BUILDING GREEN ENERGY INITIATIVES IN NORTHERN ONTARIO INDIGENOUS COMMUNITIES: CASE STUDY ON COMMUNITY DEVELOPMENT IN LAC DES MILLE LACS FIRST NATION

by

Judah Berkan

FACULTY OF NATURAL RESOURCES MANAGEMENT

LAKEHEAD UNIVERSITY

THUNDER BAY, ONTARIO

April 10, 2020

BUILDING GREEN ENERGY INITIATIVES IN NORTHERN ONTARIO INDIGENOUS COMMUNITIES: CASE STUDY ON COMMUNITY DEVELOPMENT IN LAC DES MILLE LACS FIRST NATION

by

Judah Berkan

An Undergraduate Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Honours Bachelor of Science in Forestry

Faculty of Natural Resources Management

Lakehead University

--	----------------------------------
Dr. Chander Shahi	Laird Van Damme, R.P.F.
Major Advisor	Second Reader

LIBRARY RIGHTS STATEMENT

Date: 04/21/2020

A CAUTION TO THE READER

This HBScF thesis has been through a semi-formal process of review and comment by at least two faculty members. It is made available for loan by the Faculty of Natural Resources Management for the purpose of advancing the practice of professional and scientific forestry.

The reader should be aware that opinions and conclusions expressed in this document are those of the student and do not necessarily reflect the opinions of the thesis supervisor, the faculty or Lakehead University.

ABSTRACT

Keywords: Diesel energy, collaboration, development, energy transition, hydroelectric energy, Indigenous communities, Northern Ontario, renewable energy, solar energy, transmission, wind energy

Northern Ontario's First Nations communities rely heavily on diesel energy, a fuel source with high economic and environmental costs. Thus, many communities are examining the viability of making a partial or full transition to a renewable energy-derived community power source. This thesis will examine the recent renewable energy initiatives conducted by Lac des Mille Lacs First Nation, an Ojibwe community located approximately 130 kilometres northwest of Thunder Bay, Ontario, and the benefits, challenges, and viability of such a large-scale project.

TABLE OF CONTENTS

LIST OF TABLES

TABLE OF FIGURES

ACKNOWLEDGMENTS

Special acknowledgments shall be made to Lac des Mille Lacs First Nation and JAZZ Solar Solutions Inc. for their great help and assistance with this thesis, my supervisors Dr. Chander Shahi and Mr. Laird Van Damme for their continued support and input throughout the thesis writing process, and the Faculty of Natural Resources Management at Lakehead University.

Introduction

Renewable energy transition is an ongoing process of combining business practices, technology, and government policy to transition from current fossil fuel-dependent energy systems to low-carbon, renewable (solar, hydro, wind, etc.) energy systems undertaken in various parts of the world (Natural Resources Canada 2018). The uncertain future of non-renewable energy sources, such as oil and diesel, has prompted the development of such technologies in recent years. Furthermore, significant cost drops and changing social attitudes in recent years has accelerated the replacement of fossil fuels by renewable energy (Kåberger 2018). As of 2019, renewable energy constituted over two-thirds of newly installed energy generation systems world-wide (International Renewable Energy Agency 2019). However, the transition from non-renewable to renewable energy has been arduous in certain areas of the world, such as the remote Indigenous communities in Northern Ontario.

There are 38 remote Indigenous communities in Northern Ontario, all of which are only accessible by winter roads and aircraft (Karanasios and Parker 2016). Many of these communities have shifted or are in the process of shifting from a diesel-generated energy system to a more environmentally-sound renewable energy source. The current diesel energy generation systems utilized by many of these communities have high environmental and financial costs. The total annual cost of diesel generation in the 38 remote northern communities (which includes transportation, storage, and operation) was estimated in 2013 to be $90 million a year (Ontario Ministry of Energy 2013). A renewable energy source allows Indigenous communities to meet their energy requirements while producing less greenhouse emissions and lowering environmental risks, such as toxic and/or radioactive emissions (Kåberger 2018).

Diesel energy generation can be unreliable such as is the case in Eabametoong First Nation (Labine and Clutchey 2016). The Indigenous community is located about three hundred and sixty kilometres north of Thunder Bay and unconnected to the provincial energy grid. Thus, Eabametoong First Nation must rely on diesel generation to meet their community needs, a reliance that is said to be stagnating economic and community growth (Labine and Clutchey 2016). The community has been under a boil water advisory since 2001, which has greatly affected the well-being of the community members. Recently, the community declared a state of emergency after water quality tests revealed levels of trihalomethanes (THMs), chemical by-products of chlorine interacting with unusually high levels of naturally occurring organic compounds within water, between 122 to 182 ug/L (microgram/litre) above the safety standards set by Health Canada (Barrera 2019). Eabametoong First Nation relies on a set of existing, overhauled diesel generators to power the community's wastewater lift station. Unfortunately, the diesel energy system is prone to power outages, such as a 10-day period of three power outages during summer 2019. Due to the difficulty of maintaining the aging generating stations and rising costs of diesel, the community has decided to create a community energy plan to possibly turn to alternate energy sources to suit their community needs. By doing so, Eabametoong First Nations is striving to reduce their reliance on diesel power generation (Labine and Clutchey 2016).

A recent example of a successful renewable energy infrastructure transition undertaken by a Northern Ontario Indigenous community is Lac des Mille Lacs First Nation's solar energy field construction in 2017 (JAZZ Solar Solutions Inc. 2020). Lac des Mille Lacs First Nation is an Ojibwe community situated in the Treaty 3 area, along the lakeshores of Lac des Mille Lacs, located approximately 130 kilometres northwest of Thunder Bay, Ontario. Through business partnerships and over $500,000 of federal and provincial government funding, the community was able to fund the construction of a solar-powered electric grid to effectively lower greenhouse emissions and reduce the community's reliance on diesel (Ministry of Economic Development, Employment and Infrastructure 2016). The intention of this paper is to provide an overview of renewable energy in Northern Ontario communities based on recent green energy initiatives taken by Lac des Mille Lacs First Nation and other communities' similar projects. Alternate energy options and their associated benefits and drawbacks will be compared to current diesel energy systems to provide further clarity on the possibilities for renewable energy initiatives in Northern Ontario Indigenous communities.

Methodology

This thesis reviews relevant literature, government documents, research, and other related resources owned by Lac des Mille Lacs First Nation (LDMFLN) and associates to conduct a case study on LDMLFN's recent renewable energy initiatives. Public domain literature and news sources are used to highlight the current state of renewable energy technology in Northern Ontario, environmental and sociological problems facing Indigenous communities in the region (i.e. poor drinking water and lack of community resources), renewable energy initiatives in the aforementioned communities and their benefits, the history of LDMLFN, and their own initiatives conducted to benefit the community. Accrued data from the research conducted by LDMLFN and its partners has been combined with past and current financial records to organize an analysis of the community's recent renewable energy initiatives. The information gathered for the thesis will help educate interested parties about green energy initiatives by Indigenous communities in Northern Ontario.

Much research went into the establishment of the LDMLFN's renewable energy initiatives. This thesis uses data gathered during the opening stages of the projects, including exercises such as energy audits, alternative energy-use reduction measures, and location selection. The location selection was conducted to find a suitable construction area that would result in maximum return at minimum cost. The energy audits determined whether the project land would be disturbed, altered or affected through man-made disturbance, require in-water work, or affect watersheds and animal habitat (Lac des Mille Lacs First Nation 2014). Because LDMLFN was unable to participate in net-metered grid-power production exercises at the time, the economic benefit of the project was calculated by applying the local utility tariff structure to the produced energy sourced from the utility (Lac des Mille Lacs First Nation 2014). Energy production was estimated using the Natural Resources Canada (NRCan) RETscreen modelling tool to detail PV panel efficiency and local environmental conditions (i.e. temperature, wind conditions, precipitation). The RETscreen modelling tool is a software system for energy efficiency and renewable energy technology (Natural Resources Canada 2019). Diesel savings were based on comparing projected economic costs with an average of 488 litres/MWhr (Sustainable Technology Canada 2014). The fuel and energy conservation measure (ECM) savings were quantified by establishing baseline usage characteristics during the energy audit phase. Next, the subsequent reductions in energy usage after installing efficiency measures was contrasted with this baseline. The approximate savings with this method represent energy not needing to be purchased for diesel energy generation (Lac des Mille Lacs First Nation 2014).

In addition to the aforementioned data and research on projected and estimated values, I met with JAZZ Solar Solutions Inc. in Ottawa to learn more about the construction and monitoring of the community's solar energy grid and obtain current costing and electricity data.

JAZZ Solar Solutions Inc. installed and has maintained the solar energy system in Lac des Mille Lacs since it was constructed in 2017. With the additional research, up-to-date data, and financial records acquired from the trip, a proper analysis of the project will be able to be conducted and be compared to similar projects.

Objectives

The intention of this paper is to shed light on the various challenges and benefits of renewable energy initiatives in Northern Ontario Indigenous communities. Diesel energy and its drawbacks will be contrasted with various renewable energy by examining related literature available online and in the library, news releases, and government documents. The goal of this is to present the current state of energy generation in some northern Indigenous communities while presenting various potential alternatives for possible green energy initiatives.

Secondly, this guideline will explore available environmental assessment options for northern communities presented by various research reports. The intention is to clarify the preliminary environmental work, potential consequences, and remediation techniques presented in the research reports as they are required for such a project. The environmental impact of the installation and maintenance of a renewable energy power system will also be contrasted with the environmental costs of the current diesel-powered systems present in many northern Indigenous communities.

Next, this thesis will explore the history of Lac des Mille Lacs First Nation and their recent renewable energy initiatives presented by various reports, literature, and information provided by Lac des Mille Lacs First Nation. The intention is to clarify the preliminary work, actions taken, and the state of the current system. A case study on the recent installation of a solar-powered microgrid by Lac des Mille Lacs First Nation will be presented based on data and research collected through consulting with band management and project partners. The intent of the case study is to present the process Lac des Mille Lacs First Nation had to undertake to successfully complete their green energy transition project. The environmental impact of the installation and maintenance of a renewable energy power system will also be contrasted with the environmental costs of the current diesel-powered systems present in many northern Indigenous communities.

Finally, this thesis presents the possible benefits a full transition to renewable energy can provide to northern communities. The various alternate energy options are explored, along with their benefits, drawback, and potential health risks. This information is contrasted against an overview of diesel energy. Additionally, information on other applicable communities is provided for the sake of the thesis. By examining research papers and government reports regarding renewable energy community benefits, the objective of this section is to disclose potential employment opportunity increases, lower environmental costs, and any other community benefits made possible by green energy initiatives.

Literature Review

Diesel Generation

As renewable energy (i.e. wind, solar, hydroelectric) generation technology has gained prominence in recent years, the province of Ontario has aimed to take advantage of the rising trend to reduce (and eventually replace) fossil fuels and other non-renewable energy with renewable energy generation. The most common fossil fuel for energy generation in Northern Ontario communities is diesel fuel, a widely used petroleum-based product that many communities rely on for power generation. Petroleum is a liquid made up of aromatic and aliphatic hydrocarbons that, when refined, can be used to create various products, such as asphalt. However, up to 85% of all produced petroleum is used for fuel and account for 37% of primary energy consumption in the world (U.S. Energy Information Administration 2019).

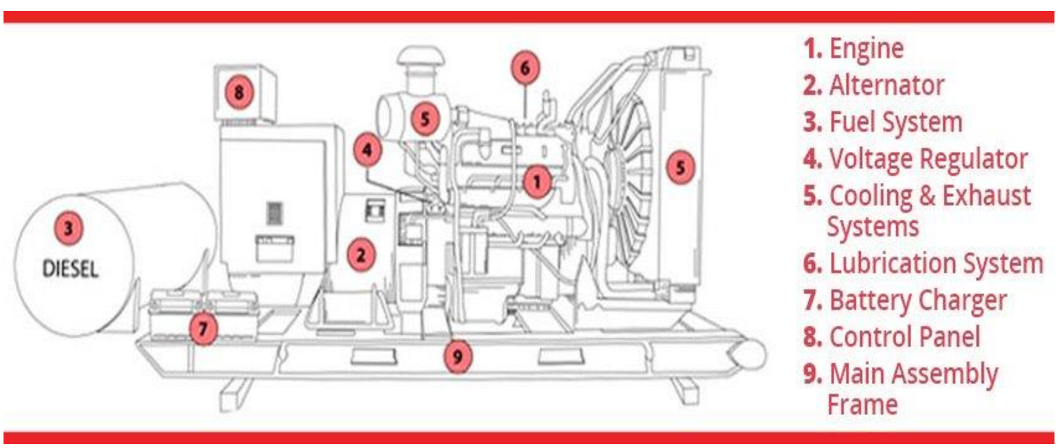

Figure 1. An example of a diesel generator (Advanced Diesel Engineering Ltd. 2018).

The pollution of watersheds and other ecological features by petroleum products is a recurring problem across the globe. For example, a petroleum residue leaking pipeline may seem into a watershed and affect a major drinking source. Thus, it is important to understand the potential effects that exposure to diesel-contaminated water may have on the human body. A recent study decided to investigate the effects of exposure to diesel-contaminated water on the hematology of mice (Udem et. al. 2011). To conduct the study, the researchers gathered a total of 20 albino mice and allowed them drink from water contaminated with diesel 1 %, v/v for 6 weeks. Compared to the control group, packed cell volume, hemoglobin concentration, red blood cell count, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration was significantly lower in the mice that drank from the diesel-contaminated water. Other enzymes, such as aspartate aminotransferase and alanine aminotransferase, increased significantly in the test mice. Maintaining proper levels of these enzymes and proteins is essential for normal cardiovascular processes. The observed hematological changes during the test study indicate that diesel-contaminated water is harmful to the health of humans, other species, and the environment (Udem et. al. 2011). A correlation between lung cancer and respiratory illnesses and prolonged exposure to the fine particulates of diesel exhaust has been identified by various health organizations. Thus, diesel emissions have been classified as being harmful to humans by organizations such as the World Health Organization (Hosszu 2017).

Since petroleum is widely used as transportation, various studies have investigated the health impacts of the fuel source. Many of these studies focus on the toxic effects of concentrated petroleum in aquatic systems. Petroleum products produce a variety of air pollutants, including but not limited to carbon dioxide, hydrocarbons, and sulfur dioxide. Different classes of aquatic organisms can become exposed to these, subsequently causing changes in metabolic, excretion, and storage processes (Connell et. al. 2009).

In order to deliver diesel fuel to northern communities, transport trucks must travel over winter ice roads to reach their destination. An alternative form of fuel transportation is by airplane, a significantly costly venture for the community. Transportation via ice road leaves the potential for spills and leakages of diesel fuel into surrounding waterways. Accidents along the winter ice roads can have major negative impacts on the watersheds in the northern boreal forest (Hosszu 2017). Further environmental impacts can occur in the storage facilities within said communities. Leakages and spills from fuel transfer between the transport vehicles and the storage units can contaminate the drinking water supply. Thus, potentially necessitating the construction of new drinking water wells and further economic costs (Hosszu 2017).

The use of diesel-powered energy systems in select Indigenous communities in Northern Ontario has contributed to a stagnation of community development. Many communities rely on a diesel-energy system that is at or exceeds the maximum community average generating capacity (HORCI 2011). Thus, brownouts and blackouts have occurred due to the high community energy demands during cold winter temperatures (Watay Power 2013). Additionally, extra diesel generators are often required to make up for the fragile diesel-energy community frameworks. Economic development and community development are difficult to implement without an adequate and reliable power source and high transportation and maintenance costs of diesel-energy systems (Hosszu 2017). Thus, it is important for northern communities to assess the various available renewable energy option to make the right choice for their community going forward.

Types of Renewable Energy: Wind Power

Wind power is a renewable energy source that is formed by the uneven heating of the earth's surface due to the rotational nature of the earth. The uneven heating causes the formation of wind currents and temperature differentials. Various topographical features, such as soil and vegetation capture and radiate heat from the sun at different rates contributing to temperature differentials (Cheremisinoff 1978). Wind turbines, which rely on wind currents to turn its blades and generate electricity, were invented to take advantage of the energy source. Wind harvesting for electrical energy conversion is an emission-free process (U.S. Energy Information Administration). Since its inception, wind power generation has made up a small but significant portion of global energy generation. For example, wind power constituted 2.9% in the United States and 12% in Ireland of all power generation in 2011 (Meyers and Spoolman 2013). Large turbine systems can be used to power entire communities. However, in the context of small northern communities, a battery system to store excess energy would be required due to intermittent nature of wind energy. This additional hardware leads to an increase in cost and complexity when compared to larger units (Hosszu 2017). Capital, operational, and fuel costs contribute to an average wind energy generation cost of $64.5 per MWh (USEIA 2017).

As with any energy source, wind energy has its own drawbacks and benefits. Due to the large size of turbine towers, large swaths of land must be cleared for the delivery of tower parts. Shipping and assembling the parts is associated with high costs (Hosszu 2017). Additionally, wind turbines have related to bat and bird mortality. However, it has been noted that the correlation is tied to the topography of said land and migration routes (Rydell et. al. 2012). Also, wind towers can be dangerous to the smaller aircraft in northern communities when combined with poor visibility conditions. Another main drawback of wind turbines is the relative unpredictability of wind patterns in certain regions due to site-specific conditions. Wind patterns are correlated with elevation, terrain, and nearby water bodies Wind maps and wind anemometers are used to measure and predict wind conditions (Hosszu 2017). Recent prototypes of aerial turbine aircraft have been developed fly at high elevations where wind patterns are more predictable (Martinez et. al. 2009). Due to the lack of greenhouse emissions, wind energy has less negative health and environmental effects than non-renewable sources (Frumkin 2010).

Types of Renewable Energy: Hydroelectric Power

Hydroelectric power generation relies on the turning of underwater turbine blades caused by striking flowing water. The turning of the turbine blades generates a renewable form of electricity Most large hydroelectric generating stations rely on the use of dams and reservoirs to ensure a continuous supply of running water Hydroelectric generating stations range from very large 20,000 MW units that can power their entire regions to very small, such as 10 kW units that are just enough to power individual buildings or small villages (U.S. Department of the Interior Bureau of Reclamation Power Resources 2005). Hydroelectric power represents 16% of the world's electricity supply and has a reputation as a clean source of energy. However, hydroelectric generation has drawbacks, such as population displacement (i.e. Lac des Mille Lacs First Nation) and causing widespread changes to animal habitat (Nunez 2019). Additional negative effects include reduced water quality, disruption of fish habitat, and contribution to greenhouse gas emissions, due to decomposition of organic matter related to flooding events (Dove-Thompson et. al. 2011). Thus, it is important to access other alternatives while planning possible green energy initiatives.

Types of Renewable Energy: Solar Power

Solar power generation relies on three technologies to generate electricity from solar radiation: concentrating solar power thermal systems, solar towers and photovoltaic (PV) cells. Concentrating solar power thermal systems commonly have towers which utilize multiple flat sun-tracking mirrors, known as heliostats, to capture solar radiation and generate electricity. The solar radiation is concentrated into a receiver at the top of the tower where a heat-transfer fluid generates heat which subsequently turns a conventional turbine to generate the power (Office of Energy Efficiency & Renewable Energy 2013). Another common technology is conventional solar towers which use hot air generated by solar radiation to turn its turbines and subsequently create electricity (Johansson et. al. 2012). Photovoltaic (PV) cells are the most common solar energy technology on the market today. Relatively cheap (compared to the other two options) and widely available, PV solar energy represents the majority of solar units today.

The technical capabilities of grid-connected solar energy generation units rely on its own unique system. In grid-connected solar systems, panels feed DC power into a grid tied inverter which converts it into AC power. All power is exported directly to the grid. Grid connected systems do not have a storage system and is typically seen in FIT (Feed-in tariff) and Net Metered programs. For example, Wiikwemkoong Unceded Territory utilizes a grid connected system that generates or consumes on site or sends back power to Hydro One to receive credit which can be used within 12 months (JAZZ Solar Solutions Inc. 2020).

In off-grid solar units, solar panels feed DC power into battery storage where the batteries then supply power to an inverter to supply building loads. In the context of the LDMLFN PV-BESS system, an off-grid solar system could deliver up to 110 MwH per year. Over a 20-year system lifespan, the cost of the energy to the community is roughly 18 cents per kWh (JAZZ Solar Solutions Inc. 2020).

The life cycle of PV cells remains the main health concern from solar power by causing greater risks to human health. PV cells are typically made with crystalline silicon and other compounds such as copper indium gallium diselenide (CGS), gallium arsenide (GaAs) and cadmium telluride (CDTe). Mining for these materials is associated with silicosis, a type of pneumoconiosis. Manufacturing processes of solar energy technology, such as semiconductor manufacturing, may lead to exposure to toxic metals and gases. It should be noted that little workplace safety information is available about potential workplace exposures, due to the relative newness of the technology. However, the overall health and environmental impacts are generally agreed to be less than that of non-renewable energy sources (Frumkin 2010).

Conversion of Diesel to Renewable Energy

Conversion of diesel to renewable is a costly venture for many communities due to the associated difficulties of potential projects, such as remoteness. Difficulty of access is a major problem posed to many northern Indigenous communities. The twenty-five isolated remote communities are only accessible by winter roads and air (Karanasios and Parker 2016). The high difficulty of access to these communities contribute to high transportation and maintenance costs. A significant aspect of conversion from diesel to renewable energy is evaluating and contrasting all the involved variables. The current diesel energy generation model involves high operating costs, a significant CO_2 footprint, risk of water contamination, and the necessity of having several stakeholders. The first step of transition to renewable energy involves evaluating the high installation and capital costs of renewable energy infrastructure, and the current economic structure of the community. For example, the average fuel cost for was $1.24/liter in 2011. At the time of the study, the average cost of diesel-generated electricity in remote communities could increase to $1.68/kWh. For comparison, the province-wide average was 0.13 cents/kWh (Arrianga et. al. 2016). The sizeable difference between the average cost in remote communities and the province-wide average is a huge detriment to the communities. In addition, diesel power generation also accounts for 40,000 tons of annual CO_2 emissions (equates to approximately 8000 passenger vehicles (Arrianga et. al. 2016). A successful renewable energy infrastructure project installation has the potential to limit fuel consumption, emissions, and operating costs (Arrianga et. al. 2016). Such projects can be modelled using formulas and diagrams like those presented in Renewable Energy Alternatives for Remote Communities in

Northern Ontario, Canada (Arrianga et. al. 2016). All potential projects on crown/private land must apply for a Renewable Energy Approval before it can go ahead with construction (Ontario Ministry of Natural Resources and Forestry 2019).

Wind Power and Solar Power Projects

Before constructing any large-scale wind power, solar power or bio-energy project on Ontario Crown land and/or private land, the project developer is legally obligated to apply for a Renewable Energy Approval (REA) administered under the Environmental Protection Act. Some small-scale renewable energy projects and waterpower projects that are subject to the Environmental Assessment Act are exempt from the application and approvals process for a REA. REAs are mandatory for Class 2 wind project facilities with a capacity over 3kW but less than 50 kW, Class 3 facilities with a capacity equal to or greater than 50 kW that generates less than 102 dBA of sound, Class 4 facilities with a generating capacity equal to or greater than 50 kW that generates 102 dB or more of sound, and Class 3 solar facilities with a power generating capacity greater than 10 kW. In addition to the specific guidelines required for a successful application and approvals process, the MNRF may make project-specific changes that affect the state of the process. Refer to Ontario Regulation 359/09 for the full REA rule set (Ontario Ministry of Natural Resources 2019).

Each Renewable Energy Approval application has its own unique traits dependent on the type of project it is. An application fee, based on project class and size, for a Renewable Energy Approval is required and may be partially refunded if the application is deemed by the ministry to be incomplete. The technology type and facility class of the proposed project determines the set of application requirements. However, the majority of applicants are still required to perform studies, detailed plans, site assessments, reports, and consult with impacted communities and the public to achieve a successful application. Once a successful application is processed, the developers are no longer eligible for a refund (Ontario Ministry of Natural Resources 2019).

Each applicant is recommended to assess nearby features to ensure the best possible condition is selected for the project site. Identifying the best site early on can help reduce the need for future mitigation efforts and improve the chances of a successful application. A checklist for picking the best possible site provided by the ministry is available to interested parties (Ontario Ministry of Natural Resources 2019).

Any information related to licensing, authorizations, and approvals may be required to meet the requirements outlined in the Approval and Permitting Requirements Document for Renewable Energy Projects. As previously stated, the Approval and Permitting Requirements Document applies to the operations of wind, solar and bio-energy projects on Crown and/or private land. The Crown may determine if a proposal is subject to requirements as seen fit if the project's operations affect a water crossing, bridge, culvert, and/or protected species. For example, the Crown can permit harvesting operations of timber resources to continue within 75 metres of a gas well, if certain conditions are met. Additionally, the applicant must abide by other regulatory requirements under federal and/or federal legislation for a successful renewable energy approvals process (Ontario Ministry of Natural Resources and Forestry 2019).

In order to be allowed to undertake a renewable energy initiative, most developers must meet set consultation requirements because of the "duty to consult" Indigenous communities, applicable municipalities, and the public. The developer is encouraged to do more than the minimum requirements to facilitate working relationships with local communities to create a sense of transparency and good faith. Further details about the "duty to consult" and consultation requirements may be found in the Municipal/Local Authority consultation form and Technical Guide to Renewable Energy Approvals (Ontario Ministry of Natural Resources 2019).

The province of Ontario requires that every renewable energy project proposal must meet the requirements of the Environmental Assessment Act. Hydropower, wind power, solar power, and bio-energy projects have their own set of requirements set out by the Government of Ontario. These sets of requirements help identify Indigenous concerns, social concerns, potential environmental impacts, preferred means to address, and more. In the case of hydropower projects (i.e. hydroelectric dams), the approval process is based on the size of the proposed facility. For example, projects smaller than 200 megawatts is based on the Class Environmental Assessment for Waterpower Project approval process. The Ontario Waterpower Association monitors the implementation of these Class Environmental Assessments. On the other hand, projects larger than 200 megawatts are subject to an Individual Environmental Assessment. Additionally, the Ministry of Natural Resources, Ontario Power Generation and Fisheries and Oceans Canada have developed the Best Management Practices Guide for the Mitigation of Impacts of Waterpower Facility Construction to assist in constructing, rehabilitating or repairing a hydropower facility in an environmentally responsible manner (Ontario Ministry of Natural Resources and Forestry 2019).

In order to receive project approval, proposed wind projects must have prevention and mitigation measures in place to protect bird and bat populations. Guidelines include mandatory post-construction monitoring measures, established bird and bat mortality thresholds, habitat evaluation measures, and a setback approach to make certain that mortality thresholds are not exceeded within the project's operating zone (Ontario Ministry of Natural Resources and Forestry 2019).

All renewable energy projects must undergo a Natural Heritage Assessment to ensure the maintenance and protection of natural heritage sites (Ministry of the Environment, Conservation and Parks 2019). By definition, natural heritage sites are natural features, geological and physiographical formations and delineated areas that constitute the habitat of threatened species of animals and plants and natural sites of value from the point of view of science, conservation or natural beauty (United Nations Educational, Scientific and Cultural Organization 2020). MNRF's Natural Heritage Assessment Guide for Renewable Energy Projects provide guidance on the proper conducting of such assessment (Ontario Ministry of Natural Resources 2019).

A proposal notice stating that the application is under review is posted whenever the Ministry of the Environment and Climate Change receives a finished Renewable Energy Approval application. The notice provides an opportunity for interested community members to provide commentary about the potential project to the ministry. All comments are valid during the application assessment. Another list containing information about approved projects, applications that are under technical review/screened, and withdrawn applications is also provided to the public for reference (Ontario Ministry of Natural Resources 2019).

If the project successfully passes the application and assessment REA process, then the project developers can commence work on the applicable renewable energy resource project. However, the project must still abide by the rules and regulations set out by the Ministry of the Environment and Climate Change before, during and post-construction to be allowed to continue operations (Ontario Ministry of Natural Resources 2019). Once a successful REA process is completed, the developers may follow the actions taken by recent green energy initiatives taken by Northern Ontario Indigenous communities.

Renewable Energy Initiatives in Indigenous Communities

In 2017, the province of Ontario implemented its Long-Term Energy Plan with the focus of providing an innovative provincial energy generation system for Ontarians. In recent years, the province of Ontario has eliminated coal-fired generation resulting in a provincial energy system that is over 90 per cent free of climate changing emissions. The commitment to phasing out non-renewable energy has resulted in investment into technology that is projected to meet provincial energy demands by the mid-2020s and improved air quality across the province. The creation of Ontario's Long-Term Energy Plan involved extensive consultations and engagements with organizations, communities, businesses, and citizens throughout the province. Additionally, the Government of Ontario consulted with representatives of over 100 First Nation and Métis organizations and communities. One of the major goals of the plan is to capitalize on the falling wind and solar energy installation costs and rapidly evolving smart grid and storage technologies to improve the affordability and cleanliness of energy generation (Government of Ontario 2017). Ontario's Long-Term Energy Plan has set targets that half of the provincial installed capacity be replaced with renewable energy sources by 2025 and calls for increased participation by Indigenous communities within the province (Karanasios and Parker 2016). The unique perspectives and knowledge of the Indigenous people has created an unprecedented level of involvement in energy planning, projects, and policies within the sector.

First Nations and Métis communities are now leading or partnering on over 600 renewable energy projects across Ontario, accounting for over 2,200 megawatts (MW) of clean energy generation (Government of Ontario 2017). Additionally, many First Nations and Métis communities lead line construction and are involved with the Independent Electricity System Operator's (IESO) Aboriginal Community Energy Plan program (ACEP). An ACEP is designed to assess and address community energy needs, priorities, and possible energy infrastructure transition opportunities. Thus, more environmental and positive social opportunities are possible due to the implementation of an ACEP (Government of Ontario 2017).

A recent news article published by CBC News expressed the high increase in Indigenous community renewable energy project partnerships and the resulting job influx. Between 2007 and 2017, the amount of medium to large renewable energy projects with Indigenous involvement increased from approximately 20 to 152 projects (McDiarmid 2017). An additional 1200 smaller projects have been developed to generate electricity for Indigenous communities. These projects have created 15,300 jobs for Indigenous workers who have earned $842 million in employment income in recent years (average wage is $55,032 a year) (McDiarmid 2017). Speaking of the recent hydroelectric plant constructed by Pic Mobert First Nation, former community leadership noted that the training for the band members who participated in the construction had positive impacts on their lives. Working on renewable energy projects provide new skills and training for community members to use to improve and bring in more income for their community (McDiarmid 2017).

In recent years an increasing amount of Indigenous communities have become involved in similar projects as renewable energy technology becomes more accessible and viable. Renewable energy technology has reached the point where northern communities are seeking to make the infrastructure transition from diesel to renewable energy power facilities (i.e. wind, solar). One such project is the recent renewable energy transition project undertaken by Lac des Mille Lacs First Nation, funded through government support and business partnerships. In spring 2016, Wikwemikong Unceded Indian Reserve, Oneida Nation of the Thames, Taykwa Tagamou Nation, and Lac des Mille Lacs First Nation each received funding from the federal and provincial governments to undergo community renewable energy initiatives (CBC News 2016). Lac des Mille Lacs First Nation received $521,324 in joint funding by the federal and provincial governments to construct a new solar-powered electric microgrid to reduce the community's reliance on diesel (CBC News 2016). Another example of a green energy initiative is Taykwa Tagamou Nation, who through its wholly owned company Coral Rapids Power LP, partnered with Ontario Power Generation to create a 25-MW hydroelectric dam. Being an equity owner of the hydroelectric dam, the Taykwa Tagamou Nation is set to benefit from over 50 years of long-term revenues and the creation of up to 100 construction jobs (Ontario Power Generation 2017).

Lac des Mille Lacs First Nation is not the only Indigenous community to enact a renewable energy transition project (Krupa 2012). Pic River First Nation, a community 25 kilometres away from Marathon, ON, has over $124 million in total investments in renewable energy (Krupa 2016). Over the past twenty-five years or so, Pic River First Nation has transformed from a small, impoverished community to a major energy developer through business partnerships and a viable leadership model (Krupa 2012). The community leadership itself largely ignores the ideas of "economic development at all costs" and globalization while advocating for a third political ecology ideology, which the author labels an Indigenous Development Perspective (IDP) (Krupa 2012). This methodology insinuates that Pic River First Nation respects traditional values but is not interested in completely shunning modern capitalism. Thus, the community leadership is willing and able to make business partnerships with non-Indigenous entities for economic benefit while maintaining their cultural ideals (Krupa 2012). By adhering to this philosophy, Pic River First Nation aims "to overcome the three key [politicized] difficulties that have made Aboriginal-led energy development in the past." Community leadership claims that lack of financial acumen, inexperience with regulatory and legal frameworks, and insufficient human capacity for developing renewable energy resources have set back Indigenous communities in the past (Krupa 2012). Pic River First Nations' IDP ideology has the potential to improve the synergistic relationship between Indigenous communities and non-Indigenous entities. Successful collaborative relationships in the profitable energy and forest sectors is the key to the success of renewable energy infrastructure implementation by offsetting the high installation and capital costs associated with such projects through funding and outside support for the community (Krupa 2012).

Lac des Mille Lacs First Nation PV-BESS System

History of Lac des Mille Lacs First Nation

Lac des Mille Lacs First Nation (LDMLFN) has had a deep and extensive history. LDMLFN is a signatory to Treaty #3 in 1873 and is the furthest east of the communities of Treaty #3 territory. LDMFLN is comprised of two distinct areas of land, Reserve 22A1 is located approximately 135 km west of Thunder Bay, ON on the lakeshores of the Lac des Mille Lacs and Reserve 22A2 is located approximately 20 km west of the township of Upsala, Ontario on the banks of the Firesteel and Seine Rivers. The Ojibway name is Nezaadiikaang, which means Place of the Poplars. Three extensive periods of flooding caused by the nearby construction of hydroelectric dams resulted in the separation of the people of Lac des Mille Lacs First Nation from their homes and traditional lands due to forced abandonment (Lac des Mille Lacs First Nation 2016). The flooding began as early as 1872, when a series of dams were placed in several locations, including one on the Seine River at Lac des Mille Lacs. (Lovisek 1994). Originally a farming village, the residents of Reserve 22A1 were forced to adapt to hunting and trapping for sustenance due to declining soil quality and crop failures. High water levels were maintained to assist hydroelectric plants downstream on the Seine River. Further flooding of rice crops in 1925 resulted in the band being “deprived of their part of their living”. Members were forced to leave their traditional lands to survive over time until Reserve 22A1 was eventually completed abandoned during the 1950s (Lovisek 1994).

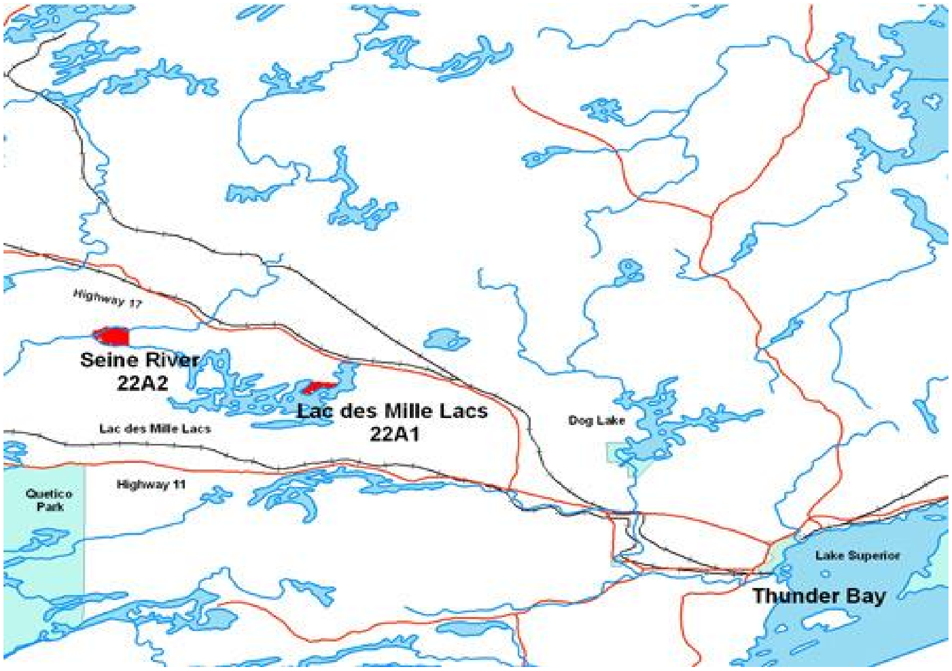

Figure 2. Location of Lac des Mille Lacs First Nation Reserve 22A1 (Lac des Mille Lacs First Nation).

Despite the past hardships faced by LDMLFN, recent initiatives by the current leadership have established a new era of reinhabitation and development within the community. Community development programs, such as the recent construction of the solar energy field, have facilitated the process of LDMLFN community members moving back to their traditional homes. The goal of the microgrid was to help the community rebuild after the aforementioned forced mass abandonment of the community’s residents (CBC News 2016).

Early Stages – Application Process & Small Communities Fund (SCF)

In 2014, Lac des Mille Lacs First Nation first put their expression of interest in renewable energy initiatives alongside fourteen other communities. Only four of the applicant communities were approved to proceed with their respective applications. Next, LDMLFN got band council resolution to proceed with the application for ECB (Energy Capacity Building) funding. Working with a lobbyist from Oneida Nation of the Thames, LDMLFN was able to secure grants from the federal and provincial governments and subsequently began work on their Aboriginal Community Energy Plan (ACEP) in 2016 (JAZZ Solar Solutions Inc. 2020).

Table 1. Detailed Project Cost for Funding Application – Estimated Cost by Fiscal Year April 1 – March 31 (Lac des Mille Lacs First Nation 2014).

Activities	2015-16	2016-17	2017-18	Total
Design/Engineering	$47,244.01	$31,496.01	$15,758.00	$94,498.02
Project Management	$6,990.08	$6,990.08	$6,990.08	$20,970.24
Leasing of Equipment	$2,540.00	$5,079.99	$2,540.00	$10,159.99

Construction	$45,504.10	$91,008.20	$4,504.10	$141,016.40
Materials	$203,147.92	$203,147.92	-	$406,295.84
Communications Materials	$1,354.67	$1,354.67	$1,354.67	$4,064.01
Miscellaneous	$31,995.64	$21,330.43	$10,665.21	$63,991.28
Total Project Eligible Costs	**$338,776.42**	**$360,407.30**	**$41,812.06**	**$740,995.78**
Total Net Eligible Costs	**$338,776.42**	**$360,407.30**	**$41,812.06**	**$740,995.78**

LDMLFN Aboriginal Community Energy Plan (ACEP)

A series of tests on the LDMLFN land base in 2016 was necessary for the development of the LDMLFN ACEP. Working closely with JAZZ Solar Solutions Inc., an on-site audit to assess the efficiency heating and cooling systems was completed by extracting diesel energy consumption data for the main community building. The team then estimated energy consumption of the building based on electrical loads. A program was then created to measure retrofits which determined that the building did not require much modification because of its newness. One of the retrofits needed balancing of the outdoor reset for boiler control to reduce the demand for heat on warmer days. Additionally, a Heating Recovery Ventilator (HRV) system was installed to reclaim heat from the shower and propane appliances were removed to save energy and increase the efficiency of the solar energy grid. Maximizing system efficiency is crucial in ensuring the environmental and economic benefits of the solar energy project. Following the retrofits, scenarios based on residential heating, cooling and ventilation for residential areas were then run testing oil, propane and electric systems. Projections based on resident electrical and fuel costs, based on the earlier tests and a four-year implementation plan revolving around the microgrid were developed. After developing the ACEP, the community of LDMLFN and JAZZ Solar Solutions Inc. were able to move onto the next stage in the renewable energy development process (JAZZ Solar Solutions Inc. 2020).

Figure 3. LDMLFN PV-BESS system exterior (Lac des Mille Lacs First Nation).

Project Summary

The project faced several challenges due to the scope of the project. At the time, technical expertise in this system size was not readily available and similar-sized systems that had been constructed by Outback Power in the United States were not well-documented. Additionally, the project faced technical hurdles with very large battery banks and massive amperages. The project involved 7801 kg (17,200 lb) of batteries, 25,038 kg (55,200 lb) of concrete ballast for rack and 5943 m (19,500 ft) of wire to accommodate the Midnite Classic 200 charge controllers, 6000 amphour battery bank, 22 kW of hot water diversion load and 9 8kW inverters. The successful completion of the project and start up of the system occurred on July 28, 2017. As an example of the project's success, the community was able to run exclusively off solar for three months until the daily amount of sunlight decreased on October 28, 2017. To mitigate this, an online controller was installed so system monitoring and control is possible from JAZZ Solar Solution Inc.'s headquarters in Ottawa (JAZZ Solar Solutions Inc. 2020).

Figure 4. LDMLFN PV-BESS system interior (Lac des Mille Lacs First Nation).

Financials & Benefits

The total cost of the LDMLFN PV-BESS system was $780,000. Using grants, $520,000 (66% of total cost) was covered by Canada and Ontario and LDMLFN spent $260,000. Lac des Mille Lacs First Nation has already reaped some benefits since the solar grid was constructed in 2017. The approximate annual economic return of Lac des Mille Lacs First Nation solar energy grid is $50,000 to $60,000/year in diesel and propane costs at an escalating rate of 3 to 5% a year. The return of investment was calculated by divided $60,000 by $260,000/year (23% investment is the average expected over 20 years). Thus, the LDMLFN PV-BESS system completely pays itself off in 4.3 years (JAZZ Solar Solutions Inc. 2020). These financial savings have allowed LDMLFN to reallocate money that would have been spent on diesel to other community programming and rebuilding initiatives.

Recommendations for Future Projects

A series of recommendations for future projects were made by JAZZ Solar Solutions Inc. The company stated that further developments to the monitoring system can improve the overall efficiency of the system. Following necessary modifications, the contracting company would be notified to perform maintenance if the community internet goes down. Thus, a proactive maintenance trip would only be necessary once a year. For example, JAZZ Solar Solutions Inc. found a series of loose wires the last time a similar test was performed on the LDMLFN PV-BESS system. In the long term, advancements in monitoring software will allow the development of an automatic monitoring system. Finally, a series of educational programs should be provided to community members (i.e. how to properly use a solar energy system) to improve sustainability measures and further improve the benefits of green energy initiatives (JAZZ Solar Solutions Inc. 2020).

Conclusion

Due to the current state of diesel-based electricity generating systems in many Indigenous communities in Northern Ontario, there has been a recent movement towards renewable energy initiatives. As stated earlier, diesel can potentially contaminate waterways causing a rise in carcinogens and potential detriments to human hematology (Connell et. al. 2009; Hosszu 2017; Udem et. al. 2011). These initiatives seek to reduce the environmental and health impacts caused by diesel fuel generation within those communities. Wind power, hydroelectric, and solar power options remain available to the applicable communities. As with anything, each of these potential alternatives have their own benefits and drawbacks. Once a community chooses their best option, they must follow guidelines set out by the Ministry of Natural Resources and Forestry to be allowed to commence renewable energy transition (Global News 2013). The applicable community can then look towards examples by Pic River First Nation, Lac des Mille Lacs First Nation, and others to see how the said communities were successful with the creation and operation of their renewable energy transition (CBC News 2017). Then, the socioeconomic, environmental, and health benefits will follow. Once this process has been completed, the community should be able to look towards a brighter future due to their renewable energy initiatives.

LITERATURE CITED

Arriaga, M., Cañizares, C.A., and Kazerani, M. 2013. Renewable energy alternatives for remote communities in Norhern Ontario, Canada. Institute of Electrical and Electronics Engineers. 4(3).

Barrera, J. 2019. Another Ontario First Nation declares a state of emergency over water. Retrieved from https://www.cbc.ca/news/indigenous/fn-ont-water-1.5211728.

Canadian Mining Journal. 2013. ELECTRICITY: Thirteen First Nations, Goldcorp create power company. http://www.Canadianminingjournal.Com/News/Electricity-Thirteen-FirstNations-Goldcorp-Create-Power-Company/1002204131/, Retrieved 27 February 2020 from WatayPower.ca.

CBC News. 2016. Lac des Mille Lacs gets $500K for solar power project. Retrieved 1 January 2020 from https://www.cbc.ca/news/canada/thunder-bay/solar-power-ontario-funding-1.3498161.

Cheremisinoff, N. 1978. Fundamentals of wind energy. Ann Arbor Science.

Connell, D.W., Miller, G.J., Farrington, J.W. 2009. Petroleum hydrocarbons in aquatic ecosystems — behavior and effects of sublethal concentrations: Part 2. CRC Critical Reviews in Environmental Control. 11(2).

Demirbaş, A. 2008. Biofuels sources, biofuel policy, biofuel economy and global biofuel projections. Energy Conversion and Management. 49(8):211-2106.

Dove-Thompson, D., Lewis, C., Gray, P., Chu, C., Dunlop, W. 2011. A summary of the effects of climate change on Ontario's aquatic ecosystems. Ontario Ministry of Natural Resources.

Frumkin, H. 2010. Environmental Health: From Global to Local. John Wiley & Sons. 1-1280.

Government of Ontario. 2017. Chapter 7. Supporting First Nation and Métis capacity and leadership. Retrieved 1 January 2020 from https://www.ontario.ca/document/2017-long-term-energy-plan/chapter-7-supporting-first-nation-and-metis-capacity-and-leadership.

Global News. 2013. Hydroelectric project in northern Ontario expected to create 100 new jobs. Retrieved 23 January 2020 from https://globalnews.ca/news/765435/hydroelectric-project-in-northern-ontario-expected-to-create-100-new-jobs/.

Hosszu, M. 2017. The economic feasibility of replacing diesel with renewable energy resources in remote First Nation communities in Northern Ontario. Lakehead University.

International Renewable Energy Agency. 2019. Renewables 2019. Retrieved 3 March 2020 from https://www.iea.org/reports/renewables-2019.

JAZZ Solar Solutions (in a presentation, Jan. 20, 2020) stated the background, specifications, and operations of the LDMLFN PV-BESS solar energy system.

Johansson, T.B., Patwardhan, A., Nakicenovic, N., Gomez-Echeverri, L. 2012. Global Energy Assessment: Toward a Sustainable Future. Cambridge University Press. 1-1882.

Kåberger, T. 2018. The new power supply! Energy Science & Engineering, (6) 1.

Karanasios, K., Parker, P. 2016. Recent developments in renewable energy in remote Aboriginal communities, Ontario, Canada. Papers in Canadian Economic Development. 16:82-97.

Krupa, J. 2012. Blazing a new path forward: A case study on the renewable energy initiatives of the Pic River First Nation. Environmental Development, 109-122.

Krupa, J. 2012. Identifying barriers to Aboriginal renewable energy deployment in Canada. Energy Policy, (42), 710-714.

McDiarmid, M. 2017. Indigenous communities embracing clean energy, creating thousands of jobs. CBC News. Retrieved 5 January 2020 https://www.cbc.ca/news/politics/first-nations-renewable-energy-projects-1.4348595FF.

Labine, J., Clutchey, C. 2016. Looking for new power. Chronicle Journal. Retrieved 10 April 2020 from https://www.chroniclejournal.com/news/local/looking-for-new-power/article_75c01770-1149-11e6-96dd-8bd5d04b242a.html.

Lac des Mille Lacs First Nation. 2014. LDML off grid solar – JAZZ power – solar ownership manual.

Lac des Mille Lacs First Nation. 2016. Our history. Retrieved 21 February 2020 from http://lacdesmillelacsfirstnation.ca/pages/view/our-history.

Lovisek, J.A. 1994. Lac des Mille Lacs "Damned and Diverted" an ethnohistorical study. Grand Council Treaty #3.

Martinez, K., McIsaac, A., Thayer, D. 2009. Aerial wind turbine. Worcester Polytechnic Institute.

Meyers, N., Spoolman, S. 2013. Environmental Issues and Solutions: A Modular Approach. Brooks/Cole. 1-439.

Ministry of Economic Development, Employment and Infrastructure. 2016. Thirteen communities to receive funding for local infrastructure. Retrieved 1 April 2020 from http://news.ontario.ca/medt/en/2016/03/thirteen-communities-to-receive-funding-for -local-infrastructure.html.

Ministry of the Environment, Conservation and Parks. 2019. Natural heritage assessment for renewable energy projects. Retrieved 11 January 2020 from https://www.ontario.ca/page/natural-heritage-assessment-renewable-energy-projects.

Nunez, C. 2019. Hydropower, explained. Retrieved 15 March 2020 from https://www.nationalgeographic.com/environment/global-warming/hydropower/

Natural Resources Canada. 2018. Generation Energy. Retrieved 3 February 2020 from https://www.nrcan.gc.ca/climate-change/canadas-green-future/generation-energy/20093.

Office of Energy Efficiency & Renewable Energy. 2013. Power tower system concentrating solar power basics. Retrieved 10 March 2020 from https://www.energy.gov/eere/solar/articles/power-tower-system-concentrating-solar-power-basics.

Ontario Ministry of Natural Resources. 2019. Renewable energy approvals. Retrieved 2 April 2020 from https://www.ontario.ca/page/renewable-energy-approvals

Ontario Power Authority. 2014. Draft technical report and business case for the connection of remote First Nation communities in Northwest Ontario for Northwest Ontario First Nation Transmission Planning Committee.

Udem, S., Lekwuwa, I., Udem, N. 2011. Effects of drinking diesel-contaminated water on the hematological and serum biochemical parameters of mice. Comparative Clinical Pathology. 20(1) 19-23.

United Nations Educational, Scientific and Cultural Organization. 2020. Natural heritage. Retrieved 23 January 2020 from http://uis.unesco.org/en/glossary-term/natural-heritage.

U.S. Department of the Interior Bureau of Reclamation Power Resources Office. 2005. Hydroelectric power. Retrieved 5 January 2020 from https://www.usbr.gov/power/edu/pamphlet.pdf.

U.S. Energy Information Administration. 2017. Annual Energy Outlook 2017. Retrieved 10 April 2020 from https://www.eia.gov/outlooks/aeo/

U.S. Energy Information Administration. 2019. Use of energy explained. Retrieved 10 April 2020 from https://www.eia.gov/energyexplained/use-of-energy/transportation.php.

U.S. Energy Information Administration. 2019. Wind explained. Retrieved 10 April 2020 from https://www.eia.gov/energyexplained/wind/wind-energy-and-the-environment.php.