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The 2nd Annual McMaster Energy Week: Energy Nexus Competition



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Abstract

The following abstracts were produced by delegates selected for the Energy Nexus Competition taking place during the 2nd annual McMaster Energy Week. The first three abstracts were selected as the winners of the competition, reported here in order of 1st place to 3rd. McMaster Energy Week is Canada's first student-led energy week that aims to take the complex and multi-faceted issue of climate change and present solutions towards building Canada's sustainable future. We are bringing together academia, industry, government, communities, and students to further the dialogue on Canadian environment and energy. For more information on this visit <https://www.mcmasterenergyweek.com/> or email chair@mcmasterenergyweek.com.

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Conference Abstracts

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Abstracts from Written Reports

Incentivizing local food production using sustainable tax policies

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In order to reduce the greenhouse gas emissions relating to food transportation and production, a local agriculture solution for a Canadian community of 200,000 is proposed. By implementing a sustainable tax policy on all food items purchased within this community, revenue can be generated in order to fund a series of greenhouses which will make use of hydroponics and urban agricultural practices to grow produce including tomatoes, lettuce, and potatoes. The aforementioned tax policy will evaluate the distance which a food was imported from, as well as the emissions involved in its production, in order to add a tax equating to \$10/tonne of CO₂e emitted. Anticipated tax revenue is roughly \$14/person/year which totals to over \$2 million/year to fund the greenhouses. The goal of the taxation policy is not only to generate the capital needed for the greenhouses project, but also to make consumers aware of the impacts their food choice habits have, which will hopefully lead to a reduction in the consumption of high-emission foods, as well as imported produce. By eliminating the need for sourcing produce from distant areas, this policy and project will work together to add resilience to the community's nexus resources.

Diversification of the transportation industry through electric vehicle incentivization and alternative fuel generation

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Significant reductions in greenhouse gases is required from all public and private sectors for Canada to achieve the Paris Agreement target of reducing emissions by 80% relative to 2005 levels. Transportation and private vehicle use contributes significantly to these emissions; data for a reference city with a population of ~200,000 people indicated that transportation accounts for 31% of emissions, with 94% being due to private vehicle use. This report outlines a systematic incentivization program that facilitates a gradual shift from gasoline to electric vehicles in private vehicle ownership. The current state of EV prevents the technology from entering the freighting and public transit industry due to limitations in charge times and battery weights. As such, a multi-sectoral solution is proposed where food and human waste produced by households, businesses and municipal buildings will be collected and processed to produce dimethyl ether, a direct substitute for diesel that utilizes existing engines and produces 30% less CO₂ than diesel. Based on projected population growth and the efficiency of incentivization programs to promote the purchasing of EV and effective composting, it is expected that CO₂ emissions would be curbed by 600,000 tCO₂e within Ontario by 2050, a 75% reduction from current projected emissions.

Addressing climate change with renewable energy

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With the gap between renewable energy and consumption growing simultaneously with energy security concerns, efforts are being made in order to diminish the environmental impact of conventional fuels and implement sustainable systems. This proposal aims to decrease waste emissions of the city by diverting organic material and sewage treatment sludge into a CHP system which will be attached to a city's new thermal grid for municipal buildings and process of electrolysis to procure hydrogen and inject this hydrogen into the local natural gas system will further lower emissions of the city for anything using natural gas, likely furnaces. Excess renewable electricity on the grid can be converted to hydrogen gas via electrolysis at a high efficiency. The hydrogen can then be injected into the natural gas system, providing a fuel blend that is up to 18% cleaner than regular natural gas. Many government policies can also be enacted to greatly reduce gas demand.

Driving change: Reducing CO₂ emissions in an urban city

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Urban cities around Canada and the world are experiencing extreme levels of CO₂ emissions caused by the millions of vehicles on the roads. Currently, car companies are producing electric vehicles which have begun to spike in popularity and importance. Government policies and interventions can help stimulate positive changes in the transportation sector to make large decreases in CO₂ emissions. Waiting for people to make these decisions on their own would result in minimal improvement, nor does it solve issues with overpacked roads. By creating policy to ban several cars from entering the downtown core, we can eliminate congestion and small trips to several locations which have a tremendous compounding effect. 40% of all combustion engine commuter vehicles can be trimmed down by encouraging carpooling, electric vehicles and most importantly, public transportation within one year, and even greater reduction in future years. Extensive public transportation coverage and driving alternatives such as bike sharing, and delivery services are essential in reducing the effect of transportation on our environment. This also allows for more efficient "road diets" and reduced land masses lost to parking.

Bringing the electric grid into the 2020s

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For Canada to reach their future climate change goals, a robust grid infrastructure system for efficient energy transportation is essential. We currently rely on several forms of energy for daily function and societal progression. Whether the energy source is from our electric grid or from the combustion of hydrocarbons, we always meet energy requirements with ease. However, harmful by-products of hydrocarbon combustion release tonnes of greenhouse gases, ultimately resulting in climate change. Global communities have outlined climate change goals to significantly reduce greenhouse gas emissions. To help society achieve these goals, Solar Saltutions have developed several strategies that are technologically, socially, and economically feasible to combat climate change. The main sector we will focus on is improving the grid infrastructure. The implementation of our energy solution includes different technological processes for tackling the varying demand for electricity. The Integral Molten Salt Reactors produce a fixed amount of electricity, which can be used to heat homes and run industrial processes that require heat. The Sonnen smart grid is also explored, with solar producing electricity and storage in batteries. Additionally, electrification of transportation and changes to grid infrastructure is tackled to compensate for the increase in demand for electricity.

Vision of an ideal smart community

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The purpose of this report is to implement a solution which addresses the growing concern of greenhouse gas emissions and energy consumption. Through extensive research, we have provided several solutions that target different areas within residential real estate such as lighting, heating, and overall energy consumption. Our ideal implementations include solar energy, mirror lighting and smart grid technologies, all of which contribute to a more sustainable home and in term, the Ideal Smart Community.

A circular economy: Addressing an approach to reducing Canada's greenhouse gas emissions

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Raising awareness and educating the population is a key step towards achieving sustainability in a society. Many of the ways in which GHG emissions can be reduced is to have a optimal waste management system in which little to no harmful waste is produced in the society. Utilizing the waste to produce energy is also a crucial step in achieving low GHG emissions.

Utilization of algae and methanotrophs in the reduction of greenhouse gases

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This paper proposes to utilize organisms such as algae and methanotrophs in bioreactor facilities to mitigate greenhouse gas emissions. The basic concept and design of such facilities is discussed, and their impact on different industry sectors (e.g. the waste management sector, grid infrastructure, agriculture, transportation and residential buildings) is explored. The report finds

that natural organisms that consume greenhouse gases as part of their natural diet can be employed to significantly reduce a community's impact on the environment and global warming.

Shifts toward sustainable, densely populated cities

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With the rising population and resultant greenhouse gas emissions adding pressure to urban transportation and agricultural systems - new economic policies, lifestyle changes, built infrastructure, and agricultural systems are critical to move toward a healthier and more sustainable future. A modal shift from personal vehicles toward active and public forms of transportation, which requires infrastructural, policy-based, economic, and community support, will reduce emissions and improve population health. Concurrently, a shift towards electric vehicles will significantly reduce the carbon emissions caused by transportation. The increased usage of these vehicles provide an opportunity to adopt a vehicle-to-grid system to better assist with electricity demand. With the rising population, the environmental imprint left by the agricultural sector continues to grow. It is therefore essential to begin placing the emphasis on effective and viable ways to reduce GHG emissions by focusing on lifestyle changes that can be adopted by consumers, such as shifting from meat-heavy to plant-based diets. To facilitate this shift, vertical farming presents an exciting opportunity to cultivate fresh produce without the need for arable land, in which many growing factors can be controlled to optimize the growth of fruits and vegetables. Though it is a technology in its infancy, vertical farming connects fresh produce directly to consumers within urban centres.

Energy optimization in wastewater treatment process

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Climate change, especially GHG emissions, is something the governments continue to address and try to tackle. To accomplish the great goal of reducing GHG emissions globally, it is crucial to act locally. This proposal focuses on a projected community of 200,000 people, with an emphasis on reducing wastewater going into the wastewater treatment plant by redirecting it to hybrid constructed wetlands. When passing through the hybrid constructed wetlands, the total suspended solids and pollutants can be eliminated. After calculation, a population of 200,000 can result in 1.468×10^{-3} Mt annual GHG emission, while the proposed wetlands only produce 5.211 ton per year. Before sewage water enters the wetlands, it goes through the microbial cells to generate electricity. Based on an assumed area of 3000m² covered at a population of 200,000, it would save 25740kWh of electricity. Based on these predictions, the proposal would lead to lower GHG emissions while optimizing electricity generation.

Conflicts of Interest

The authors declare that they have no conflict of interests.

Authors' Contributions

HC: Founder and Chair of the 1st annual McMaster Energy Week.

RR: Served as Case Competition Lead, developing the case and aiding delegates in the development of their case proposals and abstracts.

DJ: Served as VP Education, drafted the competition book and reviewed abstract submissions.

FO: Served as Competition Co-Coordinator

MA: Served as Competition Co-Coordinator

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