The Agence métropolitaine de transport (Metropolitan Transportation Agency, hereinafter AMT) is a government agency with a regional mandate and a mission to plan and promote public transportation services in order to improve the efficiency of public transportation in the Greater Montréal Area. The AMT presently operates 5 commuter train lines, 51 stations, 1 metropolitan express bus line, 61 park-and-ride parking lots with close to 31,000 parking spaces, 16 metropolitan terminuses and 82.5 km of reserved transit lanes. The commuter train system currently averages close to 16 million trips annually, ranking 6th among major metropolitan areas across North America.

To reduce transportation-related greenhouse gas (GHG) emissions and continually improve public transportation's competitive advantage over the automobile, we must increase our use of renewable energy, in this instance hydroelectricity, given Quebec's position as the world's fourth largest producer of hydro-power. As stated in its Strategic Plan, one of the AMT's main goals is to increase its reliance on renewable energy in operating the regional public transit system. As automobiles are becoming increasingly energy-efficient, public transit must undertake a swift transition to renewable energy use to keep pace and to enhance its competitive advantage, in addition to making a bigger contribution to sustainability on a region-wide basis.

The AMT is already very active in this area and several electrification projects are currently under way, including a major study on the electrification of the commuter train network, the acquisition of hybrid (dual-mode) locomotives, the implementation of a network of electric car plug-in stations and CLIC, the state of the art car-pooling program using electric cars.

1. DEVELOPMENT AND IMPROVEMENT OF SUSTAINABLE URBAN TRANSPORTATION

Commuter Train Network Electrification Study

In conjunction with the Quebec Government's Electric Vehicle Action Plan (*Plan d'action sur les véhicules électriques*), the AMT is looking to expand the electrification of its commuter train service. With the opening of the *Train de l'Est* (Mascouche Line), the commuter train network will include a total of six lines, only one of which, the Deux-Montagnes Line, is presently electrified. In 2011, the rolling stock on these lines consumed close to 10 millions liters of diesel fuel, generating thousands of tons of GHG emissions.

The results of a recently completed feasibility study have confirmed the value and importance of this electrification initiative. As a next step, the AMT will establish a project office with the mandate to conduct the preliminary studies required for the electrification of the commuter train network. This phase of the project will involve the following activities: development of the functional and technical program; visual and noise impact studies; cost estimates and life cycle analysis; development of the financial strategy; development and implementation of the master plan; and: development of the preliminary engineering plans.

With these preliminary studies, the AMT will be in a position to clearly define the project parameters as a first step of the overall plan to achieve the stated Government goal of electrifying 95% of public transportation by 2030. Ultimately, achieving this goal of replacing diesel fuel with

electrical power would prevent the release of 95 kilotons of greenhouse gases (GHG) into the atmosphere.

In addition, the AMT and Hydro-Québec are looking to work together in setting up the project office. In keeping with its' Land Transportation Electrification Action Plan (*plan d'action en matière d'électrification des transports terrestres*), Hydro-Québec is considering the possibility of providing financial support to the AMT's commuter train network electrification initiatives.

In June 2011, the AMT received the preliminary results of the feasibility study, which clearly attest to the potential for electrification and its economic benefits. In August 2011, the master plan was developed in cooperation Hydro-Québec to establish the commuter rail line electrification priorities. The lines offering good electrification potential include the Vaudreuil-Hudson Line, Blainville–Saint-Jérôme Line and the future Mascouche Line. Discussions are under way with the right-of-way owners, namely Canadian National (CN) and Canadian Pacific (CP), and with Hydro-Québec to get the Commuter Train Network Electrification Project Office up and running. Once the requisite agreements have been signed, preliminary engineering studies will be undertaken.

In Québec, hydroelectric power is deemed over 95% renewable. The use of this energy source has a significant positive impact on air quality in urban areas, and this would be especially more evident in communities located close to commuter rail lines. Trains that run on electricity are significantly less noisy than diesel trains, and vibration-related impacts are also much lower. People who live close to commuter rail lines experience a noticeable improvement in their quality of life with the use of electric locomotives, which are much quieter. In essence, this project promises significant benefits to commuter train users and those who live nearby, with shorter commuting times, less noise and lower GHG emissions and other contaminants. In addition, the project offers improvement opportunities in the areas of frequency of service and overall reliability.

Over the 40-year timeline used for this analysis, the forecast operating cost savings relating to electrification would be in the $130M to $150M range, based on lower energy costs and increased revenue to the State from the purchase of electricity ($107M). In addition, the cost-benefit ratios are very promising, as they would vary between 0.946 and 0.723 for the entire network. The overall economic benefit for Quebec would be very significant, with an additional net contribution of $1.8G to the GDP and $87M in additional net revenues to the Quebec Government.

It should also be noted that this project is consistent with Quebec's national and international commitments in the areas of climate change and sustainable development, in addition to reducing our reliance on fossil fuels.

Acquisition of dual-mode locomotives

In 2008, the AMT issued a contract for the purchase of 20 new ALP-45DP dual-mode locomotives, and took delivery of the first of these in 2011. These locomotives can operate in electrical mode under catenaries or in diesel-electrical mode on non-electrified rail lines. These are state of the art machines designed specifically for passenger trains. Diesel-fueled traction is provided by two standard diesel motors complying with current emissions standards, and they achieve superior energy-efficiency through a highly innovative power management system.

The electrification of the commuter train network, including the deployment of dual-mode locomotives, will have significant noise-reduction benefits, as these locomotives run much more silently in electrical mode than standard diesel engines. These electrical engines are smaller and operate at higher speeds, making them significantly quieter. In addition, diesel engine ventilation systems typically generate a great deal of noise, while in dual-mode locomotives, these ventilation systems run at variable speeds, greatly reducing noise levels. This would have a major positive impact for those who live close to train stations and staging areas, as locomotive noise-related disturbances would be greatly reduced.

These locomotives require less diesel fuel, as when they are in electrical mode, they consume no fuel at all. These reduced fuel requirements will bring major cost savings. The purchase of dual-mode locomotives to replace the existing diesel locomotives will make the entire AMT fleet more homogeneous, with numerous benefits such as reduced spare parts inventory requirements, simplified maintenance and increased operational flexibility, in addition to providing more opportunities to electrify additional lines or line sections in response to increases in the cost of fossil fuels, combined with lower GHG emissions, as most of the electricity produced in Quebec is from hydro-electrical sources

The dual-mode ALP-45DP locomotives fully comply with the new 2012 EPA (Environmental Protection Agency) atmospheric emissions standards: they respect all established gas and contaminant emissions thresholds. As the locomotives presently in use on the AMT commuter train network do not comply with the new 2012 standards, these new locomotives will represent a major step forward from an environmental standpoint. In addition, when the new locomotives operate in diesel mode, they will require much less fuel as they run much more efficiently than the existing locomotives. And when operating in electrical mode, they burn no fuel whatsoever and release no gases or contaminants into the atmosphere, which is a major environmental plus.

The Electrical Circuit and CLIC, the plug-in car-pooling system

During the summer of 2011, the AMT joined forces with Hydro-Québec and other corporate partners (Rona and Saint-Hubert) to establish the Electrical Circuit (*le Circuit électrique*), Canada's first public network of electric vehicle plug-in stations. Providing clean and renewable energy, these plug-in stations will be available to the public starting in Spring 2012, first on-site at project founding partner business locations, and later at select AMT stations and park-and-ride facilities. A total of 120 plug-in stations will be implemented, including close to 40 at AMT facilities.

Electric vehicle users will take comfort in knowing that they will have access to plug-in stations in publicly accessible locations, if needed. At first, the Electrical Circuit will include close to one hundred 240 V plug-in stations. These will be followed by the installation of 'quick-charge' 400 V stations, once these have been approved for use in Canada.

As a partner agency, the AMT is working with Hydro-Québec to implement new technologies that will assist thousands of people using electric cars. By making plug-in stations available at AMT park-and-ride facilities, we are providing direct access to the public transit system at key points of convergence for automobile users. These plug-in stations bear witness to the AMT's commitment to the greater use of renewable energy in all facets of public transportation.

The network partners are solid, long-established Quebec companies who are deeply committed to sustainable development, client satisfaction and the future of electrical vehicles. These publicly accessible plug-in recharge stations are of key importance to electric car users as they will answer their top-up and emergency needs. In addition, CAA Québec has also committed to the project by offering a 24/7 emergency telephone assistance service.

This initiative is the first step in the deployment of the recharge infrastructure that is crucial to the arrival of rechargeable electric vehicles in Quebec. It is a key component of the Electric Vehicle Action Plan launched by the Quebec Government in April 2011.

In addition, the AMT is also a key partner in CLIC, the plug-in car-pooling system, a pilot car-pooling program using electric vehicles exclusively initiated by the City of Laval. In this program, a total of ten four-person teams – who live in the same neighborhood and travel to work daily on the same schedule – are provide with a Chevrolet Volt electric vehicle to travel to and from their homes to one of three Laval park-and-ride facilities (Montmorency, Cartier or Sainte-Dorothée). The entire commute is fuelled by electricity, first with the electric car, then by subway or the Deux-Montagnes electrified commuter train, and back again. At the park-and-ride facility, pilot program participants are given a reserved parking space and access to the public plug-in recharge station.

The CLIC program is an important step toward sustainable mobility. This new form of car-pooling will enable the City of Laval to broaden its' offer of eco-friendly transportation alternatives, in addition to contributing to the City's commitment to increased energy-efficiency as part of its GHG reduction strategy. This initiative not only works to reduce fuel consumption, but also encourages the use of 'zero GHG emission' vehicles that are extremely energy-efficient and play a key role in achieving emission reduction target sooner.

2. DEGREE OF INNOVATION

Commuter Train Network Electrification Study

The AMT commuter trains use a rail network belonging in large part to the Canadian Pacific (CP) and Canadian National (CN) railway companies. As the AMT is planning to electrify the network, agreements will need to be signed with each of these partners to establish operational processes that are to the advantage of all parties involved. In that respect, this network electrification initiative is highly innovative as it provides for the electrification of rail lines that are currently in use and do not belong to the AMT, which is a major challenge in its own right.

In addition, striking a partnership with Hydro-Québec, the province's only energy producer, is also highly innovative. Establishing a close association with the entity that actually produces the energy required for the project is a very promising for future success. In addition, Hydro-Québec has also been enlisted as a key partner in the requisite preliminary studies relating to the electrification of individual and public transportation systems, and the AMT is proud to have established a partnership with a leading hydro-power producer that has long-standing commitment to sustainable mobility.

Finally, this project comprises another highly innovative aspect, namely the technical solutions and processes developed to provide the vertical clearances necessary for network electrification. The installation of the necessary overhead contact wires requires different types of improvements to various structures. According to preliminary studies, a total of eleven structures will require new types of improvements and five of these will need to be substantially modified.

It is worth mentioning that the Deux-Montagnes Line was the first electrified commuter rail line in Canada.

Acquisition of dual-mode locomotives

On August 18, 2008, the AMT became the first passenger transportation agency in Canada to acquire dual-mode locomotives. As a result of a joint proposal call with New Jersey Transit (NJT), a contract for construction of 20 dual-power locomotives was attributed to Bombardier Transport. This contract also includes provisions for the construction of 10 additional locomotives. This represents a total investment of $236.3M (US$223M). By associating with NJT, the AMT was able to realize substantial savings on the purchase of this rolling stock, as it was able to its' R&D and project monitoring costs by 50%. The AMT took delivery of its' first dual-power locomotive in summer 2011. This rolling stock will be incrementally deployed over the entire commuter rail network. Static and dynamic tests are currently being conducted on various railway sections.

As mentioned, the ALP-45DP model is the first North-American locomotive to run on diesel fuel or electricity (with pantograph for overhead wires). In addition, when operating in electrical mode, these locomotives develop additional power. These new units include a vast array of new technological features, including smart screens and diagnostic systems that can be accessed remotely from select AMT offices. Eventually, the widespread use of these dual-mode locomotives on all AMT commuter rail lines will make the entire AMT fleet more homogeneous, which will provide increased operational flexibility and increased reliability through simplified maintenance operations and newer equipment.

The Electrical Circuit and CLIC, the plug-in car-pooling system

The Electrical Circuit is the first public network of plug-in recharge stations for electric vehicles in Canada. This demonstrates Quebec's commitment to innovation and is a major step in the move to sustainable mobility. In this regard, Quebec is taking a cutting edge approach in its push to achieve its greenhouse gas emissions reduction goals.

CLIC is a bold, user-friendly and eco-friendly approach to public transit, as it is the first to introduce the concept of entirely electrified commuting including the use of electric cars, giving the car-pooling teams involved the opportunity to commute in a new and different way. The project provides a multi-modal, sustainable, fully integrated and eco-friendly commuting experience, a truly new way to experience the daily commute.

CLIC presents public transit in a new light. This innovative approach to car-pooling, with electric cars and reserved parking spaces in designated park-and-ride facilities, adds a totally new dimension to the quality and diversity of services provided by our transportation agencies.

3. TRANSFERABILITY TO OTHER COMMUNITIES AND ORGANISATIONS ACROSS CANADA

Commuter Train Network Electrification Study

Firstly, it has been shown that the electrification of the commuter train network is cost-effective, mainly because of the switch to hydroelectricity. Hydro power is a clean, 95% renewable energy source that is less expensive than fossil fuels, and will become even more cost-effective as oil prices keep climbing. Therefore, comparable projects could be implemented in other Canadian cities, especially larger urban areas such as Vancouver, Calgary and Toronto.

As a demonstration of the actual transferability of the knowledge acquired, the AMT is currently working with Metrolinx on the electrification of the GO Transit commuter train system in Toronto. The AMT and GO Transit situations are at a similar stage in their development. GO Transit already has one fully electrified commuter train line, and is looking to electrify the entire network over time. Both agencies are sharing the results of technical studies and are collaborating on key issues.

Acquisition of dual-mode locomotives

When it comes to acquiring dual-mode locomotives, the AMT is one the most experienced transportation agencies in Canada. There are several other similar commuter train networks across the country where the acquisition of dual-mode locomotives would improve the bottom line. Indeed, several Canadian transportation agencies have expressed interest in obtaining more details on these locomotives. GO Transit officials regularly meet with AMT authorities to ask questions to explore ways to incorporate this new technology into their operations. Without a doubt, the acquisition of dual-mode locomotives by AMT has made urban transportation officials across the country take notice.

The Electrical Circuit and CLIC, the plug-in car-pooling system

The network of plug-in recharge stations will be deployed gradually, keeping pace with the increased presence of electric vehicles in the Quebec market. The network will first be established in the metropolitan areas of Montréal and Quebec City, followed in time by other urban areas and select locations across the province. The actual location of the plug-in recharge stations will be chosen by the program partners based on specific criteria, such as ease of access. The primary objective will be to provide simple and easy recharge services to the greatest number of users possible, combined with a quick and easy payment system.

The CLIC plug-in car-pooling system could easily replicated in other communities where at least part of the public transit system is electrified. The success of this type of project rests on the active involvement of several key stakeholders with a strong commitment to sustainable development.

These two eco-friendly projects are entirely transferable to other communities across Canada. First, the Electrical Circuit is easily accessible to a broad range of companies. It only needs a

partnership structure and designated parking areas with plug-in recharge stations. The project implementation costs are relatively low, and the environmental benefits to the company are very high.

4. VALUE ADDED

Commuter Train Network Electrification Study

The key distinguishing feature of this AMT project is the partnership with Hydro-Québec to establish the project office. In keeping with the objectives stated in its Land Transportation Electrification Action Plan, Hydro-Québec could potentially provide financial support for the electrification of the AMT's commuter train network.

In 2009, the AMT and Hydro-Québec jointly sponsored a study to identify the commuter rail network sections with the best potential for electrification. This was the first step in the endeavor to electrify the entire network. Hydro-Québec provided funding for this study.

Acquisition of dual-mode locomotives

By providing the possibility of switching from diesel propulsion to electricity as needed, this new locomotive the operational flexibility required to run on partially electrified rail lines. This multi-purpose function and ability to adapt to various urban rail network configurations make this locomotive the ideal choice for the AMT network.

In combination with the deployment of the 160 new bi-level passenger cars, these 20 new dual-mode locomotives will increase the AMT commuter train peak period capacity by 70 %, and will be able to accommodate close to 43,000 passenger-trips per day. These new locomotives also represent a major leap forward: the electrification of the entire AMT commuter rail network is no longer just a possibility, it is now technically feasible. This acquisition of these locomotives will lead to the further exploration of new electrification possibilities, in cooperation with Hydro-Québec.

As stated previously, the AMT joined forces with New Jersey Transit for the acquisition of this new rolling stock. In addition, the AMT received financial support from the MTQ, which provided 75% of the funds required for the purchase of the dual-mode locomotives. When the AMT took delivery of the first dual-mode locomotive, several promotional activities were held. During the official unveiling, a media briefing was organized with in attendance Mr. Joël Gauthier, CEO of AMT and Ms. Anne MacDonald, Vice-president of Business Development and Communications at Bombardier Transportation North America.

The Electrical Circuit and CLIC, the plug-in car-pooling system

The plug-in car-pooling project and the implementation of the network of recharge stations would not be possible without the involvement and financial participation of several partners. For the Electrical Circuit project, the AMT is proud to have formed a partnership with Hydro-Québec for the installation of plug-in recharge stations in several AMT park-and-ride facilities. For the CLIC

project, the AMT naturally joined forces with the project initiator, the City of Laval, and other commercial partners, including Hydro-Québec, for various aspects of the project.

This new eco-mode sharing concept involving an electric vehicle will provide an entirely electrified commuting experience. In addition, eco-mode sharing involves a transition from an individual mode of transportation (one individual, one car) to a shared mode of transportation (car-pooling), as well as a transition from a polluting mode of transportation (fossil-fuel burning automobile) to a cleaner mode of transportation (electric car). In a nutshell, the CLIC pilot project provides a multi-modal, sustainable, fully integrated and eco-friendly commuting experience.

For the Quebec Minister of Transport, also closely associated with the project, it is a major step in the implementation of the 2011-2012 Electric Vehicles Action Plan. For a future built on a strong and real commitment to sustainability, every facet of Quebec society must rise to the challenge of sustainable mobility and innovation. This major AMT initiative shows a deep and abiding commitment to eco-responsible transportation.