School of Public Policy

UNIVERSITY OF CALGARY

Capstone Project Abstracts

MSc in Sustainable Energy Development 25/26

Celebrating Our Future Energy Leaders

In my role as Director of Graduate Programs at the School of Public Policy, I am continuously inspired by the curiosity, innovation and interdisciplinary focus of our MSc Sustainable Energy Development (SEDV) students.

The future of sustainable energy development is challenged by complex issues from the lack of infrastructure and an evolving geopolitical landscape to shifting climate change policies and rising energy demand globally. These issues need leaders who have the knowledge and interdisciplinary skills to develop practical, innovative solutions and shape the future of energy.

This collection of abstracts showcases the work of our MSc in Sustainable Energy Development students, many of whom have collaborated with industry partners, enriching their projects with real-world insights and applications. Their work reflects a diverse range of topics, from the potential of hydrogen technology and solar energy innovations to the assessment of sustainable practices across various sectors.

The following pages highlight the depth and breadth of their research, offering insights into pressing challenges and opportunities within the energy sector.

To our students, thank you for the hard work and passion you brought to the classroom and your capstone research. These projects are a testament to your dedication to advancing sustainable energy solutions and your determination to turn academic insight into real-world impact. Our team at the School of Public Policy looks forward to seeing the impact you continue to have in your professional careers.



Dr. G. Kent Fellows
Director, Graduate Programs
School of Public Policy
University of Calgary



Capstone Project Abstracts

Gurjeet Singh Bali

Assessing Biohazardous Waste Disposal at the University of Calgary: An Opportunity for Sustainability

University research laboratories generate substantial biohazardous waste; at the University of Calgary, external disposal volumes rose from 13,000 kg in 2017 to 18,000 kg in 2022, raising costs, staff burden and Scope 3 emissions. This study asks how misclassification can be reduced to improve waste stream sorting, maintain regulatory compliance and support sustainability goals. This qualitative case study combined document review, eight stakeholder interviews spanning the generation, collection and treatment chain, and site visits to two cancer research laboratories, analyzed using Kania, Kramer, and Senge's Six Conditions of Systems Change. Misclassification proved a systemic pattern rather than a knowledge gap: participants could describe correct pathways, yet yellow biomedical waste containers functioned as a default under uncertainty and time pressure, reinforced by partial container standardization, absent signage at most disposal points, and one-time onboarding training without refreshers. Layered structural, relational and transformative interventions are proposed as a phased implementation strategy.

Supervisor: Dr. Ron Thiessen, Schulich School of Engineering | Johanna Andryszewicz and Janina Willkomm, University of Calgary, Environment, Health and Safety

Helena Milovic

Assessment of Organic Food Distribution in Alberta and its Potential to Divert Food Waste from the Landfill

Food waste has an enormous impact on the environment, economics and energy within our society. There is a business opportunity to develop strategies that divert waste from the landfill and keep the energy and material within the food industry by transforming it into beneficial products. My research question focused on understanding which of three alternative uses of food waste (anaerobic digestion, composting or animal feed) is the most financially and environmentally viable for an organic food distribution center in Calgary, Alberta. Using a Cost Benefit Analysis, which combines financial and environmental calculations based on the information received from PuraBia and supplemented by a literature review, the findings suggest that composting is the most viable alternative to food waste being sent to the landfill. However, context is an essential influence as nuances related to geolocation and partnerships impact the viability of each alternative.

Supervisor: Dr. Tatenda Mambo, School of Public Policy | Caroline O'Driscoll and Napoleon Tuckler, PuraBia

Julie Boyce

Beyond the Battery: Regulatory Enablement for AI-Enabled, Carbon-Disciplined Dispatch of Storage and Renewables in Nova Scotia's Electricity Market

As Nova Scotia integrates more renewable generation and battery storage, emissions performance depends not only on capacity installed but on how and when it is operated. This capstone asks to what extent AI-enabled, carbon-disciplined dispatch of new battery storage, solar, and wind could reduce emissions relative to conventional operation, and what regulatory conditions would enable it. Using a literature review, a quantitative scenario analysis of Nova Scotia's 2024 electricity system developed with industry partner Edgecom Energy, and a regulatory analysis, the research finds that grid-charged storage increased emissions while clean-charged storage reduced emissions and retained most of the peak-demand benefit; wind and solar also reduced emissions, though even the largest scenario cut baseline emissions by less than 10 per cent. Existing carbon and renewable-electricity mechanisms in Nova Scotia do not extend to battery charging decisions, so this capstone recommends a regulatory sandbox to test carbon-disciplined dispatch before broader implementation.

Supervisor: Christopher Joy, Haskayne School of Business | Tanner Behrend, Edgecom Energy

Douglas James Braden

CARMES Feasibility Analysis

Planetary Harvest is developing the Remote Environment Vegetable Incubator (REVI), a "toolbox-fixable" vertical farm for remote Northern communities. This report examines the Compressed Air Renewable Mechanical Energy System (CARMES), a multi-blade windmill driving an air compressor with no electrical conversion, as a means of supplementing conventional energy in performing the physical work of the farm. Using thermodynamic modelling and an hourly, record-based storage simulation across four sites, a single 6 ft Aermotor 702 windmill with five 757 L vessels delivers about 787 Wh/day (287.2 kWh/yr) at the strongest site, Gjoa Haven. Performance is governed by the duration of calm periods, so storage is sized to the longest lull. CARMES carries a higher levelized cost than conventional and renewable sources, near $25.73/kWh and $14.36/kWh as shared REVI infra-structure, yet offers mechanical simplicity, fossil-fuel avoidance and resilience against supply-chain disruption. A monitored demonstration at Gjoa Haven, integrated into REVI, is recommended.

Supervisor: Dr. Simon Li, Schulich School of Engineering | Richard Gibson, Planetary Harvest Vertical Farms Inc.

Preeta Raghunathan

Enabling Non-Wires Solutions in Alberta's Electricity System: Regulatory Barriers, Cost-Benefit Frameworks, and Pathways to a Cleaner Grid

Canada's decarbonization goals and rising electricity demand are straining distribution grids, yet non-wires solutions (NWS) that could defer costly network upgrades remain underused in Alberta's deregulated, energy-only market. This study asks how NWS can be integrated into Alberta distribution planning while giving utilities a financial return and keeping electricity affordable, reliable and clean. Drawing on evaluation frameworks from Colorado, Ontario and New York as well as Alberta stakeholder interviews, this project builds a distribution-focused, Alberta-specific cost-benefit model and applies it to a demand response deferral. Demand response clears the utility, ratepayer and societal tests, but the payment of a ten-year deferral can fund only low-capital resources; shorter deferrals widen the viable set. Reforming cost-recovery rules and optimizing deferral horizons emerge as the most effective levers for scaling NWS in Alberta.

Supervisor: Dr. G. Kent Fellows, School of Public Policy

Nazifa Rahman

Enabling Strategic Secondary Copper in Canada, Policy Pathways for Domestic Recovery, Processing, and Use in Electrification and Sustainable Grid Expansion

Canada's electrification and AI-driven infrastructure expansion are intensifying copper demand at the same moment that legacy telecommunications networks are retiring copper at scale. This study asks how Canadian policy and regulation can better enable the domestic recovery, processing and strategic use of material. Documentary analysis of ten policy instruments, carrier-specific material flow estimation with scenario and sensitivity analysis and comparative assessment against four alternative supply pathways identify three structural gaps: classification, co-ordination and temporal. The national flow is estimated at 3,300–7,700 tonnes per year, central approximately 5,500, equal to roughly 2–2.5 per cent of domestic refined copper consumption and approximately 1.7 per cent of the throughput of Canada's only copper refinery. The analysis identifies a classification gap characterized by the absence of a legal mechanism through which recovered telecommunications infrastructure copper can attain secondary raw material status. No Canadian instrument reviewed establishes such a category, precluding the application of strategic recognition, certification, or procurement preferences to this material. The analysis indicates that the binding constraint is institutional.

Supervisor: Robert J. Johnston, School of Public Policy

John Velasquez Saldarriaga

Energizing Sovereignty: A Techno-economic and Financial Roadmap for Renewable Integration for the Okanese First Nation

This capstone establishes a techno-economic and financial roadmap for renewable integration within the Okanese First Nation. The study investigates how the Nation can achieve energy sovereignty and economic viability through a behind-the-meter (BtM) renewable strategy under a restrictive utility monopoly, addressing a critical literature gap regarding grid-connected communities. Informed by Indigenous self-determination and valuations from national research laboratories, this mixed-methods research integrates empirical SaskPower profiles, ArcGIS mapping and NREL's System Advisor Model to simulate 100 kWdc solar gardens and 225 kWh battery systems across four configurations. Results reveal standalone solar PV achieves grid parity (LCOE: 8.91–12.04 ¢/kWh), delivering immediate savings. However, battery storage introduces a substantial 'resilience premium' under standard commercial terms. Sensitivity analyses demonstrate that securing capital grants through public infrastructure financial institutions and clean energy promotion organizations eliminates this financial barrier, offering a replicable roadmap to bypass grid constraints and reclaim autonomy.

Supervisor: Christopher Joy, Haskayne School of Business | Mick Elliott, Okanese First Nation

Renzo Ruben Morales Nunez

Engineering Social License via Multi-Sensor Telemetry Framework for Mine Waste Management: Case Review of Antamina Mine (Peru)

Communities near the Antamina copper mine in Peru have long raised grievances about contamination, water security and structural safety, but lack access to evidence supporting their concerns. This study asks how those grievances map to a monitoring suite and answers with a community-facing dashboard. Four phases guide the work: coding 28 Spanish-language grievance documents using a 38-code codebook into five themes; translating themes into measurable variables benchmarked against Peruvian thresholds; inventory and gap analysis of existing air, water, soil and tailings assets; and framework design. Findings show the barrier is not instrumentation but access to data: monitoring runs continuously, yet records stop at the regulator, making trust a governance choice. Three grievance-derived principles (inclusion, accountability and continuity) lead to a concrete recommendation: operators should publish existing data beyond the recognized area of influence, in local languages, aligned with regulatory thresholds and with time series beyond permit requirements.

Supervisor: Dr. Adriana Guatame-Garcia, School of Public Policy

Olushola Ayobami Ojedokun

Feasibility Studies on Distributed CO_2 Transportation Network Development using LNG Virtual Pipeline Infrastructure in Western Canada

Canada's greenhouse gas (GHG) emissions largely come from the energy sector and energy end use, with stationary combustion sources and industrial processes contributing over 50 per cent of the 700 Mt-CO2eq average national GHG emissions recorded over the last decade. Carbon dioxide (CO_2) accounts for an 80 per cent mass-based share of GHG emissions. Optimally integrating off-system hydrocarbon-fuel-consuming and CO_2-emitting facilities into decarbonization schemes would enhance implementation of Canada's carbon management strategy for climate change mitigation. The results of this study show that about 50 Kt-CO_2 annually capturable by off-pipeline emitting facilities in Western Canada can be integrated into a carbon capture, utilization and storage system via deployment of a distributed CO_2 tanker-truck transportation network. The USD 56.50–124.80 per tonne cost range for efficient trucking of utilization/storage-bound liquefiedCO_2, determined by techno-economic analysis and scenario modelling and within the context of a mapped 5–310 mile distance range, could be reduced in the long run with growing investment-enabling policies.

Supervisor: Dr. Sean McCoy, Schulich School of Engineering | Kamran Chaudhry, Cryopeak Energy Solutions

Claire Obianuju Oseghale

Geothermal-Assisted Green Hydrogen Production with ORC Cogeneration from Repurposed Oil and Gas Wells in Alberta

The objective of this study was to answer the research question: to what extent can geothermal heat recovered from repurposed suspended oil and gas wells in Alberta reduce grid electricity demand, hydrogen production cost, and carbon emissions that come with proton exchange membrane (PEM) electrolysis? An integrated Geothermal-Assisted Green Hydrogen Production with Infrastructure Reuse (GAHP-IR) system was designed and evaluated through thermodynamic modelling, techno-economic assessment, life cycle assessment, and sensitivity analysis across four scenarios (i.e., base case, 90 °C, 120 °C, and 150 °C). Integrating geothermal heat recovery with an Organic Rankine Cycle operating at 150 °C led to a 44 per cent lower net grid electricity demand, a 32 per cent reduction in levelized hydrogen cost to CAD 7.49/kg H_2, and a 44 per cent reduction in carbon intensity. This study highlights the technical feasibility and economic competitiveness of harnessing repurposed suspended oil and gas wells in Alberta, Canada, to produce low-carbon hydrogen using geothermal resources at temperatures above approximately 120 °C.

Supervisor: Dr. Ian Gates, Schulich School of Engineering | Sara Gerrard, CedarStone Energy

Jasmine Bhambra

Investigating the Transferability of Public Acceptance Drivers from Wind Energy and Electric Vehicles to Carbon Capture Technology

Carbon capture, utilization and storage (CCUS) is central to industrial decarbonization, yet its deployment depends on public acceptance that remains weak, and its acceptance research has developed apart from the wider energy-technology literature. This study asks to what extent, and in what form, the drivers of public acceptance for wind energy and electric vehicles can strengthen CCUS acceptance in North America and Europe. Using a qualitative comparative case study and deductive thematic analysis of secondary sources, it examines wind cases in Germany and Texas and electric vehicle cases in Norway and Ontario, with Quest and Petra Nova as CCUS reference points. A three-tier scheme grades each mechanism, separating broad drivers from the specific instruments that delivered them. Drivers, including trust, fairness, benefit perception and policy stability, prove highly relevant, but no instrument transfers directly to CCUS. The study recommends visible accountability, adapted benefit-sharing and durable, performance-linked policy support.

Supervisor: Dr. Roberta Rice, Faculty of Arts | Symphony Huang and Travis Brookson, Svante

Isabel Rose

An Investigation of Textile Circularity while Creating Opportunities for Sustainable Employment

The textile industry is one of the most wasteful in the world, yet there is limited applied research demonstrating how non-profits can adopt circular economy strategies to support their organizational mission through the extension of the textile lifespan. Using the Recycling Council of Alberta's R-ladder as a guiding framework, this research explores how Goodwill Industries of Alberta can strengthen its textile circularity by maximizing in-house material recovery and capturing energy and material value across its value chain to create opportunities for sustainable employment. A three-phase methodology was applied: 1) a Material Flow Analysis (MFA), which found that the majority of textiles were sold to third-party companies for recycling; 2) a qualitative Multi-Criteria Decision Analysis (MCDA), which identified repair, e-commerce and upcycling as the strategies with the greatest impact potential; and 3) scenario modelling, which found all strategies effective in diverting textiles toward higher-value revenue streams, saving energy and creating employment.

Supervisor: Helga Vanthournout, School of Public Policy | Lukas Adomonis, Goodwill Industries of Alberta

Zeyad Osama Al Muhtaseb

Linking the United Nations Sustainable Development Goals to Local Content in the Annual Integrated Reporting of Oil and Gas Companies

This study asks to what extent oil and gas companies link the United Nations Sustainable Development Goals (SDGs) to local content and the employment, procurement and economic value they generate in host countries in their annual integrated reporting. Using directed qualitative content analysis, I coded 210 annual integrated reports (one company per cell across seven regions, three tiers, between 2015 and 2024) at the sentence level in MAXQDA, treating an SDG and a local content reference in the same sentence as a link. The analysis shows that companies link SDGs and local content substantially but selectively: the goals they reference most, climate and industry, are the least linked to local content, while partnerships, education and decent work are linked most. Local content is framed mainly through relational language rather than statutory obligations, and linkage is strongest where host-country rules are most demanding. The findings are descriptive and associational, not causal.

Supervisor: Dr. Irene Herremans, Haskayne School of Business | Dr. Atinuke Chineme, School of Public Policy

Jimmy Chuchuboy Mulbah

Natural Hydrogen: Its Potential Role in Canada's Low-Carbon Energy Transition

Natural hydrogen, or geologic hydrogen, is increasingly being considered a potential low-carbon energy source for Canada's net-zero transition. This review evaluates its potential contribution to Canada's low-carbon energy transition by examining geological prospectivity, techno-economic viability, environmental considerations and policy readiness. This review is based on a structured literature analysis and techno-economic screening of production, purification, and transportation costs using CAPEX, OPEX and LCOH as primary indicators. The results show that Canada has favourable geological conditions for natural hydrogen generation and accumulation, but commercial viability remains uncertain. Preliminary screening suggested a delivered hydrogen cost of approximately USD 2.10/kg, with well flow rate, purity, depth and transportation needs identified as dominant cost drivers. Although natural hydrogen presents lower emissions than conventional hydrogen, leakage, groundwater disturbance, land use and monitoring requirements must be examined. Policy frameworks remain uneven across provinces, indicating that natural hydrogen's role in Canada's low-carbon energy transition will depend on geological prospectivity, commercial viability and clearer regulatory guidance.

Supervisor: Dr. Chima Justin Ezekiel, School of Public Policy | Zachary Cunningham Calgary Region Hydrogen Hub

Ayesha Tauqeer

Public Health & Emergency Preparedness Implications of Nuclear Small Modular Reactor Deployment in Alberta

Small Modular Reactors (SMRs) are a rapidly developing technology deemed advantageous for energy diversification and decarbonization. As Alberta considers nuclear power generation in its electricity mix, it accordingly becomes essential to examine the risks associated with radiological releases and emergency accidents resulting from various initiating events. Therefore, this analysis evaluates the risk profile of SMRs and the preparedness of public health and emergency management institutions to manage such risks. Technical publications, peer-reviewed studies, and expert findings on SMR safety, operations, nuclear fuel cycle, and waste management were analyzed.

Emergency management frameworks, response plans, and regulatory guidance documents were reviewed and benchmarked against experienced jurisdictions such as Ontario and New Brunswick. The study finds that while SMRs have enhanced safety features, they nevertheless pose public health and emergency management challenges. The study also discusses gaps in the current institutional and policy landscape that must be considered when adopting nuclear energy.

Supervisor: Dr. Clark Svrcek, Cumming School of Medicine

Conlan Donahue

Public Participation Pathways Under the Building Canada Act Regime

As the energy transition accelerates infrastructure development, a tension emerges between expedited project approvals and public participation. This capstone evaluates public participation pathways within the fast-track Building Canada Act (BCA) compared to the sustainability-oriented Impact Assessment Act (IAA). Using doctrinal legal analysis and systems thinking, the study finds the BCA reorients public input from early-stage project justification to late-stage “mitigative bargaining” over approval conditions. Rather than removing conflict, this narrowed engagement risks displacing it into costly litigation, public opposition and construction delays, particularly regarding Indigenous consultation and consent. To reconcile efficiency with fair process, this research proposes structural policy reforms, including restoring early planning, alongside adaptive stakeholder strategies focused on data-driven advocacy. The central conclusion is that meaningful public participation is not a barrier to efficient infrastructure delivery, but a necessary condition for durable project execution, echoing the growing consensus that effective project execution requires “better decisions earlier, not weaker decisions faster.”

Supervisor: Prof. David Wright, Faculty of Law

Adeniyi Adeoloye

A Review of the Current Legal Frameworks for Carbon Capture and Storage in Canadian Provinces

Carbon capture and storage (CCS) is a proven emissions abatement technology that captures, transports and stores anthropogenic greenhouse gases like carbon dioxide (CO_2) in underground reservoirs. CCS is critical to decarbonizing industrial sectors that are difficult to abate and forms part of Canada's net-zero strategy, with projections that it could abate up to 80 million tonnes of CO_2 by 2050. This study reviews legislation and CCS regulations in five Canadian provinces, addressing pore space tenure duration, liability for CO_2 leaks and project approval requirements. Geological and engineering CCS project approval requirements are similar to minimize CO_2 releases and environmental safety damage. Canada's estimated storage capacity in depleted hydrocarbon reservoirs is about 389,000 Mt, with Ontario's 730 Mt indicating the need for inter-provincial CO_2 transport regulations. The study highlights the importance of regulatory certainty to support CCS deployment and reduce CO_2 emissions and offers insights for the improvement of regulations.

Supervisor: Prof. Allan Ingelson, Faculty of Law and Haskayne School of Business | Kelley Rutledge and Jamie Eddy, GLJ Ltd.

Heather Cowie

Secondary Metal Recovery from Pit Lake Remediation: A Screening Assessment of Revenue Potential and Policy Support for Sustainable Mining

Global demand for critical minerals is increasing rapidly, while the mining industry continues to manage large volumes of tailings, sludge and mine water residuals that create long-term environmental liabilities. Recent research suggests that these materials may also represent an unused source of recoverable critical minerals, creating opportunities to support both remediation and circular-economy objectives. This capstone evaluates whether pit lake sediments and treatment residuals can be repositioned from waste streams to secondary resources through integrated remediation and recovery. Using a mixed-method approach, the study combines a screening-level revenue assessment for copper and molybdenum recovery with an analysis of a Canadian mining case study with water quality data to review water treatment and circular-economy policies. Results indicate that the base-case scenario generates approximately CAD $90.77 million in potential revenue compared with no revenue under a Do-Nothing baseline. The findings suggest that biological and hybrid treatment systems may support remediation, critical mineral recovery and mine-closure objectives, although site-specific characterization, regulatory review and techno-economic assessment are required before implementation.

Supervisor: Dr. Sean McCoy, Schulich School of Engineering | Jeffrey Coombes, Integrated Sustainability

Dhruv Modi

Techno-Economic Assessment of SolarSteam's BendReality™ for Data Centre Cooling in Southern Alberta

Alberta's data-centre growth is increasing demand for reliable cooling while intensifying grid-capacity, land, water and storage constraints. This study asks whether SolarSteam's BendReality™, combined with 16 hours of thermal energy storage and a double-effect absorption chiller, can provide technically viable and economically competitive cooling for a 102.4 MW-c data-centre block in Southern Alberta. The analysis was performed based on studies on absorption cooling, high-temperature thermal storage, PV+BESS systems and Alberta large-load integration. Five cooling pathways were compared using SAM output, system sizing, a 25-year levelized cost of cooling model, sensitivity analysis, Monte Carlo simulation and market assessment. SolarSteam achieved a modelled LCoC of CAD 115.7/MWh-c, 13.9 per cent above the closest PV+BESS benchmark but required less cooling-related electrical capacity and direct solar-field area and offered substantially lower-cost 16-hour storage. The study concludes that SolarSteam is a technically plausible option well suited to phased deployment, with an initial 5–10 MW-c hybrid system supported by conventional backup.

Supervisor: Dr. Ganesh Doluweera, Schulich School of Engineering | Apostol Radev, SolarSteam Inc.

Sujib Chandra Sutradhar

Techno-Economic Comparison of Cryogenic and Amine-based Carbon Capture Systems

The study examines the comparative techno-economic performance of amine-based and cryogenic carbon capture for natural gas combined cycle power plants and cement facilities, and how economic and technical uncertainties influence the levelized cost of carbon capture (LCOCC) and technology choice. Amine capture is commercially mature but energy-intensive, while cryogenic capture is a promising alternative for operators with access to cold-energy infrastructure. An Excel-based LCOCC model was developed using process and cost data from National Energy Technology Laboratory (NETL) studies and peer-reviewed literature and applied under consistent assumptions, followed by deterministic sensitivity analysis and Monte Carlo simulation for uncertainty analysis. Cryogenic capture showed lower base-case LCOCC in both sectors, about 12 per cent lower for NGCC and 29 per cent lower for cement, and higher probabilities of achieving competitive costs. Overall, the results indicate that cryogenic systems can be a competitive alternative where cryogenic infrastructure or favourable electricity prices exist, supporting technology and investment decisions.

Supervisor: Dr. Sylvia Sleep, Schulich School of Engineering | Kamran Chaudhry, Cryopeak Energy Solutions



SEDV Class of 2026

Thank You to Our Industry Partners

We extend our sincere gratitude to our industry partners for their continued support and collaboration. Your engagement provides our students with invaluable opportunities to connect classroom learning with real-world practice while advancing innovation in the energy and environment sectors. Together, we are building stronger pathways for knowledge, growth and impact.

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