Zero Emission Cities (MSc or PhD)

Urban centers are a complex mix of people, materials and energy all generating their own types of waste. These wastes, in turn leave by air, water or land depending on the source and include water discharges, gaseous emissions from fuel consumption and solid waste sent to landfills. This is combined with the reality that renewable energy systems require land and cities are full of buildings. The challenge is then to consider the available carbon resources within the urban center and devise a utilization plan to minimize fossil CO_2 emissions. This will done by considering the electricity grid, waste management and energy storage.

The project will focus on modelling the integration of these mass flows to determine the available avenues and necessary scale of energy storage. The work will utilize MS Excel for data analysis. Using publicly available data, we will consider the importance of adding renewables to the grid and how best to integrate energy use in buildings. For example, currently there is 5 GW or installed wind energy in Ontario and only 500 MW of solar PV. These technologies have different capacity factors and peak production periods that would require different forms of energy storage. Wind energy requires seasonal storage whereas solar is more weekly storage. The biggest energy storage option is biomass, in the form of food, food waste and sewage.

The future possibilities will be investigate by considering existing green designs such as the Conde-Nast building at 4 Times Square in NYC. Here the building contains a dedicated bioreactor and heat exchangers to minimize waste disposal and fuel use. Expanding this concept to smaller buildings and neighborhoods can lead to significant GHG reductions by, for example, returning bio-methane to the natural gas network for space heating. By considering the overall material flows in the urban environment, the optimum path to net-zero can be identified.