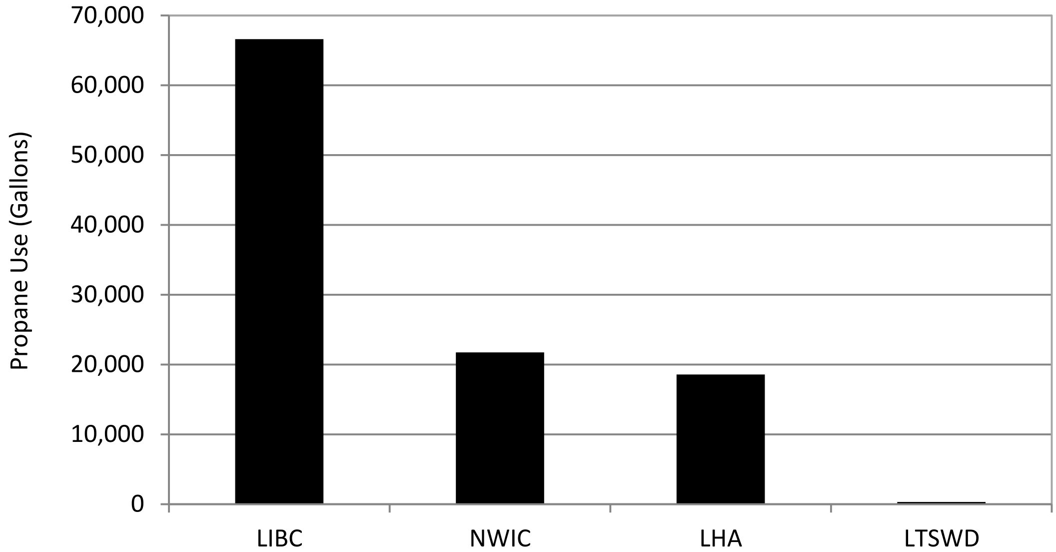


Figure 4.6 Propane Use by Tribal Institutions in 2010

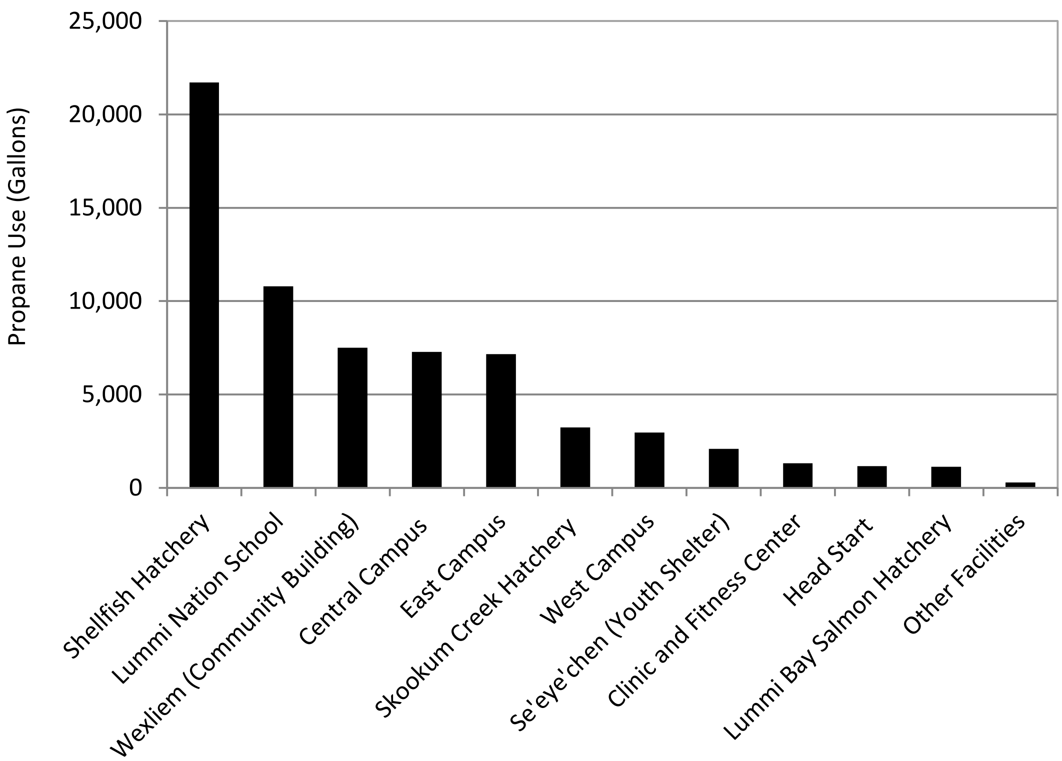


Figure 4.7 Propane Use by LIBC Facilities in 2010

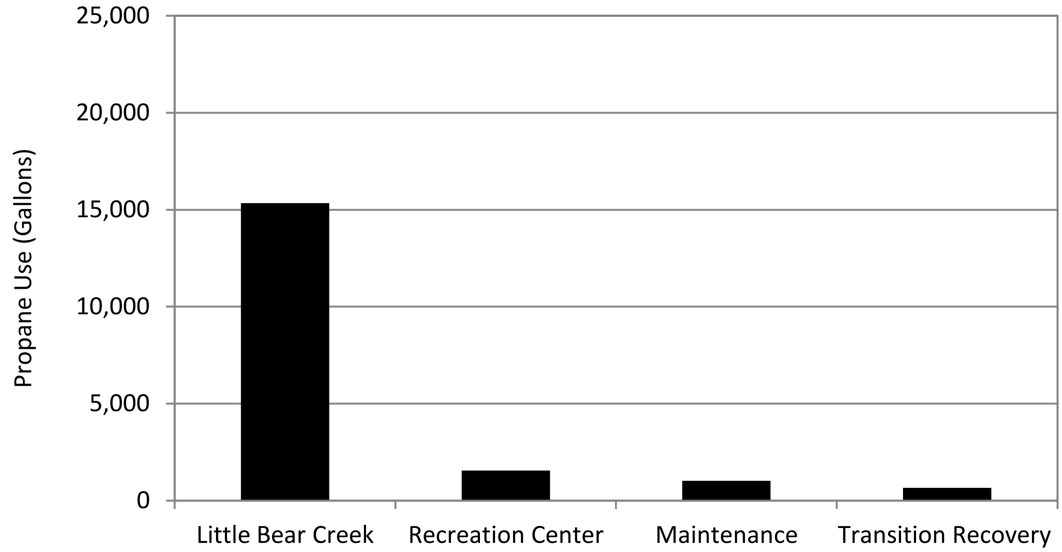


Figure 4.8 Propane Use by LHA Facilities in 2010

4.1.4. Natural Gas Consumption

There were two tribal facilities on the Reservation served by natural gas lines in 2010, the LCC Silver Reef Hotel, Casino & Spa and the LCC Lummi Mini Mart and gas station. The Silver Reef Hotel, Casino & Spa consumed approximately 87,486 ft^3 of natural gas at a cost of $132,801 (Table 4.3). The LCC reported that $1,448 was spent for natural gas at the Lummi Mini Mart and gas station in 2010, reflecting an estimated consumption of 953 ft^3.

Table 4.3 Natural Gas Use by Tribal Institutions in 2010

Tribal Institution	Tribal Facility	Natural Gas Use (ft^3)	Cost ($)
LCC – Silver Reef Hotel, Casino & Spa	All	87,486	132,801
Other LCC	Lummi Mini Mart and Gas Station	953	1,448
Tribal Institutions Total		**88,439**	**134,249**

4.1.5. Heating Oil Consumption

The old Lummi Natural Resources (LNR) building located on the Central Campus (2616 Kwina Road) was the only tribally-owned building on the Reservation heated with heating oil in 2010. In 2010, a total of 4,356 gallons of No. 2 Heating Oil were used at a cost of $10,319. This building was demolished in October 2013 after the LNR offices were relocated into the new Tribal Administration Building (2665 Kwina Road).

4.1.6. Gasoline and Diesel Consumption

The total gasoline and diesel fuel use during 2012 by tribal institutions was approximately 135,938 gallons at a cost of $526,803 (Table 4.4, Figure 4.9). The LIBC operated the largest vehicle fleet and was the highest fuel user, consuming approximately 108,306 gallons ($420,553) in 2012. Of the 81 LIBC fuel accounts active in 2012, the top five fuel consumers were the Lummi Nation Police Department (LNPD) – Law and Order (17 percent), Lummi Planning and Public Works Department – Tribal Transit (10 percent), Lummi Planning and Public Works Department – Facilities and Maintenance (7 percent), LNPD – Natural Resources Enforcement (6 percent), and the Lummi Youth Academy (5 percent). The LIBC data do not reflect reimbursements made to tribal employees for gas use in privately-owned vehicles used for work related purposes (e.g., travel to conferences). However, because department managed vehicles and the LIBC motor pool are readily available, these costs were assumed to be relatively small. Among other tribal institutions, fuel use was as follows: LHA used 10,010 gallons ($38,838), LTSWD used 7,847 gallons ($29,857), the Silver Reef Hotel, Casino & Spa used 6,522 gallons ($25,000), NWIC used 2,942 gallons ($11,355), and the other LCC used 309 gallons ($1,200) in 2012 (Table 4.4).

Table 4.4 Gasoline/Diesel Fuel Use by Tribal Institutions in 2012

Tribal Institution	Number of Vehicles	Fuel Use (Gallons)	Cost ($)
LIBC	165	108,306	420,553
LHA	19	10,010	38,838
LTSWD	10	7,847	29,857
LCC – Silver Reef Hotel, Casino & Spa	4	6,522	25,000
NWIC	9	2,942	11,355
Other LCC	1	309	1,200
Tribal Institutions Total	**208**	**135,938**	**526,803**

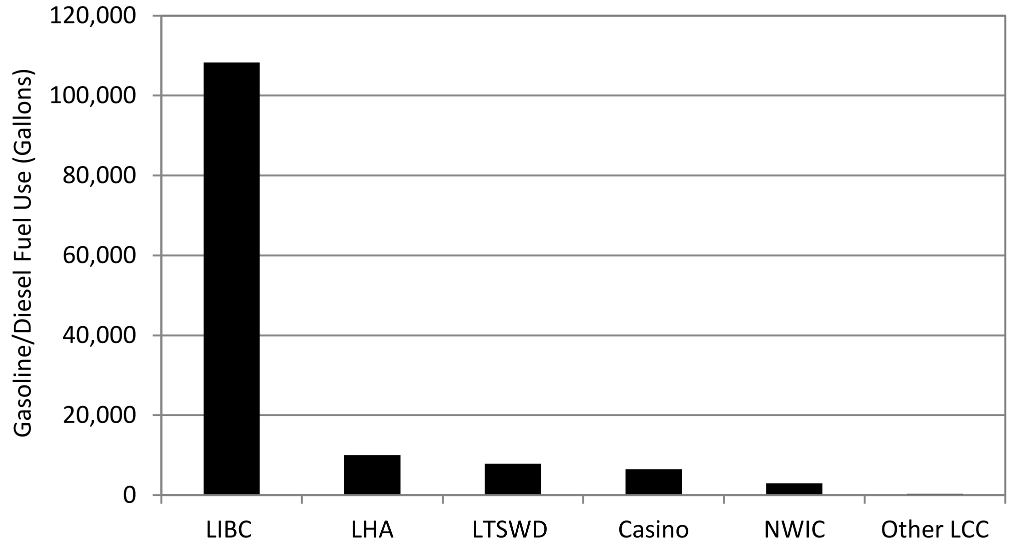


Figure 4.9 Gasoline and Diesel Fuel Use by Tribal Institutions in 2012

4.1.7. Tribal Institutions Energy Consumption Summary

In 2010, tribal institutions consumed a total of 81,302 MMBTU of energy. The LIBC and the Silver Reef Hotel, Casino & Spa were the two largest energy consumers, using 36,864 MMBTU and 23,769 MMBTU respectively (Table 4.5, Figure 4.10). The other tribal institutions used smaller quantities of energy: the LTSWD used 7,826 MMBTU, the NWIC used 6,054 MMBTU, the LHA used 4,796 MMBTU, and the other LCC used 1,993 MMBTU. The largest source of energy to tribal institutions was electricity, which accounted for 65 percent of the total energy used by tribal institutions in 2010, followed by gasoline/diesel (22 percent), propane (12 percent), heating oil (<1 percent), and natural gas (<0.1 percent) (Table 4.5, Figure 4.11).

Table 4.5 Total Energy Use (MMBTU) by Tribal Institutions in 2010

Energy Source	Tribal Institution						Total Energy Use
	LIBC	Casino	LTSWD	NWIC	LHA	Other LCC	
Electricity	15,934	22,819	6,769	3,682	1,784	1,952	52,941
Propane	6,084	-	25	1,985	1,695	-	9,789
Natural Gas	-	92	-	-	-	1	93
Heating Oil	604	-	-	-	-	-	604
Gasoline/Diesel	14,242	858	1,032	387	1,316	41	17,876
Total Energy Use	**36,864**	**23,769**	**7,826**	**6,054**	**4,796**	**1,993**	**81,302**

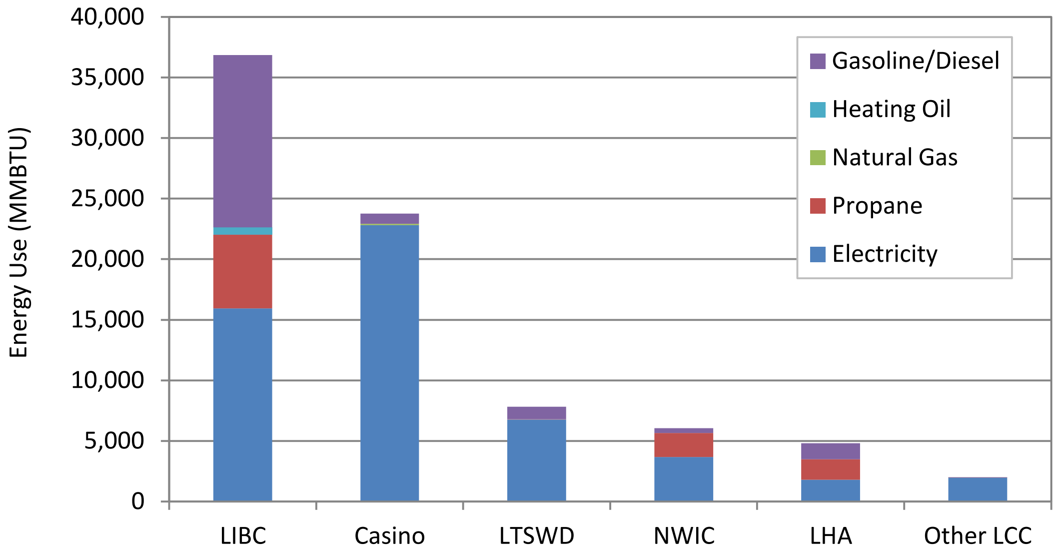


Figure 4.10 Total Energy Use by Tribal Institutions in 2010

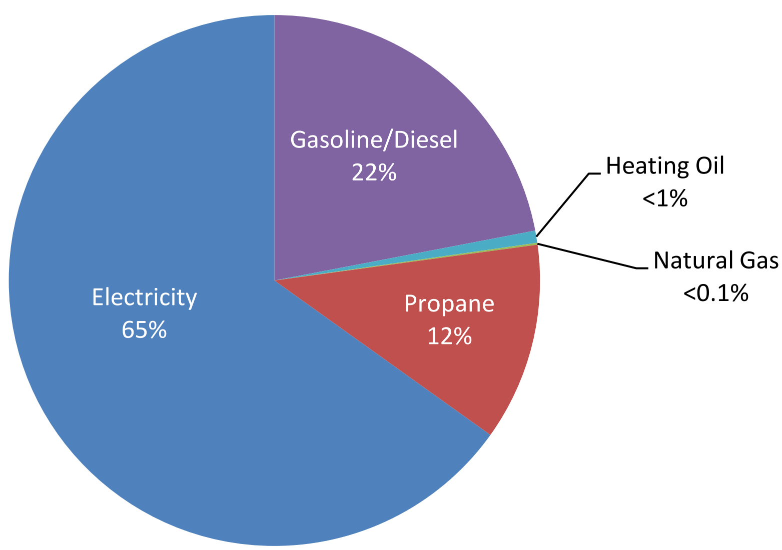


Figure 4.11 Total Energy Use by Tribal Institutions in 2010 by Energy Source

4.2. Residences

Most of the homes on the Reservation were constructed after 1960, including significant new construction and substantial improvements in the past two decades. These homes are located in several distinct residential neighborhoods that now exist on the Reservation, including Sandy Point, Neptune Beach, Sandy Point Heights, Gooseberry Point, and Mackenzie. The housing stock is largely comprised of single-family residences, although multi-family residences are becoming more abundant as the Reservation develops.

4.2.1. Methods

Residential energy consumption includes the use of electricity, propane, wood, and/or gasoline and diesel fuel.

Puget Sound Energy (PSE) provided residential electricity consumption data for the 2010 calendar year. Electricity usage (kWh) was reported as monthly totals for all residential schedule accounts located on the Reservation. Residential accounts include the units rented through the Lummi Housing Authority (LHA). Electricity cost was calculated using the average cost per kilowatt hour ($0.0804/kWh) in Washington State as reported by the U.S. Energy Information Administration (EIA 2012). It is noted that the start date and length of billing period on PSE invoices varies between accounts; thus, data reported by PSE exhibit artificial bimonthly peaks in electricity consumption that do not accurately reflect month-to-month change in use.

Residential sector propane use data were reported by the two local propane distributors, Vander Yacht Propane, Inc. and Propane Gas Industries, for privately-owned residences and by the Lummi Housing Authority (LHA) for tribally-owned housing units. Propane Gas Industries was only able to provide data for 152 of the 376 accounts located on the Reservation; propane use for the other 224 accounts was estimated based on average consumption derived from the usage data that were reported. Furthermore, propane use may be underestimated in this analysis because the local propane distributors stated there were likely additional on-Reservation accounts for which data were unavailable.

Wood consumption on the Reservation in 2010 was based largely on estimates provided by Lummi Natural Resources Department (LNR) staff, who concluded that approximately 390 tribal households on the Reservation use wood (exclusively or partially) for heating. Additionally, staff members who heat their homes using wood stoves indicated that 2-6 cords of wood are typically needed each year. Recognizing that the quantity of wood burned during a given year depends on several factors, including the size and condition of the residence, the type of stove or fireplace, the weather, and the species, quality, and seasoning of the wood, consumption of four cords of wood per household was considered a reasonable estimate for the purposes of this study. Similarly, although the cost to purchase a cord of wood is variable, a representative price per cord is $180.

Residential fuel (gasoline and diesel) consumption was estimated based on the Reservation population size and regional estimates of household fuel use and prices. In 2010, there were 1,632 households occupied year-round on the Reservation, average annual fuel expenditure was 1,090 gallons per household in the West Pacific Census Region, and the average retail price of fuel was $3.01 per gallon in Washington State (2010 Census, EIA 2015b). Calculated gasoline and diesel fuel consumption includes use on and off-Reservation.

4.2.2. Electricity Consumption

In 2010, total residential electricity consumption was estimated to be 21,661,000 kWh (or 21,661 MWh) at a cost of over $1.7 million (Table 4.6). Although the number of residential accounts changed month-to-month, PSE provided electricity to an average of 1,937 accounts each month. The average monthly electricity consumption per account was 932 kWh (approximately $75/month), which is slightly lower than the monthly averages reported for residences throughout Washington State in 2010 (1,030 kWh, $83/month). Generally, the highest electricity use was during the winter months, while the lowest electricity use was during the summer months. This pattern is consistent with increased use in the winter months due to the need for additional lighting, space heating, and/or water heating.

Table 4.6 Electricity Use by Reservation Residences in 2010

Month	Electricity Use (kWh)	Cost ($)	Number of Accounts	Average Electricity Use Per Account (kWh)	Average Cost Per Account ($)
January	2,130,241	171,271	1,902	1,120	90
February	2,763,011	222,146	1,900	1,454	117
March	1,549,668	124,593	1,898	816	66
April	2,372,409	190,742	1,911	1,241	100
May	1,312,388	105,516	1,926	681	55
June	1,821,162	146,421	1,926	946	76
July	1,004,394	80,753	1,938	518	42
August	1,569,296	126,171	1,947	806	65
September	1,028,490	82,691	1,954	526	42
October	1,662,677	133,679	1,972	843	68
November	1,382,089	111,120	1,981	698	56
December	3,065,040	246,429	1,989	1,541	124
Total	**21,660,865**	**1,741,532**	**-**	**11,190**	**901**

4.2.3. Propane Consumption

The estimated total propane consumption by the residential sector was estimated to be 257,683 gallons at a cost of $497,812 in 2010 (Table 4.7). Vander Yacht Propane, Inc. customers reportedly used a total of 20,017 gallons of propane or an average of 417 gallons ($880) per account. Propane Gas Industries customers used an estimated 167,792 gallons of propane or 446 gallons ($877) per account. The LHA reported a total consumption of 69,874 gallons of propane or 635 gallons ($1,145) per account.

4.2.4. Wood Consumption

Based on estimates provided by Lummi Natural Resources Department (LNR) staff, households on the Reservation using wood (exclusively or partially) for heating consume an estimated 4 cords of wood at a cost of $180 per cord annually. As such, all households combined (390 households) burned approximately 1,560 cords of wood as a cost of $280,800 in 2010.

Table 4.7 Propane Use by Residences in 2010

Provider	Propane Use (Gallons)	Cost ($)	Number of Accounts	Average Propane Use Per Account (Gallons)	Average Cost Per Account ($)
Vander Yacht Propane Inc.	20,017	42,238	48	417	880
Propane Gas Industries	167,792	329,585	376	446	877
LHA	69,874	125,989	110	635	1,145
Residences Total	**257,683**	**497,812**	**534**	**-**	**-**

4.2.5. Gasoline and Diesel Consumption

Given an estimated average annual fuel use of 1,090 gallons per household, the total expenditure of the 1,632 households (occupied year-round) on the Reservation in 2010 was nearly 1.8 million gallons of fuel. At an average price of $3.01 per gallon, the total cost to Reservation residents for gasoline and diesel fuel was approximately $5.4 million.

4.3. Private Businesses

In 2010, there were 251 licensed businesses located on the Reservation. These businesses included fireworks sales, food preparation and retail, wholesale, trade businesses, and professional services. For the purposes of this assessment, registered Lummi fishers were also considered to be owners of private businesses. In 2010, there were approximately 500 registered fishers (some individuals participate in more than one fishery and are "registered" multiple times each year) and the Lummi fishing fleet was comprised of approximately 375 registered vessels.

4.3.1. Methods

The energy used by private businesses located on the Reservation is likely to include electricity, propane, wood, and/or gasoline and diesel fuel. Because most private businesses located on the Reservation are operated out of residences rather than storefronts, it is recognized that energy use by these businesses is included in Section 4.2 – Residences, and is not duplicated here. What is reported in this section is electricity use at storefront businesses (e.g., Native American Seafood, Finkbonner Shellfish) and gasoline and diesel fuel use by the Lummi fishing fleet.

Puget Sound Energy (PSE) provided monthly electricity usage data for all commercial schedule accounts located on the Reservation. In the PSE schedule, private businesses and tribal institutions are both categorized as commercial accounts. Accordingly, annual consumption by private businesses was calculated as the sum of monthly electricity usage by commercial schedule accounts in 2010, minus the quantity of electricity used by tribal institutions as reported in Section 4.1 – Tribal Institutions. Annual cost was calculated using the average cost per kilowatt hour ($0.0804/kWh) in Washington State in 2010 as reported by the U.S. Energy Information Administration.

Fuel consumption by the Lummi fishing fleet in 2010 was derived from harvest records maintained by the Lummi Natural Resources Department (LNR) Harvest Management Division and estimates of fuel use provided by selected Lummi fishers. Because there are no available data for the exact number of trips made or distances traveled by the Lummi fishing fleet annually, the number of reported landings (i.e., docking to sell harvest at a licensed fish buying station) is used as a proxy for the number of vessel trips. Harvest Management Division staff reported the total number of landings by Lummi fishers for all fisheries except manila clam in 2010. Manila clam landings were excluded because they do not typically require the use of a vessel. Next, an informal survey of Lummi fishers was conducted to determine the average quantity of fuel used per landing. Although actual fuel use depends on vessel size (e.g., skiffs, gill netters, seiners), engine type (e.g., gasoline, diesel), fishery (e.g., salmon, halibut, Dungeness crab, shrimp), fishing area, weather, and other factors, an average consumption of 20 gallons of gasoline or diesel per landing was considered a reasonable estimate for the purposes of this study. Cost was estimated based on the average retail price of fuel ($3.01/gallon) in Washington State in 2010.

4.3.2. Electricity Consumption

In 2010, private businesses located on the Reservation consumed an estimated 124,654 kWh of electricity at a cost of $10,022.

4.3.3. Fishing Fleet Gasoline and Diesel Consumption

In 2010, commercial Lummi fishers made 11,980 landings. Provided that each landing correlates to an expenditure of 20 gallons of gasoline or diesel, the Lummi fleet consumed an estimated total of 239,600 gallons of fuel at a cost of $721,196.

4.4. Total Reservation Energy Use

In summary, energy consumption by tribal institutions, residences, and private businesses in 2010 included the use of electricity, propane, natural gas, heating oil, wood, and gasoline and diesel. To evaluate total energy use on the Reservation, the energy provided by different energy sources was converted to British Thermal Units (BTU) using the standard conversion factors provided in Table 3.2.

In 2010, a total of approximately 475,801 million BTU (MMBTU) of energy were used on the Reservation by tribal institutions, residences, private businesses, at a cost of $10,795,968 (Table 4.8, Figure 4.12, Figure 4.13). Over half of the energy used in 2010 was from gasoline/diesel (60 percent), the remaining was attributed to electricity (27 percent), propane (7 percent), wood (7 percent), natural gas (<0.1 percent), and heating oil (<0.1 percent). Fuel used for transportation was dominated by residential use (49 percent), while gasoline/diesel use by tribal institutions and private businesses was relatively small by comparison (4 percent and 7 percent, respectively). Second to transportation fuels, electricity accounted for a large share of the Reservation's total energy use. Again, residential use of electricity was highest (16 percent), but was closely followed by electricity use in tribal institutions (11 percent). The use of electricity by private businesses was relatively small (<0.1 percent). Propane consumption was higher in residences (5 percent) compared to tribal institutions (2 percent). Use of wood for heating was restricted to residences (7 percent), the use of natural gas was restricted to the LCC's Silver Reef Hotel, Casino & Spa and the LCC owned and operated Lummi Mini Mart (<0.1 percent), and the use of heating oil was restricted to the LIBC Natural Resources Department building (<0.1 percent).

Table 4.8 Total Energy Use on the Reservation in 2010

Energy Source	Energy User	Energy Use	Cost ($)	Energy Use (MMBTU)	Energy Use (%)
Electricity	Tribal Institutions	15,516 MWh	1,332,486	52,941	11
	Residences	21,661 MWh	1,741,532	73,907	16
	Private Businesses	125 MWh	10,022	427	<0.1
	Total	**37,302 MWh**	**3,084,040**	**127,274**	**27**
Propane	Tribal Institutions	107,188 gal	186,321	9,789	2
	Residences	257,683 gal	497,812	23,534	5
	Private Businesses	-	-	-	-
	Total	**364,871 gal**	**684,133**	**33,324**	**7**
Natural Gas	Tribal Institutions	88,439 ft^3	134,249	93	<0.1
	Residences	-	-	-	-
	Private Businesses	-	-	-	-
	Total	**88,439 ft^3**	**134,249**	**93**	**<0.1**
Heating Oil	Tribal Institutions	4,356 gal	10,319	604	<0.1
	Residences	-	-	-	-
	Private Businesses	-	-	-	-
	Total	**4,356 gal**	**10,319**	**604**	**<0.1**
Wood	Tribal Institutions	-	-	-	-
	Residences	1,560 cords	280,800	31,200	7
	Private Businesses	-	-	-	-
	Total	**1,560 cords**	**280,800**	**31,200**	**7**
Gasoline/ Diesel	Tribal Institutions	135,938 gal	526,803	17,876	4
	Residences	1,778,880 gal	5,354,428	233,923	49
	Private Businesses	239,600 gal	721,196	31,507	7
	Total	**2,154,418 gal**	**6,602,427**	**283,306**	**60**
Reservation Total			**10,795,968**	**475,801**	**100**

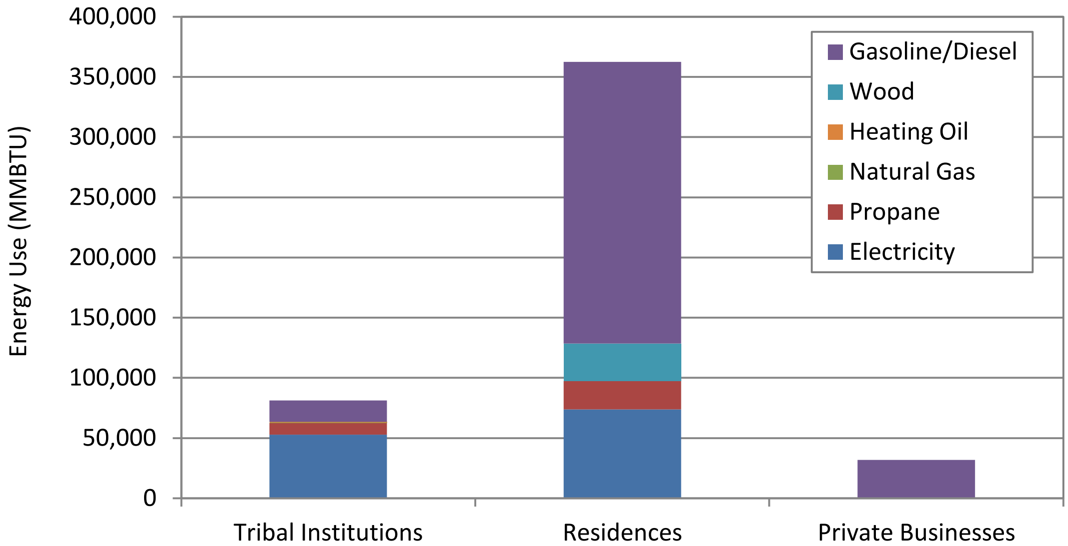


Figure 4.12 Total Energy Use on the Reservation in 2010

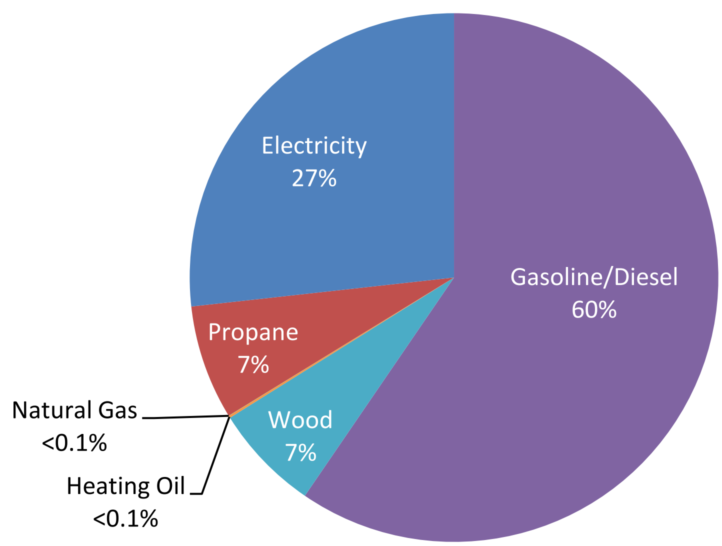


Figure 4.13 Total Energy Use on the Reservation in 2010 by Energy Source

4.5. Total Reservation Emissions

Concurrent with the financial costs of energy use, there are also environmental costs. One of the Lummi Nation's goals in developing this Strategic Energy Plan is to reduce emissions that result from energy use, which contribute to global climate change and degraded air quality. Quantifying air emissions from energy production and use is a first step toward addressing this goal.

The U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) have developed air emissions factors for determining the quantity of gasses released during energy production and consumption. The EPA Power Profiler provides estimates of gas emissions during electricity production based on the specific fuel mix used by the utility. Given the fuel mix used by Puget Sound Energy (PSE), emissions resulting from electricity production in 2010 were as follows: 819 lbs carbon dioxide (CO_2) per MWh, 1.05 lbs sulfur dioxide (SO_2) per MWh, and 1.04 lbs nitrogen oxides (NOx) per MWh. Another online EPA calculator, the Greenhouse Gas Equivalencies Calculator, provides estimates of carbon dioxide (CO_2) emissions from gasoline and diesel (20 lbs CO_2 per gallon) and natural gas (0.12 lbs CO_2 per ft^3). Estimates of emissions for propane (12 lbs CO_2 per gallon), wood (3,750 lbs CO_2 per cord, assuming a cord weight of 2,500 lbs), and heating oil (22 lbs CO_2 per gallon) were obtained from the Department of Energy (DOE). In addition to carbon dioxide, emissions from the use of propane, natural gas, heating oil, wood, and gasoline/diesel also include sulfur dioxide or nitrous oxides; the quantity of SO_2 and NOx emissions from the Reservation are not reported here only because standard emissions estimates from these energy sources were unavailable.

Estimates of the environmental impacts of energy use were completed using the emissions factors detailed above and the 2010 energy use data for the Reservation. Emissions from the production and subsequent use of electricity in 2010 were 30,550,338 lbs CO_2, 39,167 lbs SO_2, and 38,794 lbs NOx (Table 4.9, Figure 4.14). In addition to electricity use, there were emissions of CO_2 resulting from the direct use of gasoline/diesel (43,088,360 lbs CO_2), propane (4,378,452 lbs CO_2), wood (5,850,000 lbs CO_2), heating oil (95,832 lbs CO_2), and natural gas (10,584 lbs CO_2). In sum, there were approximately 83,973,595 lbs of CO_2 emissions in 2010. To provide a useful frame of reference, the total CO_2 emissions in 2010 were equivalent to the annual emissions from approximately 7,500 passenger vehicles or the carbon sequestered annually by 30,000 acres of U.S. forests.

Table 4.9 Estimated Air Emissions from Energy Consumption on the Lummi Reservation in 2010

Energy Source	Carbon Dioxide (lbs)	Sulfur Dioxide (lbs)	Nitrous Oxides (lbs)
Electricity	30,550,338	39,167	38,794
Propane	4,378,452	-	-
Natural Gas	10,613	-	-
Heating Oil	95,832	-	-
Wood	5,850,000	-	-
Gasoline/Diesel	43,088,360	-	-
Total	**83,973,595**	**39,167**	**38,794**

By comparing Figure 4.13 and Figure 4.14, source-specific energy use can be tied to resultant carbon dioxide emissions. For example, gasoline/diesel was the source of 60 percent of the energy used on the Reservation in 2010 and accounted for 51 percent of carbon dioxide emissions, whereas electricity was the source of 27 percent of the energy used on the Reservation over the same time period but accounted for 36 percent of the total carbon dioxide emissions. It should be noted that although wood accounted for 7 percent of the total energy use and 7 percent of the total carbon dioxide emissions on the Reservation in 2010, wood is a renewable energy resource and is considered to be "carbon neutral" as discussed in Section 7.6 Biomass (Bioenergy).

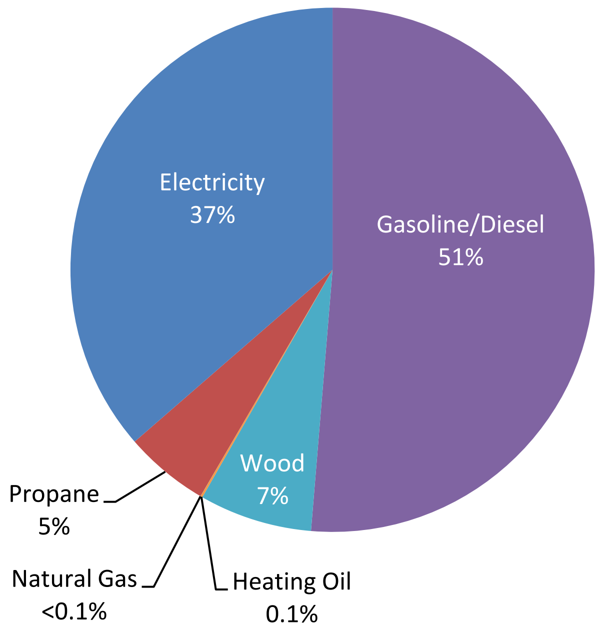


Figure 4.14 Total Carbon Dioxide Emissions on the Reservation in 2010 by Energy Source

(This page intentionally left blank)

5. FUTURE ENERGY NEEDS

Between 2000 and 2010, the Lummi Indian Reservation (Reservation) population increased from 4,193 persons to 4,706 persons according the U.S. Census. By 2020, the Reservation population is projected to grow to 5,800-6,800 persons (Northwest Economic Associates 2003). As the population on the Reservation increases, so too does the demand for energy, which is needed to support new housing and employment opportunities.

5.1. Current and Future Reservation Development

The Lummi Planning and Public Works Department is responsible for providing guidelines as to how land on the Reservation will be used over the coming decades through the development and implementation of a Comprehensive Land Use Plan for the Lummi Indian Reservation. The current draft Comprehensive Land Use Plan anticipates that population growth on the Reservation by 2030 will require development of approximately 1,850 additional homes, 1,500,000 additional square feet of commercial space (e.g., retail, light industrial, warehouse, and office uses), and 250-400 additional job opportunities, as well as improved government, health, education, recreation, and cultural amenities.

Even over the past five years from 2010 to 2015, there has been a significant amount of development undertaken or completed on the Reservation. For instance, the LIBC opened the new Tribal Administration Building (2013) and nearby Head Start (2013), effectively consolidating departmental offices that had formerly been distributed across the East, Central, and West Campuses to one location. The LIBC also plans to significantly expand the Lummi Youth Academy. In 2013, the Silver Reef Hotel, Casino & Spa completed the Phase VI expansion, which included the addition of 50,000 square feet of additional gaming area, a new restaurant, theater, and event center. The Phase VII expansion, construction of a second hotel tower, was completed in November 2015. Also between 2010-2015, several new facilities were built on the Northwest Indian College (NWIC) campus, including the Salish Sea Research Center, the Native Environmental Science building, the Cooperative Extension building, the NWIC Library, and the Information Technology building. In 2012, the Lummi Commercial Company (LCC) opened the Lummi Gateway Center along Rural Avenue near Interstate 5. The Gateway Center currently contains several offices, a multipurpose room, two cafes, a carving shed, two shops specializing in arts and crafts, and a liquor and cigarette store. Additional commercial development near the Gateway Center is planned. Finally, 275 new residential units are currently under construction by the LIBC and the Lummi Housing Authority (LHA). These developments include the Kwina Village expansion (66 units), the McKenzie IV Division 1 expansion (16 units), the McKenzie IV Division 2 expansion (14 units), the Grace Erickson Property (17 units), the Olson Property (108 units), and the Turkey Shoot Property (54 units). Residential development by private property owners has been ongoing. Given this development, it is reasonable to assume that the energy use on the Reservation has changed since the energy baseline assessment was conducted in 2010.

Some of the new facilities on the Reservation were designed to minimize energy use. As one example, energy use at the new Tribal Administration building, which became fully operational in June 2013, is described in the next section.

5.2. New Tribal Administration Building

Construction of the new Lummi Nation Tribal Administration Building (2665 Kwina Road) allowed many LIBC department offices that had previously been located in several small and outdated buildings distributed across the LIBC East, Central, and West campuses to be housed under one roof. The Tribal Administration Building was built to LEED Silver-Certified standards and uses a geothermal heat pump to minimize the amount of nonrenewable energy used for space heating and cooling. Accordingly, operation of the new building was expected to realize significant energy savings compared to the old offices, many of which were repurposed dormitories and administrative buildings associated with a former U.S. Navy Station, buildings from the old Lummi Nation School, or other pre-manufactured buildings with inefficient lighting and heating systems.

To provide a rough assessment of the degree to which energy consumption has changed since moving into the new Tribal Administration Building (TAB), energy usage in the TAB during the first full year of operation (2014) was compared to energy usage in the old LIBC East, Central, and West campus offices in 2010. It is noted that there are a few offices on the LIBC campuses that are still in use or were repopulated and/or remodeled since 2010. The results presented here are intended only to provide a ball-park comparison between the old and new facilities, and should not be interpreted as direct comparison of total energy use by LIBC offices between 2010 and 2014. In 2014, the new Tribal Administration Building used approximately 27 percent more electricity, 84 percent less propane, and 100 percent less heating oil than the LIBC offices did in 2010. When converted into BTU equivalents, the TAB used nearly 15 percent less total energy during 2014 than the LIBC offices did in 2010. These numbers are consistent with the energy efficient design and operation standards and utilization of geothermal energy in the TAB.

Another method for comparing the 2010 LIBC campuses data to the 2014 Tribal Administration Building data is to look at energy use per square foot of conditioned office space (i.e., building energy use intensity). Again, there are limitations to this approach given available data. The floor space of the old LIBC East, Central, and West campus offices was never well established; an estimated area of 105,000 ft^2 was used for analysis purposes. The floor space of the TAB is 123,000 ft^2. Accordingly, energy use intensity in the TAB was 43 $kBTU/ft^2$ in 2014, whereas energy use intensity in the LIBC offices was 59 $kBTU/ft^2$ in 2010. The average office in the United States has an energy use intensity of approximately 80 $kBTU/ft^2$ (DOE 2012). As expected given the design and operation of the new Tribal Administration Building, the TAB uses about half the amount of energy per square foot as the average U.S. office and realized significant energy savings per square foot of conditioned office space compared to the old LIBC offices. What was not anticipated however was the relatively low energy intensity of the former LIBC offices. While this may be attributed, in part, to inaccuracy in the estimated floor space, it is likely that poor condition of the old facilities also played a role. As one LIBC employee recounted of his former office: the furnace was often broken in the winter, there was no air conditioning, much of the indoor lighting was unusable, and there was little to no outdoor lighting. Given these considerations, the new Tribal Administration Building has not only reduced energy use, but has also significantly improved working conditions for LIBC employees.

Energy use data for the Tribal Administration Building are presented in Appendix D.

5.3. Projected 2030 Energy Consumption

Given projected population growth on the Reservation and increasing energy prices in the United States, it is anticipated that both energy demand and energy costs will increase on the Reservation in the future. Although a detailed analysis of future energy use is beyond the scope of this project, a few basic estimates of future energy use by residences, tribal institutions, and private businesses are provided here. Using the current residential energy use data, assuming that annual household energy use remains consistent over the coming decades, and assuming the construction of 1,850 new homes, it is reasonable to expect that energy use by Reservation residents will increase from the current level (1,632 year-round occupied households use approximately 362,564 MMBTU) to roughly 773,559 MMBTU by 2030. In 2010, tribal institutions consumed 81,302 MMBTU of energy. Assuming that tribal institutions use twice the amount of energy to meet the needs of a population twice as large, energy use may be 162,604 MMBTU by 2030. Similarly, if current annual energy demand for private businesses (31,934 MMBTU) on the Reservation doubled by 2030, then annual energy use in this sector can be expected to increase to 63,868 MMBTU annually. In sum, 1,000,031 MMBTU may be used annually by tribal institutions, residences, and private businesses on the Reservation by 2030.

Estimated future energy consumption is intended to emphasize the importance of using energy efficiently practices and developing renewable energy sources on the Reservation in order to attain the Lummi Nation's goals of energy self-sufficiency and emissions reduction. Energy efficiency is the subject of Section 6 and renewable energy sources are the subject of Section 7.

(This page intentionally left blank)

6. ENERGY EFFICIENCY PRACTICES

Rigorous application of energy efficiency practices in the tribal, residential, and commercial sectors on the Lummi Indian Reservation (Reservation) could significantly lower energy demand and contribute to the Lummi Nation's goals of energy self-sufficiency and emissions reduction. As famously stated by former U.S. Secretary of Energy Steven Chu, "Energy efficiency isn't just low hanging fruit; it's fruit laying on the ground." Put another way, the utilization of up-to-date energy efficiency technology and energy efficient habits is typically the cheapest and easiest way to attain measurable energy and cost savings. Because energy is lost at every stage of the generation lifecycle, from source to processing to end-user, every little bit of energy conservation helps and even small reductions in home or workplace energy use are amplified in upstream energy savings. Not only are there economic benefits, but increasing energy efficiency also helps protect the environment (e.g., reduce emissions, reduce environmental degradation during extraction and processing) and can contribute to higher levels of individual comfort and wellbeing (e.g., improved indoor air quality). It is the finding of this assessment that improving energy efficiency practices is likely to be the most feasible and effective means for reducing energy use and air emissions on the Reservation over the 2016-2026 planning period. As such, improving energy efficiency practices on the Reservation should be the primary focus of the early stages of strategic energy planning and implementation.

The purpose of this chapter is to discuss standard methods for improving energy efficiency, current examples of successful energy efficiency practices, and recommendations for improving energy efficiency on the Reservation. This discussion is divided into three sections, corresponding with the three categories in which energy efficiency practices are typically divided: (1) building-related, (2) behavior-related, and (3) transportation-related. Additionally, there are brief discussions of previously explored interests in the development of a cogeneration facility (i.e., combined heat and power facility) and tribally-owned electric utility on the Reservation.

6.1. Building-Related Energy Efficiency

In tribal facilities, homes, and businesses alike, significant reductions in energy use could be made through implementation of building-related energy efficiency practices that target space heating and cooling, lighting, appliances, and electronics. While energy used for these purposes is necessary to create a comfortable and productive indoor environment, many buildings use energy inefficiently, which leads to higher energy consumption, higher carbon emissions, and associated higher costs. There are many energy saving measures (e.g., energy efficiency retrofitting, weatherization) that can be applied to existing buildings on the Reservation. These may include adding insulation; preventing air leaks in the building envelope (e.g., weatherstripping, caulking) and ducts; replacing inefficient heating, ventilation, and air conditioning (HVAC) systems (e.g., with heat exchange/heat pump furnaces or more efficient furnaces); upgrading single paned windows; properly maintaining appliances and electronics and/or buying Energy Star appliances and electronics; installing controls (e.g., programmable thermostats to regulate temperature according to building occupancy and/or time of day, light switches triggered by sensors); and replacing incandescent light bulbs with compact fluorescent lights (CFLs) or light emitting diodes (LEDs). In new construction, energy efficiency can be incorporated throughout building design, construction, and use. For instance, buildings can be sited to maximize solar exposure in winter, while minimizing solar exposure in the summer (i.e., passive solar). The U.S. Green Building Council has established a set of building standards that are intended to promote environmentally-minded development; this program is called Leadership in Energy and Environmental Design (LEED). Buildings that meet credited performance levels may be LEED Certified (e.g., the Lummi Gateway Center is LEED Silver-Certified).

Building-related energy efficiency strategies are already being utilized on the Reservation and several notable examples are discussed here. To begin, the Lummi Nation School opened a new K-12 facility in 2004. The new school received high ratings from the U.S. Bureau of Indian Affairs (BIA) for energy efficiency, ranking among the top three most energy efficient BIA schools in the nation. In 2013, a discount program available through the local electricity utility was used to upgrade some of the school's outdoor lighting to LED lights. Further lighting upgrades are planned as funding becomes available.

In 2009, the Lummi Planning and Public Works Department applied for and was awarded an Energy Efficiency and Conservation Block Grant of nearly $240,000 by the U.S. Department of Energy (DOE). Energy efficiency improvement projects that were implemented using these grant funds included the installation of an electric heat pump at the East Campus Gymnasium, new doors and windows at the Lummi Bay Salmon Hatchery, on-demand water heaters and custom heat-exchange furnaces at the *Wex li em* (Community Building), and a new heating, ventilation, and air conditioning (HVAC) system at the Stommish Hall.

From 2010-2014, the Northwest Indian College (NWIC) constructed five new buildings on campus, including the Salish Sea Research Center, the Native Environmental Science building, the Cooperative Extension building, the NWIC Library, and the Information Technology (IT) building. The integration of high energy efficiency standards was a guiding principle in the campus expansion. For instance, south facing windows take advantage of solar heating and natural light; fixtures, equipment, and appliances are either Energy Star or energy-efficient rated; lights are equipped with occupancy-detection sensors and have energy efficient ballasts and bulbs; heat recovery units preheat the fresh air supply for the HVAC systems; radiant floor heat and natural ventilation are used in some buildings, while the others use energy efficient heat pumps; some buildings are equipped to use reclaimed water in toilets and for landscaping and the use of reclaimed water systems may begin when the NWIC can demonstrate that the reclaimed water is reliably and adequately treated for this purpose; some buildings are equipped to capture the heat generated by network servers, which has applications in space heating and cooling; some building have solar arrays, as discussed in Section 8.1 – Solar Energy; and exterior solar powered lights are installed around the grounds. Existing buildings on the NWIC north campus are being retrofitted with energy efficient fixtures, appliances and equipment on a continuous basis.

In 2012, the Lummi Commercial Company (LCC) opened the Lummi Gateway Center, which contains several offices, a multipurpose room, two cafes, a carving shed, and two shops specializing in arts and crafts, and a liquor and cigarette store along Rural Avenue near Interstate 5 (I-5). The Lummi Gateway Center is a Leadership in Energy and Environmental Design (LEED) Silver-Certified building.

In 2013, the Lummi Indian Business Council (LIBC) opened the Tribal Administration Building. Prior to 2013, LIBC department offices were located in several small buildings distributed across the East, Central, and West campuses. Many of these offices were repurposed dormitories and administrative buildings from a former U.S. Navy Station, buildings from the old Lummi Nation School, or pre-manufactured buildings with inefficient lighting and heating systems. While some of the old East, Central, and West Campus offices are still in use or are being repurposed and repopulated, several are no longer in use, have been demolished, or are set for demolition. The Tribal Administration Building was build to LEED Silver-Certified standards, but was not certified due to cost and staff limitations. Also, the building uses a geothermal heat pump to support the need for space heating and cooling and as described above, has realized significant energy savings per square foot of conditioned office space.

After undergoing an energy audit in 2012, managers of the Lummi Shellfish Hatchery had a new roof and an electric heat pump installed at the facility in 2014. The new roof has significantly improved building insulation and helped to maintain consistent and appropriate temperatures in shellfish rearing rooms. Meanwhile, the electric heat pump, which replaced a propane broiler, cost $50,000 for purchase and installation, but is expected to reduce annual energy costs by $40,000 (Point 2014).

Finally, the Lummi Natural Resources Department (LNR), in partnership with the Opportunity Council, developed and is implementing the Residential Energy Efficiency Pilot Program from 2014-2016. The purpose of the program is to explore a direct approach to reduce energy use in and resultant carbon emissions from the homes of Lummi tribal members and to develop a system for performing residential energy audits and energy efficiency retrofitting that addresses needs specific to the Reservation community. The Opportunity Council is a local non-profit organization that conducts energy audits, vets contractors qualified to complete energy efficiency retrofitting and weatherization, and leverages utility rebates, cash incentives, and other funding sources to subsidize the cost of some energy efficiency projects and lower the costs paid by owners. Using grant funding awarded through the Bureau of Indian Affairs (BIA) Rights Protection Implementation (RPI) Climate Change fund for FY14 ($67,135) and FY15 ($69,535), the LNR will subsidize costs that are not eligible for funding through the Opportunity Council (e.g., deferred maintenance) so that energy efficiency retrofitting and weatherization will be completed at no cost to the home owner. By the end of 2016, the LNR expects that work will be completed on at least 14 tribal member owned or occupied homes on the Reservation.

6.1.1. Costs and Benefits

The primary benefits of building-related energy efficiency practices are: (1) long-term energy and cost savings, (2) emissions reduction, (3) improved comfort for building occupants, and (4) improved indoor air quality. Poor indoor air quality (IAQ) has been linked with higher incidence and severity of asthma, allergies, and other respiratory diseases and research indicates that low income and tribal communities are often disproportionately affected by poor IAQ. Indoor air quality may be improved by application of building-related energy efficiency practices. For example, sealing the building envelope to prevent air leakage will reduce infiltration of hot outdoor air during the summer, thus preventing building overheating, drafts, moisture, and indoor air quality issues (e.g., mold and mildew). The primary costs of building-related energy efficiency practices are: (1) installation costs and (2) maintenance costs.

6.1.2. Recommended Actions

The following recommendations take into consideration the information presented in this section and the tribal goals of energy self-sufficiency and reduced emissions.

1. *Establish a permanent, full-time Energy Management Specialist position within the Lummi Planning and Public Works Department*. The purpose of this position will be to lead strategic energy planning efforts forward. Duties may include: performing ongoing monitoring of Reservation energy use, conducting energy audits and energy efficiency cost-benefit analyses, seeking funding for energy efficiency improvement projects, overseeing the implementation of energy efficiency projects, and conducting energy conservation education. It is also recommended that the Energy Management Specialist participate in the Resource Conservation Management (RCM) Program offered by Puget Sound Energy (PSE) to customers managing large facilities. By participating in this program, the Energy Management Specialist will have access to Utility Manager Software, which can be used to effectively and efficiently monitor all existing utility accounts, may be eligible for PSE funding (e.g., PSE typically enters into a three-year grant agreement and supplements the position with up to $35,000), and may participate in PSE supported training opportunities. Many jurisdictions have found that energy cost saving realized by hiring an Energy Management Specialist are more than enough to cover his/her salary.

2. *Conduct energy audits of tribal facilities and implement the recommendations of these audits*. Energy audits are instrumental in identifying and prioritizing energy efficiency improvement projects. Preferably, audits will be performed by or under the supervision of the Energy Management Specialist. Until this position has been filled, energy audit services provided by a qualified private consultants or non-profit organizations may be utilized. It is recommended that initial energy audits are focused on high energy users such as the Silver Reef Hotel, Casino, & Spa, the Lummi Nation School, and the Little Bear Creek Elder Home where efficiency improvements may have a significant impact on energy demand. As the program expands and provision of energy audits and application of energy efficiency technology and services increases, the LIBC may consider creating positions for Energy Management Technicians in the Planning and Public Works Department. Alternatively, the tribe may support or promote the training of Lummi tribal-members through the Opportunity Council's Building Performance Center or another similar program, and then contract with certified technicians on a project-by-project basis.

3. *Institutionalize the Residential Energy Efficiency Pilot Program.* A permanent program for providing energy audits and subsidizing the costs of energy efficiency retrofitting and weatherization for low-to-moderate income households on the Reservation should be pursued. Low-income households spend a disproportionately high amount of income on energy costs, and may have to choose between sufficient heating and other necessities. The new Residential Energy Efficiency Program may be added to services already provided by the Lummi Nation Community Services Department (Commods), such as the Energy Assistance Program. In 2012, approximately 740 low-income tribal households received electricity and heating subsidies through the Community Services Department

(Lane 2013). Subsidizing residential energy efficiency retrofitting and weatherization could immediately improve living conditions in currently energy inefficient homes, provide energy cost savings to low-income residents, and potentially decrease the need for energy assistance in the future.

4. *Mandate high energy efficiency standards in new construction.* A commitment to using Leadership in Energy and Environmental Design (LEED) standards in the development of new or substantially improved tribal facilities is recommended to reduce future energy use on the Reservation. Formal LEED certification may not be necessary, so long as credited LEED activities (e.g., water use, energy use, materials and resources, indoor environmental quality, innovation in design) are incorporated.

6.2. Behavior-Related Energy Efficiency

Energy efficiency technology is important, but so too are the habits of building occupants. Changing the way occupants operate lights, heaters, air conditioning, appliances, and electronics can add up to measurable energy savings. Targeted behaviors for increasing energy conservation include turning off lights in unoccupied rooms or when daylight is sufficient; choosing the lowest comfortable thermostat setting in the winter and the highest setting in the summer if you have air conditioning; turning down the thermostat when leaving the building for several hours or days (e.g., work, vacation); ensuring that windows are not open when heaters or air conditioning are running; using window blinds to help trap heat (e.g., in the winter, open blinds on sunny days and close them at night), reducing hot water use (e.g., take shorter showers, wash lightly soiled clothing in cold water) and setting the hot water heater to 120°F; using electronics less frequently and turning them off when not in use; connecting electronics to power strips that can be switched off when not in use (some electronics use power even in standby mode, i.e., "phantom power"). Some of these actions can be automated by installing occupancy-detection sensors for lights and programmable thermostats.

There are many individuals on the Reservation who have already practice energy efficient behaviors. There are also some opportunities for individuals who are not aware of the actions that may be undertaken to conserve energy to learn more about energy saving measures, such as the Energy Workshop lead by the Opportunity Council on July 31, 2014 in combination with registration for their Energy Assistance Program. In the Tribal Administration Building and other recently constructed buildings on the Reservation, occupancy-detection sensors and programmable thermostats are used to automate actions that increase energy conservation.

Additionally, what we buy and how we manage our waste can significantly affect our carbon footprint. Simple actions like reducing, reusing, and recycling can help reduce energy use and carbon emissions from resource extraction, manufacturing, and disposal. Everyone can likely find ways to reduce consumption and reuse certain products. Recognizing the need to better serve the community, the Lummi Nation has recently adopted the Lummi Indian Reservation Integrated Solid Waste Management Plan (2014). Some key recommendations of this plan are to re-establish a Solid Waste Management Division within the Lummi Nation Planning and Public Works Department and to fully subsidize weekly curbside solid waste and every other week recyclable collection or its equivalent. If this program is fully implemented, individuals will be afforded ample opportunity to recycle.

6.2.1. Costs and Benefits

The primary benefits of behavior-related energy efficiency practices are: (1) long-term energy and cost savings, (2) emissions reduction, (3) improved comfort for building occupants, and (4) fostering a culture of energy awareness. The primary costs of behavior-related energy efficiency practices are: (1) the cost of program development, albeit low when compared to energy efficiency retrofitting or weatherization, and (2) costs associated with lack of participation and/or noncompliance.

6.2.2. Recommended Actions

The following recommendations take into consideration the information presented in this section and the tribal goals of energy self-sufficiency and reduced emissions.

1. *Provide public education and outreach to encourage and promote energy efficient behaviors at home and in the workplace*. Education and outreach addressing energy conservation is important, not only for providing community members with specific methods for reducing energy use (i.e., "How can I conserve energy?"), but also for instilling a sense of responsibility for energy conservation (i.e., "Why should I conserve energy?") among participants. There are a plethora of environmental educational materials that have been developed for a wide range of audiences and purposes that are readily available for use. For reference, several easy-to-understand energy efficiency guides are provided in Appendix E. Energy efficiency educational programs may be integrated with other related topics, such as solid waste reduction and water conservation, as part of the K-12 curriculum.

6.3. Transportation-Related Energy Efficiency

As discussed in Section 5.4 – Total Reservation Energy Use, transportation accounted for the largest share of energy use, energy costs, and carbon emissions from the Reservation in 2010. Although some of these transportation energy uses and associated carbon emissions are unavoidable due to the cultural and economic importance of fishing, the limited nature of fishing seasons, the location of the fishing grounds relative to mooring or launching facilities, and the size of the fishing fleet, there are options for reducing the relatively high carbon footprint associated with transportation – particularly on land. The best way to reduce emissions is to leave the car/truck at home and walk or ride a bike to a destination instead. Although desirable, walking and/or biking will not be a viable option for all individuals and activities and/or for the entire year due to poor weather conditions and short day lengths during the winter months. Another good option that is accessible to most Reservation residents is to use public transportation (e.g., Lummi Transit, Whatcom Transportation Authority [WTA]) or carpooling. The Lummi Nation may choose to further promote alternative transportation through incentives and infrastructure. For instance, employer incentives could take the form of the LIBC encouraging employees to participate in the wellness/fitness program (30 minutes of paid exercise time 3 days per week) to walk or bike to work, allowing employees to telecommute to work, allowing employees to opt into a compressed work schedule (e.g., 10 hours per day, 4 days per week rather than 8 hours per day, 5 days per week), providing a free WTA bus pass, developing a carpool network, or developing a bike share program (i.e., public bicycle system) on the Reservation.

Utilizing non-motorized transportation has many benefits for the environment and human health, but there are also risks associated with a lack of pedestrian-friendly infrastructure. Like many rural areas, more sidewalks, bike lanes, and other transportation system upgrades (e.g., roundabouts) can significantly improve pedestrian safety. The LIBC has invested in such infrastructure improvements in recent years, with projects including the 1.8 mile Haxton Way pedestrian path (completed in 2010), the Kwina Road and Blackhawk Way sidewalks (2011), the Haxton Way/Kwina Road roundabout (2013), and the Haxton Way/Smokehouse Road roundabout (2014). There are plans to install several additional miles of sidewalk in the coming years including projects along Lummi Shore Road (between Scott Road and Kwina Road), along Lummi View Drive/Haxton Way (between Gooseberry Point and Balch Road), and a pedestrian pathway to connect the McKenzie Housing Development to the Lummi Nation School.

Even when driving is necessary, there are still ways to limit emissions. For example, the type of vehicle and how it is driven can make a big difference. Individuals planning to buy a new or used car may choose an electric, hybrid, or high fuel economy vehicle to maximize their potential reduction of carbon emissions and fuel cost savings. The LIBC already owns at least one hybrid car and has installed two electric car charging stations at the new Tribal Administration Building. A commitment to purchase hybrid and/or electric vehicles by tribal institutions could have a significant impact on transportation sector carbon emissions from the Reservation. Reducing emissions from boats can be achieved by replacing or retrofitting older, inefficient motors with newer and more energy efficient models or parts. In 2014, the Harvest Management Division of the Lummi Natural Resources Department obtained $300,000 in grant funding from the Environmental Protection Agency (EPA) as part of the Diesel Emissions Reduction Act (2005) to retrofit diesel engines on commercial fishing vessels. Six Lummi-owned vessels were retrofitted in 2014, and additional funding was awarded in 2015. Other ways to reduce emissions while driving include using fuel efficient driving habits (e.g., slow and smooth starts and stops, maintain a steady speed) and keeping the car or boat well maintained (e.g., replace filters as needs, keep tires properly inflated, minimize hull fouling).

6.3.1. Costs and Benefits

The primary benefits of transportation-related energy efficiency practices are: (1) long-term energy and cost savings, (2) emissions reduction, (3) improved individual and community health, and (4) improved pedestrian/bicycle safety. The primary costs of transportation-related energy efficiency practices are: (1) capital costs and (2) maintenance costs.

6.3.2. Recommended Actions

The following recommendations take into consideration the information presented in this section and the tribal goals of energy self-sufficiency and reduced emissions.

1. *Encourage walking, biking, carpooling, and public transportation on the Reservation by providing employer incentives*. For instance, the LIBC and other tribal employers could encourage employees to participate in the wellness/fitness program (30 minutes of paid exercise time 3 days per week) to walk or bike to work, allow employees to telecommute to work, allow employees to opt into a compressed work schedule (e.g., 10 hours/day, 4 days/week rather than 8 hours/day, 5 days/week), provide a free Whatcom Transit

Authority (WTA) bus pass, develop a carpool network, or develop a bike share program (i.e., public bicycle system) on the Reservation.

2. *Continue investing in pedestrian and commuter friendly infrastructure*. As previously discussed, providing sidewalks, bike lanes, and other transportation system upgrades (e.g., roundabouts) can significantly improve pedestrian safety, while also making walking and biking more enjoyable and desirable activities.

3. *Update the tribal vehicle fleet and decrease vehicle use*. Several actions are recommended to reduce energy use by tribally-owned vehicles. First, tribal policies should be adopted that mandate that hybrid or electric vehicles should be prioritized for purchase over standard models. If a hybrid or electric vehicle is not suitable for anticipated vehicle use, then flexible fuel vehicles or otherwise fuel efficient models may be considered. Second, to reduce miles travel, when practicable, employees should be encouraged to take advantage of video conferencing systems, online webinars, and conference calls rather than traveling to meetings. Finally, participation in the Clean City Coalition is recommended. The Clean City Coalition is a public/private partnership that works together with the U.S. Department of Energy's (DOE) Clean Cities Program with the goal of reducing petroleum consumption by providing education, access to grant funds, and technical assistance to corporate and municipal fleets.

6.4. Cogeneration Facility

Cogeneration facilities, or combined heat and power facilities, simultaneously capture both electricity and heat from a single power station. Significant quantities of heat are lost during conventional electricity production – approximately 60 percent of fuel input is typically lost as waste heat. Cogeneration facilities capture and distribute this heat to nearby buildings or facilities through district heating. Cogeneration facilities lose only 20 percent of fuel inputs to waste heat, constituting a substantial improvement in energy efficiency compared to conventional power production. There are two cogeneration facilities that operate near the Reservation, a PSE facility (previously Tenaska Washington Partners, L.P.) and a BP Cherry Point facility; both are 270 MW natural gas-fired power plants. However, these plants do not operate at maximum capacity because of low demand for electricity in excess of grid supply. Development of a cogeneration facility was considered by the tribe in the early 1990s and in the mid-2000s, but was not pursued at the time because of low market demand and high capital costs.

6.5. Tribal Utility

In 2011, staff from the Lummi Natural Resources Department, the Lummi Planning and Public Works Department, the Economic Development Task Force, and the Reservation Attorney's Office participated in a pre-feasibility transmission assessment meeting with representatives from the Bonneville Power Administration (BPA), an agency within the U.S. Department of Energy (DOE), to discuss the formation of a Lummi Nation electricity utility. Meeting topics included BPA's standards of service, transmission interconnection procedures, and transmission billing and rates. In part, the Lummi Nation decided not to pursue a pre-feasibility transmission assessment study because the benefit of a tribally owned utility had little cost advantage when the high capital investments needed to acquire the transmission grid serving the Reservation from Puget Sound Energy (PSE) were taken into account. Additionally, the Lummi Indian Reservation Wind Energy Development Feasibility Assessment Project was underway at this time and preliminary estimates suggested that expected energy production (30 MW) would not reach a scale capable of exporting electricity to BPA. The results of the wind energy study later indicated that wind energy development was not economically viable and was thus not pursued.

Although initial assessments of tribal utility were deemed unfeasible at the time, this does not preclude the pursuit of such a utility in the future. If so, the next step will be conducting a pre-feasibility transmission assessment study.

6.6. Energy Efficiency Practices Summary

There are many opportunities to improve energy efficiency practices on the Reservation. Generally, these opportunities are low cost, relatively easy to implement, and have immediate energy and cost savings. It is for these reasons that improving energy efficiency on the Reservation should be the primary focus of the early stages of strategic energy planning and implementation. Table 6.1 provides a summary of the recommendations for the 2016-2026 planning period that are presented in this chapter.

Table 6.1 Summary Energy Efficiency Practices Recommendations

Target	Recommendation
Building-Related Energy Efficiency	1. Establish a permanent, full-time Energy Management Specialist position within the Lummi Planning and Public Works Department.
	2. Conduct energy audits of tribal facilities and implement the recommendations of these audits.
	3. Institutionalize the Residential Energy Efficiency Pilot Program.
	4. Mandate high energy efficiency standards in new construction.
Behavior-Related Energy Efficiency	1. Provide public education and outreach to encourage and promote energy efficient behaviors at home and in the workplace.
Transportation-Related Energy Efficiency	1. Encourage walking, biking, carpooling, and public transportation on the Reservation by providing employer incentives.
	2. Continue investing in pedestrian and commuter friendly infrastructure.
	3. Update the tribal vehicle fleet and decrease vehicle use.

(This page intentionally left blank)

7. RENEWABLE ENERGY SOURCES

Achieving tribal goals of energy self-sufficiency and reduced emissions requires two complementary components; energy efficiency, which will reduce energy demand, and energy production from renewable energy sources, which will provide for remaining energy needs. Renewable energy production is preferable to conventional, fossil fuel based energy production because development and use of renewable energy resources will significantly reduce, and in some cases eliminate, pollution of the land, water, and air. The purpose of this chapter is to provide an overview of different types of renewable energy sources, current examples of successful renewable energy use, and recommendations for developing renewable energy sources on the Reservation or Lummi Nation trust lands. There are seven types of renewable energy resources discussed: (1) solar energy, (2) geothermal energy, (3) wind energy, (4) micro-hydropower, (5) tidal energy, (6) biomass (bioenergy), and (7) green power.

7.1. Solar Energy

Solar energy, the energy contained in sunlight, can be captured by photovoltaic (PV) cells to generate electricity (i.e., solar electricity or photovoltaics) or captured by a fluid contained in solar thermal panels and used for water heating (i.e., solar thermal). Although the Puget Sound region is characterized by its mild maritime climate with frequent rain and cloud cover, the region actually has significant solar energy development potential. Notably, the Pacific Northwest receives a similar amount of solar radiation as Germany, one of the world leaders in the installation and manufacture of solar systems and production of solar energy. Options for development of solar electricity and solar thermal on the Reservation are discussed below.

Photovoltaic systems come in different sizes and capacities to meet a broad array of applications, ranging from charging electronics to utility-scale electricity production. Although utility-scale solar installations have yet to be developed in western Washington, distributed systems installed on commercial or residential buildings and designed to generate electricity for onsite use have proven effective when properly sited (e.g., photovoltaic panels are located in an area without shade, oriented toward the south, installed at a right angle to the direction of incoming solar rays). There are four different types of distributed photovoltaic systems: they may be tied to the grid or off the grid and they may be equipped with batteries or not equipped with batteries. Currently, most distributed systems on houses or similar buildings are grid-connected and may, at times, generate electricity in excess of building demand. When this occurs, surplus electricity flows into the electrical grid. Conversely, when the building consumes more electricity than the panels produce, electricity is drawn for the grid. Customers pay for the net electricity use ("net-metering") and can receive refunds from the electric utility if use is less than production. In this manner, the grid acts as storage for surplus electricity generated during the day, while electricity is provided from other sources at times of low solar production. When not connected to the grid, but instead combined with a battery array that stores electricity, solar panels can power independent systems such as streetlights.

Solar thermal systems operate by capturing thermal energy in a heat-transferring fluid and are usually comprised of three components: a solar collector, a heat exchanger, and a storage tank. Like photovoltaic panels, solar collectors are mounted in areas receiving direct sunlight. When sunlight hits the solar collector, the water or other heat-transferring fluid being circulated through small tubes in the solar collector absorbs heat. The heated fluid may then be put to direct use (e.g., swimming pool) or stored for later use. In the Puget Sound region, low- to mid-temperature applications of solar water heating (e.g., residences, hotels, laundries, and cafeterias) are viable options.

Two buildings on the Northwest Indian College (NWIC) campus have photovoltaic systems: the Native Environmental Science building has a 7.8 kW PV system that was installed in 2010 and the Salish Sea Research Center has a 25 kW system that was installed in 2014. The Cooperative Extension Building is "solar-ready" and installation of photovoltaic panels is planned when funds become available. Figure 7.1 illustrates the monthly electricity generation (kWh) from the photovoltaic system atop the Native Environmental Science building in 2012. During 2012, this photovoltaic system generated approximately 9,000 kWh of electricity and the NWIC account was credited with nearly $2,000 in revenue from net-metering.

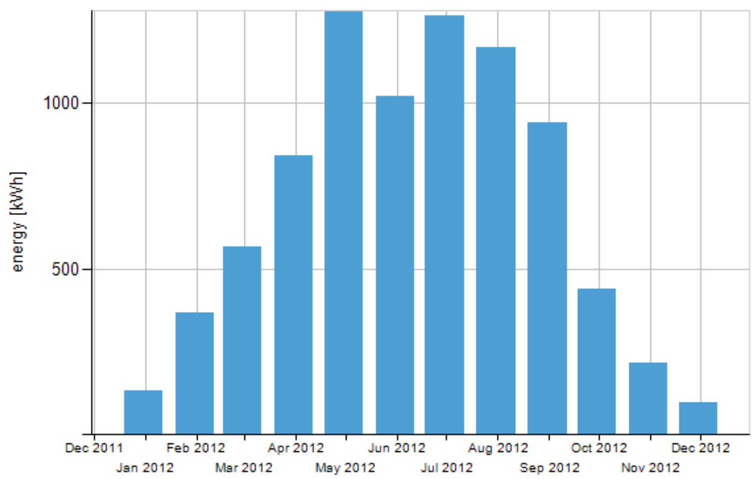


Figure 7.1 Electricity Generation of a 7.8 kW Photovoltaic System at the NWIC in 2012

In 2010, the Lummi Planning and Public Works Department installed nearly two miles of solar lighting along the new Haxton Way Pedestrian Pathway. The solar lighting was designed to automatically adjust to the time of day and weather condition, promoting use of the trail at all hours of the day. Not only does this project utilize renewable energy, but it also supports transportation-related energy efficiency discussed in Section 7.3 by providing safe access for walkers and bikers along Haxton Way.

7.1.1. Costs and Benefits

The primary benefits of solar energy production are: (1) emissions reduction, (2) long equipment lifetime, (3) relatively short payback period, and (4) long-term production potential at low and fixed costs. Photovoltaic systems have a typical lifetime of 30-50 years, require minimal maintenance, and have typical payback periods of 5-10 years. Solar thermal systems have a typical lifetime of 10-20 years, require regular, but minimal, maintenance (e.g., more moving parts and potential for leaks), and have typical payback periods of 5-10 years. Capital costs for both systems may be reduced through grants, incentives, or subsidies, which are often readily available. Income generation from net metering may also reduce the payback period in the case of photovoltaic systems. Estimates provided by a local contractor suggest the installation of a 1 kW photovoltaic system currently would cost approximately $6,000. For context, a 1 kW photovoltaic system in western Washington could be expected to generate approximately 1,200 kWh of electricity per year, or about 10 percent of the average annual electricity demand of a typical home. Finally, as discussed previously, the cost of electricity from conventional sources is expected to continue increasing in coming years. Solar energy systems offer an opportunity to replace or supplement the use of energy derived from conventional sources, thereby offsetting costs and reducing vulnerability to potentially volatile future energy markets. The primary costs of solar energy production are: (1) moderate to high capital costs and (2) variability in production. The quantity of solar energy production depends not only on site location, but also the time of day, the season, and local weather conditions. When production is low and storage capacity limited, energy must be supplemented from other sources.

7.1.2. Recommended Actions

The following recommendations take into consideration the information presented in this section and the tribal goals of energy self-sufficiency and reduced emissions.

1. *Identify and prioritize existing tribal facilities where photovoltaic and/or solar thermal systems would likely be successful*. There are several tribal facilities with high demand for electricity and/or water heating that are located in appropriate areas and have available roof space for solar installations. These facilities include, but are not limited to, the Silver Reef Hotel, Casino & Spa, the Tribal Administration Building, the Lummi Nation School, the Lummi Bay Salmon Hatchery, the Shellfish Hatchery, the Skookum Creek Hatchery, Lummi Housing Authority residential developments, and the Gateway Center. A feasibility assessment conducted by a qualified professional should be commissioned to determine the potential production capacity and economic viability of solar installations at these and other sites on the Reservation.

2. *Make a commitment to pursue solar electricity and solar thermal in new development on the Reservation*. The Lummi Indian Business Council (LIBC) and other tribal institutions may consider making a formal commitment to pursue solar technology in all new development on the Reservation and Lummi Nation trust lands where solar energy production is technically feasible. As above, a feasibility assessment conducted by a qualified professional should be commissioned to determine the potential production capacity and economic viability of solar installations at new development sites on the Reservation.

7.2. Geothermal Energy

Geothermal energy refers to heat generated from the earth and may be captured from both high and low temperature geothermal resources. High-temperature geothermal systems use the heat in hot springs, underground hot water reservoirs, or underground volcanic activity to produce steam that powers turbines to produce electricity. Although there are several active volcanoes in Washington State, areas with near-surface geothermal activity are largely located in remote areas in the Cascade Mountains and have not yet been developed for electricity production. On the other hand, low-temperature geothermal resources, which rely on the relatively stable year-round ground temperature (approximately 50°F) found at depths of 6-10 feet below the ground surface, are readily available across the region. This second system is the type that can be utilized on the Reservation through the use of a geothermal heat pump (GHP; aka., ground-source heat pump, water-source heat pump). A typical geothermal heat pump consists of three components: a heat exchanger comprised of a series of underground pipes ("loops") filled with water, a heat pump, and an interior heating/cooling distribution system. In the winter, when the ground temperature is higher than the air temperature, the ground operates as a heat source and the heat pump circulates warm air for space heating. When the air temperature is higher than the ground temperature during the summer, the ground operates as a heat sink and the heat pump removes heat from the building and provides for space cooling. In addition to space heating and cooling, geothermal heat pumps can be equipped to supply hot water. There are many different types of geothermal heat pumps (e.g., open-loop versus closed-loop, ground-coupled versus groundwater versus surface water); the suitability of a particular GHP depends on site specific geologic conditions, available space, and the presence or absence of a nearby water body. As such, geothermal heat pump design can easily be adapted to best match the site conditions.

The new Tribal Administration Building has a geothermal heat pump with a closed-loop, ground-coupled heat exchanger (a.k.a., a vertical ground loop arrangement). The heat exchanger, which has 120 wells that are each approximately 350 feet deep, is located under what is now the building's parking lot. Installation of the geothermal heat pump was completed in 2011; though the building did not become fully operational until 2013. Prior to construction, the Lummi Planning and Public Works Department contracted a consulting firm (John Geyer & Associates Inc.) to conduct a feasibility assessment for the use of a geothermal heat pump in the Tribal Administration Building. Table 7.1 shows economic comparisons between geothermal heating and cooling, air cooled chiller and electric furnace, and wet chiller and propane furnace in 2010 that were developed by John Geyer & Associates Inc. These data clearly indicate that although geothermal systems have high capital costs, the long-term economic benefits are worth the investment. The actual cost to install the geothermal heat pump, approximately $1,050,000, was significantly less than projected in this report.

Table 7.1 Economic Comparisons Between HVAC Systems

Cost	Geothermal	Dry Cool/Electric Boiler	Wet Cool/Propane Boiler
Installation	$3,128,000	$2,600,00	$3,217,000
Annual Operations and Maintenance	$56,200	$210,442	$220,603
Annual Savings	$154,182	-	-
Years to Payback	3.4	-	-
System Life	25-30 years	16-20 years	12-18 years

As a part of the aforementioned geothermal feasibility assessment, John Geyer & Associates Inc. also identified several other opportunities for the development of geothermal resources on the Reservation, including opportunities associated with the Chief Martin Road Reservoir, the

Kwina Road Wastewater Treatment Plant (WWTP; a.k.a., Membrane Bio Reactor [MBR] Plant), and the Gooseberry Point WWTP.

Should individual homeowners decide to install geothermal heat pumps at the scale of a single-family residence, they can expect high capital costs that are recovered over time through low operation costs. One estimate indicates that installation costs for residential geothermal heat pumps ($15,000-$20,000) are higher than those for conventional heating and cooling systems ($10,000); however, the cost to operate a GHP in a 3,000 ft² house ($700/year) is less than the cost to operate a conventional system in the same space ($6,000/year) because GHPs use 25-50 percent less electricity than conventional heating and cooling systems. These energy savings result in payback periods of 5-10 years.

7.2.1. Costs and Benefits

The primary benefits of geothermal energy production are: (1) emissions reduction, (2) long equipment lifetime, (3) relatively short payback period, and (4) long-term production potential at low and fixed costs. Geothermal heat pumps use less electricity and have lower emissions than conventional heating and cooling systems. If coupled with photovoltaic systems, geothermal heat pumps may have zero greenhouse gas emissions after installation. Geothermal heat pumps have a typical lifetime of 25-50 years, require regular, but minimal, maintenance, and have typical payback periods of 5-10 years. It should be noted that the lifetime for the heat exchanger, which is protected underground, is typically higher (e.g., 50 years) than that of interior components (e.g., 25 years). Finally, geothermal energy is consistently available for exploitation year-round and throughout the day. The primary costs of geothermal energy production are: (1) moderate to high capital costs.

7.2.2. Recommended Actions

The following recommendation takes into consideration the information presented in this section and the tribal goals of energy self-sufficiency and reduced emissions.

1. *Make a commitment to pursue the use of geothermal resources in new tribal developments or redevelopments on the Reservation*. As development on the Reservation continues, tribal institutions, particularly the LIBC and the Lummi Housing Authority (LHA), should consider the use of geothermal heat pumps rather than conventional HVAC systems. Specifically, the use of geothermal heat pumps should be explored when development is concentrated, so that neighboring residences or facilities can share a heat exchanger (e.g., housing projects, development along Kwina Road). A feasibility assessment conducted by a qualified professional should be commissioned to determine the potential production capacity and economic viability of geothermal applications at planned development sites on the Reservation.

7.3. Wind Energy

Wind energy production is growing rapidly in the United States, having captured 35 percent of all new energy generating capacity in the United States since 2007 (EIA 2012b). Although they come in different shapes and sizes to meet different needs, most wind turbines have three blades that sit on a tall tower. When the wind turns the turbines blades, this movement spins a shaft that is connected to a generator, thus producing electricity. Wind turbines work best when elevated above any surrounding buildings or vegetation, where wind speed is high and turbulence is low compared to ground level. Similar to photovoltaic systems, wind turbines can be grid connected and/or battery connected.

The Lummi Natural Resources Department (LNR) explored the possible use of wind turbines for electricity generation on the Reservation through the Wind Energy Development Feasibility Assessment Project from 2009-2012. The purpose of the feasibility assessment was to provide the information necessary to make an informed determination of whether or not a wind generation project on the Reservation would provide enough economic, environmental, cultural, and social benefits to justify the cost of development.

Interest in wind energy production on the Reservation was initiated by a nationwide wind power assessment by the National Renewable Energy Laboratory (NREL) in 2002, which indicated that large areas of the tribally-owned tidelands and floodplain have Class 3 (“fair”) wind power potential. The NREL data were useful, but provided insufficient information for making the substantial capital investment required to install wind turbines and associated transmission infrastructure. Other factors affecting the feasibility of a wind energy project on the Reservation, such as cultural, socio-economic, natural resources, noise, aesthetics, and adjacent land uses, also needed to be taken into consideration. The Lummi Indian Reservation Wind Energy Development Feasibility Assessment Project, which funded through a U.S. Department of Energy (DOE) grant, was initiated in 2009 to determine if and at what cost wind energy development on the Reservation could help achieve the tribal goal of energy self-sufficiency. The feasibility assessment had three components, each intended to answer one of the following questions: (1) Wind Assessment – Is there enough wind to justify further pursuit of developing wind energy generation capabilities on the Reservation? (2) Wildlife Assessment – What are the likely wildlife impacts associated with installing one or more wind turbines and what are practicable mitigation measures if there are unavoidable impacts? (3) Noise Assessment – What are the likely noise impacts associated with installing one or more wind turbines and what are practicable mitigation measures if there are unavoidable impacts?

The Wind Assessment was conducted by DNV Renewables (USA) Inc. (DNV KEMA) who evaluated two wind project scenarios: (1) the installation and operation of a small, 5-megawatt (MW) “community” wind project and (2) the offset of electrical usage through 100-kilowatt (kW) of net-metering with a single 100-kW wind turbine. Two anemometer towers were erected on the Reservation in December 2010 to measure wind speed and duration for one year. Using the data collected at the anemometer towers, DNV KEMA provided an evaluation of the economic feasibility of each project scenario. In the final report, it was determined that neither project scenario would likely be economically viable for the LIBC (DNV KEMA 2012). As a result, the Lummi Nation has not pursued wind energy development on the Reservation.

7.3.1. Costs and Benefits

The primary benefits of wind energy production are: (1) emissions reduction and (2) long equipment lifetime. Wind turbines have a typical lifetime of 20 or more years and require only minimal maintenance. The primary costs of wind energy production are: (1) high capital costs, (2) relatively long payback period, and (3) variability in production. Wind power production will vary depending on wind speed and duration.

7.3.2. Recommended Actions

Taking into consideration the information presented in this section, it is recommended that wind energy production is not pursued by the Lummi Nation during the 2016-2026 planning period unless new technologies or new incentives become available that result in economic and environmental costs that are less than the economic and environmental benefits.

7.4. Micro-Hydropower

As discussed in Section 3.1 – Energy Sources in the United States, hydroelectric power accounted for 35 percent of renewable energy production nationwide in 2011, with over one-fourth of this electricity being generated in Washington State. Unlike the large hydropower facilities on the Columbia River, which have production capacities in the thousands of megawatts and provide a significant amount of electricity nationally and regionally, micro-hydropower (a.k.a., micro-hydro) facilities have capacities in the range of hundreds to thousands of kilowatts and are utilized to provide electricity at the community-scale. Micro-hydro facilities are typically, but not always, run-of-the-river or pumped storage facilities rather than impoundment facilities (i.e., dam stores river water in a reservoir). In a run-of-the-river facility, a portion of the river's water is diverted into a pipeline ("penstock"), flows downhill, spins turbines in the powerhouse, generates electricity, and is returned to a downstream reach of the river. In a pumped storage facility, water is pumped from a lower reservoir to an upper reservoir where it is stored during periods of low electric demand. When demand for electricity is high, the water is released back to the lower reservoir, generating electricity by turning turbines in the powerhouse along the way.

Within the Nooksack River watershed, there are currently three micro-hydropower facilities that are currently in operation. The largest is the 1,500 kW Nooksack Falls Project, which is a run-of-the-river micro-hydro facility that is located on the North Fork Nooksack River near the town of Glacier, Washington. The facility was constructed in 1906 and operated for the next 91 years, until the plant was damaged by a fire in 1997. In 2003, Puget Sound Hydro LLC purchased the Nooksack Falls Project from then owner Puget Sound Energy (PSE) and resumed operations. The facility itself is comprised of a diversion dam located upstream of the nearly 100 foot high Nooksack Falls, a half mile long pipeline, and a downstream powerhouse. Water is reintroduced to the North Fork Nooksack River below the Nooksack Falls and there are minimum requirements for instream flow in the bypass reach. In addition to the Nooksack Falls Project, there are two other smaller hydropower developments within the Nooksack River watershed. One is the 500 kW Sygitowicz Creek Power Project on Sygitowicz Creek along the western side of the lower South Fork Nooksack River (FERC Project No. 5069). The second is the 1,000 kW Hutchinson Hydro LLC turbine that is in the pipeline used by the City of Bellingham to divert water from the Middle Fork Nooksack River to Mirror Lake/Lake Whatcom (FERC Project No. 7747). Over the past few decades, there have been several applications filed with the FERC for new micro-hydro development on the Nooksack River and its tributaries. To date, none have been approved.

7.4.1. Costs and Benefits

The primary benefits of micro-hydropower production are: (1) emissions reduction, (2) long equipment lifetime, and (3) long-term production potential at low and fixed costs. As evidenced by the Nooksack Falls Hydro Project, micro-hydropower facilities can have incredibly long lifetimes; however, it should also be noted that maintenance costs can be high. Once operational, the Northwest Power and Conservation Council estimates that micro-hydro facilities can produce electricity at a cost of 6-9 cents/kWh, a competitive rate compared to the cost of electricity in 2010 (6.5 cents/kWh). The primary costs of micro-hydropower production are: (1) high capital costs, (2) variability in production, and (3) fish and wildlife impacts. Cost estimates for micro-hydro construction are site specific and require detailed analysis, but are assumed to be relatively high. Production at micro-hydro facilities depends on streamflow, which is high in the winter (i.e., from precipitation) and spring (i.e., from snowmelt) and low in the summer. During the summer months, production may be reduced due to requirements to maintain minimum instream flows to protect fish habitat. Finally, hydropower facilities can negatively impact fish and wildlife habitat and, under some circumstance, may create conditions that cannot be mitigated.

7.4.2. Recommended Actions

Taking into consideration the information presented in this section, it is recommended that micro-hydropower production is not pursued by the Lummi Nation during the 2016-2026 planning period. Although there may be potential sites for micro-hydro development on tribally-owned properties where water intake and conveyance systems are already in place, such as the tribally owned and operated salmon hatcheries and wastewater treatment plants, the relatively small volumes of water involved and the relatively flat terrain traversed by the existing pipelines suggest that this development would not be economically feasible.

7.5. Tidal Energy

Tidal power captures the energy of the tides. In the United States, the potential for tidal energy development is largely restricted to the inlets and sounds of Washington, Alaska, and Maine. The bathymetry in these areas is unique in that tidal waters are funneled through constricted spaces, thereby increasing tidal velocity to the level necessary for generating electricity. Because tides are driven by the gravitational effect of the sun and the moon on the oceans, tidal energy resources are predictable and inexhaustible. Although tidal mills have been used for centuries to grind grain, the current applications of tidal energy are still in the early stages of development and are not expected to be economically viable at the community-scale during the 2016-2026 planning period. Economic assessments of future tidal energy prices are conflicting; some studies suggest that significant subsidies will be required to make tidal energy competitive with other renewable energy sources, while others indicate that tidal energy prices will be economically viable. Given the uncertainties associated with future tidal energy production, cost estimates and payback periods are currently unavailable. Even as cost estimates are improved, there will be important environmental factors (e.g., endangered species, marine mammals, benthic ecosystems, noise pollution), and human factors (e.g., navigational safety, cultural resources, interference with fishing activities) that may prevent or limit widespread application.

The Public Utility District (PUD) No. 1 of Snohomish County, Washington had until recently planned to develop a tidal energy project in Admiralty Inlet off the Coast of Whidbey Island, which would have been the first tidal energy project in the Puget Sound. The PUD's proposal was to place two 20 foot diameter, 300 kW tidal turbines at depths of 200 feet; each turbine would be connected to onshore facilities through separate 7,000 foot long trunk cables. The project was intended to serve as a pilot, testing the energy production capacity and potential environmental impacts of tidal energy development in the Puget Sound. The PUD's application to the Federal Energy Regulatory Commission (FERC) was approved in 2014, but plans were scrapped shortly thereafter when bids for installation and monitoring (over $35 million) suggested that the costs would be significantly higher than initial estimates (approximately $20 million).

A much smaller scale tidal energy project may be possible on the Lummi Indian Reservation at the tide gates for the Seapond Aquaculture Facility located in Lummi Bay. The concept that has been discussed is to install one or more turbines at the tide gates to generate power as the water flows through the tide gates that separate the 750 acre aquaculture pond from Lummi Bay.

7.5.1. Costs and Benefits

The primary benefit of tidal energy production is: (1) emissions reduction. The primary costs of tidal energy production are: (1) high capital costs, (2) uncertain economic viability, (3) uncertain production capacity, and (4) uncertain fish and wildlife impacts. In addition, tidal energy projects may impact treaty protected fishing rights within the Usual and Accustomed fishing areas of the Lummi Nation. The economic feasibility of installing a tidal energy project at the Seapond Aquaculture Facility, including any necessary repairs to the existing tide gates, needs to be further analyzed before a definitive statement can be made about the feasibility of this project.

7.5.2. Recommended Actions

Taking into consideration the information presented in this section, it is recommended that a large scale tidal energy production project is not pursued by the Lummi Nation during the 2016-2026 planning period. However, the tidal energy potential and associated costs and benefits of modifying the tide gates of the Seapond Aquaculture facility should be evaluated during the 2016-2026 period.

7.6. Biomass (Bioenergy)

Biomass is plant derived organic matter that can be burned, fermented, or otherwise processed to generate energy (bioenergy) in the form of electricity, heat, or biofuels (e.g., ethanol, biodiesel). The Federal Energy Regulatory Commission (FERC) provides the following definition of biomass: "Any organic material not derived from fossil fuels." The distinction that combustion of fossil fuels releases carbon that has been sequestered for millions of years, while burning biomass re-releases carbon that has only recently been removed from the atmosphere is important. It is this distinction that makes biomass a renewable energy source that is considered carbon neutral. Biomass sources include wood and wood waste (e.g., sawdust, forest thinnings, residual from timber harvest activities [aka "slash"]), agricultural crops (e.g., corn, wheat, soy), agricultural waste (e.g., corn stover, wheat straw), animal waste (e.g., cow manure), pulping liquors (e.g., black liquor), and more. Processes for deriving bioenergy are varied and the following three forms are discussed below: direct combustion, anaerobic digestion, and biofuel production.

Direct combustion uses a conventional boiler, wherein biomass is burned, water heated to generate steam, and turbines spun for electricity production. In Washington State, woody debris and agricultural wastes are the most readily available fuel sources for direct combustion. The Reservation does not likely have a sufficient land base to maintain sustained production of biomass from either forests or croplands. If direct combustion were pursued, the biomass supply would need to be attained from off-Reservation and questions of availability, reliability, cost, quality, transportation, and storage would need to be addressed.

Anaerobic digestion, or methane recovery, is another way to generate bioenergy. When organic matter is decomposed by microorganisms under anaerobic conditions (without oxygen), the microorganisms respire methane. Methane is the primary component of natural gas and can be used for heating or electricity generation. A relevant application of this technology is in low-solids digesters, which are used to process materials that are less than 15 percent solids, and are becoming common on farms and in wastewater treatment plants. In Whatcom County, several businesses and dairy farmers have begun using manure digesters to recover methane from cow manure. One local operation (Farm Power) with facilities in Lynden has found that not only do manure digesters generate electricity, but they also alleviate the need for long-term storage of animal waste in manure lagoons, produce relatively pathogen-free liquid fertilizer, and yield relatively pathogen-free solid materials that may be used for other purposes (e.g., cow bedding). Similar opportunities exist at the Lummi Tribal Sewer and Water District's (LTSWD) three wastewater treatment plants.

Lastly, biofuels (e.g., ethanol, biodiesel) are fuels that can be mixed with or replace conventional petroleum-based liquid fuels (e.g., gasoline, diesel) used for transportation. Ethanol is an alcohol that is made from sugars (e.g., sugar cane, sugar beet) fermented by yeast. Ethanol is already added to gasoline to reduce emissions and increase octane. Most cars can run on up to 10 percent ethanol without any mechanical modifications and newer flexible fuel vehicles can run on a gasoline blend of up to 15 percent ethanol. Biodiesel is derived from oils and can be blended with or entirely replace conventional diesel. There are two potential sources of biodiesel on the Reservation, waste oil and algae. Waste oil from food preparation (e.g., used vegetable oil, fryer oil) could easily be collected from the restaurants in the Silver Reef Hotel, Casino & Spa and converted into biodiesel. Although still in the early stages of development, technology for algae production and conversion to biodiesel looks promising in some parts of the United States where sunlight and solar radiation is high and can support algae production without additional energy inputs.

7.6.1. Costs and Benefits

The primary benefits of bioenergy production are: (1) carbon neutral and (2) possible production from usable biomass currently going to waste. The primary costs of bioenergy production are: (1) moderate to high capital costs and (2) uncertain economic viability.

7.6.2. Recommended Actions

The following recommendation takes into consideration the information presented in this section and the tribal goals of energy self-sufficiency and reduced emissions.

1. *Explore production of bioenergy from readily available sources of organic waste on the Reservation*. Bioenergy production is diverse, and although some sources of biomass are unavailable on the Reservation, the use of biomass that is currently going to waste may

provide a reliable source of bioenergy. Two potential sources of biomass energy on the Reservation are (1) anaerobic digestion at the LTSWD wastewater treatment plants (WWTPs) and (2) biodiesel production from waste oil at the Silver Reef Hotel, Casino & Spa. Methane recovered at WWTPs can be use for heating or electricity generation and may have applications within the current facilities or future, nearby development. Biodiesel derived from waste oil could be used by diesel vehicles in the tribal fleet, or sold at the Lummi Mini Mart or other diesel retailers. As with all new renewable energy resource development, a feasibility assessment conducted by a qualified professional should be commissioned to determine the potential production capacity and economic viability of bioenergy production at these or other sites on the Reservation.

7.7. Green Power

Rather than developing renewable energy sources directly, another option to reduce carbon emissions from energy production and support the development of renewable energy in the region is to purchase "green power" by participating in the local utility's green power program or purchasing renewable energy certificates (RECs).

Pursuant to Washington State Law (Revised Code of Washington [RCW] 19.29A.090), electricity utilities are mandated to provide customers with the option to voluntarily participate in green power programs. In these programs, customers pay their utility bill as usual plus an additional premium. The premium ensures that independent renewable energy facilities in the Pacific Northwest supply additional electricity to the grid. In this manner, "green power" replaces conventional "brown power." Puget Sound Energy (PSE) is the electricity provider on the Reservation and provides green power at a rate of $0.0125 per kilowatt hour (kWh). At this rate, an average household using around 1,000 kWh per month can offset 100 percent of their usage through PSE's Green Power Program for approximately $12.50 additional dollars each month (PSE 2014). The LIBC may opt to lead by example and commit to purchasing a designated amount of green power. For example, the nearby City of Bellingham purchases enough Green Power to offset 100 percent of electricity use in municipal facilities and has been recognized as a leading EPA-Certified Green Power Community nationwide (COB 2014). The LIBC used approximately 4,670 MWh of electricity for municipal operations in 2010 at a cost of $38,000 per month. To offset 100 percent of this electricity use through the purchase of Green Power at current rates would cost an additional $4,900 per month, or about 13 percent more per month.

Buying renewable energy certificates (RECs) is similar to purchasing green power, except that RECs are sold separately from electrical power and in larger quantities (MWh increments rather than kWh increments). Renewable energy certificates may be the preferred options for buyers looking to offset large quantities of electricity use or for buyers interested in targeting specific types of renewable energy projects. Costs for renewable energy credits vary, with prices ranging from $5 to $50 per MWh (i.e., $0.005-$0.05 per kWh). Using these price estimates, the cost to offset 100 percent of the LIBC's electricity use in 2010 could range from $1,950 to $19,500 per month.

7.7.1. Costs and Benefits

The primary benefits of purchasing green power are: (1) emissions reduction, (2) community leadership, and (3) administrative efficiency. The cost of purchasing green power is: (1) the dollar amount spent (e.g., $0.0125 per kilowatt hour in PSE's Green Power Program).

7.7.2. Recommended Actions

The following recommendation takes into consideration the information presented in this section and the tribal goals of energy self-sufficiency and reduced emissions.

1. *Purchase green power to offset some or all electricity use at selected tribal institutions*. Purchasing green power, either through Puget Sound Energy's Green Power Program or through renewable energy certificates, is the quickest way to offset electricity use on the Reservation. If the Lummi Nation were to set a quantifiable goal for reducing emissions (e.g., reduce emissions by 15 percent from 2010 levels by 2025), this goal could almost immediately be accomplished by purchasing green power.

7.8. Renewable Energy Sources Summary

Currently, the Reservation does not contain any single renewable energy source with the capacity to provide enough energy to meet community needs. However, attaining a portfolio of different renewable energy sources will make progress towards energy self-sufficiency. In the meantime, energy generated from renewable sources located off-Reservation can be utilized to reduce greenhouse gas emissions. Table 7.2 provides a summary of the recommendations for the 2016-2026 planning period that are presented in this chapter.

Table 7.2 Summary Renewable Energy Source Recommendations

Target	Recommendation
Solar Energy	1. Identify and prioritize existing tribal facilities where photovoltaic and/or solar thermal systems would likely be successful.
	2. Make a commitment to pursue solar electricity and solar thermal in new development on the Reservation.
Geothermal Energy	1. Make a commitment to pursue the use of geothermal resources in new tribal developments or redevelopments on the Reservation.
Tidal Energy	1. Explore developing tidal energy at the tide gates of the Seaponds Aquaculture Facility.
Biomass (Bioenergy)	1. Explore production of bioenergy from readily available sources of organic waste on the Reservation.
Green Power	1. Purchase green power to offset some or all electricity use at selected tribal institutions.

8. ACTION PLAN 2016-2026

This chapter provides an action plan for implementing the recommendations of the Lummi Nation Strategic Energy Plan over the 2016-2026 planning period. The following action items should be implemented as soon as practicable:

1. Adopt a Lummi Indian Business Council resolution that establishes an achievable but ambitious goals for reducing energy use on and carbon emissions from the Lummi Indian Reservation. Goals should provide clear direction and set specific standards against which improvements may be measured (e.g., "reduce emissions by 15 percent from 2010 levels by 2025").

2. Create a permanent, full-time Energy Management Specialist position within the Lummi Planning and Public Works Department. See Table 8.1 for the estimated annual budget.

3. Implement all of the energy efficiency practices recommendations presented in Table 6.1 and the renewable energy sources recommendations presented in Table 7.2, focusing initial efforts on the following high priority items:

    a. Conduct energy audits at tribal facilities and prioritize the implementation of energy efficiency practices based on the findings of these energy audits.

    b. Institutionalize the Residential Energy Efficiency Pilot Program as funding allows.

    c. Encourage walking, biking, carpooling, and public transportation on the Reservation through employer incentives and infrastructure improvements.

    d. Mandate high energy efficiency standards in new construction.

    e. Purchase green power to offset some or all electricity use at selected tribal institutions.

    f. Continue to pursue photovoltaic (solar) electricity production and geothermal heating/cooling in new or substantially improved tribal facilities.

4. Provide community education and outreach to increase awareness of the issues surrounding energy and climate change and increase participation in energy conservation programs.

5. Identify and obtain funding to implement energy efficiency improvements and development of renewable energy resources. See Table 8.2 for a partial list of potential external funding sources.

Table 8.1 Estimated Annual Budget for Energy Management Specialist

Budget Category	Total
PERSONNEL Energy Management Specialist (1 FTE [2,080 hours x $21.82/hr])	**$45,386**
FRINGE BENEFIT[1] Energy Management Specialist (36.88% of salary)	**$16,738**
TRAVEL	**$0**
EQUIPMENT	**$0**
SUPPLIES (Miscellaneous supplies, educational material, mailings, photocopies)	**$7,000**
CONTRACTS (contracts greater than $5,000 are not subject to indirect charges) Professional services for energy audits and energy efficiency feasibly assessments	**$20,000**
OTHER (Training and continuing education for Energy Management Specialist)	**$2,500**
TOTAL DIRECT COSTS SUBJECT TO INDIRECT	$71,624
INDIRECT @ 15.62%	$11,188
TOTAL DIRECT COSTS NOT SUBJECT TO INDIRECT	$20,000
TOTAL	**$102,812**

[1]Fringe Benefit costs are for employee health benefit, social security, Medicare tax, state unemployment, Life/AD&D insurance, LTD insurance, STD insurance, Employee Assistance Program, Workers Compensation, Retirement (401K), and fitness center. The fringe benefit costs per employee are essentially the same; the difference in percentage in fringe costs reflects the differences in hourly rates between employees and/or minor differences due to different Workers Compensation categories assigned to the various job titles.

Table 8.2 Potential External Funding Sources

Source	Program
FEDERAL[1]	
Department of Agriculture	Rural Energy For America – Renewable Energy Systems and Energy Efficiency Improvement Loans and Grants Program
	Rural Energy For America – Energy Audit and Renewable Energy Development Assistance Grants
	Rural Business Development Grant Program
	Conservation Innovation Grant Program
	Business and Industry Guaranteed Loan
	Intermediary Relending Program
Department of Energy	Renewable Energy or Energy Efficiency Deployment in Indian Country
	Weatherization Assistance Program
	Tribal Energy Program
Department of Housing and Urban Development	Rural Housing and Economic Development Program
	Healthy Homes Program
Department of Health and Human Services	Low-Income Home Energy Assistance Program
	Social and Economic Development Strategies Grants
Department of Interior	Tribal Energy Development Capacity Grant Program
	Energy and Mineral Development Grant Program
	Indian Loan Guarantee, Insurance, and Interest Subsidy Program
Environmental Protection Agency	Indian Environmental General Assistance Program
	National Pollution Prevention Grant Program
	Clean Air Act Tribal Program Funding
Department of the Treasury	Residential Renewable Energy Tax Credit
	Renewable Electricity Production Tax Credit
	Clean Renewable Energy Bonds
	Qualified Energy Conservation Bonds
STATE[1]	
Department of Revenue	Renewable Energy Cost Recovery Incentive Payment Program
Utilities and Transportation Commission	Net Metering of Electricity
UTILITY	
Puget Sound Energy	Resource Conservation Management Program
	Commercial Rebate Program
	Commercial Custom Retrofit and Custom New Construction Grant Program
	Comprehensive Building Tune-Up Program
	Residential Rebates and Offers Program
Cascade Natural Gas	Conservation Incentive Program – Commercial and Industrial
	Conservation Incentive Program – Existing and New Homes
NON-GOVERNMENTAL ORGANIZATION	
Opportunity Council	Low-Income Weatherization Program
	Energy Assistance Program
	Community Energy Challenge

[1] DOE 2015, DOE 2015b

(This page intentionally left blank)

9. CONCLUSION

As demonstrated in this Strategic Energy Plan: 2016-2026 (SEP), the opportunities to attain the Lummi Nation's goals of (1) improved economic and energy self-sufficiency and (2) reduced emissions from energy use on the Lummi Indian Reservation (Reservation) are both substantial and attainable. Building a community that embodies these goals will require coordinated and comprehensive strategic energy planning. The emphasis of initial planning efforts should be on improving energy efficiency, which was identified in the SEP as providing the most feasible and effective means for reducing energy use and carbon emissions on the Reservation over the 2016-2026 planning period. Implementation of energy efficiency improvements provides economic advantages as well, including low capital costs, substantial long-term energy cost savings, and job growth. Another component of strategic energy planning should be the support of renewable energy production or the direct development of renewable energy resources. While there is currently no single, utility-scale source of renewable energy on the Reservation that can be developed in an economically feasible manner with current technology, there are still many options for promoting and utilizing renewable energy on the Reservation in the near-term.

Based on the assessment of current energy resources, baseline energy use, anticipated future energy demand, and current and potential future energy efficiency practices and renewable energy development on the Reservation, this Strategic Energy Plan recommends that the following action items be implemented in the 2016-2026 planning period:

1. Adopt a Lummi Indian Business Council resolution that establishes an achievable but ambitious goals for reducing energy use on and carbon emissions from the Lummi Indian Reservation. Goals should provide clear direction and set specific standards against which improvements may be measured (e.g., "reduce emissions by 15 percent from 2010 levels by 2025").

2. Create a permanent, full-time Energy Management Specialist position within the Lummi Planning and Public Works Department. See Table 8.1 for the estimated annual budget.

3. Implement all of the energy efficiency practices recommendations presented in Table 6.1 and the renewable energy sources recommendations presented in Table 7.2, focusing initial efforts on the following high priority items:

    a. Conduct energy audits at tribal facilities and prioritize the implementation of energy efficiency practices based on the findings of these energy audits.

    b. Institutionalize the Residential Energy Efficiency Pilot Program as funding allows.

    c. Encourage walking, biking, carpooling, and public transportation on the Reservation through employer incentives and infrastructure improvements.

    d. Mandate high energy efficiency standards in new construction.

e. Purchase green power to offset some or all electricity use at selected tribal institutions.

f. Continue to pursue photovoltaic (solar) electricity production and geothermal heating/cooling in new or substantially improved tribal facilities.

4. Provide community education and outreach to increase awareness of the issues surrounding energy and climate change and increase participation in energy conservation programs.

5. Identify and obtain funding to implement energy efficiency improvements and development of renewable energy resources. See Table 8.2 for a partial list of potential external funding sources.

10. REFERENCES

Bortleson, G.C., M.J. Chrzastowski, and A.K. Helgerson. 1980. *Historical Changes of Shoreline and Wetland at Eleven Major Deltas in the Puget Sound Region, Washington*. U.S. Geological Survey. Hydrologic Investigations Atlas HA-617.

Deardorff, L. 1992. *A Brief History of the Nooksack River's Delta Distributaries*. Lummi Nation Fisheries Department.

DNV-KEMA. 2012. *Wind Resource and Feasibility Assessment Report for the Lummi Reservation*. Prepared for the Lummi Indian Business Council, Bellingham, Washington.

Federal Emergency Management Agency (FEMA). 2004. *Flood Insurance Study: Whatcom County, Washington (All Jurisdictions).* FIS No. 53073CV000A. Prepared by Michael Baker, Jr., Inc. January 16, 2004.

Gillies, J. 1998. *Personal Communication with J. Gilles*. April 13, 1998.

Kamkoff, V. 2011. *Personal Communication with Vela Kamkoff.*

Lane, E. 2013. *Personal Communication with Elaine Lane, Community Services Program Manager.*

Leckman, S. 1990. *A Forest History of the Lummi Indian Reservation.*

Lummi Indian Business Council (LIBC). 1996. *Lummi Nation Comprehensive Environmental Land Use Plan: Background Document*. LIBC, Bellingham, Washington.

Lummi Indian Business Council (LIBC). 2003. *2003 Lummi Tribal Survey*. LIBC, Bellingham, Washington.

Lummi Water Resources Division (LWRD). 2000. *Lummi Indian Reservation Wetland Management Program Technical Background Document*. Prepared for the Lummi Indian Business Council, Bellingham, Washington.

National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center. 2006. *Regional Land Cover Database: Data Collected 1995-Present*. Charleston, SC. Data accessed at www.csc.noaa.gov/landcover.

Northern Economics, Inc. (NEI). 2005. *Lummi Nation Workforce Skills Inventory and Analysis: Final Report*. Northern Economics, Inc., Bellingham, WA. Prepared for the Lummi Development Authority and Lummi Indian Business Council, Bellingham, Washington.

Northwest Indian Fisheries Commission (NWIFC). 2012. *Tribal Online Accounting System (TOCAS)*. http://access.nwifc.org/webapps/. Website accessed January 2012.

Pierson, W. 1953. *The Geography of the Bellingham Lowland, Washington*. University of Chicago, Department of Geography Research Paper No. 28. University of Chicago Press, Chicago, Illinois.

Point, F. 2014. *Personal communication with Flavian Point, Shellfish Manager, Lummi Shellfish Hatchery*. August 26, 2014.

Puget Sound Energy (PSE). 2015. *Energy Supply*. http://www.pse.com/aboutpse/EnergySupply. Website accessed February 10, 2015.

Smelser, C. 1970. *Sequent Occupance of the Nooksack River Valley and the Influence of Man on the Rate of Sediment Delivery to Bellingham Bay*. Master of Science Thesis, Western Washington State College, Bellingham, Washington.

U.S. Army Corps of Engineers (ACOE). 1997. *Detailed Project Report: Lummi Shore Protection Project, Lummi Indian Reservation, Whatcom County, Washington*. Corps of Engineers, Seattle District, Washington.

U.S. Bureau of Indian Affairs (BIA). 1999. *Indian Service Population and Labor Force Estimates*. U.S. Department of the Interior, Bureau of Indian Affairs.

U.S. Department of Agriculture – Soil Conservation Service (USDA). 1992. *Soil Survey of Whatcom County Area, Washington*.

U.S. Department of Energy (DOE). 2011. *Energy Efficiency and Renewable Energy for Tribal Community Development National Workshop*. Presented by the DOE National Renewable Energy Laboratory (NREL). February 22-24, 2011. Seattle, Washington.

U.S. Department of Energy (DOE). 2012. *2011 Buildings Energy Data Book.* Prepared for the Buildings Technologies Program of the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE). Washington D.C.

U.S. Department of Energy (DOE). 2015. *Tribal Energy Program – Current Opportunities for Tribes*. http://apps1.eere.energy.gov/tribalenergy/. Website accessed February 13, 2015.

U.S. Department of Energy (DOE). 2015b. *Database of State Incentives for Renewables and Efficiency (DSIRE)*. http://www.dsireusa.org/. Website accessed February 13, 2015.

U.S. Energy Information Administration (EIA). 2012. *Annual Energy Review 2011*. Publication DOE/EIA-0384(2011). Washington, DC.

U.S. Energy Information Administration (EIA). 2012b. *Renewable Energy Explained*. http://www.eia.gov/energyexplained/index.cfm?page=renewable_home. Website accessed March 25, 2013.

U.S. Energy Information Administration (EIA). 2013. *Annual Energy Outlook 2013: With Projections to 2040*. Publication DOE/EIA-0383(2013). Washington, DC.

U.S. Energy Information Administration (EIA). 2013b. *Electricity Data*. http://www.eia.gov/electricity/data.cfm#sales. Website Accessed April, 2013.

U.S. Energy Information Administration (EIA). 2015. *Energy Explained*. http://www.eia.gov/energyexplained. Website accessed January 5, 2015.

U.S. Energy Information Administration (EIA). 2015b. *Petroleum and Other Liquids – Washington Gasoline and Diesel Retail Prices*. http://www.eia.gov/petroleum/data.cfm. Website accessed January 15, 2015.

Valz, E. 2003. *LIBC and NWIC Employment Information*. Lummi Nation Statistics Department. Bellingham, WA.

Washington State Department of Conservation (WSDC). 1960. *Water Resources of the Nooksack River Basin and Certain Adjacent Streams*. Water Supply Bulletin No. 12.

Washington State Department of Health (DOH). 1997. *Sanitary Survey of Portage Bay*. Office of Shellfish Programs.

Werner, K. 2007. *Personal communication with Kevin Werner, Assistant General Manager, Silver Reef Hotel, Casino & Spa*. February 19, 2007.

Western Washington University (WWU). 2013. *Top 25 Employers in Whatcom County*. Western Washington University, College of Business and Economics, Center for Economics and Business Research, Bellingham, WA. http://cbe.wwu.edu/cebr/documents/top25employersinwhatcomcounty2013.pdf.

Whatcom County. 2005. *Whatcom County Comprehensive Plan*. Whatcom County Planning Department, Bellingham, Washington. http://www.co.whatcom.wa.us/pds/planning/comp_plan/comp_plan.jsp.

(This page intentionally left blank)

11. ACRONYMS AND ABBREVIATIONS

Programs, Terms, Agencies, and Organizations:	
BIA	Bureau of Indian Affairs
BPA	Bonneville Power Administration
BTU	British Thermal Units
Corps/ACOE	United States Army Corps of Engineers
County	Whatcom County
DOE	United States Department of Energy
DOH	Washington State Department of Health
Ecology	Washington State Department of Ecology
EIA	United States Energy Information Administration
EPA	United States Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
GIS	Geographic Information System
GHG	Greenhouse Gas
HVAC	Heating, Ventilation, and Air Conditioning
IAQ	Indoor Air Quality
kW	Kilowatt
kWh	Kilowatt Hour
LCC	Lummi Commercial Company
LCL	Lummi Nation Code of Laws
LEED	Leadership in Energy and Environmental Design
LHA	Lummi Housing Authority
LIBC	Lummi Indian Business Council
LNR	Lummi Natural Resources Department
LTSWD	Lummi Tribal Sewer and Water District
LWRD	Lummi Water Resources Division
NWIC	Northwest Indian College
NOAA	National Oceanic and Atmospheric Administration
NWIFC	Northwest Indian Fisheries Commission
Planning	Lummi Planning and Public Works Department
PSE	Puget Sound Energy
Reservation	Lummi Indian Reservation
Treaty	1855 Treaty of Point Elliott
U&A	Usual and Accustomed
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
WRIA 1	Water Resources Inventory Area 1
WWTP	Wastewater Treatment Plant

(This page intentionally left blank)

APPENDIX A

LIBC RESOLUTION NO. 2014-084

(This page intentionally left blank)

LUMMI INDIAN BUSINESS COUNCIL
2665 KWINA ROAD • BELLINGHAM, WASHINGTON 98226 • (360) 312-2000

RESOLUTION #2014-084 OF THE LUMMI INDIAN BUSINESS COUNCIL

TITLE: Guiding Principles to Address Climate Change

WHEREAS, the Lummi Indian Business Council is the duly constituted governing body of the Lummi Indian Reservation by the authority of the Constitution and By-laws of the Lummi Tribe of the Lummi Reservation, Washington; and

WHEREAS, it is the Mission of the Lummi Indian Business Council "To Preserve, Promote, and Protect our Sche Lang en and Work Together as One Mind and One Spirit"; and

WHEREAS, the Lummi Indian Business Council has the power to safeguard and promote the peace, safety, morals, and general welfare of the Lummi Reservation pursuant to Section VI, Section 1(l) of the Lummi Constitution; and

WHEREAS, there is overwhelming scientific evidence that global climate change, which includes observed 20th century warming (global warming), ocean acidification, sea level rise, increased frequency and intensity of storm events, glacial retreat, and other impacts are driven by anthropogenic activities including the burning of fossil fuels and the release of greenhouse gases into the atmosphere; and

WHEREAS, the Lummi Nation like other place-based American Indian and Alaska Native people live on the front lines of a changing world, where the disruptions to our natural resources caused by changes in the climate are having real and measurable effects on the livelihoods of our people; and

WHEREAS, we agree with President Obama that responding to the very real threat of climate change is a moral obligation to future generations; and

WHEREAS, the effects of climate change, evident on local, regional, and global scales, will significantly impact the Lummi Nation due to local climate change impacts, and other associated effects on the local environment, natural resources, and infrastructure on which the Lummi Nation has traditionally relied; and

WHEREAS, it is the duty and responsibility of the Lummi Nation to provide for the well-being of the community, its local environment, natural resources, and social systems; and

WHEREAS, through traditional knowledge, practice, experience, and relationships with nature the Lummi Nation has an important role in defending, restoring, and healing the natural environment; and

WHEREAS, under Executive Order 13175 and the United Nations Declaration on the Rights of Indigenous Peoples, tribal Nations have the right to be involved directly in all decision-making; and

NOW THEREFORE BE IT RESOLVED, the Lummi Nation will undertake effort as soon as practicable to determine the potential local effects of climate change as may affect the Lummi Nation, including effects and projected impacts on the local environment, forestry resources, fish and wildlife, water resources, as well as critical infrastructure and public health and shall:

(1) develop appropriate policies and strategies for adapting to effects and projected impacts of climate change on the Lummi Nation and for contributing to reduction of the causes of climate change and global warming by reducing emission of heat trapping green house gases through renewable energy production and energy efficiency practices;

(2) develop appropriate goals for addressing effects of climate change and for contributing to reduction of the causes of climate change;

(3) develop potential programmatic and/or regulatory actions and changes consistent with said policies, strategies, and goals as appropriate to addressing the effects of climate change and contributing to reduction of the causes;

(4) communicate and coordinate with other tribes as well as local, state, regional, national, and international entities and jurisdictions on addressing projected impacts of climate change, including government-to-government cooperation and identification of funding sources and opportunities as possible and available;

(5) inform the Lummi people about issues and concerns regarding the causes, effects, and projected impacts of climate change; and

BE IT FURTHER RESOLVED, the Lummi Nation commits to collaborating with the Affiliated Tribes of Northwest Indians (ATNI) and the National Congress of American Indians (NCAI) to develop an action plan which lays guiding principles and action steps to address the impacts of climate change upon tribal governments, cultures, and lifeways; that will protect and advance our treaty, inherent and indigenous rights, tribal lifeways and ecological knowledge; and

BE IT FURTHER RESOLVED, that the Lummi Nation shall collaborate with ATNI and NCAI to evaluate effectiveness of Executive Order 13175, and Secretarial Order 3289, and the United Nation Declaration of Indigenous Peoples (UNDRIP), in protecting and advancing the principles in the context of addressing the causes, effects, and response to global warming and climate change; and

BE IT FURTHER RESOLVED, that the Lummi Nation declares that it is the Federal Government's Trust responsibility to provide the tribes equitable opportunities and funding to participate meaningfully in the development and implementation of federal climate change policies and programs; and

BE IT FINALLY RESOLVED, that the Chairman (or Vice Chair in his absence) is hereby authorized and directed to execute this resolution and any documents connected therewith, and the Secretary (or the Recording Secretary in his absence) is authorized and directed to execute the following certification.

LUMMI NATION

Timothy Ballew II, Chairman
Lummi Indian Business Council

CERTIFICATION

As Secretary of the Lummi Indian Business Council, I hereby certify that the above Resolution **#2014-084** was adopted at a Regular/Special Meeting of the Council held on the **27th** day of **May,** 2014, at which time a quorum of **9** was Present by a vote of **8** For, **0** Against and **0** Abstention (s).

Jeremiah Julius, Secretary
Lummi Indian Business Council

APPENDIX B

LIBC RESOLUTION NO. 2016-041

(This page intentionally left blank)

LUMMI INDIAN BUSINESS COUNCIL
2665 KWINA ROAD • BELLINGHAM, WASHINGTON 98226 • (360) 312-2000

RESOLUTION #2016-041 OF THE LUMMI INDIAN BUSINESS COUNCIL

TITLE: Adoption of the Lummi Nation Strategic Energy Plan 2016-2026

WHEREAS, the Lummi Indian Business Council (LIBC) is the duly constituted governing body of the Lummi Nation by the authority of the Constitution and Bylaws, as amended, of the Lummi Tribe of the Lummi Reservation, Washington; and

WHEREAS, pursuant to Article VI, Section (l) of the Lummi Constitution, the LIBC is required to safeguard and promote peace, safety, and welfare of the Lummi People and the Lummi Reservation community; and

WHEREAS, it is the mission of the LIBC "*To Preserve, Promote and Protect our Sche Lang en*" (LIBC Resolution #2012-025); and

WHEREAS, the LIBC is responsible for the protection, restoration, enhancement, and management of the natural resources within the exterior boundaries of the Lummi Reservation and throughout the Lummi Nation's usual and accustomed fishing grounds and stations (U & A) and hunting and gathering territories; and

WHEREAS, tribal energy self-sufficiency has been a goal of the Lummi Nation since at least 1993 when the LIBC adopted Resolution #1993-121 directing the Community Development Director to explore a proposal for a tribally owned and operated gas-fired cogeneration facility on the Reservation; and

WHEREAS, the LIBC adopted Resolution #2014-084 "*Guiding Principles to Address Climate Change*" resolving that the Lummi Nation will undertake efforts as soon as practicable to develop appropriate goals, strategies, and policies to address the local effects of climate change on the Lummi Nation and contribute to a reduction of the causes of climate change; and

WHEREAS, the Lummi Natural Resources Department (LNR) has developed the Lummi Nation Strategic Energy Plan: 2016-2026 (SEP), pursuant to LIBC Resolution #2014-084; and

WHEREAS, climate change is caused, in large part, by the production and use of nonrenewable, carbon-based energy sources (e.g., petroleum, natural gas, coal), which releases carbon dioxide, a heat-trapping greenhouse gas, into the atmosphere; and

WHEREAS, the SEP evaluates current and future energy needs and resources on the Lummi Reservation and identifies options for reducing greenhouse gas emissions by improving energy efficiency and developing renewable energy resources; and

WHEREAS, successful implementation of the SEP will help to achieve the Lummi Nation's goal to become more energy self-sufficient and to contribute to a reduction of the causes of climate change; and

WHEREAS, the LNR Director and Deputy Director (meeting on December 1, 2015), the Lummi Fisheries and Natural Resources Commission (meeting on December 3, 2015), and the Lummi Planning Commission (meeting on December 8, 2015) met to review and discuss the SEP, and recommend that the LIBC adopt the SEP.

NOW, THEREFORE, BE IT RESOLVED that the LIBC adopts the Lummi Nation SEP: 2016-2026; and

BE IT FINALLY RESOLVED that the Chairman (or Vice Chair in his absence) is hereby authorized and directed to execute this resolution and any documents connected therewith, and the Secretary (or the Recording Secretary in her absence) is authorized and directed to execute the following certification.

LUMMI NATION

Timothy Ballew II, Chairman
Lummi Indian Business Council

CERTIFICATION

As Secretary of the Lummi Indian Business Council, I hereby certify that the above Resolution **#2016-041** was adopted at a **Regular/Special** Meeting of the Council held on the **16th** day of **February, 2016**, at which time a quorum of **11** was present by a vote of **10** for, **0** against, and **0** abstention(s).

OFFICE OF THE ARCHIVIST · LUMMI NATION TRIBAL ARCHIVES ·

Shasta Cano-Martin, Secretary
Lummi Indian Business Council

APPENDIX C

MONTHLY ENERGY USE FIGURES

(This page intentionally left blank)

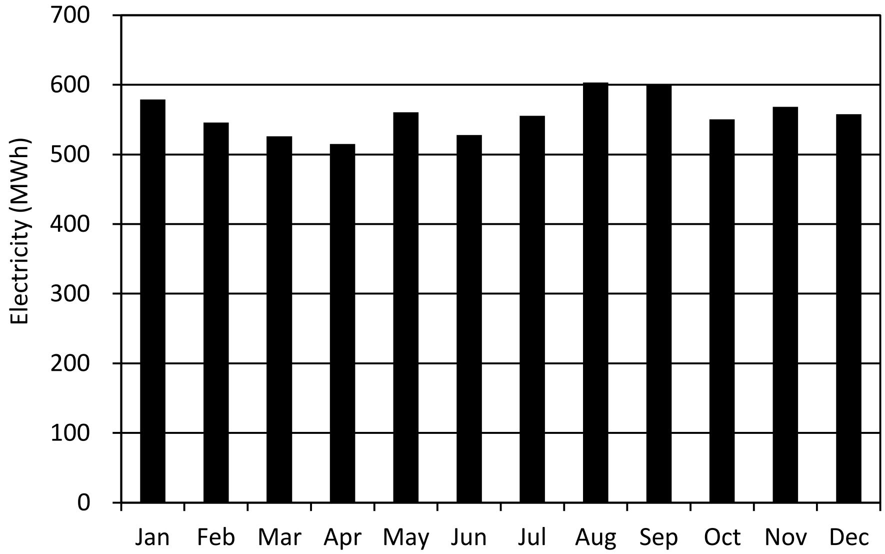


Figure C-1 Monthly Electricity Use by the Silver Reef Hotel, Casino & Spa in 2010

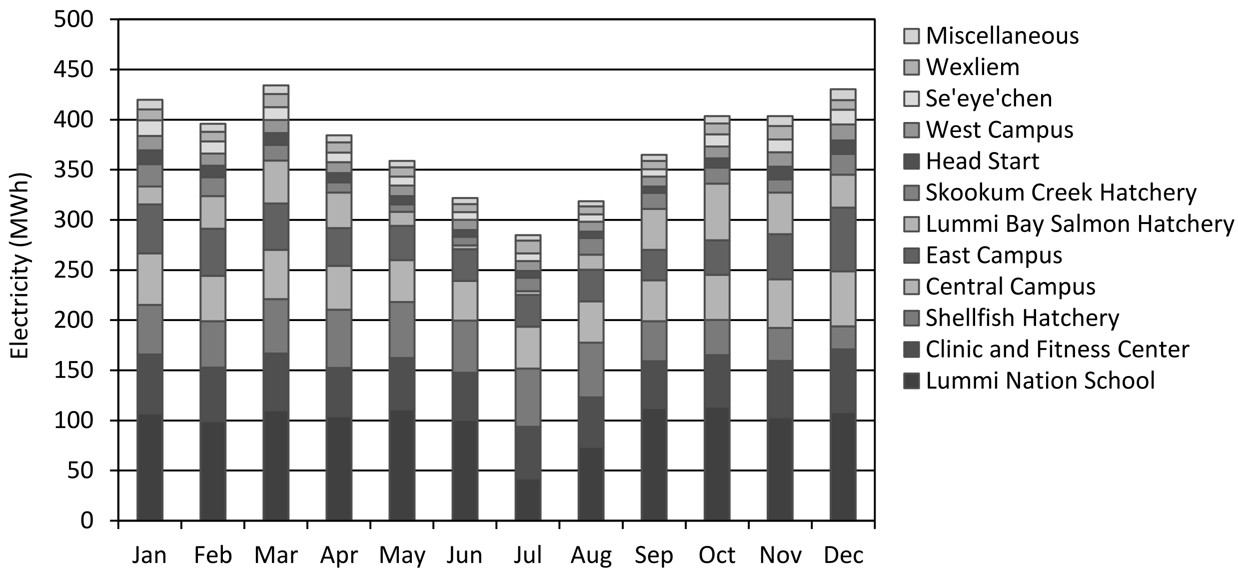


Figure C-2 Monthly Electricity Use by the LIBC in 2010

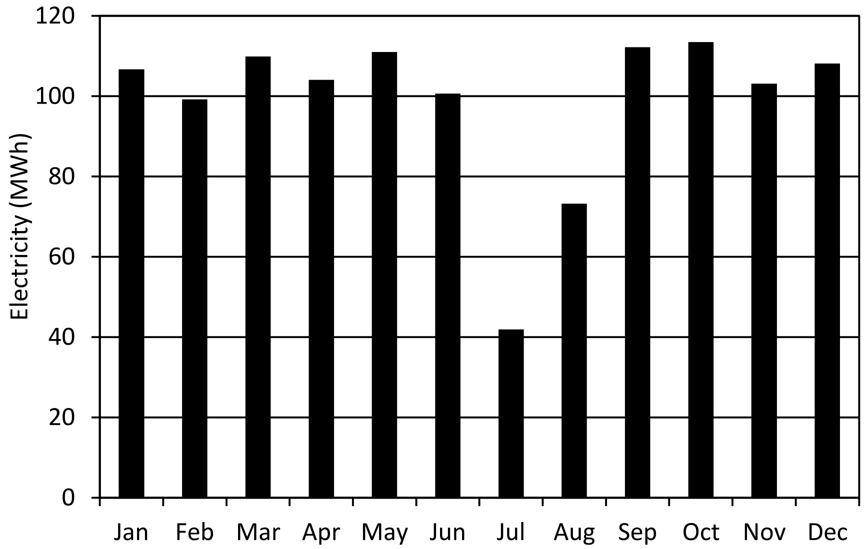


Figure C-3 Monthly Electricity Use by the Lummi Nation School in 2010

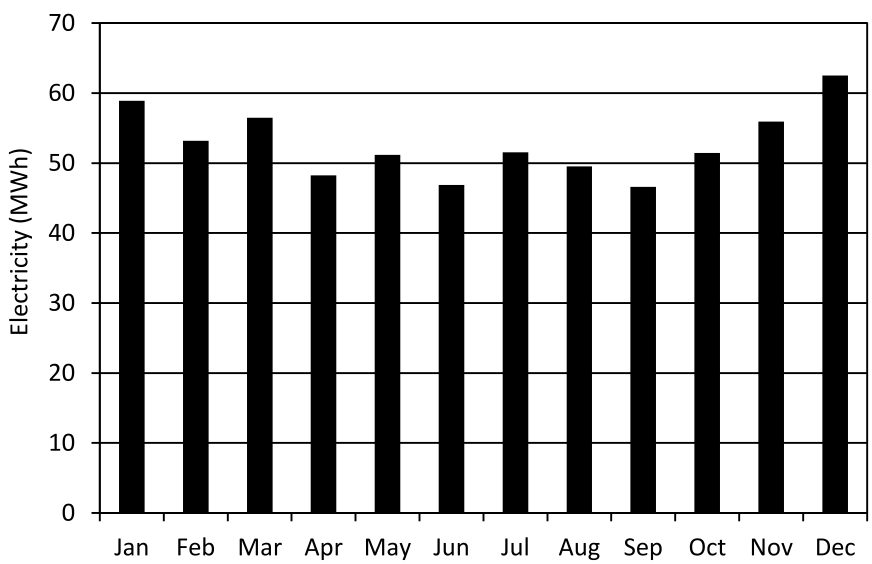


Figure C-4 Monthly Electricity Use by the Clinic and Fitness Center in 2010

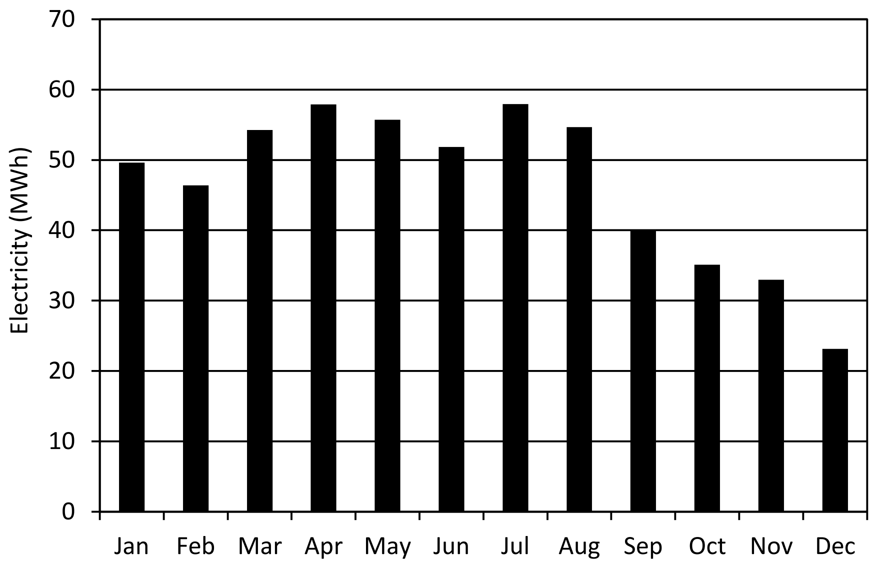


Figure C-5 Monthly Electricity Use by the Shellfish Hatchery in 2010

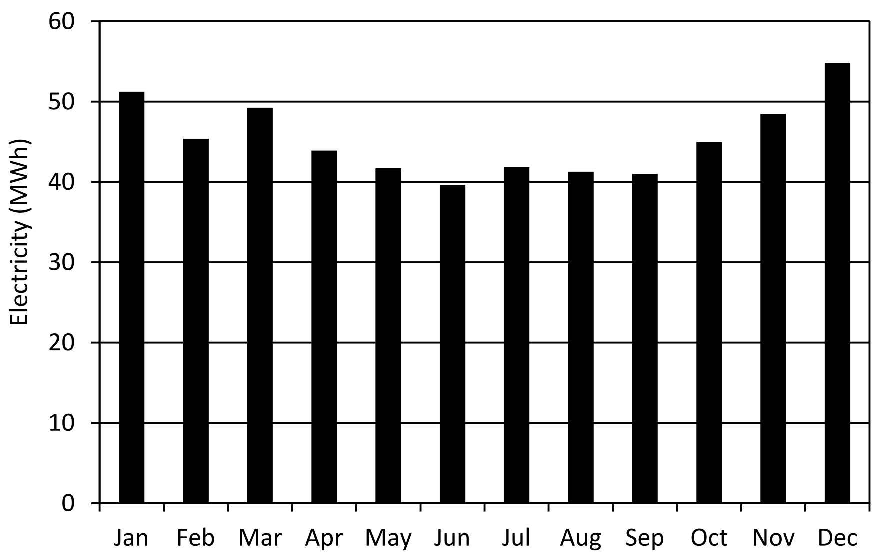


Figure C-6 Monthly Electricity Use by the Central Campus Offices in 2010

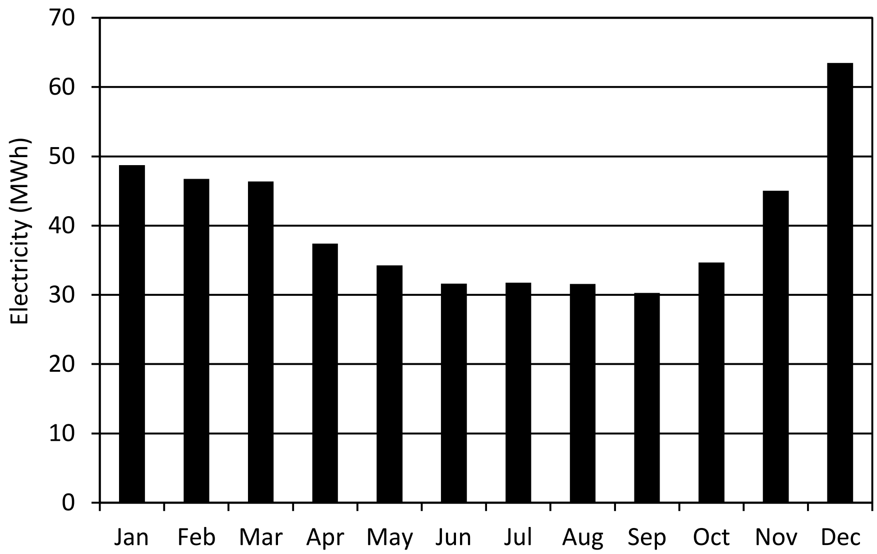


Figure C-7 Monthly Electricity Use by the East Campus Offices in 2010

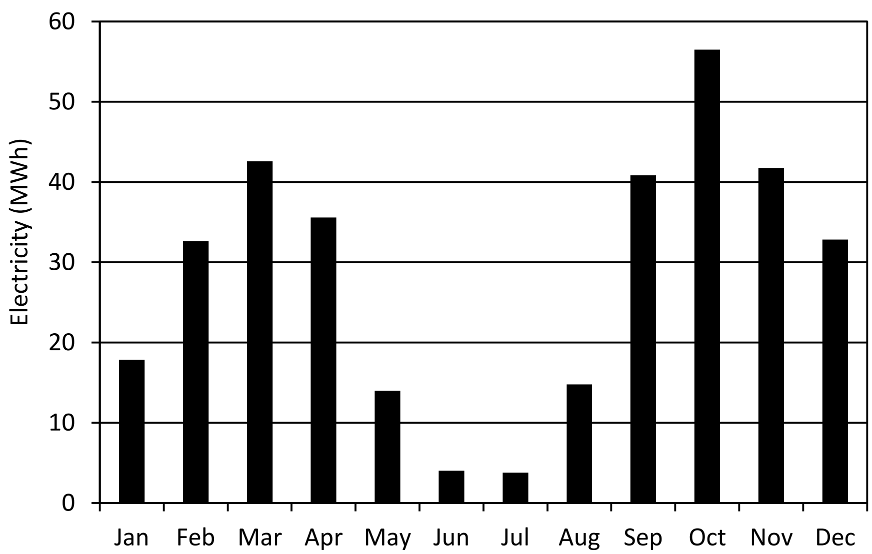


Figure C-8 Monthly Electricity Use by the Lummi Bay Salmon Hatchery in 2010

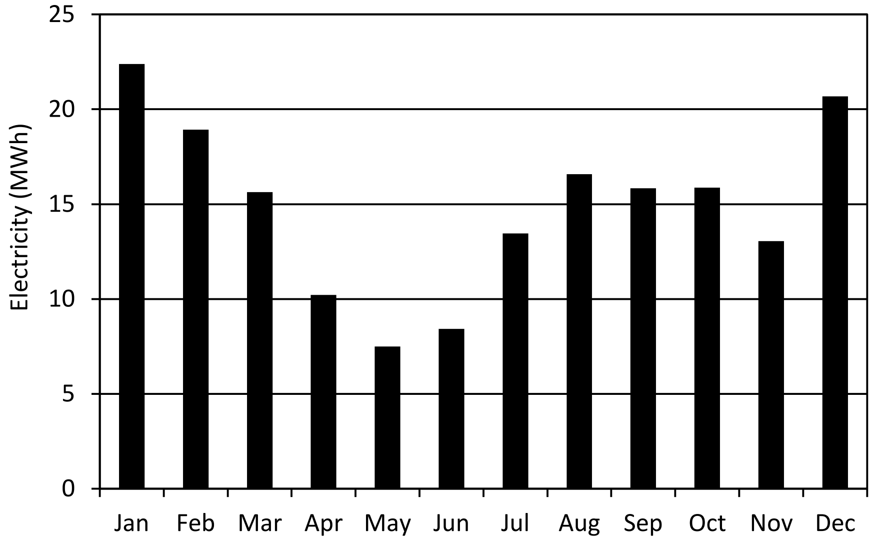


Figure C-9 Monthly Electricity Use by the Skookum Creek Hatchery in 2010

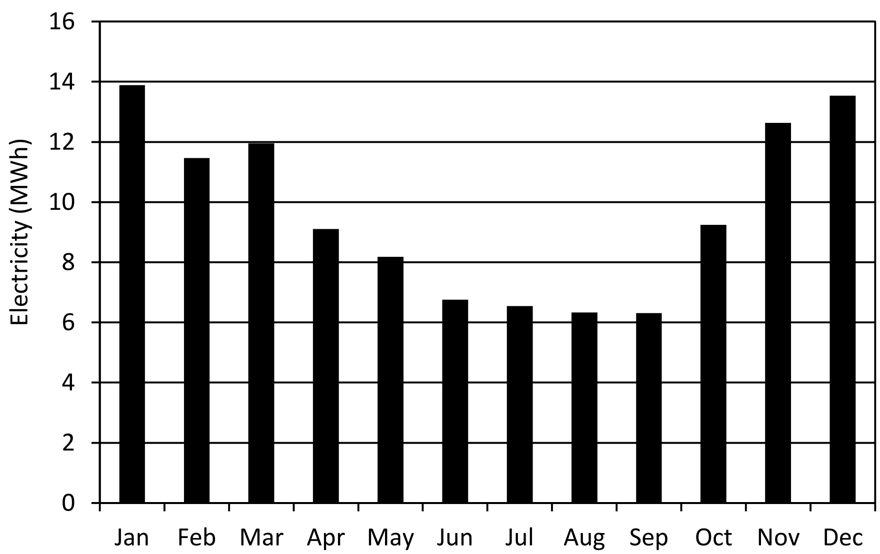


Figure C-10 Monthly Electricity Use by Head Start in 2010

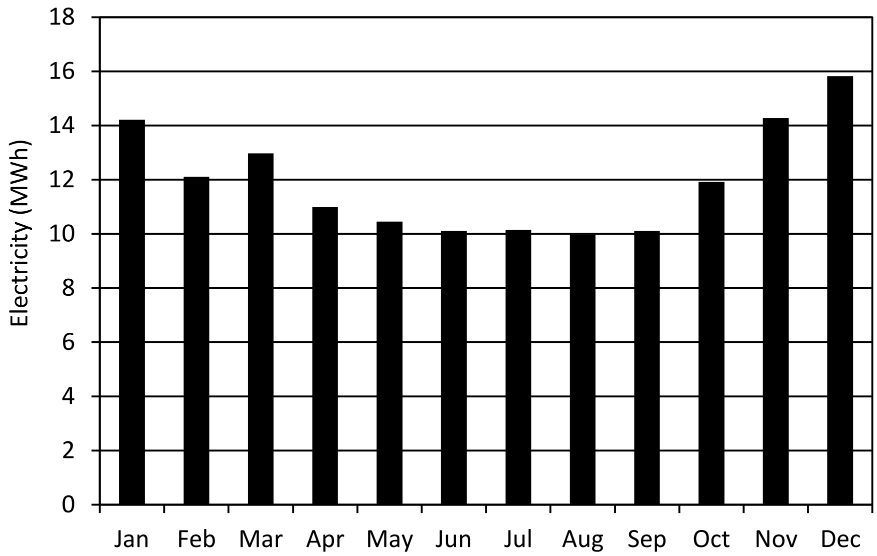


Figure C-11 Monthly Electricity Use by the West Campus Offices in 2010

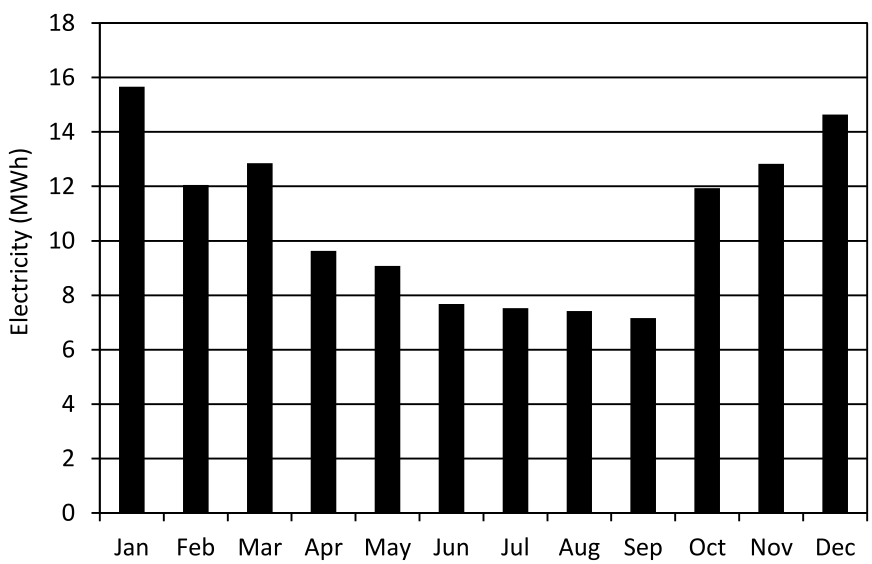


Figure C-12 Monthly Electricity Use by the Se’eye’chen (Youth Shelter) in 2010

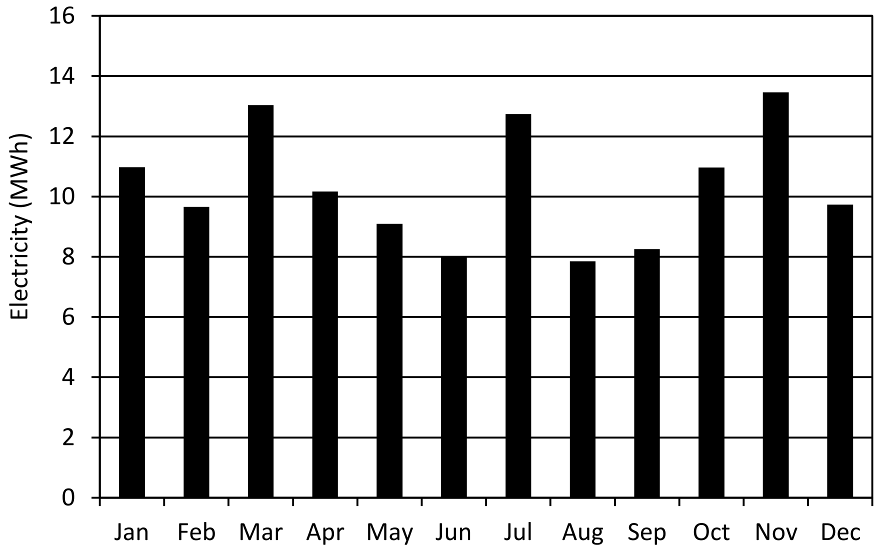


Figure C-13 Monthly Electricity Use by the *Wex li em* (Community Building) in 2010

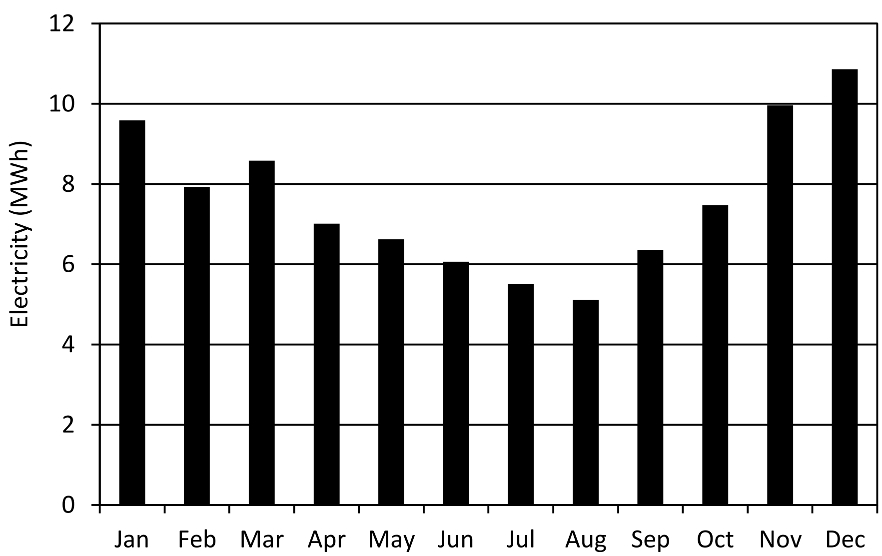


Figure C-14 Monthly Electricity Use by Miscellaneous LIBC Facilities in 2010

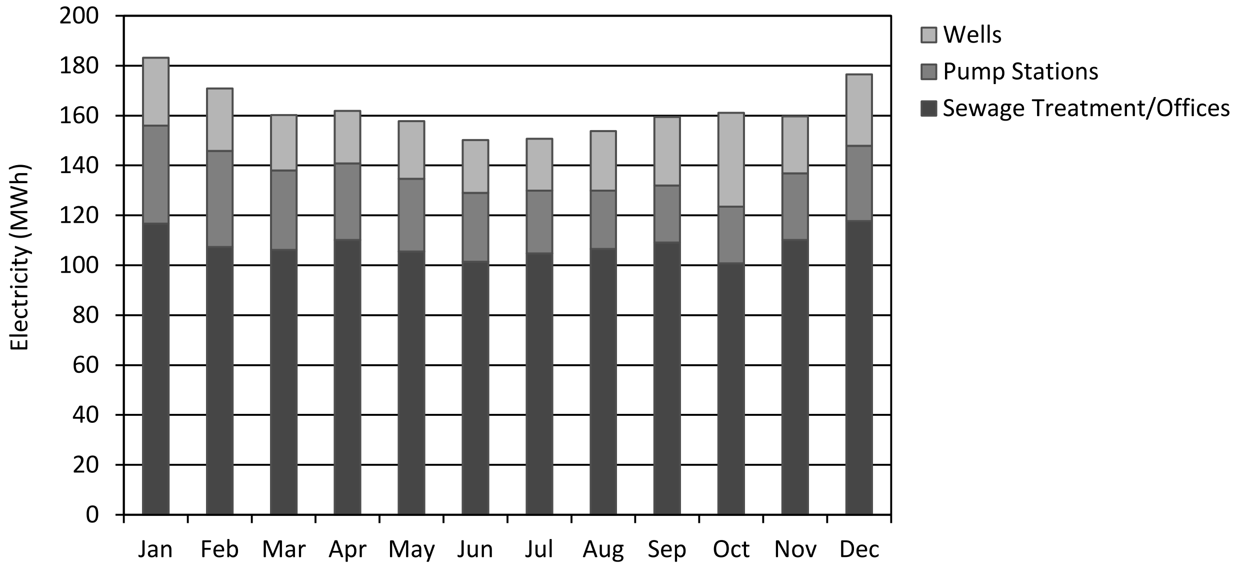


Figure C-15 Monthly Electricity Use by the LTSWD in 2010

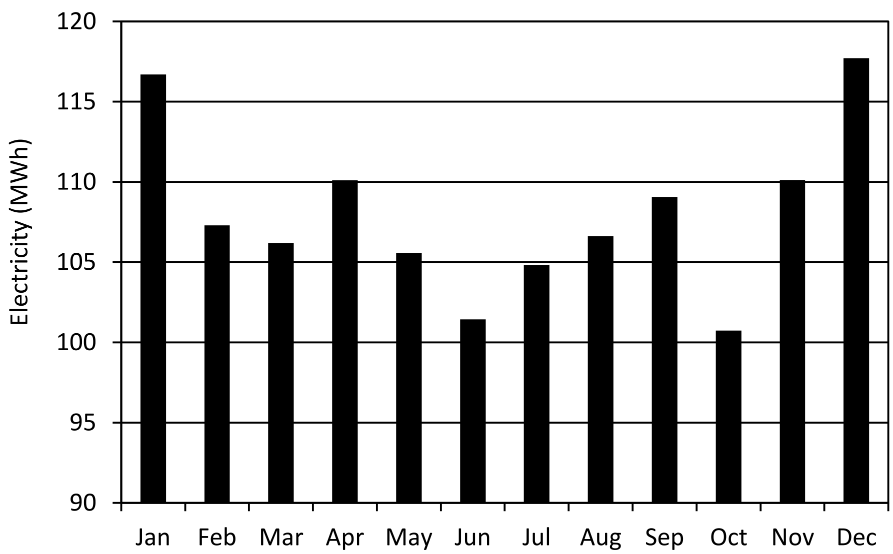


Figure C-16 Monthly Electricity Use by Sewage Treatment and Offices in 2010

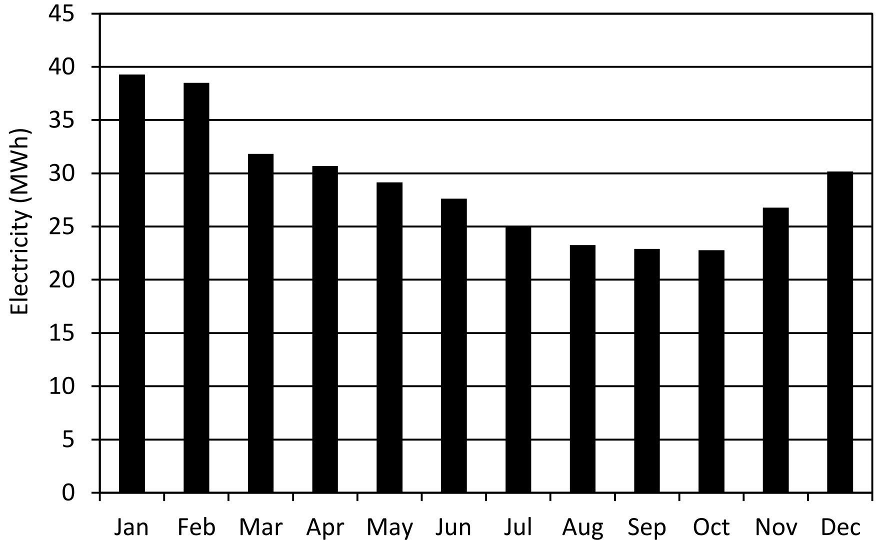


Figure C-17 Monthly Electricity Use by Pump Stations in 2010

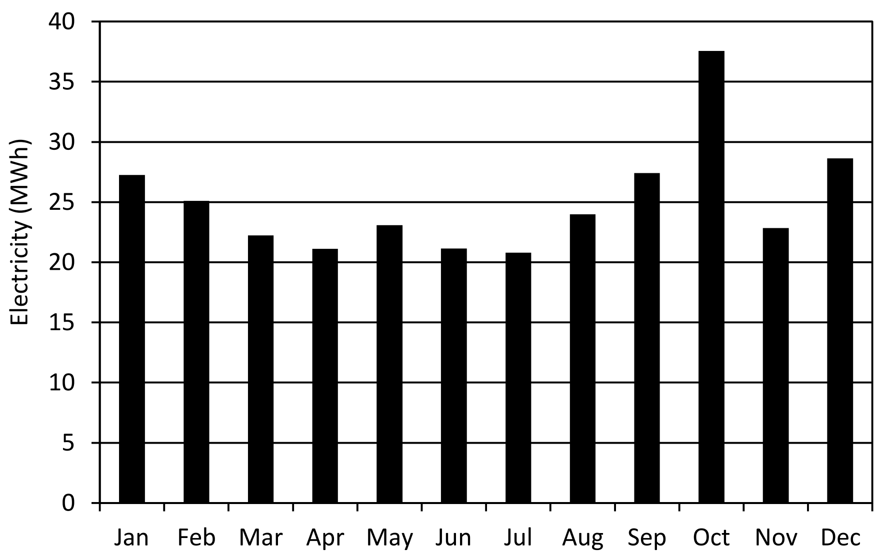


Figure C-18 Monthly Electricity Use by Wells in 2010

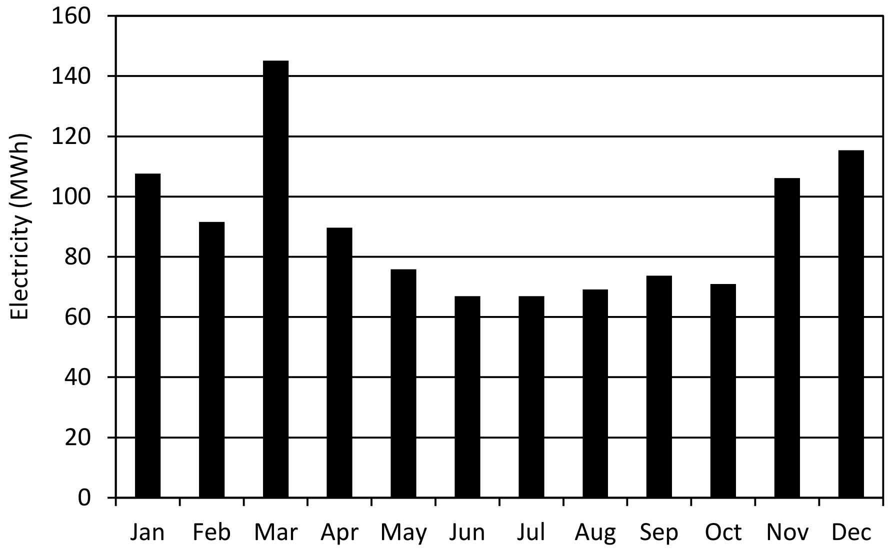


Figure C-19 Monthly Electricity Use by the NWIC in 2010

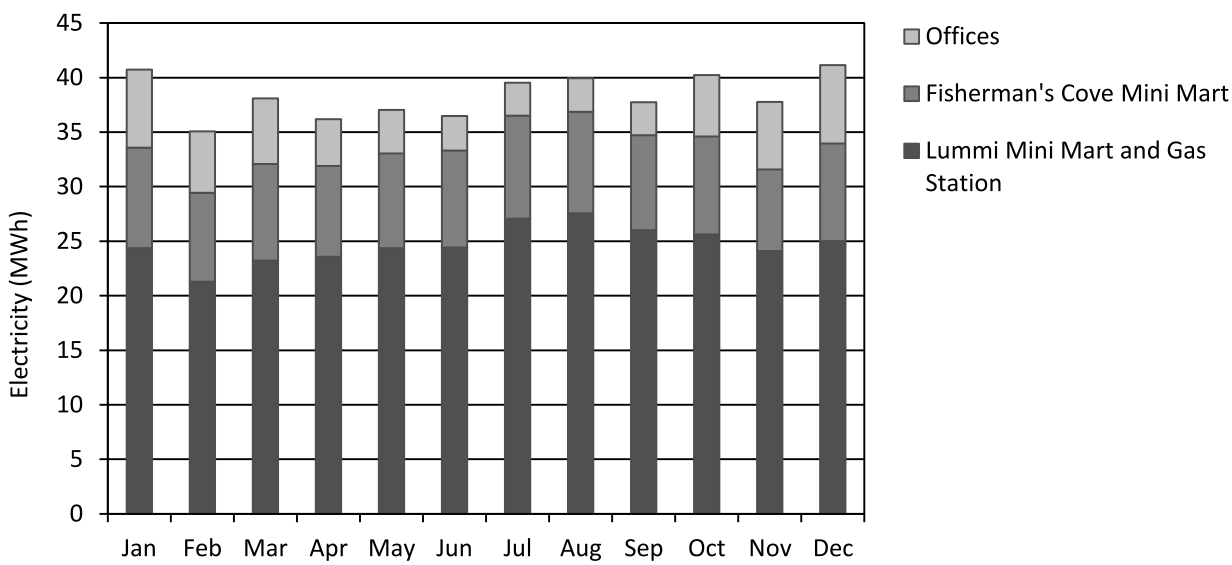


Figure C-20 Monthly Electricity Use by the Other LCC Facilities (not including the Silver Reef Hotel, Casino & Spa) in 2010

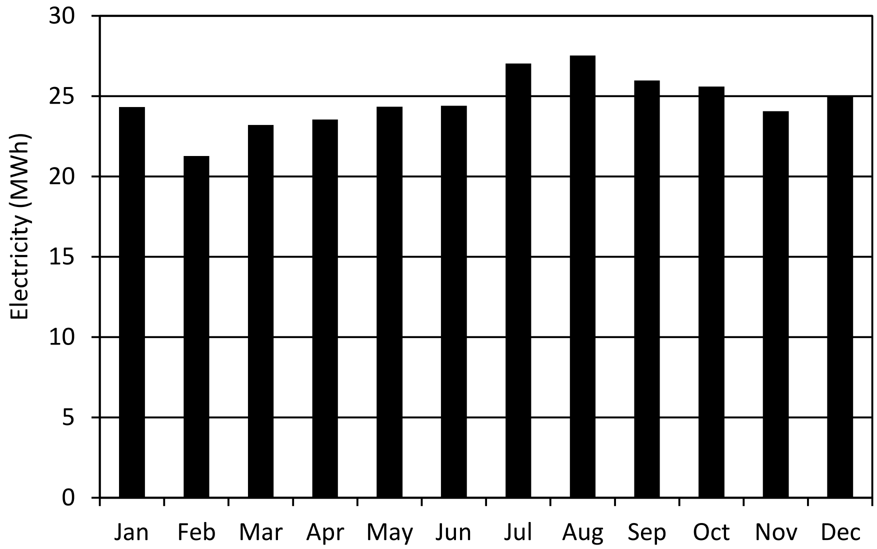


Figure C-21 Monthly Electricity Use by the Lummi Mini Mart and Gas Station in 2010

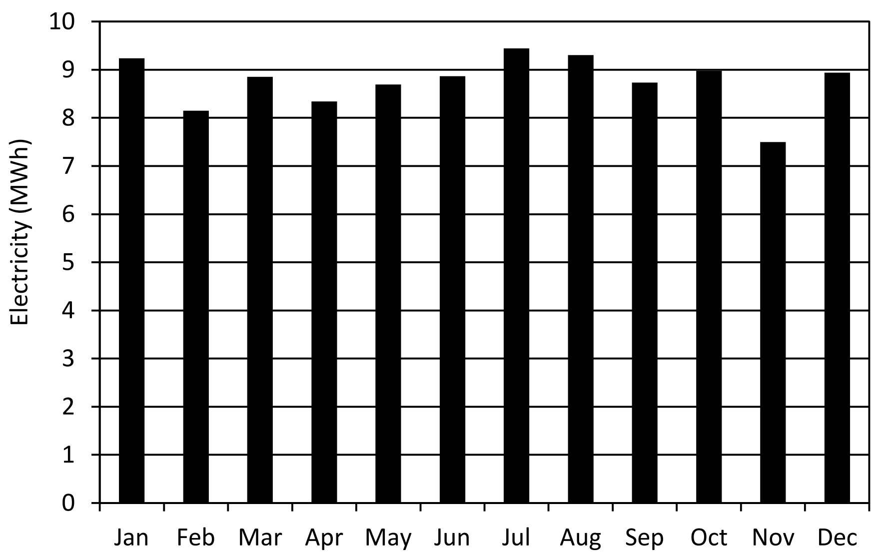


Figure C-22 Monthly Electricity Use by the Fisherman's Cove Mini Mart in 2010

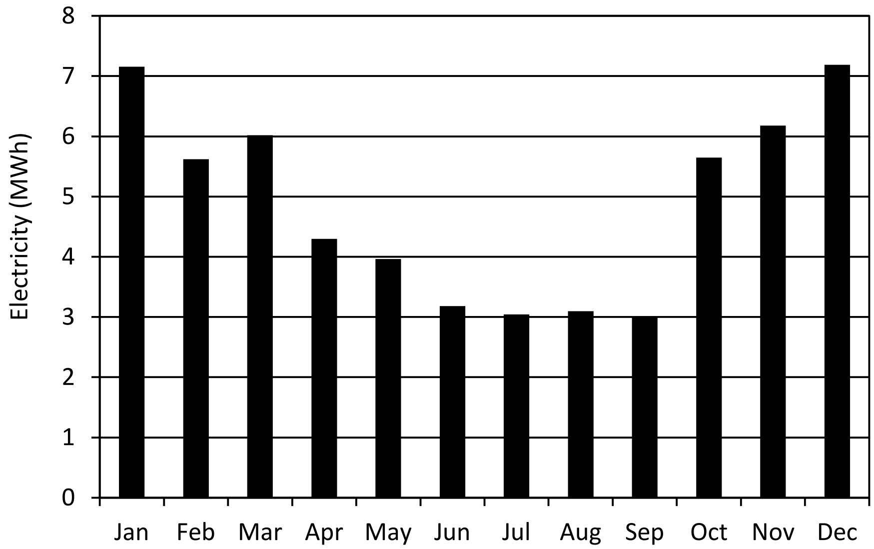


Figure C-23 Monthly Electricity Use by the LCC Offices in 2010

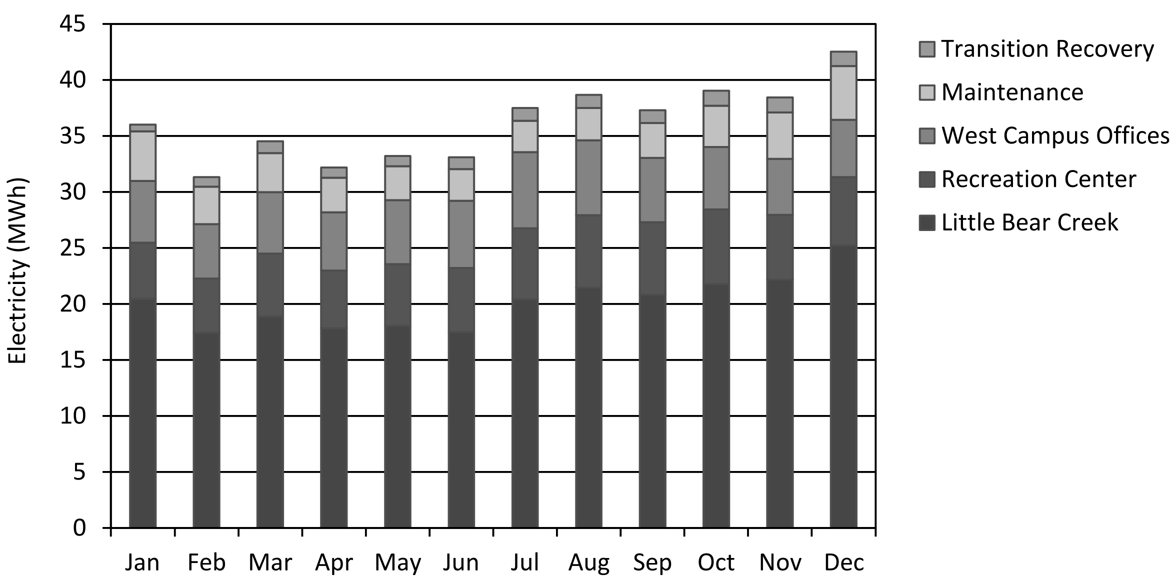


Figure C-24 Monthly Electricity Use by the LHA in 2010

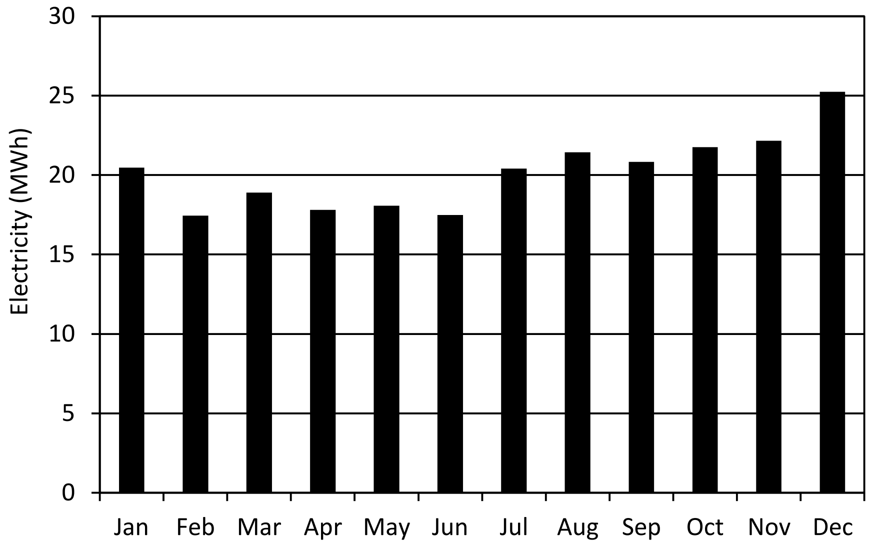


Figure C-25 Monthly Electricity Use by the Little Bear Creek in 2010

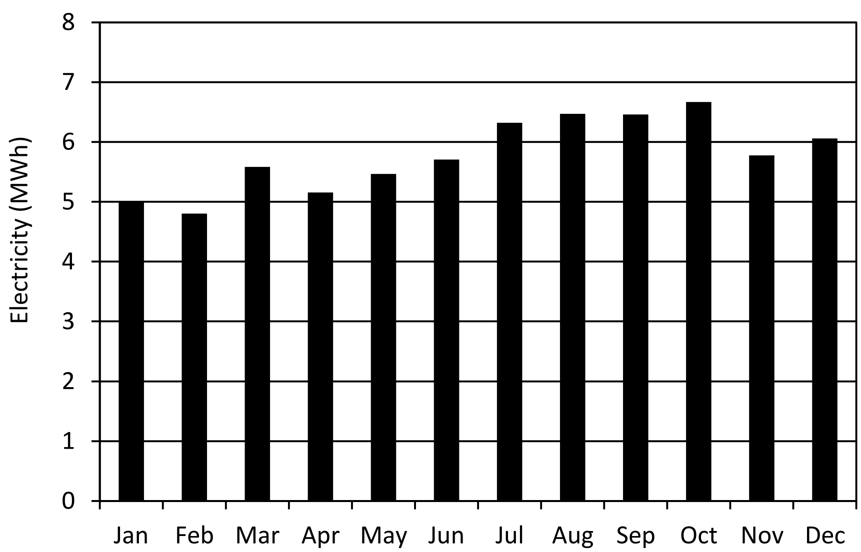


Figure C-26 Monthly Electricity Use by the Recreation Center in 2010

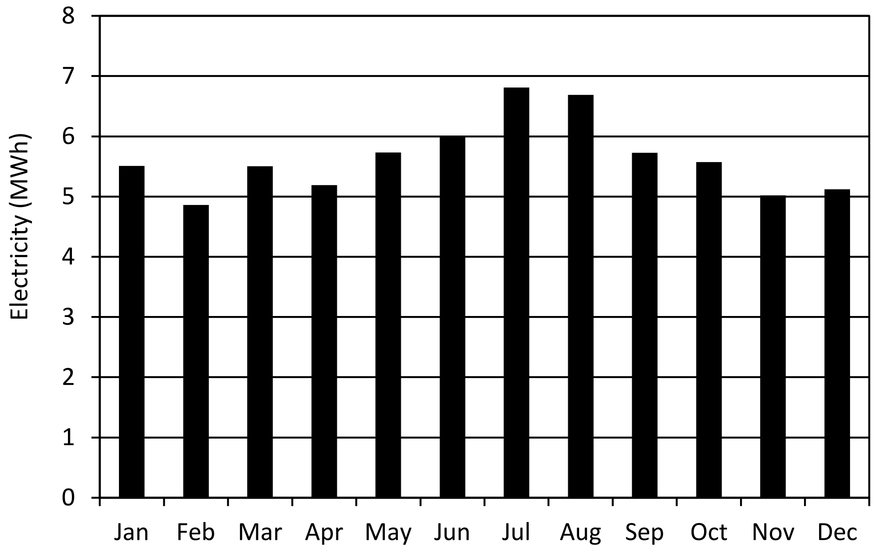


Figure C-27 Monthly Electricity Use by the West Campus Offices in 2010

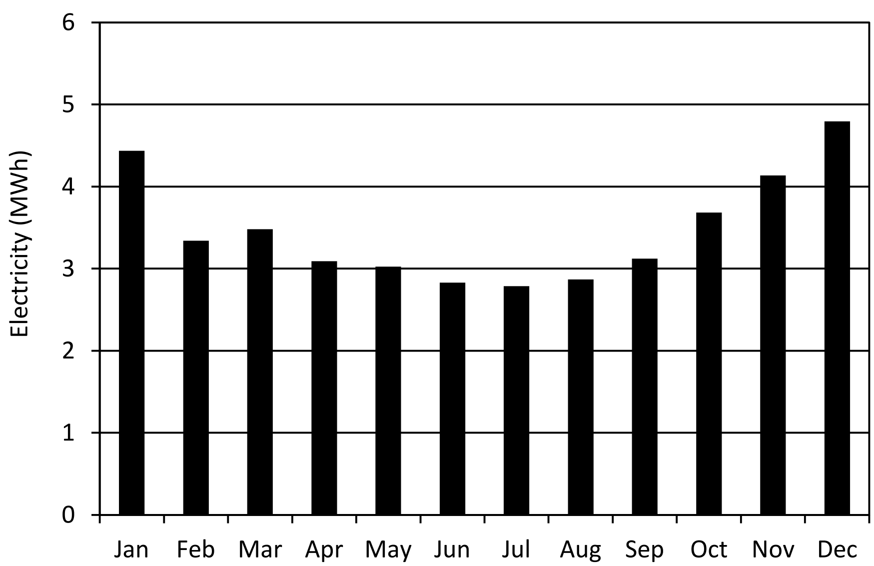


Figure C-28 Monthly Electricity Use by Maintenance in 2010

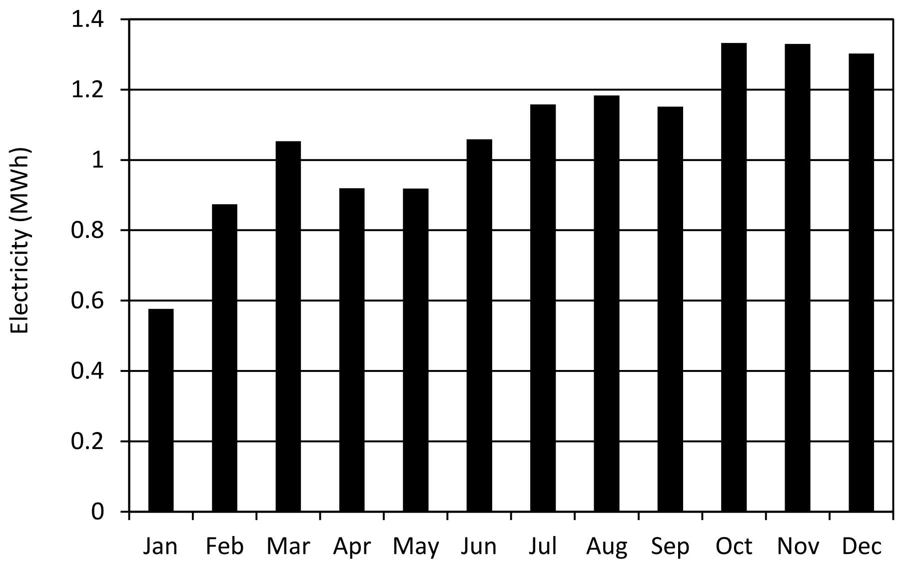


Figure C-29 Monthly Electricity Use by Transition Recovery in 2010

(This page intentionally left blank)

APPENDIX D

TRIBAL ADMINISTRATION BUILDING ENERGY USE IN 2014

(This page intentionally left blank)

Table D-1 Electricity Use in the Tribal Administration Building, 2014

Month	Electricity Use (MWh)	Cost ($)
January	139	11,483
February	140	13,028
March	117	11,432
April	116	10,270
May	124	10,586
June	113	9,672
July	116	10,001
August	126	10,628
September	115	9,687
October	122	11,218
November	134	12,752
December	128	12,263
Total	**1,490**	**133,021**

Table D-2 Propane Use in the Tribal Administration Building, 2014

Month Billed	Propane Delivered (Gallons)	Cost ($)
January	614	1,396
March	612	1,479
May	452	739
August	594	799
November	550	817
Total	2,272	5,229[1]

[1]Includes $275 Annual Tank Rental Fee

(This page intentionally left blank)

APPENDIX E

EXAMPLES OF EDUCATION AND OUTREACH MATERIALS

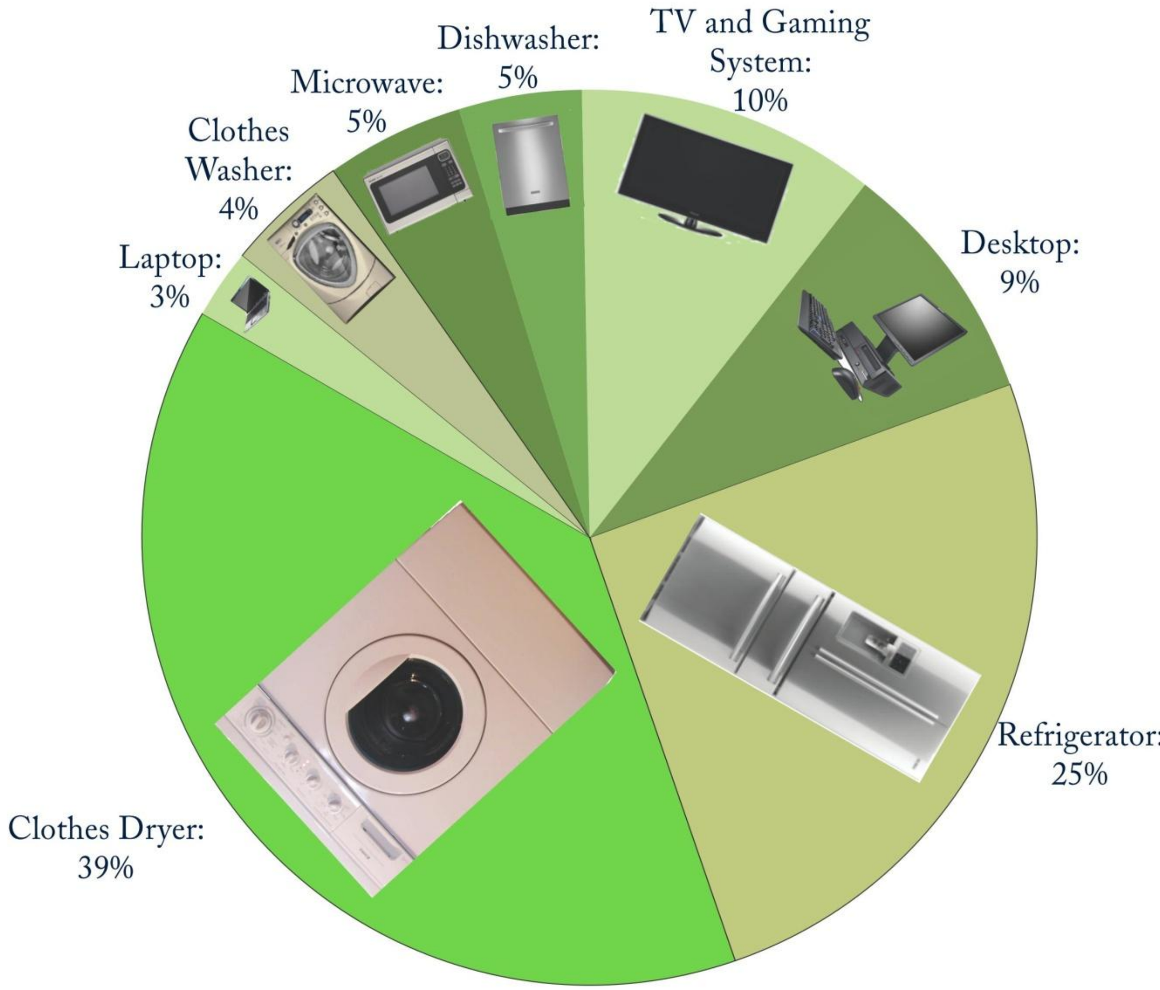
(This page intentionally left blank)

APPLIANCES

A Guide to Reducing Household Energy Waste

Appliances and Your Energy Bill:

Simple Steps to Save Over $200 Each Year*



This graph shows the relative amount of energy consumed by common household appliances. Use this to guide how often you run each appliance to maximize your savings!

*By plugging your chargers, lights and appliances into powerstrips (and turning them off regularly), the average home saves $200.

GEORGETOWN UNIVERSITY ENERGY PRIZE

Steps for Saving Money and Energy

1. Rethink Laundry

- Wash your clothes in cold or warm water when possible and use cold water detergents.
- Wash clothes, sheets and towels in full loads.
- Use a moisture sensor on your dryer to prevent using extra energy.
- Consider air drying your clothes - this protects the color and lowers your bills!
- Clean your lint screen to allow air to move freely through the dryer.

2. Use Powerstrips

Electronics continue to use energy while they're plugged in, even if they're switched off. To save energy, plug your appliances, lights and chargers into a power strip. Turn the power strip off whenever you are not using the appliances.

To learn more about specific powerstrips, visit the Department of Energy.

3. Improve Your Kitchen

- Cover your pots and pans while cooking. This decreases cook-time and saves energy.
- Let dishes in the dishwasher air dry. If you don't have this setting, turn it off after the last rinse and crack the door so that the air can escape.
- Check the temperature of your refrigerator and freezer. The recommended temperature is 35-38° F for refrigerators and O° F for freezers.
- Cover dishes in the refrigerator - uncovered food releases moisture and uses more energy.
- Use a microwave or toaster oven to reheat small amounts of food - this is far more energy-efficient than using an oven.*

*If you're replacing your oven, consider a natural gas stove, as natural gas appliances are less expensive and cleaner burning than electric appliances.

GEORGETOWN UNIVERSITY ENERGY PRIZE

HEATING & COOLING

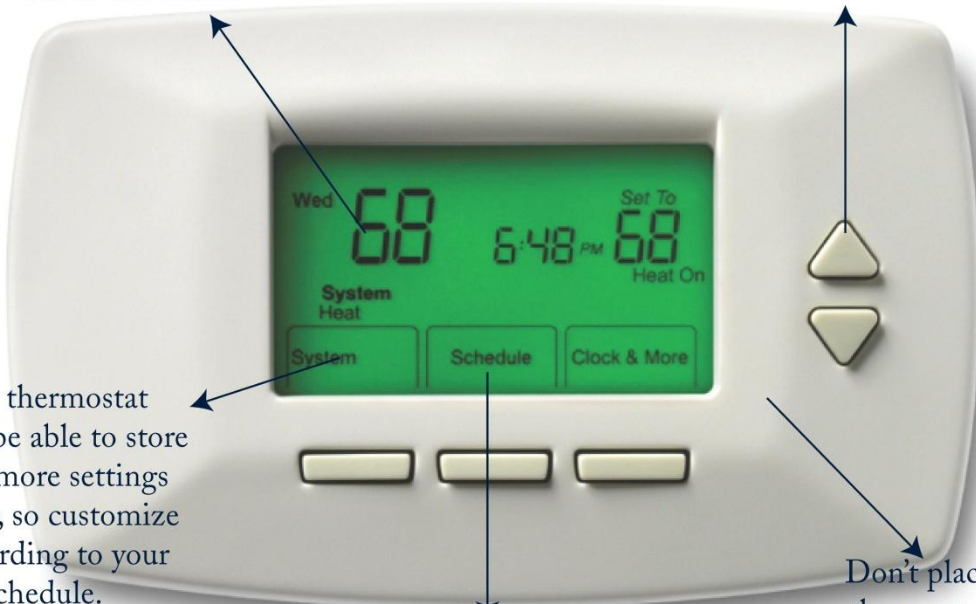
A Guide to Reducing Your Utility Bills

Programmable Thermostats:

How to Cut Your Energy Bill by 10% Each Year

Set your thermostat down in the winter and up in the summer by 7-10˚F for 8 hours while you're asleep or out of the house.

Settings on most programmable thermostats can be overriden without changing the rest of the day or week's schedule.



Your thermostat should be able to store six or more settings per day, so customize it according to your schedule.

When you first turn on your air conditioning, don't set it lower than usual - it won't cool your home any faster and will only increase your energy expenses.

Don't place your thermostat near appliances that give off heat like a lamp or oven.

$ {the costs}

The national average cost for self-installing a programmable thermostat is $100. Using the tips above, you can save an average of $180 on your HVAC bills each year after installation. Also consult your utility to find out about possible rebates!

GEORGETOWN UNIVERSITY ENERGY PRIZE

Steps for Saving Money and Energy

1. Maintain Your System

- Change your filters once a month to keep air flowing properly through your house.
- Call a contractor to ensure that things are working correctly. Professionals can tighten connections, check controls and inspect the drainage system, which will increase your HVAC efficiency.
- Clean your air registers, baseboards and radiators regularly.

2. Insulate Air Ducts

- Check for air leaks in your duct system. You can do this by looking for obvious holes and feeling jointed areas for gaps.
- Use a heat-approved tape to seal any leaks; rubber duct-tape will not provide long-lasting insluation.
- Consult a professional to prevent moisture condensation and pipe freezing.

3. Update Your Hot Water Heater

- Check the temperature settings on your hot water heater. Set it to 120˚F for hot water that uses less energy.
- Insulate your hot water heater so that the heat does not escape. Make sure to follow instructions for safety!
- Replace an inefficient water heater with one that's Energy Star rated - this can cut your costs substantially.
- Tankless or on-demand systems can greatly reduce your energy use because they heat water when needed, rather than on a constant basis.

* If your system is more than 10 years old, consider replacing it with an Energy Star model to increase efficiency and reduce costs.

GEORGETOWN UNIVERSITY ENERGY PRIZE

LIGHTING

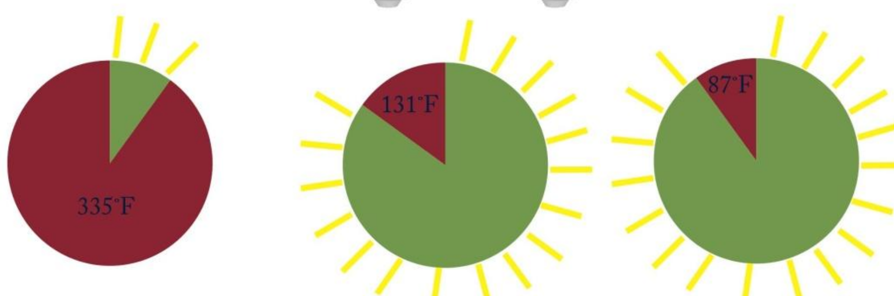
A Guide to Energy Efficient Lighting

Light Bulb Comparison:

Switch 15 Incandescents to CFLs or LEDs and Save up to $50 Each Year

{least efficient} → {more efficient} → {most efficient}

	Incandescent Bulbs	Compact Flourescent Lights (CFLs)	Light Emitting Diodes (LEDs)
# {bulbs needed}	42	5	1
% {amount of energy converted to light}	335°F	131°F	87°F
$ {costs of bulbs and energy}	$352	$90	$86
= {the total}	50,000 hours of light		



GEORGETOWN UNIVERSITY
ENERGY PRIZE

Steps for Saving Money and Energy

1. Make Simple Household Changes

- Turn off lights when you leave a room.
- Replace Incandescent Bulbs with CFLs or LEDs over time.
- Safely recycle your CFLs at a local disposal site. Find one near you at the EPA's website.
- Keep curtains open to reduce the need for light bulbs.

2. Choose the Right Type of Bulb

Incadescent Light
The "original" light bulb. Most of the energy is wasted as heat.

Compact Florescent Light
(CFL) - an energy efficient alternative to an incandescent light.

75% More Efficient Than Incandescents

Light Emitting Diode
(LED) - The most efficient light bulbs.

80% More Efficient Than Incandescents

3. Read the Lighting Label

B E F O R E: Light bulbs were measured in **watts**, which indicate how much energy they use.

N O W: Bulbs are measured in **lumens**, a unit that tells you about the brightness.

W H Y: Energy efficient bulbs need less energy to produce the same brightness!

Lighting Facts Per Bulb

Brightness	870 lumens
Estimated Yearly Energy Cost Based on 3 hrs/day, 11¢/kWh Cost depends on rates and use	$1.57
Life Based on 3 hrs/day	5.5years
Light Appearance Warm — Cool 2700 K	
Energy Used	13 watts

T I P: Use this chart to convert betweeen watts and lumens as you replace old incandescent bulbs!

Watts	Lumens
100	1,600
75	1,100
60	800
40	450

4. Try Bigger Improvements

- Install timers, dimmers or sensors on your lights to prevent overuse.
- When installing or replacing "can" lighting, choose fixtures that are rated for insulation and are air tight to conserve energy.

GEORGETOWN UNIVERSITY
ENERGY PRIZE

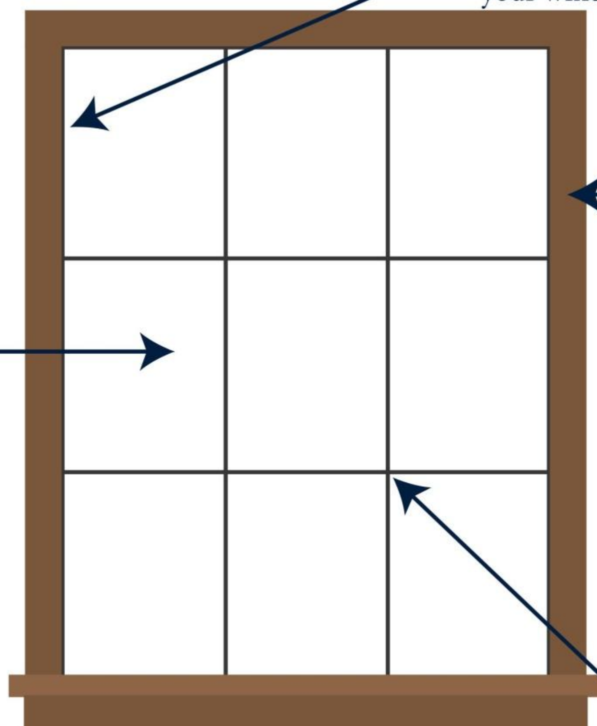
WINDOWS

A guide to preventing air leaks in your home.

Improve Your Windows:

Upgrade Your Frames and Panes to Save 10-25% on Your Bills

Weatherstripping: Add weather-stripping along moving parts of your windows to reduce air leaks.



Frames: If your window frames are deteriorating or made of metal, replace them with a more insulating material. See next page for more information.

Films: Apply films to your windows to reflect sunlight or decrease heat transfer. Consult a home supply store to find the right version for your climate.

Window Panes: Consider replacing your single-paned windows with double or triple-paned windows to prevent air flow.

Caulk: Use caulk to fill in any gaps around your window frames.

+ {the benefits}

- Reduced heating bills
- Less moisture and frost
- Decreased paint/fabric fading
- Lower lighting costs
- Increased comfort

GEORGETOWN UNIVERSITY ENERGY PRIZE

Steps for Saving Money and Energy

1. Make Changes to your Current Windows

- Use caulk to seal any gaps around the stationary parts of your windows.
- Add weatherstripping to moving parts of your windows to keep air out. For more information about types of weatherstripping, visit the Department of Energy's site.
- Install drapes, heavy shades or awnings to prevent air from coming in.

2. Consider Window Coatings

Adding a film to your windows can decrease energy bills. Examples are:

- Low-E coatings: this type of coating prevents heat transfer through the windows.
- Reflective coatings: these films reflect sunlight, keeping both hot air and sunlight out. This is not very common, as lighting bills increase to offset lack of sun.
- Spectrally Selective coatings: best for hot climates, this type of coating filters 40-70% of heat and can reduce energy bills by 40%.

3. Install New Windows or Frames

{least efficient} {more efficient} {most efficient}

type of frame

Metal
Heats up very quickly, making it a bad insulating material.

Fiberglass
Made of glass fibers and plastic, this material can be filled with insulation

Vinyl
If filled with insulation, this plastic frame can be a very effective energy saver.

Wood
A good insulator, but requires maintenence because it expands and contracts.

number of panes

1
Only have 1 layer of glass; cheapest initial cost, but high energy bills.

2
These have two layers of glass; the space is filled with gas to prevent air leaks. Initially more expensive.

3
With three panes, these windows best prevent air leaks. Most expensive initially.

GEORGETOWN UNIVERSITY
ENERGY PRIZE

INSULATION

A Guide to Insulating Your Home

Types of Insulation:

The Most Cost Effective Way to Save Money and Energy

Material	what it is	R value per inch of thickness	where it goes	who can do it
 Concrete Block	Foam boards that go inside or outside of concrete blocks.	1-2	Inside Unfinished Walls or Cavities	Trained Professionals
 Blanket	Insulation made from fiberglass and rock wool.	2.9-3.7	Ceilings or Unfinished Walls	Homeowners *Fill the walls fully to avoid leaks.
 Foam Board	Panels made from foam. Expanded Polystryene (EPS) is the most common.	5.5-6.5	Walls, Floors and Ceilings; must be weather or fire treated	Homeowners *Check packaging for indoor/outdoor placement guide.
 Spray Foam	Blown-in insulation can be made of foam or fiberglass. It expands to fill air leaks.	3.5-6.8	Attic, Cavities *Also strangely shaped places	Trained Professionals
 Reflective	Foil-wrapped sheets that reflect heat instead of absorbing it.	1-4	Cavities, Ceilings and Floors	Homeowners *Consult a professional for placing guidelines.
 Fiber	Boards made of mineral wool and fiberglass. Can withstand high temperatures.	3.9-6.8	Attic, Floor	Trained Professionals

*See back for information on R-values in your region.

GEORGETOWN UNIVERSITY ENERGY PRIZE

Steps for Saving Money and Energy

1. Answer Insulation FAQs

Why should I worry about insulation? Insulation allows you to keep cold air inside your home during the summer and outside during the winter, saving both money and energy.

Where should I insulate? Start by testing for air leaks by holding an incense stick by your windows, doors, ceiling fixtures, etc. When smoke flows horizontally, there is an air leak. Areas that commonly need insulation include: attics, floors, ducts, exterior walls, garages and basements.

2. Learn about R-value

R-value is a material's resistance to heat flow. The warmth of an insulating material is measured by its R-value; the higher the R-value, the more insulation it will provide. Materials all have different R-values that correspond to the amount of warmth that 1 inch of thickness provides. You can compare the R-values of common insulators on the front page.

3. Check Local Insulation Recommendations

Suggested Insulation Values Based On Region and Room Type

Zone	Attic	Cathedral Ceiling	Cavity	Insulation Sheathing	Floor
1	R30-49	R22-49	R13-15	None	R13
2	R30-60	R30-60	R13-15	None	R13
3	R30-60	R30-60	R13-15	None	R25
4	R38-60	R38-60	R13-15	R2.5-6	R25-30
5	R38-60	R38-60	R13-15	R2.5-6	R25-30
6	R49-60	R49-60	R13-21	R5-6	R25-30
7	R49-60	R49-60	R13-21	R5-6	R25-30

*Zone 1 includes Hawaii, Guam, Puerto Rico and the Virgin Islands. Alaska is in Zone 7.
**Recommendations may vary slightly based on your heating and cooling system.

GEORGETOWN UNIVERSITY ENERGY PRIZE

Insulation Worksheet

1. Select the space in your home that you want to insulate.

2. Using the map and chart on the previous page, find the recommended R-value for your location and room type.

   Suggested R-value: ___________________

3. Measure the current thickness of your insulation in inches and multiply by 3.14.

   Current Inches of Thickness: ________ x 3.14 = __________

4. Subtract your Step 3 answer from your answer to Step 2.

   Step 3 Value________ - Step 2 Value __________
   =________ Desired Additional R-Value

5. Check the first page to determine the R-value of the material you plan to use.

   Average R-value: ___________________

6. Divide your answer from Step 4 by the average R-value found in Step 5 to get the number of inches of insulation you will need.

   Step 4 Value________ / Step 5 Value __________
   =________ Inches of Insulation Needed