APS1012 Management of Innovation in Engineering

"Team IV Smart Cities"

i. Executive Summary

The transition from carbon-intensive to low-carbon technologies comes along with the Information Technologies Revolution. The use of sustainable energy resources in the current energy mix has its main opportunity of development. In electrification for example, electricity utilities have had struggles integrating innovative technologies to what might be defined as a "commodity", therefore it is harder to innovate in a proven technology. However, sustainable energy and cities as complex systems will be the driver for the transition to "Smart Cities" that integrate new ways of thinking and cities modeling.

Today coal still represents over 35% of the current energy mix (British Petroleum, 2014), Renewable energy sources are still not big players in the industry. The Information Technologies (IT) Revolution has shown the capabilities of the infrastructure to become a more connected network. However, innovation is taking an important role in making more cost-effective projects for renewable. Moreover, smart cities are bringing the idea of energy efficiency. Smart grid and cities share the same advantages and features that, all combined, will bring continuous growth and innovation to large cities. To exemplify the previous, multidisciplinary approaches have focused on modeling and developing smart buildings, which model human and environmental behavior and integrate with other technologies such as storage.

To understand the concept of a City as a "Smart System", there are several characteristics that have to be integrated such as cost and energy savings, improved service delivery and quality of life, reduced environmental footprint, connectivity and access to information, Global Information Systems, and systems of systems (Holistic approach).

Cities are complex and dynamic systems, but they are also smart; people behave as autonomous agents and need to be modeled. Cities represent three quarters of energy consumption and 80% of CO2 emissions worldwide, and represent the largest of any environmental policy challenge (British Petroleum, 2014). Urbanization is only set to increase; cities house half the world's population today but are set to host three quarters in 2050 (The Guardian, 2014).

In Canada, buildings account for about 30% of total energy consumption, 53% of total electricity consumption and 28% of total GHG emissions (NSERC, 2012). The vast amount of energy consumption by buildings shows that a Smart City cannot exist without Smart and Sustainable buildings. Smart Cities requires Smart and Sustainable buildings that demand less electricity but eventually buildings can be a source of electricity through the use of renewable energy technologies.

The concept of a smart city is a reality and there exists a constant process of innovation at all levels, dimensions and disciplines. Some cities have already adopted this approach with success, and although it requires political willingness and it will involve some resistance of change from different sectors, the path is clear. Like Automobiles electrification, Smart Cities will bring new technologies and ideas to life and will boost the growth of new urban developing regions without impairing the quality of life. The transition to becoming a smart city is a process and cities must prepare for the transformational change as they put in place entirely new systems that interact with each other and people in extraordinary ways. City administrators must assemble the right team by integrating with other levels of government as well as private and non-profit sectors. Cities must take into account the interrelationships between systems. By using instrumentation, the condition of the systems can be monitored and trended and incorporating intelligence into this monitoring will enable pattern recognition and system optimization. At all times, the larger picture must be considered as a change to one system will impact others and the best approach is to consider the impact of change from all angles so maximum benefit can be achieved.

There are several constraints that the transition to a smart city will encounter. First of all, is competing with the management of change in Utilities companies and Government policies, where political willingness is needed to encourage the transition to Smart Cities by an integrative and holistic decision making process. Second, multidisciplinary approaches through think tanks will have to work on a framework to achieve the modelling of city behaviour and growth to plan ahead. Third, management of information through the models has to be homogenized to be easily interpreted by other sectors and disciplines; also protection of information has to be ensured. Fourth, diffusion of innovation has to take an important role to make people adopt new consumption habits and technologies to make systems modeling easier for companies and policy makers, one good objective to achieve this is to flatten the base and peak loads in defined urban

regions. In this regard, power supply will provide an example of a holistic approach in innovation by achieving the coverage of a service of an entire region with a smart grid.