



UNIVERSITY OF  
CALGARY

MSc in Sustainable Energy Development

SEDEV

#° hou\ V- 'hk\ K #uo

## **Adjustments to Alberta's SGER to Ensure the Polluter Pays**

*Rebecca Vinova*

Since 2007, Alberta's oil and gas driven economy has been prescribed the Specified Gas Emitters Regulation (SGER) policy, using market-based economic instruments to drive down greenhouse gas (GHG) emissions intensity. This research project reviews the policy assumptions that underpin the development of the SGER and tests the policy's commitment to holding large emitters of industries more accountable by proposing the definition of large emitter be changed from individual facilities to all facilities included under a corporate portfolio within Alberta. By comparing emissions data of facilities within Alberta, I found that large multinational corporations avoided responsibility for a portion of their corporate emissions that could have been covered under the compliance options of the SGER. Quantifying these outlier emissions and converting the hypothetical funds into real world applications of wind turbines, it is evident that the government lost opportunities for further economic investment in renewable projects.

## **Applying the All-Hazard Approach to Managing Sour Gas Emergencies in Alberta and British Columbia**

*Cameron McDowell*

The concerns about sour natural gas exploration and production include significant environmental and health effects associated with the hydrogen sulphide (H<sub>2</sub>S) contained in the gas. Methane has a Global Warming Potential (GWP) that is 25 times that of carbon dioxide (CO<sub>2</sub>) (IPCC, 2007). A person who is exposed to as little as 100 ppm (0.01%) of H<sub>2</sub>S can experience respiratory irritation, sore throat, and wheezing whereas exposure to concentrations of 1000 ppm (0.1%) of H<sub>2</sub>S can result in death (Alberta Health Services, 2007). This prompts the question; are the emergency management regulations in Alberta and British Columbia adequate to mitigate the impacts to the environment and human health? A comparative methodology was used to compare the emergency management regulations in Alberta and British Columbia against a known model for managing emergencies, known as the Four Pillars of Emergency Management. This research project suggests that British Columbia has adopted superior emergency management regulations that satisfied the outlined criteria 94% of the time whereas Alberta's regulations satisfy the criteria only 69% of the time.

## **Can Optical Gas Imagery Effectively Meet Federal Methane Reduction Goals?**

*Shea Caughlin*

The objective of this project is to determine the effectiveness of Optical Gas Imaging (OGI) to detect, monitor, and mitigate methane emissions in Alberta's upstream oil and gas sector. This is in support of the emerging Canadian government regulation to reduce methane emissions by 40- 45% below 2012 levels by 2025 (Alberta Government, 2017). As time is considerably limited for this industry to result in an immense operational and infrastructural change, commercial ready technology (TRK 9), such as OGIs, is fundamental as it is prepared for full marketable distribution and currently present within the industry. While operators utilize forms of OGI technology for leak detection, scientific evidence suggests under certain environmental conditions, detection effectiveness reduces significantly. Thus, this paper proposes to determine the number of days OGI technology can be used effectively in Alberta's climate to detect emissions to meet federal methane reduction goals by 2025.

## **Central Solar Heating with Seasonal Storage: A Feasibility Study for the Town of Banff**

*Michael James Hay*

The Town of Banff uses approximately 740,000 gigajoules of natural gas for space heating each year – two-thirds of total natural gas consumption. This is responsible for 36,000 tonnes of CO<sub>2</sub>e emissions annually. Central Solar Heating with Seasonal Storage (CSHPSS) is one technology that can displace natural gas as a heating fuel, helping to reduce emissions and fossil fuel dependence. This study examines the feasibility of a CSHPSS for Banff's industrial park. Four scenarios are investigated that provide heat to between 4 and 93 buildings, and heating demand from 590 MWh/year to 10260 MWh/year. Solar fractions ranging from 24-97% are achievable depending on heating demand, the size of the solar field, and the seasonal storage type. Integration with biomass and natural gas boilers is straightforward, and recommended. CSHPSS shows great promise, but substantial building efficiency improvements are required if the technology is to supply heat to areas beyond the industrial park.

## **A Cooperative Approach to Address the Barriers to Renewable Energy Integration in Remote Indigenous Communities in British Columbia, Canada**

*Allegra Hollingbury*

Many remote Indigenous communities in British Columbia rely on diesel for their energy needs and this reliance has significant social, environmental, and economic consequences. Because of this, replacing diesel power with renewable energy sources needs to be a priority in these communities. However, remote communities face numerous unique barriers to renewable energy development. This project explores the historical, institutional, technical, societal, and financial barriers, and proposes that a cooperative approach to renewable energy development has the potential to help these communities overcome many of these barriers. Cooperatives have been proven to have many significant positive social and economic impacts when implemented in the renewable energy industry and in Indigenous communities in Canada. This project argues that the remote communities in British Columbia can experience these same benefits by employing a cooperative to provide a platform for community level renewable energy integration.

## **Developing the Net Zero Energy Brand: How to Mainstream High Performance Energy Efficient Housing in Alberta**

*Nermine Sorial*

The objective of this project is to identify key barriers to mainstreaming high performance and net-zero energy homes in Alberta, and uncover opportunities for accelerating market uptake. These homes can be a cornerstone of a future low-carbon economy and yet they continue to be trapped in the demonstration stage attracting only a niche market. A home builder survey and an energy/economic evaluation of a suite of energy efficiency upgrades were performed. Of the potential technical, economic and market barriers explored, the most significant was found to be the lack of visibility of energy efficiency. Yet many upgrades were found to be viable affordable options in the Alberta housing market today. The research concludes that selling energy efficiency requires a compelling value proposition for the homebuyer to make that investment in their home. Recommendations are offered for positive action that can be taken to mobilize market change towards more sustainable homes.

## **Drake Landing Solar Community: An Analysis of Future Renewable Energy Systems**

*Dan Sudeyko & Dave Greacen*

The Drake Landing Solar Community is a 52-home community utilizing renewable energy for district heating and thermal storage. In 10 or more years from now, when certain equipment needs replacing, there may be an opportunity for the incorporation of alternative forms of renewable energy generation in the community. This paper explores five different scenarios of energy production that could be integrated into the district heating system at Drake Landing in the future. Using RETScreen software for analysis, scenarios include a mix of solar thermal panels, solar photovoltaic panels, cogeneration or boiler technology, to generate heat and electricity for the community. Results show the incorporation of photovoltaic panels into the Drake Landing system indicate improved environmental performance and reduce operational costs. Although regulatory challenges constrain opportunities for optimal benefits, each model gives an indication of future possibilities for the Drake Landing Community.

## **Economic and Environmental Implications of Shale Gas Development in New Brunswick**

*Raphael Somayina Akaeze*

My project assessed the economic and environmental implications of the Frederick Brook shale gas development in New Brunswick, and sought to ascertain how FBS gas development could boost economic growth, impact land use, water resources, the research also assessed current regulations effectiveness in managing these impacts. Economic-impact modeling estimated the total tax revenue as \$CAD754 Million; GDP-\$CAD 5223 Million, and annual employment of 656 Full-Time-Equivalent between 2020-2037. Water contamination, well integrity, chemical health risks, and freshwater supply security are major development concerns; identifying sources of groundwater contamination is challenging, because isolating other gas and brine migration channels is difficult. 9,440,000 m<sup>2</sup> landmass and 47.2 billion litres of water was estimated for development of 13.4 tcf gas in FBS. Current regulation of hydrocarbon development is ineffective because it involves many presiding jurisdictions which are often in conflict. Environmental cost-benefit analysis is recommended to provide input for shale gas development decisions.

## **The Effect of Chemical Treatment on Oil Sand End-Pit-Lake Microbial Communities: an Investigation For a Proxy of Reclamation Status.**

*Samuel Rawluk*

Genetic analysis of microbial communities residing in Syncrude's Base Mine Lake was performed before and after chemical treatment of the surface water cap with liquid aluminium sulfate (alum) solution. 16S and 18S rRNA genes were amplified with pfu polymerase chain reaction, purified, and barcoded with Illumina primers for reading sequences. Bioinformatic analysis with QIIME software demonstrated that alum addition resulted in a significant community composition shift among eukaryotes in pre/post alum addition timeframes. Prokaryotic communities were relatively less impacted but showed some variation among target taxonomic clades. A discussion of the microbiological community responses to environmental manipulation provides insight into the benefits and shortcomings of end-pit lake technology. The results from this investigation provide a positive indication that Base Mine Lake is headed in the correct direction to achieve reclamation status. Findings can be applied to optimize future end-pit lake endeavours.

## **Energy Benchmarking and Policy Implications for 550 Jarvis Street**

*Alexandra Frastacky*

Toronto's residential dwellings can be broken down into subcategories, one of which is multi-residential apartment buildings (MRABs). This paper focuses on that sector. MRABs represent the largest component of the Toronto residential building inventory and are responsible for 2.5 million tonnes of eCO<sub>2</sub> emissions annually. Provincial and municipal governments are implementing new energy efficiency legislation in this sector. Using a case study research design, this paper will benchmark the energy and carbon intensity of a single Toronto MRAB, 550 Jarvis Street, against 78 similar MRABs in the Greater Toronto Area. The purpose of this research is to provide the owners with a weighting of their property's energy use in the MRAB subcategory. The paper also provides an overview of recent government policy initiatives, an explanation of how to perform energy calculations for the purpose of benchmarking and a financial template for assessing future retrofit programs. This research adds to a growing body of work that explores the benefits of, and the economically attractive solutions to, reducing a Toronto MRAB's carbon footprint while also improving the operating income and property value for the investor-owner.

## **Environmental Impact Assessment of Anticipated 2037 Electrical Vehicle Adoption in Alberta**

*Kobi Thomson*

This study assesses the environmental impacts of the projected adoption of electric vehicles in Alberta in 2037, evaluates receptiveness of the current regulatory environment and identifies policies to encourage adoption. Four scenarios are modeled including two electric vehicle uptake projections and two anticipated Albertan energy mixes. Findings suggest greenhouse gas reductions between 57.8% and 63% per kilometer could be achieved, with Alberta-wide reductions being between 1,910,000 and 3,120,000 tonnes GHG-100 annually. Substantial reductions of criteria pollutants can also be achieved but sulphur dioxide emissions will increase due to grid dependency upon natural gas. Policy research suggests the regulatory environment is somewhat receptive to electric vehicle adoption, but numerous potential incentives could further encourage uptake. Environmental benefits from adopting electric vehicles are currently minimal but these will become increasingly pronounced as the grid develops towards 2037 projections. Policies to encourage electric vehicle adoption should be scaled accordingly to maximize environmental benefits.

## **An Evaluation of the Effectiveness of Cumulative Effects Assessment (CEA) in North East Alberta**

*Scott Robert Layher*

This report looked at cumulative effects assessment (CEA) in the context of woodland caribou (*Rangifer tarandus caribou*) conservation in north eastern Alberta. Despite the mandate for CEA to monitor and manage impacts of development in an area, woodland caribou populations are declining across Canada. This report attempts to look at where the failing in CEA may lie. Five CEAs done for energy projects in north eastern Alberta were examined and scored using an evaluation framework developed for this study. It was found that nearly all CEAs had some departure from best practices for CEA, and one was entirely inadequate. Despite this, all had been approved by regulators. This suggests that to improve CEA going forward, regulation and policy needs to be developed to place more emphasis on cumulative effects in the review of projects, as well as improve guideline minimum standards for proponents to use when conducting CEA.

## **Evaluation of Solar PV Installation in Wheatland County**

*Oksana Treacy*

In December 2016, Wheatland County installed a rooftop solar photovoltaic system on its administration building under Alberta Municipal Solar Program. As solar incentives are new to Alberta, there are no performance reports for such systems in the province. To fill this gap, my study determines if the installation is producing energy as designed, while also evaluating its economic and environmental benefits and effectiveness of the subsidy. Actual electricity production and insolation are compared with projections and historical averages, generating a 25- year forecast to calculate economic and environmental benefits. Simple paybacks are compared to those published for Ontario projects. Energy and environmental performance exceeds expectations in the first eight months of operation. At the current electricity prices, it would take Wheatland County 19 years to recover its capital investment, longer than it did for Ontario projects under feed-in tariffs. Without incentives, payback time exceeds the 25-year life cycle of the system.

## **Examining the Energy and Emissions Associated with the Acquisition and Use of Clothing, and the Waste Associated with the Disposal of Clothing Among Fast Fashion, Neutral Fashion, and Slow Fashion Consumers**

*Zahra Altaf Damji*

Previous research indicates that aftercare in the use phase of clothing generates the largest proportion of greenhouse gas emissions in a garment's lifecycle. However, use phase emissions largely depend on longevity of wear. Furthermore, fast fashion consumers acquire and discard clothing more often than regular consumers. To date, there are no studies examining the environmental footprint of clothing acquisition and use among different types of fashion consumers. This research examined the energy and emissions associated with clothing acquisition and use, and the disposal behavior and potential for waste among fast, neutral and slow fashion consumers. A total of 100 surveys were administered to shoppers in the city of Calgary. Results indicate that transportation emissions from clothing acquisition are larger than use phase emissions, and that the majority of fashion consumers trash clothing that is damaged. Adjusting mode of transportation, shopping frequency, and disposal choices can greatly reduce one's environmental footprint.

## **Exploratory Study of the Potential of Crowdfunding for Sustainable Energy Projects in Canada**

*Kristin Skelton & Yijun Yang*

Crowdfunding has been increasingly considered by sustainable entrepreneurs as an alternative means to finance their projects around the world. In Canada, crowdfunding is also gaining the momentum thanks to the regulations on crowdfunding prospectus exemptions that are newly effective across jurisdictions in Canada. Based on the findings from a mixed methods research approach including interviews and an online survey, this paper gives an exploratory assessment of how the founders, funders, intermediary platforms can together make an impact on the success of crowdfunding sustainable projects in Canada. It also seeks to provide insights into how the potential of crowdfunding can be explored for renewable and sustainable energy development. Finally, this paper suggests managerial advice for founders to consider when starting a sustainable energy crowdfunding campaign as well as commercialization implications for intermediary platforms to develop a multi-functional crowdfunding platform that specializes in sustainability including providing supporting services to the sustainable entrepreneurs.

## **Geothermal Energy Opportunities for the Kaska Nation in the Yukon**

*Kasondra Harbottle*

Geothermal energy provides a versatile, renewable energy opportunity well suited for northern Canadian communities. Early stages of geothermal exploration have commenced in collaboration with the Kaska Nation in southeastern Yukon. This research is for the purpose of community outreach and education; it is meant to contribute to the progress of geothermal exploration and development in Kaska Dena traditional territory and across the Yukon. Building on work by the Barkley Project Group and Mira Geosciences in evaluating geothermal resources along the Tintina Fault Zone, this report provides an interdisciplinary perspective on geothermal energy opportunities for the Kaska Nation. The study includes a review of geothermal resource understanding, potential social and environmental implications of geothermal development, and pre-feasibility economic evaluation of diesel replacement with geothermal. It is shown that geothermal energy could provide multiple heat and power applications that would serve the long-term socio-economic goals of remote, northern communities in the Yukon.

## **The Impact of Demand Side Management on the Residential Electricity Use in the City of Calgary**

*Andun Jevne*

Under the Climate Leadership Plan, Alberta is beginning a significant transition in how it generates electricity. The anticipated phase out of coal fired power production combined with an increase in renewable generation capacity is expected to increase consumer costs for electricity in the near future. This study predicts that for the City of Calgary, demand side management measures could have a positive impact on the electricity system by reducing peak consumption, reducing average daily consumption, and reducing emissions produced through electricity generation. This could translate to savings at the household level as well as on a larger systems level in potentially delaying the need to replace or upgrade current generation, transmission, and distribution infrastructure. In particular, the demand side management method of In-Home Displays provides a cost effective way to achieve desired reductions, reducing costs to consumers, and improving the public's energy literacy.

## **Increasing Energy Efficiency in Banff Municipal Operations**

*Colin Popenia*

Energy efficiency has been identified by municipal, provincial and federal governments as a crucial tool in reducing greenhouse gas (GHG) emissions and fighting climate change. This study identifies the energy efficiency policies and initiatives that will be most effective in moving Banff municipal operations toward a goal of 100 percent renewable energy. A summary of the Town's current energy planning policies is provided, as well as an account of the Town's energy usage for heating, electricity and transportation, based on the Town's records. Other municipal energy efficiency leaders (Aspen, Vancouver, Frankfurt) are examined for best practices. Banff's 2016 municipal energy usage totaled roughly 70,000 GJ – primarily from electricity and natural gas (heating) consumption. Electricity accounted for the highest financial costs and GHG emissions. Increasing energy efficiency in Banff will require improvements to building energy performance, an expansion of local energy generation, and improved reporting and follow-through on existing energy policies.

## **An Investigation of the Energy, Environmental, and Economic Aspects of Waste to Energy Technology as an Alternative Solution to Divert Waste from Landfills in the City of Calgary**

*Octavia Castro*

This research project investigates whether waste to energy methods offer a better solution to the current landfill system in the city of Calgary considering the environmental, economic and energy aspects. Municipal solid waste is a by-product of a high consumption society. For some nations, waste became a renewable source of energy instead of a problem. European countries are using waste-to-energy as an effective waste treatment method that also generates energy. Sweden has been a worldwide pioneer and leader on converting waste into energy due to the environmental, economic, and energy aspects of municipal solid waste management. Conversely, Calgary is still using landfills as its primary waste treatment method. The city has one of the highest waste per capita volumes in Canada, which makes it one of the top waste producers globally.

## **Geothermal Heat in Calgary: An Oil and Gas Retrofit**

*Jennifer Reid*

Alberta is home to hundreds of thousands of non-productive oil and gas wells that are currently both safety and financial liabilities to companies. A portion of these wells has potential to become an asset. This project seeks to determine if non-productive wells can be converted to geothermal purposes to provide heat to Calgary homes and businesses. To date, the research in this area is quite limited, but did provide the basis of design for the geothermal heat exchanger modelled in this project. To advance work in this field of study, an extensive review of existing work was performed. Then the most viable well was selected and used as the basis for a heattransfer model. The study concludes with economic and environmental assessments. The project shows that while a geothermal retrofit of a non-productive hydrocarbon well is possible, it is not economically viable under the circumstances of the study.

## **The Pan Canadian Framework in Achieving 30% reductions by 2030: Success or Failure?**

*Jass Baidwan*

The Paris Agreement allows countries around the world to determine their own contributions towards combating climate change and the rising temperatures. Canada intends to reduce the greenhouse gases it emits by 30% below 2005 levels by 2030. To assist in meeting this goal, the Pan Canadian Framework on Clean Growth and Climate Change was adopted in 2016. Outlined in this framework are several policies and measures that are intended to reach the emissions reduction. This paper examines some of the policies and measures and compares them to other studies and reports in effort to determine whether or not they will reduce emissions enough to meet the goal by 2030. It is shown that the framework falls short of the targets and ultimately fails in fulfilling Canada's goals in the Paris Agreement.



## **Perceived Risks of Energy Pipelines: A Proposal for More Integrated Risk Management**

*Bernard Ho Wai Wong*

This project attempts to answer the following questions: Is there a risk perception gap regarding the safety of energy pipelines? How can the gap be closed if there is one?

Research on perceived risks of pipelines is important because the public's risk perceptions and the resulting attitudes, behaviors, and judgements can significantly impact projects and operations. Existing risk perception research has not included pipelines. This project integrates literature review and survey data analysis to identify patterns of perceived risks of pipelines. The project finds that the perceived risks of pipelines are strongly influenced by psychological, sociological, and anthropological factors. Also, this project finds that the media plays a large role in influencing the public's perceptions. This project proposes strategies for managing the perception gap, including 1) improving perceived benefit distribution, 2) improving familiarity, 3) acknowledging and accommodating the public's different world views, and 4) systematically managing perceptions in the media.

## **A Reduction in Canada's Freight Transportation Greenhouse Gas Emissions by 2030 and 2050**

### **A Scenario Analysis**

*Jessica Lof*

Greenhouse gases (GHG) from Canada's freight transportation must be reduced by 30% to meet 2030 climate change commitments and by 80% to meet Canada's 2050 targets. Despite the importance of this sector to Canada's economy, there is an absence of cost-effective, low carbon options and the pathways to a low carbon future remain undefined. To explore this challenge, the historical emissions profile for rail and road transport in Canada are deconstructed and insights are used to scenario model a low carbon future with a greater share of freight shifted to rail and the energy intensity of road transportation improved. While reducing emissions by 18 Mt CO<sub>2</sub>e/yr relative to a reference scenario in 2030, the low carbon scenario failed to meet Canada's reduction targets. The results demonstrate that for Canada to meet its long-term economic and climate change goals, development in disruptive technology, such as alternative fuel systems, is needed.

## **A Pre-Feasibility Study As To Whether An Anaerobic Treatment Concept Can Be Implemented In Northern Alberta Communities**

*Belinda Tindyebwa*

In Northern Alberta, aging infrastructure and increasing demand places constraints on water security and sanitation. This study is aimed at determining whether an anaerobic treatment concept can be implemented in Northern Alberta communities. The objective is to assess the feasibility of the concept as well as the socio-economic, environmental and energy outcomes of the proposed facility. This study primarily uses literature review and data collected from the pilot project in Sneek, Netherlands where the anaerobic concept is applied. The results show that this concept is attractive due to the social benefits, low costs and production of biogas as renewable energy. This research is also timely given the Alberta Government's 2016 Climate Leadership plan to reduce methane emissions by 45% before 2025. This study provides insight pertaining to the implementation of the proposed facility on First Nation reserves to cover the gap that exists between these communities and non-First Nations.

## **Residential Solar Heating in Southern Alberta**

*Alison Denny*

Southern Alberta has excellent solar resources that should be put to our best use. Since nearly 60% of residential energy use comes from home heating, I wanted to compare options for solar heating. I have reviewed four different heating options: natural gas, voltaic with electric heaters (and electric back-up), photovoltaic with heat pump (with electric back-up), and solar thermal space heating (with electric back-up). Each space heating system was evaluated under two scenarios: an average residential insulation scenario and an upgraded insulation scenario. Under the average insulation scenario, natural gas was still the best option with the lowest GHG emissions and best economics. With improved insulation, an electric air source heat pump supplemented by photovoltaics proved the best option. The energy demand was covered fully by the PV; therefore GHG emissions for heating were nil. However, the financial payback for the PV and the heat pump was approximately 40 years.

## **The Role of Risk Management and Maintenance of the Five Capitals Through The Oil Price Drop 2014-2015**

*Arturo Mariño Echegaray*

The Alberta's Climate Leadership Plan directly undertakes carbon emissions establishing that production of energy will be oriented to replace coal-fired generation. Consequently, promotion of renewable energy sources, adoption of sustainable public policies and corporate strategies, and redesign of regulatory frameworks will also be required. As Alberta's energy mix will definitely change through the next decade, this research (1) preliminarily explores the risk management drivers in top five oil companies of Alberta and studies how they optimally could afford the adaptation process into new regulatory energy schemes; (2) identifies key factors and variables correlated to surviving throughout the change of energy mix processes; and (3) determines the initial variables to compose a Sustainable Risk Management Model, and which of them have more impact and effectiveness to ensure the maintenance of five capitals from a sustainable perspective. Therefore, processing and modelling we will obtain a unique set of recommendations for each segment of companies.

## **The Role of Small-Scale Geothermal Power Plant in Escalating Energy Capacity in Indonesia**

*Shinta Acintya Pradipta*

To successfully meet the increased Indonesian electricity demand, phase out oil and increase electrification, the country plans to add 35 GW of electrical generation capacity by 2019. As a country with the third highest reserves of geothermal energy in the world, geothermal power generation is an option to reduce its CO<sub>2</sub> emissions and increase electrification. Geothermal energy is a viable resource for Indonesia, because of abundant supply due to its location, relatively low CO<sub>2</sub> emissions, and low operational cost. However, geothermal development in Indonesia has been slow. One reason for this slow growth is Indonesia is still facing many challenges in terms of poor regulatory structure, technology difficulties with respect to sub-surface, and unclear financial structure. To understand the key barriers of geothermal development and the role of small-scale geothermal power plants in escalating the energy capacity in Indonesia, the author presents the following report that is a compilation and analysis of literature reviews and company's data.

## **The Role of Social Sustainability in Canadian Environmental Assessment Processes**

*Jillian Berthelet*

The Government of Canada's mandate to review environmental assessment (EA) processes recognized the current assessment regime defined under CEAA, 2012 needed necessary repair to deal with present day threats and impacts. This article interprets the degree in which social sustainability was integrated into the two Expert Panel Reviews set out to reform Canadian environmental regulation. A clear pathway for social sustainability in energy development has been considerably inconsistent throughout sustainable development discourse. For this reason, eight social sustainability indicators were established from a literature review. The criteria were then used to identify critical gaps in both reports to decipher the extent to which each review proposed to consider social sustainability in future environmental regulation and assessment. This analysis uncovers a flawed representation of social sustainability in the Review of Environmental Assessment Processes and the Modernization of the NEB which could unfavourably shape future sustainable development in Canada.

## **The Role of Stakeholder Engagement in Corporate Change in North America's Oil and Gas Indust**

*Allison Mones*

The purpose of this paper is to investigate what events have occurred over the past 50 years to motivate North America's oil and gas companies to incorporate environmental, social and governance factors within their operations, including how shareholder engagement is being used as a tool to understand investor demands and drive ESG related behavior. The foundation of the paper is set through a comprehensive literature review of the major environmental, social and economic factors that have led to changing public and investor perceptions and driven corporate change. Trends in shareholder resolutions and proxy voting were analyzed and the resulting behavior of two oil and gas companies compared in order to highlight key ESG-related trends and provide commendations for identifying and mitigating the risks associated with both daily operations and future sustainability challenges. Future research might include additional case studies as well as analyzing the economics associated with changes in ESG-related behavior.

## **SAGD Emissions Intensity**

*Douglas Kenneth Koroluk*

Steam assisted gravity drainage (SAGD) is a technique used to produce significant volumes of bitumen from Alberta's oil sands. The generation of steam from natural gas combustion generates greenhouse gas (GHG) emissions. There is increased concern about climate change associated with increasing GHGs and a desire for action to reduce GHGs through initiatives such as the Alberta Climate Leadership Plan (CLP). One CLP aspect restricts oil sands GHG emissions at 100 megatonnes per year. An advisory body, the Oil Sands Advisory Group, drafted recommendations for managing the emissions limit in 2017 that are currently under government review. Use of modified SAGD technologies, such as solvent assisted processes, can reduce the GHG intensity for bitumen production. Economic success of such processes depends upon the amount of solvent that can be recovered from the reservoir. Effective implementation of the emissions limit will be key to continued oil sands production in Alberta.

## **Simplifying the Oil Climate Index: Evaluation of Methods to Increase Accessibility**

*Bryce Xavier Edwards*

Various oil sector stakeholders believe that the Oil Production Greenhouse gas Emissions Estimator (OPGEE), a component of the Oil Climate Index, can encourage improvements in energy efficiency, emissions reductions, and carbon management if it is operationalized for users in specific oil companies. One deterrent for wide-spread industry adoption of OPGEE is its perceived complexity. Here I attempt to simplify the user experience by searching for the salient model inputs that produce accurate emissions estimates. Two approaches are investigated: Approach 1 evaluates the error generated from using salient model inputs identified in a previous study but applied to a small number of oil pathways. Approach 2 explores the sensitivity of all primary model inputs for nine hypothetical oil fields based on 64 global oils on emissions estimates to identify and compare salient inputs. Salient inputs from Approach 1 produce emissions that exceed  $\pm 20\%$  error 53% of the time and identified salient inputs from Approach 2 are inconsistent across hypothetical fields, implying that universal salient inputs capable of generating accurate emission estimates do not exist. Recommendations are made for simplifying OPGEE's user interface instead of minimizing data requirements.

## **SunMine: Evaluating the Potential of Grid-connected Solar Photovoltaics with Energy Storage**

*Jose Alejandro Duenez Hurtado*

Global warming mitigation is translating into actions worldwide. Canada targets higher levels of clean energy sources in its electricity mix. Solar photovoltaics is the fastest growing renewable electricity source and energy storage is positioned as the enabling technology to increase its contribution integrated with the grid by providing reliable and greenhouse gas free electricity when needed. This project consolidates knowledge from multiple sources and applies it to SunMine, the largest solar photovoltaics plant in British Columbia. The goal is to maximize revenue at the lowest cost by investigating the economics of adding battery storage to allow photovoltaic electricity to be sold when the price is higher. While batteries used for a single service do not result in a net-economic benefit, this project unveils the roadmap to enhance its value proposition through strong collaboration between utility, plant owner, solar and energy storage suppliers towards the Canadian electricity market of the future.

## **Sustainable Destinations A Comparison Study of Energy and Water Audits of Hotels in the Galapagos Islands and Banff.**

*Connor Bedard*

This paper seeks to understand the challenges and opportunities that exist for water conservation and energy efficiency in the hospitality industry in two separate and distinct destinations: the Galapagos Islands and the Town of Banff. Energy and water audits were conducted on a sample of six hotels and hostels in each destination to understand energy and water consumption and identify opportunities for improvements and savings. We found that low-cost initiatives such as using LED lights, installing low-flow water fixtures and altering business practices to increase efficiency can realize electricity savings of approximately 10% and water savings of 25% per year across all hotels and hostels in both destinations. Our findings reinforce the work of authors such as Amory Lovins amongst others who have wrote about the low-hanging fruit that is energy efficiency and water conservation in buildings.

## **Sustainable Development Goals (SDGs) and Firm Level Response: Suncor's Sustainability Reporting and Disclosure Strategy**

*Markus Guy Selkirk*

A single case study design was used to discover any strategic implications that the Sustainable Development Goals may have on Suncor Energy's sustainability and reporting strategy. A literature review exploring how the SDGs impact the private sector revealed prominent themes relating to the concepts of increasing expectations of private sector SDG alignment, private sector SDG alignment driving value creation, and SDG alignment within the private sector mitigating risk. Data was collected through participant-observer and secondary data techniques, and the analysis of the data occurred through an iterative process that involved coding and investigation of thematic areas. This research discovered that critical elements utilized in Suncor Energy's strategy involving sustainability reporting standards and frameworks, sustainability assessments, and ESG ratings all experienced significant changes in direct response to the SDGs. The SDG related changes across the critical elements identified occurred more rapidly and were of greater significance than Suncor Energy anticipated.

## **What are the economics, environmental and social benefits of the implementation of a solar photovoltaic (PV) system through the Alberta Indigenous Solar Program (AISP) within Peavine Metis Settlement?**

*Juan Sebastián Pfeiffer Pulido*

On October 2016, the Government of Alberta announced the introduction of the Alberta Indigenous Solar Program (AISP) as part of its Climate Leadership Plan (CLP). This study aims to identify the economic, environmental and social benefits of the implementation of an 85kW solar PV system within Peavine Metis Settlement, made possible by the AISP. Specifically, by using energy modeling, projections are developed in order to establish the financial performance indicators of the project as well as GHG emissions reduction. Social benefits to the community are established with a qualitative approach. Results show that the grant guarantees a strong financial performance of the project with a payback period of less than 7 years that would not otherwise be possible due to current Alberta electricity market conditions. Additionally, it is expected to reduce 1400 tCO<sub>2e</sub> of GHG in its lifetime and to bring basic training opportunities and temporary jobs for some members of the community during the construction.

## **What are the proven utility scale applications for Solar Steam systems in Alberta?**

*Apostol Radev*

This paper will assess What are the proven utility scale applications for Solar Steam systems in Alberta? Although Alberta does not have adequate sunshine to generate year-round electricity through solar technology, there is suitable irradiance to economically produce high-quality steam for use in industrial processes. Solar steam systems will empower Alberta oil industry meet its environmental commitments while providing revenues that can help recoup capital investment. This study will integrate an economic analysis as an additional dimension to energy generation potential and environmental benefits of the technology. The financial modeling will reflect the baseline cost for solar fields within NREL's System Advisor Model. The performance-enhancing and cost-reducing model of enclosing solar mirrors in a glasshouse, proven by GlassPoint, will increase the viability of solar steam applications in Alberta. Building a solar steam generation system is seen as technically feasible, with the obstacles being mainly economic and surface right allocation.



## Contact us

**University of Calgary**  
**MSc Sustainable Energy Development Program Offices**  
2500 University Drive NW  
Calgary, AB T2N 1N4  
CANADA

+1.403.220.2013  
sedv@ucalgary.ca  
**[ucalgary.ca/sustainableenergy](http://ucalgary.ca/sustainableenergy)**