Tyler Lewis Clean Energy Research Foundation

2019 Grant Recipients

Technology Assessment, Vibration-Based Wind Energy and Second-Life Batteries

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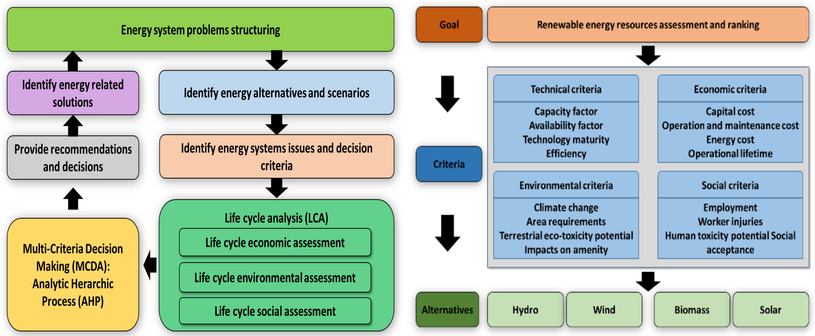
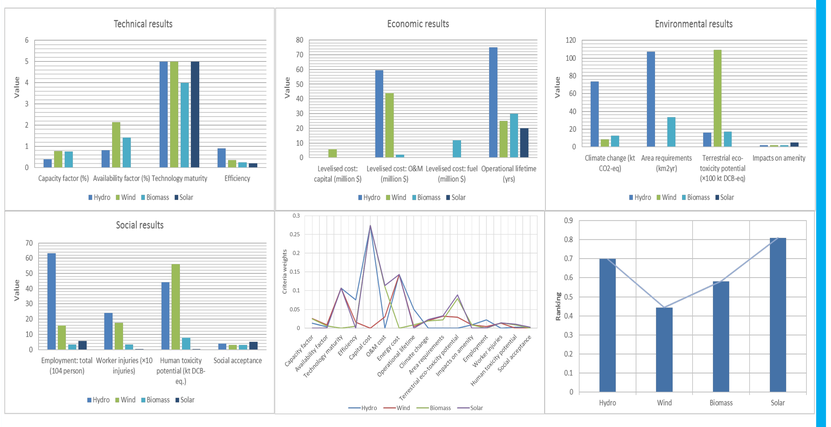
*Assessing Clean Energy Technologies for Canadian Communities

Energy resources are usually evaluated as a key contributor for social sustainable development. The purpose of this work focuses on conducting sustainability evaluation of renewable energy systems and obtaining a set of sustainable indicators by combining the methods of Life Cycle Analysis (LCA) and Multi-Criteria Decision Making (MCDM). Four criteria have been selected by consisting of four technical, four economic, four environmental, and four social sub-criteria. Then the assessment of alternatives was derived quantitatively with respect to each sub-criterion using the method of analytic hierarchy process (AHP).



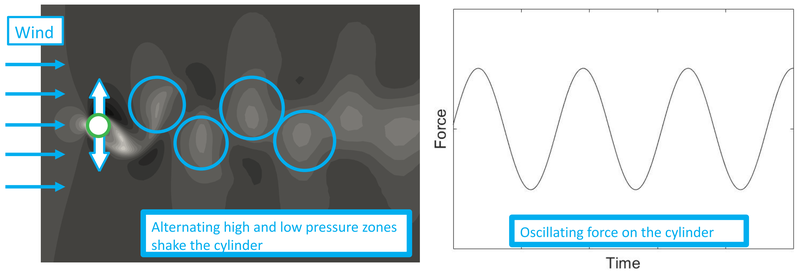
The technical scoring and energy resources ranking can provide an overall assessment of given technologies under a particular decision context. Solar power is found to perform well given the sixteen sub-criteria considered and then followed by hydro power in Canada. These technologies are mature with low emissions, low impacts on amenity, low area requirements, high public acceptance, and improvement in terms of market maturity and cost reduction. Although wind generally is found to score poorly indicating that it may only have a limited role at present, it can still play an important role in more site-specific energy projects in the future. Further studies on the energy technologies ranking and assessment under future scenarios are desired.



†Optimizing Performance of Vibration-Based Wind Energy Farms

What is vibration-based wind energy?

When the wind blows past a structure, alternating regions of high and low pressure are created as vortices are shed in the wake. Under the right conditions, the structure can shake due to the oscillating wind forces. Energy can be harvested from these vortex-induced vibrations using a special generator.

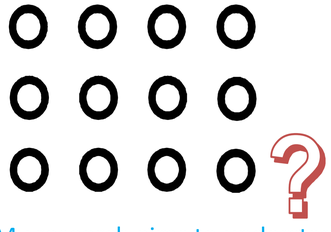


Why is vibration-based wind energy important?

Source: Vortex Bladeless Instagram

Vibration-based wind technology aims to access currently untapped wind energy sources in areas inaccessible using large, conventional turbines. For example, conventional wind turbines are not suited to urban environments due to their size, noise, and the wind instability around buildings. Vibration-based wind technology is quiet, less hazardous to wildlife, and smaller than conventional wind turbines.

How the TLCERF has been essential to my research



We use computer simulations of the wind flowing past the vibrating structure to better understand the physics and how to maximize the energy generated during vibrations.

My research aims to understand how we can generate the most energy when these devices are placed in an array, generating complex flow structures. These simulations require large amounts of processing power. The grant has accelerated my research by allowing me to complete over 150 different simulations to date, providing essential insight into the complex flow physics that will be used to optimize this new technology.

‡Smart Controller for Second-Life Batteries

Energy Storage for Electricity Grids

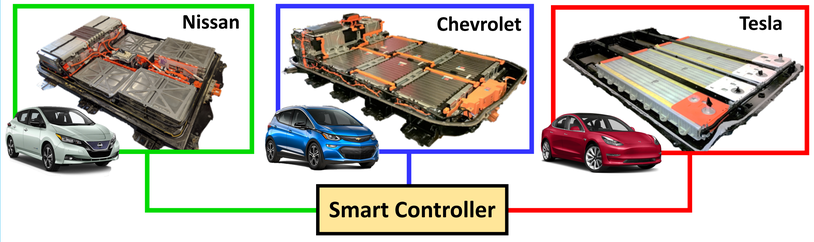
The clean energy transition will require vast amounts of energy storage to stabilize the world's electricity grids and allow for increased wind and solar energy. The world's largest lithium-ion battery does this for the South Australian electricity grid, as pictured below. Such enormous batteries are expensive and require a lot of mining for raw materials.

Second Life for Electric Vehicle Batteries

Millions of used lithium-ion batteries will be discarded from retired electric vehicles (EVs) in the coming years. Used EV batteries can be installed on the electricity grid and operate for several additional years before they are sent for recycling. Compared to new batteries, second-life batteries have a fraction of the economic and environmental cost.

Smart Controller for Optimized Performance

Unlike a typical grid battery system, a second-life battery system will be made of many different types of EV batteries. I am developing a new smart controller software to manage such a diverse battery team and improve its performance. The simplified example below shows three unique EV batteries connected to the controller, which regularly adjusts the role of each battery to maximize the performance of the team as a whole. The adjustments are made according to performance scores that I have determined for each EV battery through laboratory experiments. The chart at the bottom summarizes three key performance scores.



Energy: how effectively do they store energy?

Volume: how many can fit in a given space?

Thermal: how well do they avoid overheating?