The role for

Hydrogen Fuel Cells

to help achieve HRM's climate change goals.

Heritage Gas

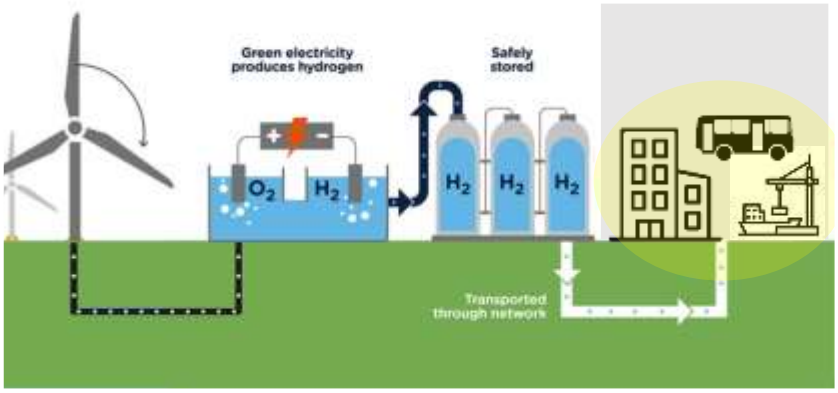
To achieve its targets of net-zero municipal operations by 2030 and net-zero community wide emissions by 2050, HRM must implement actions and solutions to eliminate emissions in every energy sector, including heavy transportation – a sector that will be difficult to decarbonize only with battery electric technologies.

Hydrogen fuel cell electric vehicles can help achieve HRM's net-zero municipal operations target by offering a practical solution to decarbonize HRM's heavy transportation fleets, including transit buses, ferries, and large trucks.

Until recently, the lack of access to affordable, low-carbon hydrogen in HRM has limited the potential for fuel cell vehicles over the next few years. However, hydrogen development is advancing quickly. Jurisdictions around the world, including in Canada,

have concluded that low-carbon hydrogen will be needed to achieve net-zero emissions by 2050, and they're working on hydrogen strategies, action plans, and projects to support global hydrogen development. The Hydrogen Strategy for Canada, released by the Government of Canada in December, 2020 set the development of a clean hydrogen economy as a strategic priority for Canada.

Hydrogen, like electricity, is a sustainable and clean **energy carrier** that doesn't emit any GHGs when it's used.



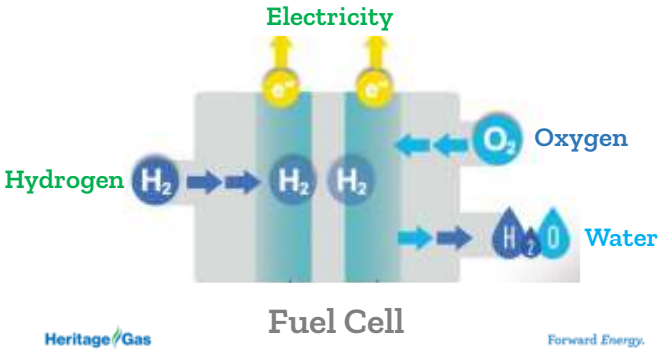
Low-carbon or "green" hydrogen is produced by using renewable electricity to split water molecules into hydrogen and oxygen in a process called electrolysis. Hydrogen can be safely stored in tanks, blended with natural gas, or transported by pipe or truck to be used in other applications, like heavy transportation.

Heritage Gas is working on a project to produce low-carbon hydrogen in HRM. We recently applied for funding to support our proposed 5 MW hydrogen project that will produce about 700 tonnes (100,000 GJ) of low-carbon hydrogen per year – enough to fuel about 50 transit buses, or to heat 1,000 homes. The project will produce hydrogen through electrolysis using renewable electricity from a local wind project.

The electrolyzer facility is proposed to be located in Burnside, only a few hundred metres from Halifax Transit's Burnside garage. Some of the hydrogen will be blended in the natural gas distribution system, and the rest will be available to supply heavy transportation applications in the Halifax area including vehicles operating at one or more Port of Halifax sites, drayage trucks transporting shipping containers around HRM, the new rail shuttle between the Port of Halifax's South End and Fairview Cove container terminals, or even Halifax Transit's new zero-emissions ferry between Bedford and downtown Halifax.

In transportation applications, the hydrogen would be used in a fuel cell that, like batteries, produces electricity and emits no GHGs.

A battery stores energy in its electrodes to produce electricity, while a fuel cell combines hydrogen and oxygen to produce electricity and water vapour. In essence, a fuel cell is like an electrolyzer working in reverse.



Fuel cell vehicles ARE electric vehicles. Batteries and fuel cells both produce electricity that can power a vehicle motor, and both can eliminate transportation emissions if zero emitting energy is used as input.

Batteries and fuel cells each have unique advantages and disadvantages that determine their best applications in the transportation sector. For passenger and light duty vehicles that sit idle for much of the time, usually travel short distances, and don't carry much cargo, batteries are practical.

In the heavy transportation sector, however, both batteries and fuel cells will have a role to play. Fuel cell electric vehicles have the advantage of longer range, much faster refueling times, and more cargo or passenger capacity, and more power when it's needed, like on hilly terrain.

For example, whether powered by a battery or a fuel cell – electric buses produce zero tail pipe emissions. Fuel cell electric buses have the same electric drivetrain as battery electric buses, and battery electric and fuel cell electric buses share over 90% of the same parts.

Battery electric buses, like the sixty buses that Halifax Transit has committed to purchase, have some advantages over fuel cells. However, fuel cell electric buses also have important advantages over batteries, especially on long or hilly routes.

A fuel cell bus stores hydrogen in on-board pressurized tanks. Hydrogen is a very light fuel, so significantly more energy can be stored on a fuel cell electric bus than the equivalent weight of batteries. This enables significantly longer ranges, especially in cold winter weather.

Hydrogen fuel cell electric buses can match the performance of diesel buses and are simpler to integrate into the operations of diesel bus fleets than battery electric buses. They have a range of up to 500 km. before refueling vs. 250-350 kilometers for battery electric buses, and the range and operation of a hydrogen fuel cell electric bus is not negatively impacted by cold weather or hilly routes, and – unlike with battery electric buses- range doesn't deplete over the life of the bus.

Hydrogen is ideal for the centralized fueling of transit buses. While battery electric buses are typically re-charged overnight in 4-6 hours, fuel cell electric buses can be refueled in less than 10 minutes, similar to the way that Halifax Transit's diesel buses are refueled today. Beyond a

fleet size of 40-50 buses, the cost per bus for refueling infrastructure for fuel cell electric buses is typically lower than the charging infrastructure for battery electric buses.

While the upfront capital cost of battery electric buses is currently lower than for fuel cell electric buses, the gap is narrowing quickly as fuel cell technology advances and bus manufacturers scale up production of fuel cell buses.

This comparison is similar for ferries. Compared to battery electric, fuel cell electric ferries offer more fueling and scheduling flexibility – a hydrogen ferry can operate all day using the hydrogen on-board and fuel overnight in about 45 minutes, while a battery electric ferry will need to be charged after each trip, making hydrogen fuel cell ferries more flexible and resilient to schedule disruptions like power outages.

Both battery electric and fuel cell electric vehicles have a role to play in HRM's transportation decarbonization plans. Heritage Gas is looking forward to supporting HRM to evaluate the opportunity to help decarbonize the city's heavy transportation fleets - including transit buses, ferries, and refuse trucks - with fuel cell electric vehicles.

Heritage Gas is interested in working with Halifax Transit to complete a business case for a fuel cell electric bus pilot project. Heritage Gas would also like to discuss the role for hydrogen fuel cell electric buses as part of their transition to a zero-emissions fleet to ensure that the design and construction of the new Burnside transit garage will have the capability to refuel hydrogen fuel cell buses.