Ottawa

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Hydrogen and the City of Ottawa's Energy Evolution Plan

The City of Ottawa's community energy plan, Energy Evolution, was passed unanimously by Ottawa City Council on October 28th, 2020. The plan created a 100% scenario which laid out the actions required to reduce greenhouse gas emissions (GHG's) on a timeline which will reduce Ottawa's emissions at a rate that's consistent with the global effort required to prevent global heating exceeding 1.5°C.

Like many community energy plans, Energy Evolution's emission modeling followed the global protocol set by the World Resources Institute on community energy and emissions modelling. Such community plans are unique because they are integrated and holistic. They are integrated in that they consider how individual actions proposed to encourage an energy transition plan impact all other actions under consideration. They are holistic in that they relate all actions to the pool of zero emission energy available and always require that changes to energy demand are met with changes in supply.

This rigorous approach can place community energy plans in a unique position to inform and comment on energy initiatives by other players (other governments, corporations, community lead projects). Hydrogen, for example was included in the City of Ottawa's Energy Evolution plan after being subject to the rigours of the plan's modelling process. The plan recognized synergies for making green hydrogen at places where renewable natural gas in generated and access to low cost electricity is possible.

The holistic nature of the plan, however, recognized the limitations of hydrogen relative to other energy options. This is most evident in our city's two largest emissions sources, building heating and transportation. In building heating, Energy Evolution values the use of heat pumps (a mix of ground and air source) most highly for heating as overall one unit of energy input can produce three or more units of heat. By comparison, combustion-based heating (which would include hydrogen blended into the gas grid) produce just under one unit of heat per unit of energy inputted. In transportation, research into power trains suggested that battery electric power trains are more efficient than fuel cell power trains and the scenario modelling assumed that battery electric power trains will become the preferred technology. In fairness however, the direction for zero emission heavy fleets has yet to play out and won't be determined by municipal governments.

Should the future of heating and transportation rely more on combustion and fuel cells respectively than the current 100% scenario foresees, a considerable amount more zero emission electricity will be required. Its notable that the current scenario model foresees the need for 3.2 GW of additional wind[1] and 1.1 GW of solar for Ottawa by 2050 in addition to a modest contribution from additional hydro power. At 2050 its anticipated that annual hydrogen production will be 85 TJ at 80% efficient production facilities and that this will be blended into 540 TJ of biogas derived from wastewater and municipal solid waste.

Hydrogen and the City's Wastewater Treatment Plant

As mentioned, the City of Ottawa's Energy Evolution strategy identified the generation of green hydrogen at places where biologically based RNG can be produced. Currently, the City is undertaking a study on optimizing biogas production at its only wastewater treatment plant. Power to gas was included in the scope of work for this study to help it support the Energy Evolution strategy. This is fortunate, as the addition of a power to gas system at our wastewater treatment plant is showing strong potential.

Figure 1 shows the potential role of an electrolyzer at a wastewater treatment plant. What is important to note is that all products from the electrolyzer have potential for productive use:

- The most obvious product, hydrogen, can be readily blended into the renewable natural gas being produced from biogas from the treatment plant's anaerobic digesters.

- The oxygen can be used to enrich the air going to the wastewater aeration basins. With the air so enriched, a smaller mass of air is required to complete the process of wastewater aeration. This in turn means that the air compressors will have less air to move and will therefore consume less power. Air compressor power is the largest single use of electricity at the City of Ottawa's wastewater treatment plant.

- The heat used produced by the electrolyzer can be used as a thermal source at the wastewater treatment plant. Heating of anaerobic digesters and seasonal use of this heat in site buildings are the two potentially largest uses for the thermal output of the electrolyzer.

- As there are no limitations to the ramp up or ramp down time for the electrolyzer, the hydrogen production may have a role in grid regulation. For an individual customer, the bridge rectification of power feeding the electrolyzer should allow for a site to improve its power factor performance.

[1] Its anticipated that the wind power will have to be produced regionally as initial indications from a study currently underway indicate that this amount of wind power will not fit into the rural and urban areas of Ottawa.

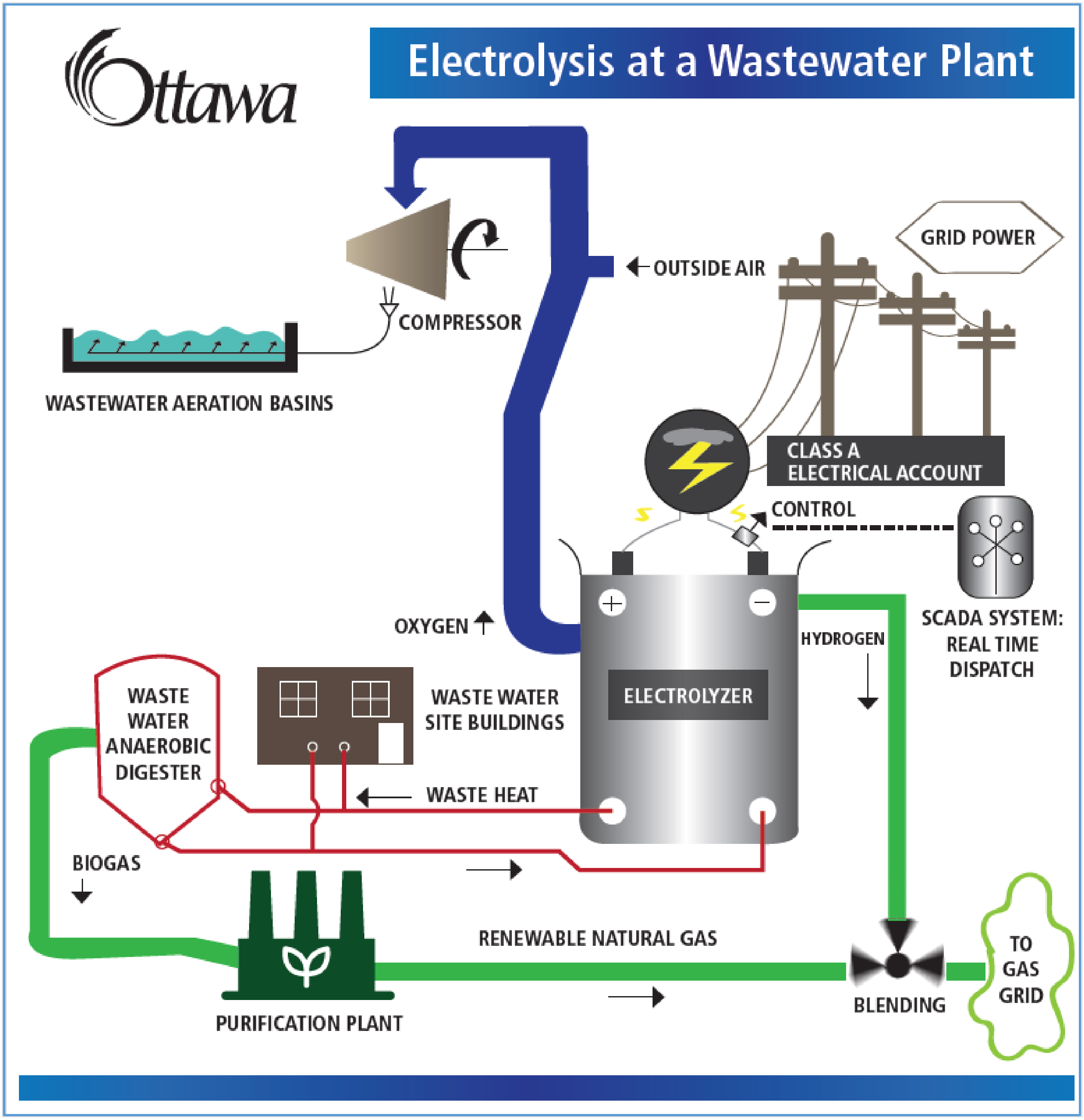

Figure 1: A Conceptual Arrangement of Electrolysis at Wastewater Treatment

Two major factors contribute to the value proposition we foresee in power to gas at the wastewater treatment plant. The first is that the site has a class A electrical account. Provided the prospective electrolyzer is dispatched to avoid the five annual provincial demand peaks, the average annual electricity cost should be relatively low. The City already had direct experience in accessing low cost electricity from class A accounts at City buildings with real time dispatch and feel we could extend this experience to the dispatch of an electrolyzer.

The second opportunity has not reached commercial scale but, after discussions with researchers at the National Research Council (NRC), it appears to hold promise. NRC has discussed how a wastewater treatment plant's by-products could be used to convert hydrogen into methane. Raw materials to convert hydrogen into methane would include sludge from the plant's anaerobic digestors and carbon dioxide from the purification plant which converts biogas into grid-grade renewable natural gas. The conversion of hydrogen into methane has the ability to eliminate production restrictions caused by a hydrogen blending rate limit (Energy Evolution assumes this will eventually be 15%) and to increase overall RNG production.

Other Synergistic Opportunities for Hydrogen

The thinking about the synergies about producing hydrogen at Ottawa's wastewater treatment plant could apply to other facilities. The following are ideas that may be with pursuing:

- In a hospital, the primary electrolyzer product might be oxygen, with the hydrogen perhaps finding a combustion service or being exported from the hospital site and the waste heat being used to help to meet the thermal demands of hospital, which are present throughout the year.

- In a district heating application, both hydrogen and heat could be valuable outputs from an electrolyzer. During lower thermal demand periods, heat from the electrolyzer could meet thermal demand while the gas could be exported as a premium-priced, ultra-low carbon fuel.

Conditions which Buttress Hydrogen Adoption

The Province's initiative to look at hydrogen through this collaborative approach is encouraging. At a high level, green hydrogen can work well with our province's electricity grid to make productive use of electricity when surpluses occur. Indeed, if hydrogen is lucrative, its generation could become a large source of dispatchable load, which could in turn encourage renewable generation development.

A plethora of actions can help Hydrogen advance and make a larger contribution to our climate goals. The following are ideas that have become apparent to us through our work:

- Market access to customers who will pay a premium for low carbon hydrogen. This seems to be in place and the focus should be on maintaining the required market structure and increasing demand for low carbon hydrogen.

- Access to low carbon electricity. This can be advanced by either allowing hydrogen producers to be virtual consumers of renewably generated electricity or, perhaps more ideally, by reducing the emissions intensity of electricity on the bulk electrical grid in Ontario.

- Access to low cost electricity. In the example of Ottawa's wastewater treatment plant, the facility is served by a class A account and we are confident about being able to avoid the ICI peaks and periods of high prices. Giving some kind of access to low priced electricity in class B accounts might be a consideration to allow further market penetration of this technology. This would also allow the electricity market to find a use and revenue stream for electricity during periods of relative abundance.

  Blending limits are a natural barrier to blending hydrogen into the existing gas grids. Efforts to increase the blending limit have been identified. One strategy may be to concentrate infrastructure changes in areas where hydrogen production is planned as opposed to waiting for province wide upgrades and a province-wide increase in the blending limit. Also, in areas where hydrogen production is planned, natural gas should be supplied without any upstream hydrogen enrichment. This will allow prospective projects to optimize hydrogen production from zero initial hydrogen concentration up to the full blending limit.

<u>In Summation</u>

The City of Ottawa thanks the Province for soliciting input on hydrogen. Wisely, the solicitation asked for niche or synergistic roles for hydrogen and we hope aspects of this submission have addressed this request. As discussed, hydrogen has a role in the City of Ottawa's community energy plan and the role of the Province is key. Access to low cost and low carbon electricity and the ongoing development of markets are, to a large extent, in the Province's realm and will be critical to accelerating hydrogen's expanding role in energy markets. Interest and technical developments in this field are growing rapidly and we look forward to further discussions.