SUMMER COURSE 2020

ECO-QUARTIER LACHINE-EST
SUMMARY BROCHURE

ENCS 691 GA in Urban Energy Systems
from CERC Prof. Ursula EICKER
and the NEXT-GENERATION CITIES team

Photo by: Soufia Mohammadi
Master student CERC team

14 INTENSIVE SUMMER DAYS,
PROF. URSULA EICKER,
A REAL-WORLD PROJECT,
A TEAM OF 30 STUDENTS
AND 40 EXPERTS CO-CREATED
INNOVATIVE AND INTEGRATED
URBAN ENERGY CONCEPTS
FOR THE NEXT-GENERATION
ECO-QUARTIER LACHINE-EST

THE PROJECT

The content of the engineering course ENCS 691 GA in “Urban energy systems” was initiated by three women, when the paths of the Concordia’s Canada Excellence Research Chair in Smart, Sustainable and Resilient Communities and Cities, Prof. Ursula Eicker, the developer Natalie Voland (Quo Vadis) and the Lachine Mayor Maja Vodanovich were crossing. Three different perspectives, three different approaches and personalities and one aim: consciously and pro-actively fighting and preventing the consequences of climate change by providing a better, liveable and healthier future for the living in a next-generation neighbourhood. The pilot project of Eco-quartier Lachine-Est unified the strengths of the innovative scientific know-how, the best sustainable building and construction know-how, and the open-mindedness, willingness and engagement of a local decision-maker. Together they decided to create a pilot project showcasing what an innovative and holistically co-created Eco-Quartier means. This project’s place is a historically significant site in Lachine-East. The Dominion Bridge company produced innovative bridge systems that made it possible to build the railway through Canada to connect the east with the west coast.

Under the supervision of Prof. Ursula Eicker, the CERC Next-Generation Cities Team has designed and performed an engaging course. Within the summer course, the students had a unique chance to get in touch with practitioners, improve team and collaboration skills, and work pro-actively on an innovative real-world project. Valuable input from experts, local decision-makers, developers, and community groups supported the course participants in understanding the complexity, the chances, and the project’s challenges and obstacles.

The course outcome showcases proposals for innovative sustainable urban energy systems for the development of the Eco-Quartier Lachine-Est. These proposals are based on several urban design scenarios developed by the students that were used to find solutions for buildings efficiency and renewable integration, active transportation and intelligent waste management. The different concepts aim to present the pros and cons of various sustainable energy approaches and their applicability within innovative Eco-Quartier projects.

The integral concepts for the ex-industrial heritage area of Dominion Bridge offer different solutions for transforming this place into a liveable, desirable, sustainable and energy-efficient neighbourhood.


HOPITAL DE LACHINE
PARC LASALLE
Rue Victoria
Rue William-MacDonald
6e Avenue
ECO-QUARTIER LACHINE-EST IN THE FORMAL DOMINION BRIDGE AREAL
Avenue George-V
Rue Victoria
GARE DU CANAL
Boulevrd Saint-Joseph
Rue Saint-Louis
Boulevrd Saint-Joseph
Rue Saint-Patrick
Lieu Historique National DU CANAL DE LACHINE
CANAL DE LACHINE
PORT DE PLAISANCE
MUSEE DE LACHINE
Chemin du Musee
PARC MARRONI
CITY HALL PARK
PARC MARTINEAU
PARK DALMANY
PARK MOHAWK

THE VALUABLE COLLABORATION

Maja VODANOVICH

Lachine Mayor

It was an immense pleasure for me to partake in Ursula Eicker's summer class, exchange and learn from so many talented, intelligent and passionate students.

Last summer, 500 000 citizens marched in Montréal asking politicians to take action to fight climate change. Taking the right kind of action and making the right decisions is an immense responsibility and a difficult task for politicians. It is why academic research and innovation are more important than ever, it is why we need to work together.

We can only fight climate change through our collective intelligence. The problems we face are complex and far reaching. I hope that we continue our collaboration.

I have faith that when investors, promoters, bankers, academics, scientists, engineers, artists, and lawmakers come together that we will be able to find the answers and build a more durable way of life for all.

Thank you for sharing your work and research with me!

Lachine
Montréal

NEXT-GENERATION ECO-QUARTIER LACHINE-EST

UNIVERSITÉ Concordia UNIVERSITY

CERC NEXT-GENERATION CITIES
CANADA EXCELLENCE RESEARCH CHAIR FOR SMART, SUSTAINABLE AND RESILIENT CITIES AND COMMUNITIES

Prof. Ursula EICKER

Canada Excellence Research Char (CERC) in Smart, Sustainable and Resilient Communities and Cities, Concordia University, Montréal

Next-generation eco-quartiers are inclusive, connected, collaborative, ecological, healthy, mobile, and encourage engagement. Next-generation eco-quartiers not only seek to protect resources and urban landscapes, they also accord greater importance to connectivity and knowledge exchange.

Our summer course project in Lachine-East is an outstanding example of public and citizen engagement to ensure that this urban community will be empowered, resilient, prosperous and equitable. Concordia University´s CERC team focuses on transforming and creating eco-quartiers that are built for this and the next-generation - quartiers that are sustainable and livable communities where people can thrive.

With the advent of smart cities, urban districts are increasingly connected, automated and interwoven with technology. Our next-gen approach critically engages with the smart city idea and asks the question “how do we create zero carbon eco- quartiers and who are they built for?” Smart city concepts should not only allow the optimization of city’s operation, but focus on the quality of life of its inhabitant’s and the types of relationships they maintain with one another.

Eco-quartiers in Montréal are widely discussed and so far mainly concentrate on greening, urban farming, healthy food access, waste management and sustainable transportation. This is not surprising, as the clean hydro-electricity in Québec and electric heating in the building sector results in a very low carbon footprint of housing. Transportation clearly is the major ecological challenge in Montréal. All the same, the buildings remain major energy consumers and if they become energy efficient, green electricity will become available for transportation and the goods and services sectors.

The time is ripe for sustainable construction, where low carbon, recyclable materials are used and where excellent insulation standards lead to very low building energy consumption.

In the Lachine-East project, the student team developed 3D models of all the buildings and critically investigated the impact of urban density and building construction on the energy demand and local renewable potential. We showed that with highly efficient buildings more than 50% of the total energy can be covered with local photovoltaics and that a geothermal heat pump system can deliver heat and cold to all buildings. A green space layout with urban farming and a mobility hub with e-cargo bikes and car sharing provides an infrastructure for active transportation and zero carbon logistics. An intelligent waste strategy with re-use centers and waste to energy projects completed our analysis.

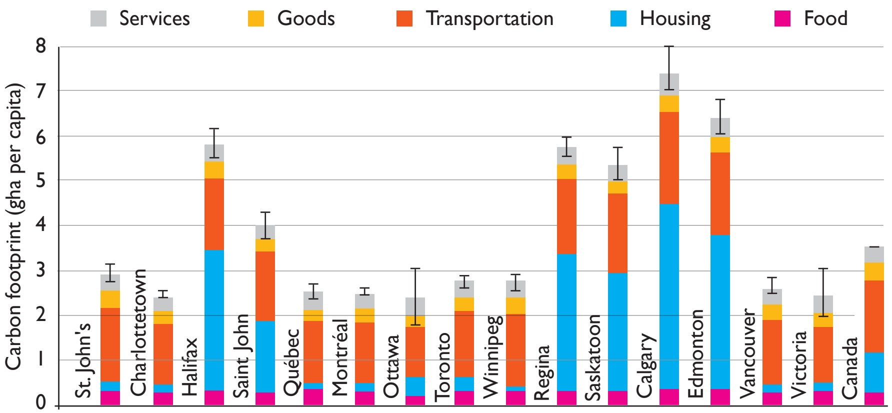

Figure 1: Based on the Ecological Footprint assessment for targeting climate change mitigation in cities: A case study of 15 Canadian cities according to census metropolitan areas, Journal of Cleaner Production, Volume 174, 2018, Margaux Isman, Maude Archambault, Patricia Racette, Charles Noel Konga, Roxana Miranda Llaque, David Lin, Katsunori Iha, Claudiane M. Ouellet-Plamondon

Lachine-East is an exciting project to become reality in the next decade. We very much hope to stay involved in this adventure and continue our collaboration with the Mayor of Lachine and our company partners that already became allies and friends during our endeavors.

THE CHALLENGES IN THE REALIZATION OF AN ECO-QUARTIER

GESTION IMMOBILIÈRE
QUO VADIS

Natalie VOLAND

Sustainable Community Developer from "Quo Vadis," Public Speaker and Concordia's INDI program Ph.D. candidate

The Lachine Est project has been an amazing opportunity to define the challenges and opportunities to build an eco-quartier in Montréal's urban setting. Having discussions and work sessions with architects, engineers, environmental remediation consultants, city elected officials and planning authorities, local community groups, and engaged citizens, alongside developers and University research specialists has allowed for frank discussions on the facts on hand and the opportunities to build for future generations.

DEFINITION & MEASUREMENT

Early on, we realized that not everyone had a clear definition of an eco-quartier and how one would measure the impacts of such a new type of development. Each interest group had a different definition of what an EQ was, based on their individual goals. For instance, a community group insisted that an EQ had zero cars, which would immediately impact the businesses and new residents with difficult access to their work or home. If they could not have access to a car as public transportation is limited in Lachine Est, with currently over 70% of current Lachine residents having to rely on single cars. An EQ for some developers meant high density that would allow for easier access to positive cash flows so that the land costs of the highly contaminated sites would be absorbed. However, high density alone could negatively affect the community if services are not locally available. Higher levels of traffic impact the quality of life of existing citizens paired with difficulties of integrating higher density buildings with an existing community used to 3-floor buildings.

With the work of Concert'Action Lachine and their themed Ateliers, definitions and guidelines are being developed to have clear definitions and targets for the proposed EQ with the option of having groups like GRAME and Universities to be able to have an independent way of measuring impact for the new propositions.

HOW TO BUILD

As Lachine Est could become Montréal's first EQ, there are no precedents in the area as to how to build such a community and no backstop to see what the challenges and opportunities could be for each stakeholder. The City of Lachine, being led by their Mayor Maja Vodanovich, worked for over five years with other cities worldwide to discover the best practices of cities like Strasbourg, to draw on their experiences and knowledge they built their communities. NPO's like Concert'Action Lachine, GRAME, Vivre en Ville, Imaginer Lachine Est, and engaged citizens have amassed a considerable amount of information on what they would like to see included in the building of their future EQ. Lachine's community has engaged many thought leaders and now have developed an extensive partnership with many of Montréal's Universities to work together to make this dream a reality.

NIMBY

Regardless of everyone's good wishes to build better, even for the community's long-term inclusive development, people still do not adapt well to change. Often residents want to pick and choose parts of new development without understanding that the EQ needs many moving parts to work together to make it work. For example, the cost of acquisition of lands that are heavily contaminated due to heavy previous industrial use, higher prices per square foot associated to inclusive master planning, and best practices for engineering modeling on alternative energy loops, paired with higher quality construction methods all can be seen as cost overruns to "traditional" development and need to be accounted for somehow. These additional costs must be borne by government subsidies, research grants, bonus densities, and favorable financing options to make the development feasible.

Besides, some community groups want a new tram to be built to better access public transit. However, the transit authority needs density and possible ridership to pay for this tram's long-term operation, which translates into high-density requirements for an area to justify the tram's public investment. These opposing interests can cause friction in the development of an EQ, as some current residents want the tram without the new increase of residents. Financial realities must be considered and carefully mitigated with accepted best practices that will demonstrate that the favorable new amenities to the area like better access to public transportation, can outweigh the perceived negative impacts of more people. More people can also lead to better security in an area and increase local stores' offerings as more services can often move into an area if more people support local businesses.

Another example of NIMBY is, for instance, access to a great local market. The current market has not been a success as there are not enough patrons to make such a market feasible in the long term. However, this local produce market could work with the addition of double the current Lachine population to come onto Lachine Est lands over the next ten years. It could benefit the current citizens and mitigate their push back to the development of the EQ. This push back is not without reason; many developments do not integrate the new residents well with the existing residents that often result in NIMBY syndrome and the negative effects of gentrification. This new governance process that the Mayor of Lachine and Lachine's stakeholders have embarked on definitely shows that working together to address shared concerns, policies, and processes can be put in place to mitigate the most disturbing negative effects of gentrification. Policies of social and economic inclusion and opportunities for the expansion of services, employment opportunities, and increased green public space are all positive effects of building an EQ.

THE CHALLENGE TO THE STATUS QUO OF DEVELOPMENT

Collaboration between citizens, government, and developers is the best way to address the challenges of the status quo in developments and forces each group to not only listen to the individual challenges of each stakeholder, but together they can find the solutions that each group could not find on their own. Local citizens can suggest services that are missing in the area, universities can address how sustainable energy loops can be designed and built, and developers can discuss their budget challenges. Simultaneously, city authorities can play a mitigation role between all these groups and create the guidelines of the possibility that innovation in collaboration can positively affect the actual building of an EQ.

Integration between design and trades can also positively affect the challenges of timing and budgets, so the construction industry can actually learn from how Lachine Est is being led by innovation in governance and collaboration to showcase at the beginning of the design-build of an EQ to build better, faster and with less cost for something that has not been built on this scale in Montréal yet.

LACK OF LOCAL RESOURCES FOR MATERIALS AND EXPERTISE TO BUILD

The lack of local resources coined with the willingness to buy local is for once a challenge and opportunity at the same time. Especially in the times, we are going through related to a world pandemic, the drive to be self-sufficient in our food systems is also translated in our desire to buy local construction materials that have less carbon association to transportation and support local job creation. Life cycle modeling and embedded carbon reduction aspirations are clear in building an EQ, and Lachine Est can be the beginning of the creation of more local supplies for the construction industry. People are starting to question why Québec wood is harvested to be sent to China to be cut and then shipped back to Québec as the plywood we need for support in some of our new construction. With the push of an EQ, we can use local materials from local companies with local employment.

THE CHALLENGE TO FINANCIAL MODELS, ROI, AND INVESTOR / FINANCE PARAMETERS

It is time to rethink our performance of new development projects to include local EQ parameters. Developers, Investors, and Banks need to sharpen their pencils and go back to the drawing board (even if they are now virtual) to rethink financial modeling to include local inclusive developments. With new by-laws around social inclusion measures, park fees, REM contributions, developers are being pushed far to rethink how they can make the returns they use to make a new project financially viable and financeable.

However, if zoning can be a quicker process for those developers that are willing to tackle the principles of an EQ, the carrying costs of a project can be substantially lower. If there are innovations on-site remediation concerning by-laws surrounding cleanups of contaminated land, this would be another positive push to the viability of the project of an EQ. Bonus density could also be considered as another way to provide for units for social inclusion, and if parks become cultivation lands that generate a financial model for food production, we all collectively gain in the process do build better communities; not only for the investors and developers but also for the end-users and the local citizens in the area.

END USERS AND CHANGE OF HABIT MOBILIZATION

It is not just the local community groups, government, developers, builders, and university researchers who have to "think outside the box" and the new residents who will live, work, play, and farm in the new EQ. Waste management is the responsibility of all and starts with our consumer habits. New residents need to consider zero waste as part of a daily challenge and manage their properties in their commercial, office, or residences that they can exemplary in the way they manage their daily lives. It was said, "it takes a village to raise a child," and now we need to see that "it takes a village to build and EQ". Collaboration, transparency, and innovation need to be in the new participants' on-going DNA in the EQ. They can model their behavior into what is possible for all communities in Montréal.

Personally, I cannot wait to see what the future collectively holds for us to use the EQ in Lachine Est as a return to the basics of why we live in an urban environment, to begin with: to learn together and benefit from shared resources.

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GROUP I
BUILDINGS

GROUP I
BUILDINGS

URBAN MORPHOLOGY

This project aims to generate urban morphology based on the required buildable area in the urban district Lachine Est. Respecting the current heritage structure on the site, the team designed buildings considering the level of height in the adjacent neighborhood community, while maintaining the required floor area from the developer's specifications. The strong stakeholder's commitment to support equity is reflected in the proposal of different housing options for mixed-income groups, including affordable, social, rental, and condominium housing. By considering all these aspects, we elaborated on a concept of an iconic attractive, lively and vibrant eco-quarter development that builds a bridge between the site history and future of Lachine Est by approaching resilient planning and design.

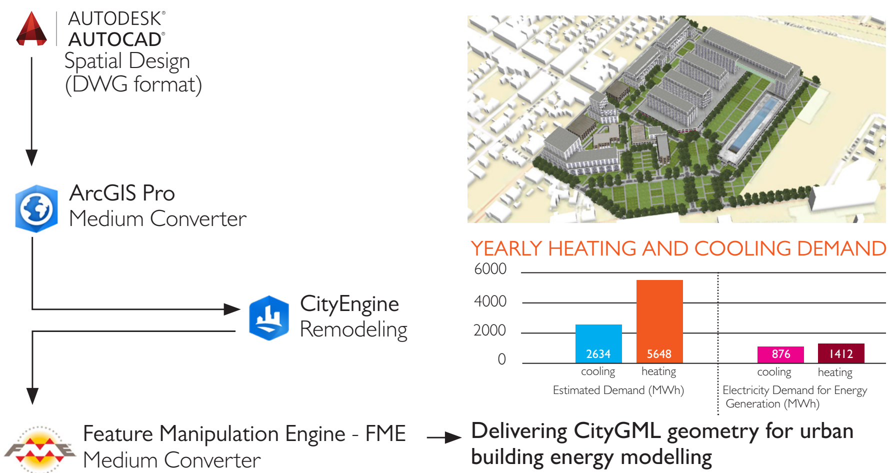


Figure 1: The process from urban geometry to urban building energy modelling (UBEM)
The technical process of urban modeling began with AutoCAD (2018) software, which helps architects translate their minds into 2D and 3D models with a high flexibility level. In the next step, using ArcGIS Pro (10.4), the model was converted to a multi-layered SHP format and then transferred to CityEngine for 3D modeling in the urban context. For the last step, we used the Feature Manipulation Engine (FME) tool to convert the output 3D model to CityGML format to serve the simulation modeling platform provided by the CERC team.

In terms of energy-efficient urban design, we applied a high level of compactness in the horizontal and vertical axis concerning energy-efficient urban design, in addition to deploying various measures of building setback in height respecting the mutual shadowing pattern of buildings on each other, pedestrians and urban spaces. We applied different levels of sun exposure plane monitoring to control the shadow pattern of the buildings and minimize building surfaces in the shade, especially during cold seasons. Furthermore, we tried to support the Eco district concept by providing 60% of the ground floor with open and green spaces accessible for visitors and the community through walkways and bicycle pathways.

Aside from the required floor areas, energy consumption should be considered as one of the main design factors. Along with other essential elements such as human-centric design and maintaining the identity of this site, energy consumption is an integral topic for urban morphology choices. Basic urban morphology design is the first step towards targeted design. Therefore, four different scenarios were researched in the first step.

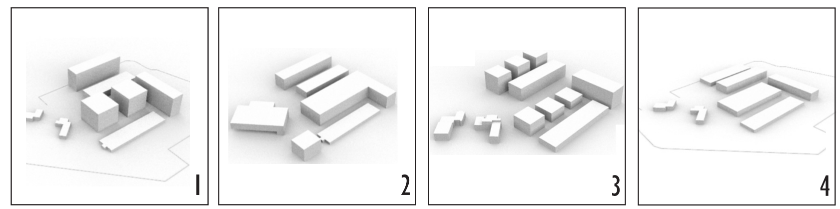


Figure 2: Four suggested urban morphology scenarios

During the optimization process, more than 500 geometries were generated; only the ones that met the required buildable floor area realistically were simulated in EnergyPlus. The results shows that using early-stage urban morphology optimization can reduce energy consumption significantly, in our case by around 10%.

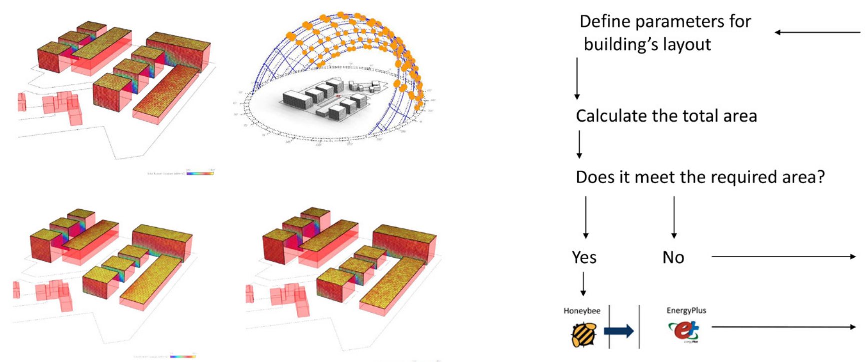


Figure 3: Right: workflow diagram for energy simulation part applied to one of scenarios (4).
Left: solar optimization of solar gains on facade applied to one of the scenarios (3)

URBAN MICROCLIMATE

Pedestrian comfort is mainly composed of three different parts: (1) thermal comfort, (2) wind comfort, and (3) pollutant dispersion. One significant problem of today's life is pollution from dust, vehicle exhausts, and toxic and odorous emissions. Computational fluid dynamics (CFD) is a useful tool for microclimate studies. Firstly, we studied the impact of the height of buildings on the airflow pattern and the pollutant dispersion in the wake region of the buildings. This was studied using isolated generic structures in isothermal conditions. Then, employing the same methodology, the Lachine area in Montréal was assessed in terms of the airflow pattern and velocity and the dispersion process. Two different scenarios for newly-constructed buildings, with constant-heights and variable-heights, were investigated.

The main findings of the studies are:

- The height of buildings can significantly alter the airflow pattern within a metropolitan area.
- Any change in the airflow pattern can remarkably affect the distribution of pollutants within an urban area.
- Variations in buildings heights can improve pedestrian comfort regarding wind comfort.
- The impact of inlet velocity on the dispersion process is significant.

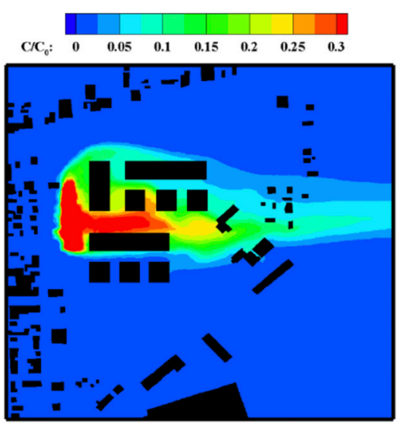


Figure 4: Contours of the dimensionless pollutant concentration at the pedestrian level for variable-heights scenario. The pollutant source is on the left side of the image.

URBAN BUILDING ENERGY MODELING (UBEM)

An automated workflow was developed to use 3D geometry in the CityGML data format and model heating and cooling energy demand. The detailed and most realistic scenario 5 from the CityEngine work of the urban planning group is used as the case study for energy analysis. Figure 5 shows how the workflow converts the City GML model into files formthe energy modeling in EnergyPlus.

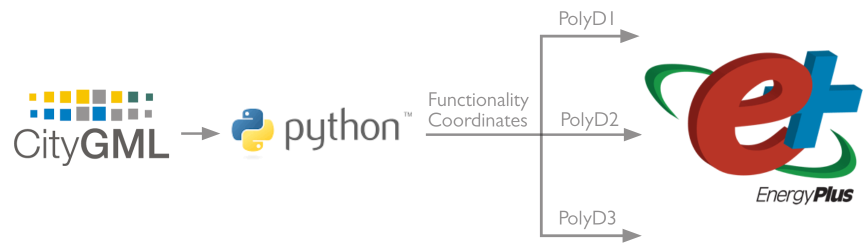


Figure 5: 3D urban modelling for energy simulation

To show the capability of the detailed urban building-energy modelling process, various parametric studies were performed during this project. A high-performance NREL construction archetype library is used to study energy efficient building scenarios of the Lachine district. Figure 6 compares the hourly heating demand (kWh) of the Lachine district using EnergyPlus default construction and NREL energy efficient construction values (189.1-2009). Findings showed that using high-performance building construction has a significant effect on energy demand and can decrease the annual heating demand by 18%.

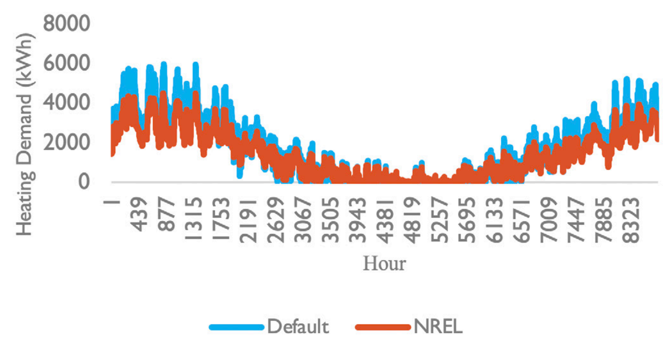


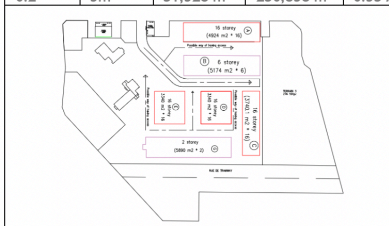
Figure 6: Hourly heating demand (kWh) comparison between UBEM with EnergyPlus default construction and NREL efficient construction.

BUILDING INFORMATION MODELING

This section is about using Building Information Modeling (BIM) for the simulation of energy consumption. The goal is to assess the applicability of using BIM for energy analysis during the conceptual design phase. It is feasible to identify energy-saving measures and requirements in the earlier stage of a building's life cycle. The BIM energy simulation approach also provides cost-effective decision-making during construction. It creates a set of data files that will remain with the project through design, construction, and operational life.

For this project, a building was modelled using Revit as a native software tool to provide a gbXML file. Then the *.xml file was used for conducting energy simulations. Green Building Studio (GBS) was used for the energy simulations. The results were compared to the ones from the urban modeling tool UMI, which uses EnergyPlus as an engine. The findings and some of the assumptions for the district of the Dominion Bridge are in Lachine east, are:

Window to wall ratio	Floor-to floor height	Floor area of the modelled building	Totoal floor area	Infiltration rate	Occupancy density	Equipment power density	Lighting power density	Ground temprerature
0.2	3m	51,328 m²	250,838 m²	0.35 ACH	0.027 P/m²	5.42 W/m²	6.46 W/m²	14 degC



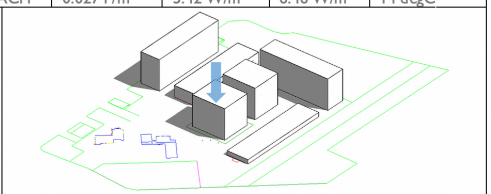


Figure 6: The masterplan and the building's location

Table 1: General Information and Assumptions

MONTHLY TOTAL ENERGY (MWh)

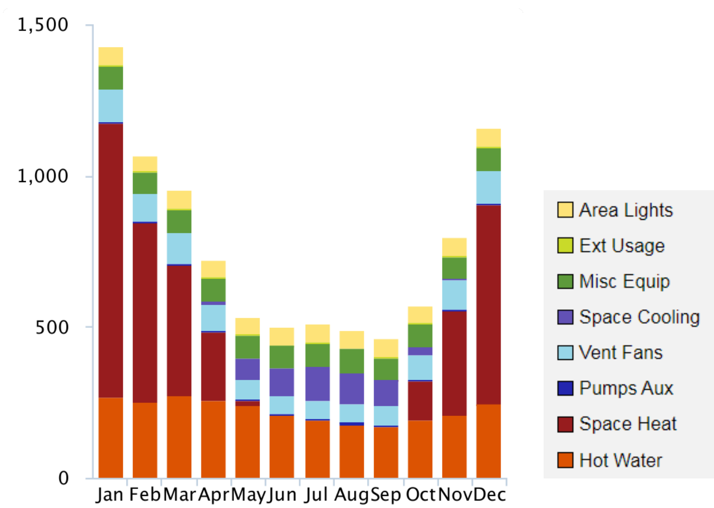


Figure 7A: Results from green building studio GBS

ANNUAL TOTAL ENERGY

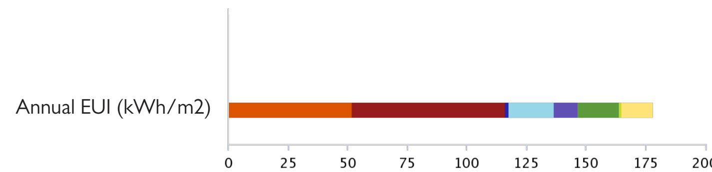


Figure 7: Results from green building studion GBS

The BIM scheme can be modified during the course of the design process to meet all criteria of the stakeholders. This procedure could go back and forth to reach the standard that the project is aiming for.

GREEN ROOF

The benefits of green roofs were investigated for a case study building. Based on the Green Roof standards, construction details, and thermal properties were chosen for a roof with a total surface area of 5,8871.8 ft². The Green Roof specified has a Growing Media Depth of 8 inches, a Leaf Area Index of 4 and covers approximately 40% of the total roof area (the rest being a white roof). While the energy savings of the green roofs are not significant compared to the white roofs, green roofs have other benefits such as reducing urban heat island, sequestering CO_2 and retaining storm water.

BENEFITS FOR ECO-QUARTIER LACHINE-EST

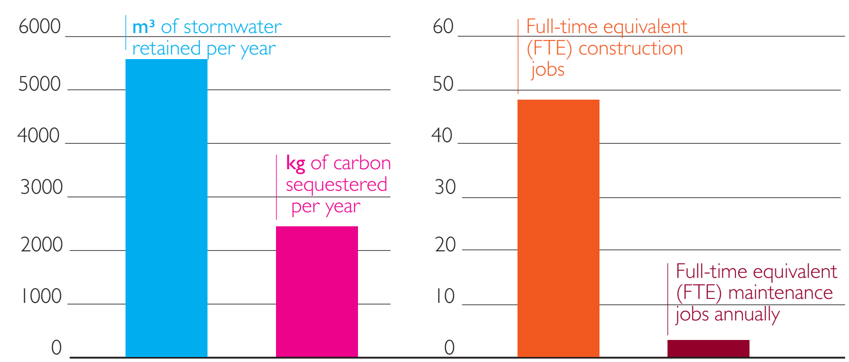


Figure 8: Annual stormwater retention, carbon sequestration and job impacts for 11,500 m2 green roofs.

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GROUP 2
ENERGY

GROUP 2
ENERGY

INTRODUCTION

Renewable energy is defined as the energy derived from natural resources that replenish themselves in less than a human lifetime without depleting the planet's resources. Sunlight, wind, biomass, and thermal energy stored in the earth's crust are among the different renewable sources available for utilization. These are virtually inexhaustible, and what is even more important, they cause little climate or environmental damage.

In addition to low greenhouse gas emissions and low air pollution, other benefits are associated with the utilization of renewable energy sources instead of conventional fossil fuels. Firstly, renewable energy systems create jobs benefitting the local community. The largest portion of renewable energy investments is spent on materials and workmanship to build and maintain the facilities, rather than on costly energy imports. Renewable energy investments are usually spent within the continent, frequently in the same country, and often in the same town, which means the money citizens pay on their energy bill stays home to create jobs and support the local economy. Moreover, renewable energies make energy systems resilient, which is important during outages. Renewables make urban energy infrastructures more independent from remote sources and grids. Businesses and industry invest in renewables to avoid disruptions, including resilience to weather-related impacts of climate change.

Finally, renewable energy is accessible to all, which is beneficial for development. In many parts of the world, renewables represent the lowest-cost source of new power generation technology, and costs continue to decline. Especially for cities in the developing world, renewable energy is the only way to expand energy access to all inhabitants, particularly those living in urban slums and informal settlements and suburban and peri-urban areas.

This group's main concerns were to analyze reliable energy supply, cost competitiveness to traditional sources, local employment creation as a form of regional economic development, and concepts for new sources of energy for the eco-district in Lachine Est. The group addressed the municipal government's ambitious goals to reduce GHG's by 37.5% by 2030, increase renewable energies by 25% and decrease fossil fuels by 40%. For developers to start to adopt these goals, options of best practices in line with cost-saving measures are needed, and the academic community could play a leading role in showing the developers how to address these challenges. Since the eco-district had already agreed that there would be no fossil fuel used to heat and cool the buildings, alternative sources of affordable energy beyond natural gas and heating oil are needed. The vision of group 2 was to promote local renewable and low carbon energy production linked to high public awareness and participation related to open data sources. They simulated scenarios were based on 10,000 new possible citizens in Lachine Est and a total load for an extremely efficient building scenario of 10,000 MWh of annual building electrical energy consumption needs.

During the intensive summer course, the defined projects included utilizing different renewable sources, including solar, wind, and geothermal energy, to supply the predicted heating, cooling, and electrical demands. For solar energy, group 2 was doing a detailed feasibility study of providing electrical demand for a building with PV panels. The possibility of installing off-shore and on-shore wind turbines were also among the topics. Geothermal heating networks and ground source heat pumps were considered in the projects to supply some existing buildings' heating and cooling demand. Finally, utilizing all these resources jointly in an optimized way was another project of the course.

PROJECT / SOLAR ENERGY

A preliminary assessment of the Dominion Bridge area's PV potential shows that we can supply 34-50% of the energy demand for all future buildings. As the civic center is a municipal asset within the eco-district concept, the students used it as a lighthouse project to highlight the fact that cities can and should lead the way with pilot projects. Such simulations could easily be used by the City of Montréal to start to incorporate these strategies in municipal buildings that can be open to the public so that particip ation in these types of low carbon renewables would be an increasingly used option to traditional projects in Montréal. IIt is assumed that the civic center will be turned into an office building that will operate every day from 8:00 am till 5:00 pm. Considering the available roof area, we calculated that on average 42% of the daily consumption (212 kWh per day) could be generated from PV panels.

PROJECT / WIND ENERGY

To study the feasibility of utilizing wind energy in the Lachine east area, the wind speed was analyzed and compared to monitoring data from Anse-a-Valleau wind Farm in Gaspe. The average wind speed is 6.5-7.5 m/s at 100 m height and 7.75-

8.25 m/s at 150 m. According to the result, Montréal, especially the Lachine Area and the St. Lawrence River, has a good potential for wind energy since it has only a 3% lower average speed than Anse-a-Valleau Gaspe. Based on the predicted energy demand for the Dominion Bridge Site, the number of wind turbines has been calculated. We considered on-shore wind turbines with a 2.5 MW capacity while the off-shore wind turbine has 3.6 MW as an option. Two scenarios have been considered: to have an off-shore wind farm or to have an on-shore wind farm. The developers' first instincts might be to say the water is not a private resource, and they cannot com- mit to this option, and that the by-laws would not allow these massive structures to be placed in an urban environment. An alternative to large scale wind would be po- tential discussions with Parks Canada to see how smaller versions of wind turbines could be developed that could be seen as public art installations along the Lachine Canal, and the developers could initiate this as a form of collaboration.

Vertical axis wind turbines (VAWTs) are known for their effectiveness in areas with highly fluctuating, turbulent flows. This characteristic makes them ideal for urban/suburban areas with such wind characteristics, and this is a significant advantage since power is generated close to where it is used. More so, the structure of VAWTs, as opposed to Horizontal axis wind turbines, allows for generators to be placed at the base, a general boost to the plant stability. By proposing H-type VAWT, three main advantages are achieved: Harvesting the energy from the wind regardless of the wind direction due to its straight blades. Also, it decreases high costs because of its unique feature, compared with the traditional HAWT that needs to be aligned with the incoming wind. Moreover, in turbulent wind conditions, the H-type VAWT is ideal for installations.

PROJECT - GEOTHERMAL ENERGY

Geothermal loops are very attractive options for supplying thermal energy to buildings. To date, most large scale, private projects are just not seeing the quick enough return on investment to persuade developers to invest. A low-temperature district heating network to distribute such renewable energy is also a very interesting option. However, the main question is who pays the cost for the initial installation. As the developers do not see the long term return of the high up-front costs, they have not yet been willing to reduce their profits to pay for geothermal. Also, the consumers have not demonstrated that they would be willing to pay more for their energy system because it has geothermal on a large scale. During the course, we had interesting discussions with a local company called Marmot Energy that is developing an investment proposal for geothermal, including a modular heat pump system that the students had the benefits to discuss together. The Mayor also brought the students' attention to addressing Hydro Québec as an option for a potential partner in a geothermal district energy system.

Sizing of geothermal heat pumps for two existing buildings in the Lachine-East area is one of the projects done in this group. The project's main objective is to compare heating costs using the sized heat pumps with direct electrical heating. The results show that electrical energy costs for the heat pumps alone (without geothermal(can be as low as 0.024 CAD/kWh.

District heating systems can be used to supply the energy demand of districts, malls or industrial sites. The linkage between plants and consumers plays a vital role in this concept, as the heat losses and pressure drops occur while transferring the hot water to consumers. Therefore, the "District Heating Network: Hydraulic and Thermal Modeling" project aimed to calculate the pressure and temperature levels along the distribution network pipes. Moreover, by integrating renewable energies into district heating systems, a new stakeholder named "prosumer" is introduced, a consumer that can also produce energy. In the mentioned project, the effects of prosumers on temperature and pressure levels have been investigated.

OPTIMIZATION

Designing and sizing an optimal integrated renewable energy system for a 100% renewable scenario and evaluating the economic and technological performance is the main objective of this section. Solar PV, wind turbine, biomass gasifier, Li- ion batteries, and converters were considered as the main components of this study.

KEY FINDINGS

Here is a list of key findings from different projects conducted in this group:

- • The System Advisor Model SAM was used to optimize the tilt angle for solar panels in the area and then find the best system size according to a given build- ing's annual consumption and generation profile. The results show that the best tilt angle is 32 degrees and the system size for net-zero building with 75 MWh annual consumption is 61 kWpeak (Figure 1)
- The cost analysis of installing a PV system on the civic center showed that the payback period is 11.5 years.
- The levelized cost of energy for an offshore wind farm is 0.07 $/kWh.
- The total number of small wind turbines of H-type VAWTs type installed in

Lachine-Est with an available area of 37970 m², would be 844. The total energy captured from all wind turbines is 670.9 MWh, and the cost associated with it would be between 3,376,000 and 4,388,000 CAD.

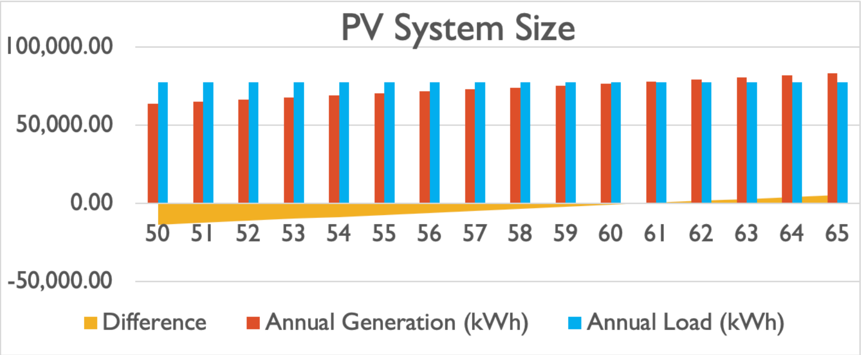

Figure 1: PV System Size in kWpeak according to System Advisor Model - SAM simulation

- The geothermal heat pump study results revealed that the cost of electrical energy for the heat pump system is 0.02 CAD/kWh, while Hydro Québec sells power at 0.07 CAD/kWh rate. The cost of the geothermal heat needs to be added to the electricity costs of the heat pump.
- For the 23MW off-shore wind farm, 7 wind turbines are needed for the same capacity, and for on-shore farms 10 wind turbines are required.
- It was found that using prosumers can reduce the overall heat loss and pressure drops within the supply pipes of a geothermal heating network; however, prosumers increase the pressure and temperature levels in the pipes near them. In conclusion, the network models help us better understand the systems' behaviour and design an optimum district energy system.
- The optimization results showed that for a 100% renewable energy scenario, the Levelized cost of electricity is around 20 cents per kWh. The initial capital cost of such a 100% renewable scenario is 79.7 million USD.

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GROUP 3
WASTE(WATER)

GROUP 3

WASTE(WATER)

WASTE / PROBLEM & VISION

Solid waste management poses significant challenges for the city of Montréal in the next ten years; the city has adopted a "Zero Waste" goal of diverting 85% of materials from landfills by 2030, but the current diversion rate is only 48%. Closing this gap will require tackling major issues, for example that 70% of organics in the city are still not collected for composting or energy generation. With the "out of sight, out of mind" design of waste management systems, citizens dispose of waste in curbside bins and have little connection with or understanding of the processes, policies, and economics of managing these outputs. The disconnection from the technical and natural cycles of materials leads to a lack of understanding of the immense energy used and emissions generated in creating these products, and of the limited global stores of many of these resources. Citizens also face information overload when sorting waste and are often asked to travel inconvenient distances for proper disposal of special categories of waste. Low-value items that are not worth the time to post for sale on online classifieds end up being thrown to the curb. These factors lead to a significant decrease in the likeliness of participation in proper disposal and circular economy activities.

To overcome these obstacles and reach 85% or more diversion at the Dominion Bridge site, we propose an on-site, zero waste, circular economy approach to solid waste management, which prioritizes best practices in waste sorting and education, including smart waste management systems, a local reuse center, and local waste to energy treatment. Bringing heightened awareness through smart systems, local reuse, and local waste to energy treatment will help Lachine citizens be more connected to the material cycles. Cutting-edge waste management technology on-site can also be used for research purposes, turning the Lachine site into a living laboratory.

METHODOLOGY & RESULTS / WASTE GENERATED & LIFE CYCLE ASSESSMENT

Our team's starting point was to determine how much waste and what types would be generated at the Lachine site. Using waste characterization conducted by Recyc-Québec, we extrapolated waste generation patterns expected from a hypothetical site with 10,000 residents, 32 commercial establishments of various sizes, one floor of offices, and a school. We determined that the vast majority of yearly output (3,000 tonnes) would be from the residents, 47% of which would be organics. Other important materials are the 1,521 tonnes of recyclables and 444 tonnes of construction and bulky materials, which are often reusable and recyclable. A life cycle assessment (LCA) was conducted on the projected waste generated to compare environmental impacts before and after our proposals. The LCA considers all waste management activities, including collection, transport, and processing at sites like material recovery facilities, composting facilities, energy recovery facilities, and landfills. The local treatment scenario would have a maximum transport distance of 2km. CO_2 equivalent emissions would be reduced by over 50%, from around 1,000 tonnes CO_2 emissions to approximately 400 tonnes.

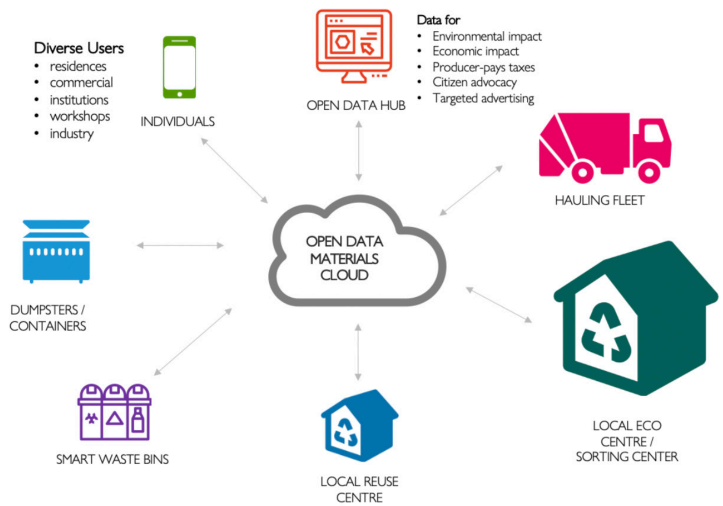
ZERO WASTE VISION FOR LACHNE-EST ECO-QUARTER

METHODOLOGY & RESULTS / SMART WASTE MANAGEMENT

We propose combining simple planning approaches with smart, sensor, and AI-powered feedback to close the gap in proper sorting of organics and recycling. Research confirms the phenomena that proximity significantly increases participation, so all principal waste disposal options must be available adjacent to one another to discourage disposal of organics, recyclables, and reusable items in landfill bins. We will use waste bins with integrated microcomputers, cameras, and AI algorithms that identify materials to provide real-time feedback to users, while the same functionality can be accessed on a mobile app for questions that arise on the go.

A local reuse center will give consumer goods, construction materials, and other reusables the opportunity to pause, maximizing the opportunity to connect with someone in need of that item. Residents, businesses, community spaces, and individuals can scan items on their mobile phones to alert their availability to the reuse center and nearby community members. The reuse center provides cost-savings to the community by offering wood, fabric, paper, tools, and even recycled plastic for 3D printing free of charge. Packaging waste can be centralized and collected by shipping companies. Staff will use electric cargo bikes to collect deposited materials from the various buildings. All of the waste management data collected through these interfaces will be made available on an open data platform and benefit many stakeholders, including government, industry, businesses, researchers, and individuals.

OPEN DATA, CLOUD-BASED, AI-POWERED SMART MATERIAL ECOSYSTEM

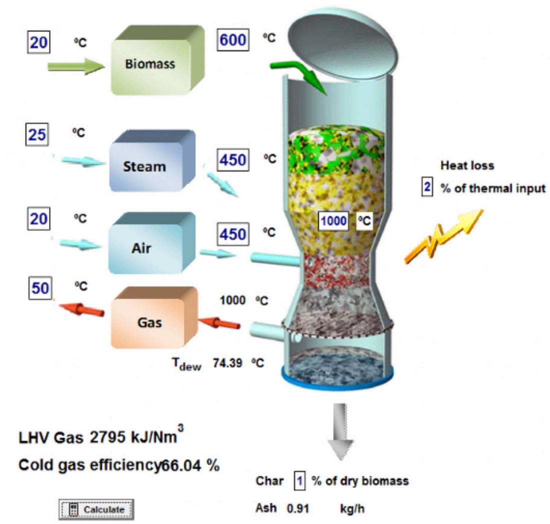


A local reuse center will be available to give consumer goods, construction materials, or other reusables the opportunity to pause, maximizing the opportunity to connect with someone in need of that item. Residents, businesses, community spaces, and individuals can scan reusable items on their mobile phone, signalling to the reuse center and other community members their wish to dispose of and the availability of their items. The reuse center can provide cost-savings to the community by offering wood, fabric, paper, tools, and even recycled plastic for 3D printing free of charge. Packaging waste can be centralized and collected by shipping companies. Staff will use electric cargo bikes to collect deposited materials from the various buildings. All of the waste management data collected through these interfaces will be made available on an open data platform, where the information can benefit many stakeholders, including government, industry, businesses, researchers, and individuals.

METHODOLOGY & RESULTS / ENERGY RECOVERY FROM WASTE

The city of Montréal produces 273,000 tonnes of organics per year, but only 35% is collected for compost, leaving a huge fraction that could be collected for energy generation. A variety of options exist for converting waste materials to energy: anaerobic digestion, landfill with gas capture, incineration, pyrolysis, gasification, and plasma gasification. Gasification technologies have the highest average energy values (0.685 MWh per ton and 0.815 MWh per ton for gasification and plasma gasification, respectively). We estimated that the energy recovery potential and power generation potential through a thermochemical process would be 0.79 MWh/ton and 0.15 MWh/ton for a biochemical process.

BIOMASS GASIFICATION



The MAGS (Micro Auto Gasification System) system from Terragon Environmental Industries, a local company specializing in waste to energy technologies, thermally breaks down hydrocarbons into solid carbon and synthesis gas, using the gas to fuel the process. It can treat 50kg of mixed solid waste per hour, produces 120kW of hot water at 60C, and has a relatively small footprint.

WASTEWATER / PROBLEM & VISION

Wastewater treatment in Montréal released 33% of the municipality's scope one greenhouse gas emissions in 2015, equal to total fleet emissions (33%) and more than building-related emissions (20%). The entire city depends on one major wastewater treatment plant in the east of the island, approximately 29 km from Lachine. Pumping the wastewater from Lachine requires between 45 to 250 kWh of energy per day, and the plant only provides primary treatment of sewage. Finally, this system does not recover any of the energy, nutrients, and usable water from the sewage. We propose a decentralized wastewater treatment system at the Dominion Bridge site that reduces pumping energy and source-separated blackwater and greywater to allow for greywater reuse and to maximize wastewater resource recovery. We also propose to recover energy from the sewage sludge (the output of the treated wastewater).

METHODOLOGY & RESULTS

We applied generic figures of litres per resident to 10,000 residents, yielding 2.25 million litres/day of total wastewater from the Dominion site, 75% of which is greywater from showers, baths, laundry, dishwaters, and other sources that can be separated for reuse. The sewage sludge generated from the treatment of the remaining 25% blackwater and in-sink kitchen waste would be around 1,000 litres/day.

WETT – ELECTROCHEMICAL WASTEWATER TREATMENT TECHNOLOGY

To improve on the status quo, our team considered options for energy and reuse of wastewater. We considered a decentralized in-situ wastewater treatment plant (WWTP) with anaerobic digestion of blackwater and kitchen waste for the Lachine district. The current technology in use at the Jean-R. Marcotte WWTP is incineration; this method consumes more electricity compared to anaerobic digestion. We determined that methane generation from blackwater with cogeneration from kitchen waste in the Lachine district would be 105,000 m^3 of methane per year with the energy potential of 1,040 MWh/year for 10,000 inhabitants, about one-tenth of the total demand. Municipal sludge has energy content in the range of 2.49-6.3 kWh/kg dry sludge, depending on its organic content, so energy recovery from sludge is considered a very attractive option. Food waste and sludge can be integrated for further energy recovery, although more analysis would need to be conducted.

The team also considered Terragon's WETT technology usage, which can be applied to greywater (WETT-G) and blackwater (WETT-S). Both are relatively small systems based on electrochemical technology that purify water for on-site recovery or discharge. A sample calculation conducted for one building on the site, consisting of 6 floors with 48 units and 144 residents, resulted in 32,400 litres of wastewater to treat per day. This falls within the design capacity of one WETT-S and two WETT-G systems. Several of these systems could treat a significant portion of wastewater generated on-site. At the same time, sludge could be treated with mixed waste for energy recovery via MAGS, where 150 to 200 residents would require one MAGS machine. Implementing these local wastewater treatment solutions can reduce energy demand at the central treatment facility, reduce potable water consumption by 70%, and decrease the energy demand of buildings via the provision of hot water while the use of the MAGS system to treat sludge along with mixed waste can yield energy recovery. This would lower greenhouse gas emissions from conventional wastewater treatment by over 50% and provide a higher degree of purification of microorganisms and pathogens.

CONCLUSION

Starting with smart waste sorting and favoring local reuse and energy recovery will help align the Lachine district with Montréal's 85% diversion goals and yield significant greenhouse gas savings. These systems can serve as a valuable educational resource for citizens and a living laboratory research opportunity for Concordia researchers, giving Lachine residents a sense of pride and serving as a model for other city communities.

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GROUP 4

TRANSPORTATION & GREEN SPACES

GROUP 4
TRANSPORTATION & GREEN SPACES

VISION FOR AN ECO-QUARTIER AND THE PURPOSE OF THIS STUDY

The development of sustainable urban mobility concepts is critical for cities to become more energy-efficient and reduce greenhouse gas emissions (GHG). In principle, two areas must be considered within mobility: moving of people and moving of goods. Walking is one of the critical elements of achieving sustainable transportation (Handy & Niemeier, 1997). It is the most important mode of travel, especially for short trips to specific destinations such as shops, schools, or public transportation stations and leisure trips where walking in itself is the primary purpose. The vision for an eco-quartier is to combine sustainable urban planning elements with the idea of giving the rights to all to access to opportunities, education, services, and all the resources available via no- or low-cost mobility options. In an eco-quartier, people can walk and cycle safely, comfortably, and affordably reach the most distant destination through rapid and frequent transit, low-energy vehicles, and live a good life free of dependence on cars.

The study area will soon be transformed from an industrial area into a modern residential and commercial neighbourhood. Dominion Bridge is located in an area with low walkability. Streets are not safe for pedestrians and cyclists, and they are pedestrian/cyclist-dysfunctional, given the distances between amenities and available infrastructure in Lachine-Est as a car-saturated development. The only public transit is the bus, and a reliable and rapid public transport cannot be introduced in the near future because of the low density and the expected small number of passengers. Car ownership is high, and most of the residents work in other parts of the city. Due to public transportation's weakness, they have to commute with their cars, which leads to congestion and emission.

This study used a method for measuring walking accessibility in a neighbourhood considering the walking distance between origins and destinations. It aims to investigate the effectiveness of changes in a new development in improving active transportation. Distances between origins and destinations are calculated to compare the Lachine-Est neighbourhood's current walkability with the proposed future scenario.

METHODOLOGY TO ESTIMATE THE QUALITY OF ACCESSIBILITY

In the search for sustainable development, a practical tool is TOD - Transit Oriented Development. TOD is a planning and design strategy; it is used to achieve well-de- signed, high-density, mixed-use, mixed-income, pedestrian, and bike-friendly urban development organized around mass transit stations. In 2014, the Institute for Transportation Development Policy ITDP launched the "TOD Standard." They recommend eight measures based on eight principles: Walk, Cycle, Connect, Transit, Mix, Density, Compact, and Shift. It is a unique as- sessment tool available to score the plans and products of urban development.

Accessibility is a measure of the spatial distribution of activities around a point location, adapted to people's ability and desire to overcome spatial divides. Walking accessibility, defined as the ease of reaching essential targets in the catchment area and a reasonable level of it, can improve active transportation in any neighborhood. (Yang et al., 2018) In this study, the analysis of walking distances was done with two steps: first, examining the walking distance between all residential buildings in the area of study and some activities in the current scenario, and the second step focused on these distances in the future situation with newly added activities. For both phases of analysis, a brief theoretical background regarding the importance of each metrics and the reason for choosing them will be provided.

For lack of data availability, lack of time, and the current limitation for doing observation in the site, the number of TOD metrics has been reduced. Fig.1 shows selected metrics for three principles of ITDP TOD standards. The software tool QGIS was employed to compute distances between origins and destinations. Since the bus is currently the only public transportation mode in the area of study, we considered just existing bus stations for calculating the cycle score in the current scenario. However, four new tram stations proposed by the community group GRAME were integrated. This tram will connect Montréal downtown to the YUL Airport and noticeably improve the mobility and the attractiveness of this area.

The general willingness to walk and the inclusion of people of all physical abilities can be significantly improved by providing shade and other shelter forms from harsh climate conditions. Trees are the simplest, most effective, and most durable way of providing shade in most climates, and they have well-documented environmental and psychological co-benefits. They provide shade, shield rain, add visual interest, and protect pedestrians from the cars if placed along the curb. Tall buildings significantly impact the surrounding air temperature and provide thermal comfort for pedestrians. In this study, the shade of buildings and trees on the walkways were calculated using QGIS plus-in UMEP. Adding new buildings and trees to the site as the new scenario increases shadow and comfort for walking accordingly.

RESULTS

The results show that the average final score for the current scenario was 0.672. Scores were widespread, ranging from 0 to 1. The minimum score was 0.17, and the maximum was 0.787. The analysis with QGIS confirmed the perception that the area of study is located in an area with low walkability. The obtained results were influenced by the fact that the area is industrial with low access to public services (see figure 2).

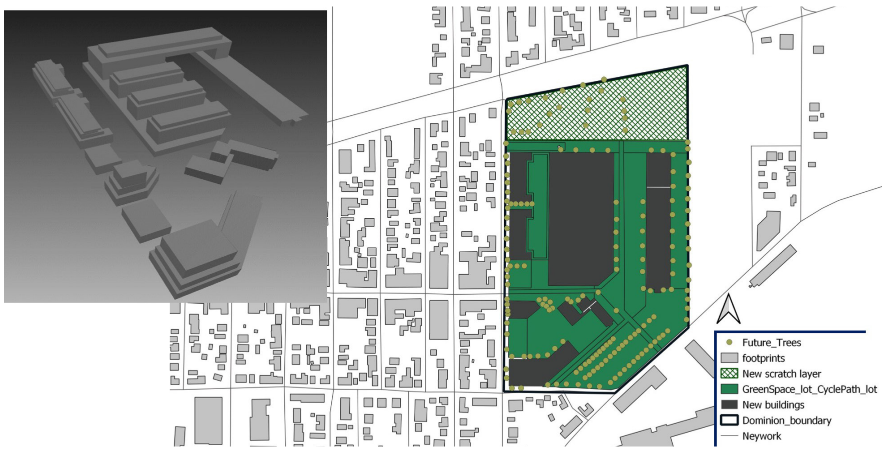

Figure 1: future scenario

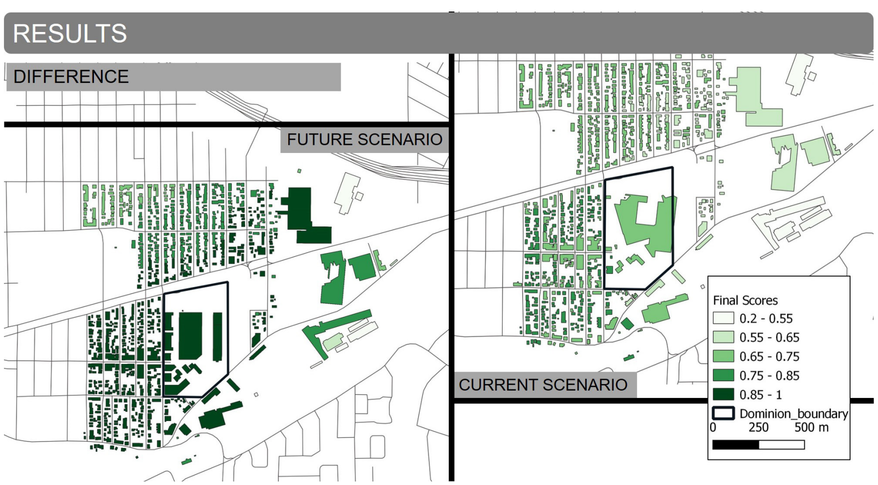

Figure 2: Final scores for the current scenario and future scenario

The new proposed urban structure, which redefines the vast industrial yards, is an extension of the surrounding grid and neighborhoods. Shared streets, public spaces, pedestrian walks, and cycling paths open onto the Lachine Canal, reconnecting the city's life with life along the water's edge.

Figure 2 shows the results of the future scenario. In this scenario, the average final score was 0.718. Scores were widespread, ranging from 0 to 1. The minimum score was 0.29, and the maximum was 0.994. This figure visualizes each building's final scores in the future scenario, which is the average of walk score, bike score, and transit score. In this case, the obtained results were influenced by the new amenities and facilities and reduced walking distance between them and residential buildings as well as the increased shadow of new trees and buildings in the future scenario.

CONCLUSION, LIMITATIONS, AND UNCERTAINTIES

In this study, QGIS calculations were done to assess walking accessibility as a significant element of walkability. According to the results, newly added activities and facilities, will improve the walkability of that neighborhood, and have positive effects on the surrounding areas. Establishing urban-planning guidelines to improve walking accessibility in the Dominion Bridge site can help lessen the adverse effects of car trips, and people can take advantage of the opportunities that help create healthy and sustainable cities.

In order to have a more accurate analysis, it would be interesting to adopt a field survey in the case study for a confirmation of the data that was considered in the analysis. More detailed information should be added to the new scenario and be considered in QGIS calculations from a walkability perspective. As shown in this report, public transportations has a fundamental role within the scope of vibrant and sustainable neighborhoods. Attention needs to be paid to the human comfort in all seasons.

METHODOLOGY TO ESTIMATE FUTURE POTENTIALS OF MOVING GOODS

Sustainable transportation of goods in urban areas has the potential to reduce GHG emissions significantly. A phenomenon that each of us has probably already noticed is the increased traffic through small delivery trucks caused by parcel delivery. Looking at the corresponding delivery concepts of online retailers, it becomes evident that the last mile, in particular, has a considerable influence on traffic volumes.

Many delivery trucks create a wide variety of problems in the traffic sector, not only that the road network has to cope with increased traffic volumes, but also that illegal second-row parking leads to congestion. Studies by McKinsey (2016) show that a significant increase rather than a decrease in deliveries can be expected.

The city of Montréal officially launched the eco-friendly urban delivery project Colibri in September 2019, located on the site of the former Montréal bus station on Boulevard De Maisonneuve Est. It introduces environmentally-friendly delivery vehicles such as e-cargo bikes for last-mile delivery.

In the Colibri project, the parcels are delivered to a central contact point, a so-called mini-hub, and then distributed by e-cargo bikes to the customer.

- A mini-hub is a (flexible) consolidation point located in and around medium to high-density areas
- Trucks pick up parcels from a warehouse outside the area (15-20 km) and bring it to a mini-hub
- Distribution of parcels for the last 1-5 km is done by e-cargo bikes or smaller electric trucks
- A mini-hub could be operated by logistic companies or local service providers

This study aimed to identify potential savings in emissions and traffic volume from a mini-hub located in Lachine East. For this, the road network, the population density of Lachine East and the surrounding areas were investigated. Based on the given conditions, two scenarios were developed. In scenario one, the delivery takes place as usual, and in scenario two, the distribution of parcels for the last 5 kilometres is done by e-cargo bikes.

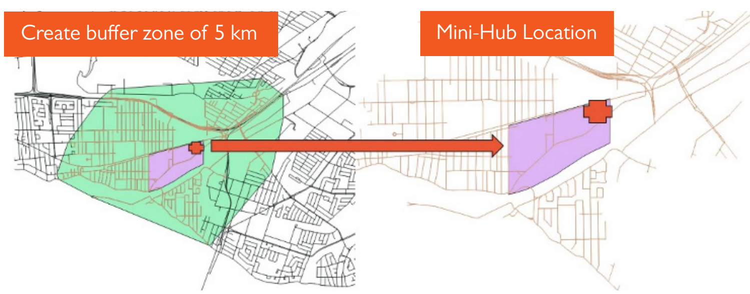

Figure 4: Mini-hub location in Lachine East area (purple) and grater service area (green area)

RESULTS

Based on the potential delivery distance of 5 kilometers, the road network was analyzed to determine the service area of the mini-hub located in Lachine East. Figure 4 shows the results of this investigation. The delivery area comprises about 6500 households, taking into account the average household size for Montréal. The number of people living in the area is between 25 and 27 thousand.

The delivery route cost trade-offs between electric-assist cargo bicycles and delivery trucks in dense urban areas were investigated as well as the parcel capacities of e-cargo bikes and delivery trucks, taking into account typical sizes of trucks and e-cargo bikes. The capacity of an e-cargo bike is one-tenth of a truck and has an average capacity of 40 parcels. Taking into account that a person receives an average of 21 parcels per year, the parcel load for the Lachine East area and the before calculated service area with a 5-kilometer radius can be calculated as shown in the following table.

Table 2. Calculation of the parcel load in the service area

	Population	Parcels / year and person	Parcels / year	Parcels/day and area
Lachine-East	12000	21	252000	690
Service area	15000	21	315000	863
Total	27000	21	567000	1553

In the next step, the CO_2 emissions of both scenarios where calculated, assuming that the electricity for the e-cargo bikes comes entirely from renewable sources and therefore does not produce any significant emissions. Table 2 shows the resulting calculation. Scenario 1 results in a total of 6.63 tons of CO_2 emissions compared to 4.98 tons in scenario 2, which corresponds to saving on 25 % or 1417 fewer trucks in the service are per year.

Table 2. Calculation of the parcel load in the service area

	Number	Distance in km	Total mileage per day in km	CO_2 emissions in g/km	CO_2 emissions in kg/day	CO_2 emissions in tons/year
Scenario 1 – business as usual						
Trucks	3.88	20	77.67	234	18.18	6.63
Scenario 2 – last mile delivery by e-cargo bikes						
Trucks	3.88	15	58.25	234	13.63	4.98
e-cargo	38.84	5	194.18	0	0	0

CONCLUSION

- New routing concepts will save time, costs and emissions.
- Life Cycle Analysis (LCA), where the emission in the production and disposal phase are considered is important.
- New business models for last-mile transportation will change the market.


DIFFERENT / MIND EXPANDING / INVENTIVE /
THE HARDEST COURSE / FUTURE REALITY /
WASN’T SUMMER / MARATHON / DENSE /
ZOOM EXPERT /MIND CHALLENGING /
GREAT BUT INTENSIVE / TEAMBUILDING /
USEFUL / EXSITING / NETWORKING / BORING /
LEADERSHIP / TEAMWORK / BENEFITIAL

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