



UNIVERSITY OF CALGARY
School of Public Policy

Innovative
minds.
Creative
solutions.



MSc in Sustainable Energy Development
2023 Capstone Project Abstracts

About the Program

Founded in 1996, the School of Public Policy at the University of Calgary's Master of Science in Sustainable Energy Development (SEDEV) is an interdisciplinary graduate program providing a balanced education related to energy and environment management.

With the teaching and expertise of faculty from the School of Public Policy, Haskayne School of Business, Schulich School of Engineering, Faculty of Law, School of Architecture, Planning, and Landscape, and Faculty of Science, the SEDEV curriculum delivers a degree for students wanting to move from a business and/or technical foundation to a truly interdisciplinary professional practice. Our graduates pursue a diverse range of careers in oil and gas, renewable energy, energy efficiency and conservation, consulting, research and development, government, regulatory bodies, and more.

ABOUT SEDEV STUDENTS

SEDEV students are talented individuals who are passionate about sustainable energy and motivated to make a positive impact through the energy transition.

During this 16-month program, students are exposed to all facets of the sustainable energy industry with courses focused on:

- Renewable and non-renewable energy
- Pollution and mitigation
- Environmental and social sustainability
- Energy and climate policy
- Environmental law
- Economic and commercial sustainability

SEDEV CLASS PROFILE*

Students progress through this cohort-based program alongside others from varied academic backgrounds and diverse roles within the energy sector and others to complement the multi-discipline and function learning environment we strive to create.

- Academic backgrounds:
 - Sciences - 40%
 - Engineering - 30%
 - Business - 15%
 - Architecture - 5%
 - Law - 5%
 - Public Administration - 5%
- Average experience - 4 to 15+ years
- Domestic - 70% | International - 30%

**Class of 2023*

2023 Capstone Project Abstracts

Air Travel Carbon Audit: A Study of the University of Calgary International

Aleem Tejani

Global commercial aviation is a growing source of greenhouse gas emissions. The purpose of this study is to determine a suitable methodology to quantify emissions produced by University of Calgary International (UCI), as well as quantify emissions based on the selected methodology. The analysis found that an important consideration is the use of a radiative forcing factor, a multiplier that accounts for the increase effect of carbon dioxide and other pollutants at high altitude. The study also analyzes to which countries and world regions is travel producing the most emissions, as well as proposes general recommendations on ways in which emissions can be mitigated. This is a preliminary step towards a more comprehensive understanding of emissions produced through air travel. The research questions this study addresses is how can UCI expand its global partnerships and student mobility program while working to mitigate its institutionally driven air travel emissions impact.

Alberta's Energy Transition: What Impacts Foreign Participation?

Michael Holland

Traditionally seen as an oil and gas powerhouse, Alberta has witnessed unprecedented growth from renewables. But this growth requires significant investment, with estimates as high as \$5.4bn annually by 2040. Multinationals provide one source of funding in the form of foreign direct investment (FDI). This study examines what influences foreign companies to enter Alberta's renewable energy market. Expert interviews reveal what matters most to investors, and how the province might attract future international investment. Organized around seven key themes, the study finds that investments are a multi-criteria decision-making process dominated by industry and organization-specific factors. The research highlights that Alberta's open and deregulated marketplace benefits from abundant natural resources, supporting robust financial performance. Investor reactions to the 2023 moratorium on approvals, are explored, and have added to concerns about the polarized political landscape, limited provincial government support, and regulatory delays.

Bridging the Climate Action Gap using Solar Thermal Energy: A Study on Feasibility

Falone Shamba

Solar energy is among the most-cited renewable energy sources noted as instrumental to the energy transition. Currently, there is more focus on industry-led efforts to reduce the adverse effects of climate change. However, there is evidently a need for individuals to also participate in climate action. This research paper uses techno-economic modelling to analyze the clean energy potential for domestic hot water and space heating, the environmental impact relative to current practice and corresponding cost implications to evaluate the feasibility of implementation and consequently, the potential of individual climate action in Alberta. Homes using electricity (as opposed to natural gas) benefit more from this investment due to differences in emission factors and fuel prices. A low adoption scenario results in 330 MJ saved and 0.3 Mt CO₂e offset and a high adoption scenario result in 989 MJ saved and 0.88 Mt CO₂e offset.

Building Resiliency: Learnings from Water Management Approaches in Indigenous Communities near Grande Cache, Alberta

Vishnupriya Kannankulathu

Many Indigenous communities face an ongoing issue in Canada: access to adequate, sustainable, and acceptable safe drinking water. The problem extends to the hamlet of Grande Cache and the surrounding Indigenous communities that comprise the five Co-operatives and two Enterprises. Although there is previous literature regarding water availability concerns and infrastructural limitations in Indigenous communities, there is a need to explore community-specific barriers and opportunities for resilience building in rural and remote settings. The research delves into the experiences, perceptions, and actions of the Indigenous communities surrounding Grande Cache, ultimately aiming to provide insights into how these communities have navigated water-related challenges, their outlook for potential resource extraction impacts, and their broader resilience-building efforts. This research contributes to a deeper comprehension of the community-specific factors that influence the desired water management methods. This may offer insights for local decision-makers to strengthen water resource management and improve community well-being.

Commercialization of AgriSolar Shelters as a Non-Profit Social Enterprise in Calgary, Canada

Tari Tebepah

The question raised in this capstone project was: “Whether the AgriSolar Shelter is commercially feasible on a non-profit social enterprise basis in Calgary, Canada?”. Hence, the author examined the deployment of the agrisolar technology referred to as “AgriSolar Shelter” which is to be integrated into a pilot project in Calgary, Canada called “Community AgriSolar Hub” on a non-profit social enterprise basis, and whether the concept is feasible for subsequent commercialization. The study’s importance lies in the potential of AgriSolar Shelters to address climate change concerns and provide the target populations with access to renewable electricity, decreased energy costs, fresh agricultural products, and sustainable agricultural choices. The results indicate that while the AgriSolar Shelter exhibits promise in terms of its capacity to offer sustainable energy, lower energy expenses, access to /conservation of water, and efficient crop production, additional research and a detailed review of its technical composition and economics are necessary.

Creating Cohesion in Energy Strategy: An Analysis of Risk Management in the Western Canadian Petroleum Industry

Christopher Hoang

Strategic synergy can lead to operational efficiencies and improved performance, a phenomenon not sufficiently explored within the environmental strategies of the Western Canadian petroleum industry (WCPI). This study, therefore, explores, “to what extent does the WCPI demonstrate synergy in the discussion of risk between their environmental and corporate strategies?” and, “how is this relationship moderated by industry subsector and firm size?”. Through textual analysis of published environmental and corporate reports, firms demonstrated a lack of strategic synergy and inconsistent risk disclosures: citing more environmental risks in their environmental reporting, with inconsistent financial and operational risks within corporate reporting. Although some relationship to the moderating variables is observable, statistical analysis provided mixed results. Moreover, firms demonstrated homogeneity in risk disclosures and strategic methodologies, with evidence of coercive and mimetic institutional isomorphic forces. Stricter ESG frameworks or adopting integrated reporting could drive greater consistency but will still require additional oversight and regulation.

Factors Influencing Energy Transition in a Local Community

Chijindu Ubani

Canada has experienced an increase in the frequency of extreme weather events in recent times. Energy transition offers a potential solution to mitigating these climatic effects. However, several factors influence energy transition in a community. This research sought to investigate factors influencing energy transition in a local community by conducting a case study of Hinton, Alberta. The research also sought to compare community sentiments observed in this study to the communication and transition policy recommendations of the Alberta Narrative Project (ANP). This study found that economic, governmental, social, and overlapping factors, both negatively and positively, influenced energy transition in the community, while environmental factors drive energy transition. Additionally, study sentiments were similar to the ANP's communication and transition policy recommendations. This study's findings can be applied in developing and implementing energy transition policies and developments that are more applicable and suitable for communities in Alberta.

Feasibility of Implementing Renewable Energy Power Generation Capability at BASF's Regina and Saskatoon Facilities

Amrit Singh

As organisations strive to meet their decarbonization commitments, emphasis is placed on the scope 2 emissions associated with the use of grid electricity. In this context, BASF Canada would like to investigate the feasibility of producing electricity onsite from a renewable source at their Regina and Saskatoon facilities. A multi-criteria decision-analysis was used to compare the technologies of which integrated solar was ranked the highest. A techno-feasibility analysis of this technology using System Advisor Model software revealed challenges. The low capacity factors resulting in high levelized cost of electricity for the systems rendered the projects uneconomical at this time. Additionally, the low cost of electricity from the grid diminished the incentives for onsite generation. Ongoing technological advancements and market dynamics may offer renewed opportunities for BASF in the future. Alternatively, a power purchase agreement for clean electricity can help the company meet its near-term emission reduction commitments.

Feasibility Study of a Biomass-Methane Clean Fuel Project in Punnichy, Saskatchewan

Heikan Zhou

This study aims to explore the economic feasibility of Rainforest Energy Corporation's first biomass-methane dual feedstock clean fuel project in Punnichy, Saskatchewan. The research is crucial not only for various stakeholders to assess the project's financial sustainability for decision-making purpose, but also for the industry to benchmark and the government to adjust policies where appropriate to contribute to Canada's net-zero greenhouse gas emissions commitment. Methodologies used include projection of financial statements and critical performance indicators, as well as performance of sensitivity and ratio analysis. At a strategic level, the project appears to be the most favorable option when it manages to achieve both positive investment return and negative carbon footprint. Detailed financial analysis also sheds light on the project's economic vibrancy. Although investment return is more sensitive to decrease in the product output price, such risk may be mitigated through price hedging and other structural measures.

Healthcare System and Scope 3 Emissions Reduction

Ezinne Osiogou

This study's main goal is to offer Alberta's healthcare industry resources on how to lower their overall environmental footprint through addressing Scope 3 emissions by expanding their Environmental, Social and Governance (ESG) strategy to foster increased engagement along the healthcare supply chain. A detailed literature analysis was undertaken to grasp the intricacy of the subject, as well as to identify current best practises in the field. The methodology also includes qualitative data collection via interviews with industry experts and from individuals from prominent facilities based in Calgary, Alberta. The conclusion of the study demonstrates the steps that healthcare institutions need to take in order to create relationships with external organisations and providers. The strategy entails recognising benefits, which aids in the alignment of their ecological aims and the reduction of their collective environmental imprint.

Indigenous Relations and Energy Businesses: Building Foundations for Authentic and Sustainable Community Partnerships

Hanna Thai

Community engagement in the energy sector is about recognizing Indigenous sovereignty and fulfilling reconciliation objectives, however the prescriptive nature of regulations on consultation generates the exact opposite outcomes. Subsequently, this research is meant to address how energy businesses can conduct more meaningful engagement through partnerships. The elements of a partnership are defined through interviews with engagement professionals in the energy sector. Such findings will be applied to a case example between two businesses called Rainforest Energy Corp. (RFEC) and the Touchwood Agency Tribal Council Economic Development Company Ltd. (TATC), an organization representing four First Nations groups in Saskatchewan, Canada. Both corporations have established a joint venture for developing a biofuel facility on the First Nations' traditional territories. Board members from each corporation were also interviewed for this study. Using content analysis to examine the interview transcripts, six themes and four sub-themes were discussed broadly and applied to the case example.

The Interface of Wildfires and Electrical Utilities in Western Canada

Jamie Eddy

Climate change is leading to more frequent and severe wildfire patterns in Western Canada. During a climate disaster like a wildfire, keeping the power on and protecting electrical infrastructure is a crucial pillar of emergency response and recovery. However, electrical infrastructure igniting wildfires is a well-documented problem in the United States. This research investigates what are the major concerns and preventative measures at the interface of wildfires and electrical utilities in Western Canada. Case study comparisons explore this topic by comparing Australia's Black Saturday Bushfires, California's Camp Fire, and interviews with subject matter experts in British Columbia and Alberta. The results show that there is a dual risk in Canada, but electrical infrastructure is at extreme risk. Inconsistent policy hinders the ability of companies to mitigate this threat, and while a fatal wildfire has so far been avoided, this current situation may be a disaster waiting to happen.

Pathways to Restore Power over Energy, Environment, and the Economy on the Navajo Nation

Kelley Rutledge

A historically complex regulatory system guiding land use on the Navajo Nation has led to land use plans advised or created by the Bureau of Indian Affairs (BIA) that fail to involve the Indigenous Peoples they represent. Stripped of all cultural and traditional elements, these plans are largely rejected by the communities, and are considered to have fueled the widespread unemployment, poverty, and lack of access to basic utilities. This study, which included a literature and regulatory review, identified that limited community engagement and restricted land considerations led to constrained visions and land use plans. Through a multifaceted approach of pre-planning to incorporate cultural elements and capacity building, the creation of a united Tribal Vision and Integrated Resource Management Plan, and a concurrent Strategic Environmental Assessment, the Navajo Nation can potentially remove the hurdles that have prevented them from creating their own pathway forward toward decolonized land use planning.

Potential Retrofit of Heat Pumps in Multi-Use Residential Buildings in Alberta

Mercy Jenifer Gunasekaran

Canada has committed to attaining net zero emissions by 2050 with an interim goal of 40% to 45% emission reduction by 2030. The building sector is Canada's third largest producer of greenhouse gas emissions. Around 70% of buildings' emissions come from space and water heating equipment. Therefore, this research focuses on finding the most suitable time and approach for retrofitting heat pumps in multiuse residential buildings. This research assesses the various retrofit options considering the specific characteristics of the building. Subsequently, it establishes a set of decision criteria to evaluate these alternatives. This set of decision criteria pertains to both the building and its specific location. It enables homeowners to make informed choices that diverge from the conventional approach of retrofitting. After a detailed analysis, the research concludes that the hybrid system aligns best with the building's characteristics and is well-suited to adapt to the changes in the electricity grid.

Solar Panels in Alberta and Greenhouse Gas (GHG) Emissions

Ossama Pervez

The project quantifies Greenhouse Gas (GHG) emissions reduction in Alberta if it is considered that 25% of total energy generated from natural gas and coal is soon replaced with solar panels. A typical solar panel lifecycle is 25 years. When 25% of electricity is generated from solar panels in Alberta, calculating environmental payback time shows that solar panels will be carbon neutral after two years of operation. Whereas over 25 years of operation, 29.6 Mt CO₂eq is avoided compared to consuming electricity from the grid. The project also aims to assess the GHG footprint during the upstream manufacturing of solar panels deployed in Alberta, and how to improve sustainability for the upstream value chain of major Alberta solar projects. The primary reason for identifying GHG emissions during the upstream side of solar panels will help potential customers of Alberta to know how sustainable solar technology is across its entire lifecycle.

Sustainable Management of the Organic Waste at the Spy Hill Campus

Muhammad Samiul Alam Mondal

Spy Hill Campus at the University of Calgary owns a fully operational organic waste composting facility with 800 tons/year capacity. This project aims to manage the organic waste generated by the animal farm located on campus, including animal manure. The primary reason for identifying potential uses of compost would enhance economic, environmental and energy benefits. It has been identified from this project that an anaerobic digester is an option because energy production is possible besides maintaining zero emissions. Generating 3.41 kWh/year of electricity from 1 kg of waste is possible. Also, other options, i.e. moving compost to WA Ranch or the university's main campus, can save a significant amount of fertilizer cost, which is financially and environmentally profitable. Thus, by implementing the fertilizer management strategy, this research addresses SDG 8: Decent Work and Economic Growth, SDG 11: Sustainable Cities & Communities, and SDG 12: Responsible Consumption and Production.

Techno Economic Feasibility of a Hydrogen Supply Using In-situ Generation from Hydrocarbons with Catalysts and Electromagnetic Heating

Caleb David Neufeld

To meet the global goal of net zero emissions by 2050, a combination of low-carbon energy sources will be needed to replace fossil fuels. Hydrogen has the potential to compliment other renewable energy sources to meet future energy needs. The research documented here explores the economic and technical feasibility of generating hydrogen within hydrocarbon reservoirs (in-situ) using electromagnetic-assisted catalytic heating. The process was analyzed in terms of cost, energy input, efficiency, GHG emissions, and water usage. The results show that this process can be a feasible way to generate hydrogen at input energy rates between 5 - 25 kWh/kg H₂, which result in competitive production costs of around \$1.00 to \$4.50/kg H₂, using 100% grid power at a price of \$0.08/kWh. Generating hydrogen within hydrocarbon reservoirs would allow the associated GHG's from the process to remain underground, compared to having to be collected and sequestered for above ground processes.

Techno-Economic Feasibility of Eavor-Loop Green Hydrogen Production

Annika Naylor

An Eavor-Loop is a closed loop multilateral geothermal system with two vertical wells and 12 multilateral passes to conductively harvest heat at depths of 7-9 km. That heat can be converted to power through an Organic Rankine Cycle generator for production of green hydrogen via electrolysis. Green hydrogen could replace diesel fuel in long-haul transportation due to carbon-free emissions and quick refuelling. However, there are logistical and economic challenges with transportation, handling, and storage of hydrogen. Onsite production of hydrogen at fueling stations using Eavor-Loop energy eliminates many of these challenges. This project analyses the financial and emissions intensity of Eavor-Loop, fossil fuel, wind, and solar powered hydrogen production systems, with case studies in California, Japan, and Germany. Overall, hydrogen fuel production using closed loop geothermal heat is lower in emissions than alternative green energy sources, and Eavor-Loop hydrogen refueling stations can provide competitively priced hydrogen to the hydrogen economy.

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