Map the system 2019

Quebec's energy transition: Are social innovation and biogas the keys to unlocking Quebec's energy transition?

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About this project

This project is about mapping a particular system: Quebec's energy transition. More specifically, it is about understanding the barriers preventing Quebec from unlocking its biogas potential, existing solutions and the gaps that need to be bridged to bring system change.

All the tools mentioned in this document are adapted from the *Student Guide to Mapping a System* written by Anna Johnson, Daniela Papi-Thornton, and James Stauch.

About *Map the system*

Map the system is an academic competition organized by the Skoll Centre for Social Entrepreneurship, from the Said business school of Oxford University. The goal is to bring students to focus on a systems approach to solve system problems, and not the typical business start-up approach, also known as heropreneurship.

The first step to understanding a system problem is by mapping the system. This is the author's first step to understanding the energy transition in Quebec's situation regarding biogas.

Additional documents and references

This project is accompanied with a map and a bibliography. The map was created to visually support the report and is recommended to keep alongside while reading the report. The bibliography contains the sources used for this project, including complementary sources to understand relevant topics. Notes have been added along the way to identify gaps in the research and where more research is needed to further understand the system.

Acknowledgement

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System thinking and system mapping are about people, and without the contribution of so many, this project would not have been possible.

Social Media and contact

Follow this project on social media for more updates and videos.

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Happy reading!

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What is the current situation?

Global warming

is caused by Green House Gas emissions from human activity, mostly from the use of fossil fuel energy, according to the IPCC.

In a recent report, the Intergovernmental Panel on Climate Change (IPCC)[1] warned the international community about the impacts of a 1.5 degree increase in global average temperature above pre-industrial level. To avoid this, there must be a reduction of Green House Gas (GHG) emissions from human activities.

What is the energy transition?

The energy transition[2] is about reducing GHG emissions from fossil fuel energies and turning to renewable energies[3], in a spirit of energy efficiency and energy consumption reduction. In other words, the energy transition is about decarbonizing the economy and human activities.

Quebec's global rank

Quebec, being the 3rd highest energy consumer per capita in the world[4], can do its part, but like any other province, state and country, it faces its own challenges. One of them is replacing natural gas with biogas.

Natural gas

is biomass that takes millions of years to decompose hundreds of meter under the surface of the earth[7].

A recent study form Deloitte and WSP Canada[5] demonstrated that biogas could replace two thirds of natural gas consumption, which would represent a 8% GHG reduction and a 1.6 billion dollar market[6]. Since biogas is in part made from organic waste, it would also prevent organic waste from going to landfills, which represents another 12% of Quebec's total GHG emissions[8].

Biogas

is a renewable energy produced from organic waste, such as food waste, agriculture byproducts and sludge water[9].

In other words, replacing natural gas with biogas would allow Quebec to reduce its GHG emissions up to 20%. This represents more than half of Quebec's 2030[10] goal of reducing its GHG emissions by 37.5%.

However, replacing natural gas with biogas is much easier than done. The current system does not allow for this.

In the next section, we will explore why.

Challenge Mapping: What is the problem?

Biogas is a complex process[11]. In this section, we will explore how biogas is produced and what is preventing Quebec from tapping into its biogas potential.

Feedstock

This is the biomass that is fed to the digester from which biogas is produced. Biomass includes organic waste and crops.

To being with, not enough people are included in the organic waste management system. In Quebec, only 25% of residents use their brown bin for organic waste collecting[12]. Companies are not included in the organic waste management services of the cities and their organic waste ends up in landfills. This is a big loss of biogas production potential.

Feedstock collecting

Organic waste and biomass can be collected by trucks or pipelines. This depends on the form factor of the biomass.

Quebec and waste management companies don't have the capacity to collect biomass. Larger cities send sludge water to a water treatment plant when it could go to a biogas plant[13]. Also, Quebec is a very large territory, which is a challenge in terms of feedstock collecting. By the time the organic waste is collected, the trucks will have emitted more GHG than expected the planned GHG emission reduction for the replacement of natural gas with biogas[14].

Biogas production

Biomass is fed to a digester, where it decomposes without oxygen. This is call anaerobic digestion. This process is considered carbon neutral.

Even if it was possible to collect it, there currently isn't enough biogas plants to treat the biomass. The province does have a funding program for developers. However, most project have not been accepted more various technical or economic reasons[15].

Quality control and supply

For biogas to be injected in the grid, it must be 99% pure. If it is not, it can not be injected in the grid.

Sometimes, the biogas does not pass the quality control or is too far to connect. This causes a reduction in supply and a lack of reliability[16].

Consumption

Biogas can be consumed locally or exported.

At this moment, 85% of the biogas produced in Quebec is sold to the United-States[17]. This means Quebec is not reducing its GHG emissions as much as it could.

These are technical gaps preventing biogas production. In the next section, we will explore additional overall system barriers.

Additional overall system barriers

Biogas technology is mature, but for it to be implemented, it needs a favorable landscape. Here are barriers that go beyond technological and business solutions.

Unexpected high costs

Cities push back the construction of biogas infrastructures due to their unexpected high cost[19].

Complicated governance

There are many organisations that can affect biomass collecting and bioenergy production. This creates complicated governance.[20].

No social acceptability

Some neighbourhoods do not welcome biogas plants due to the smell[21]. There is also an organization that prevents farm land to be used to build biogas plants[22].

No sense of urgency

The abundance of hydropower and natural gas temper the sense of urgency regarding the energy transition[23].

History and future of the challenge

Understanding how we got here helps put in perspective this challenge.

How did we get here?

In the 1950's, Canadian government supported Canadian investors take control of natural gas production[24]. In the 1960's, Quebec's government nationalized Hydropower[25]. By doing so, natural gas and hydropower have become abundant, cheap and reliable[26].

Who gains from this ?

Quebec represents a 2 billion dollar market to Alberta's natural gas producers[27] and Quebec's state-owned hydropower production generates is over 4 billions dollars[28].

International market

Europe demand for natural gas[29] and United-States demand for hydropower[30] keep local authorities and stakeholders invested in the dominant system[31], feeding a positive feedback loop.

Future of this challenge

If nothing is done, Quebec will not be able to reach its GHG emissions reduction goals and will contribute to global warming, air pollution and more. On the other hand, if Quebec does divest from Albertan natural gas, this could results in more political tension[32].

Action is being taken and solutions are being implemented. In the next section, we will explore two examples from which Quebec's biogas stakeholders can learn from.

Quebec's Solution Landscape

In Quebec, the most recent biogas plant demonstrate how social innovation made this project possible.

City led strategy

This project was possible first and foremost because the City of Saint-Hyacinthe[33] saw an opportunity to reduce its natural gas consumption and its waste management cost.

Regional cluster

After a few years of planning, 24 additional municipalities joined the project, including the agriculture and food processing industries.

Governmental support

Then, the city received funding from the federal and provincial governments to build and expands its biogas infrastructures[34].

Creating a market

The Quebec Energy Agency created a market for biogas by passing a regulation requiring gas utilities to include 5% of biogas in their network by 2025[35]. This pushed the gas utilities to offer a guaranteed fixed purchase price for any exceeding biogas the city would produce.

Acknowledging assets

In total, it took over 7 years between organic waste collecting and the construction of the biogas plant. This was possible due to many partnerships. This can be considered a social innovation, as stakeholders from many sectors came together to solve a system problem. In this situation, everybody wins, including the citizen, who will see their cities services improve / increase, as money generally spent on energy and transport will be invested in city services.

Gaps in the solution

The biggest gap with this biogas project is that it isn't a reproducible model[36]. In other terms, the entire process must be repeated for every project, since every city and its surrounding partners are different. This affects feedstock, feedstock collecting and the amount of biogas produced. This also means each municipality must learn about biogas and the learning curve can be steep, which sometimes push them to disregard the idea.

Unfortunately, there hasn't been any other recent success stories in Quebec, as many gaps in the system remain.

Germany's Solution Landscape

In this section, we will explore Germany's solution landscape. We will also identify gaps between Germany and Quebec's solution landscapes to understand why some solutions are not applicable.

National priority

The first thing Germany was to make the energy energy transition a non-political issue. Every party voted in favour of this.

Germany, with funding from the European Union, created the Agora Energiewende[37],a think thank specialized in writing policies intended to parliament. This allows for a faster energy transition.

Gap

Canada does not have this type of jurisdiction in provinces. Although it could take "greener" actions, it isn't making the energy transition a priority. Quite on the contrary, federal parties are pushing to get a cross-Canada pipeline built and this is creating political tension in Quebec[38].

Financing renewable energy

The logic behind this is simple: once the investment is paid back, the infrastructure requires less recurring costs than fossil fuel infrastructures, making renewable energy a more profitable investment on the long run.

Germany passed a law (EEG) allowing renewable energy prices to compete with fossil fuel. Profit made from fossil fuel is invested in renewable energy. This law guarantees a fixed purchase price for 20 years for renewable energy projects, creating incentives for developers to invest in renewable energy[39].

Gap

Quebec does have an energy agency but it can only fix bottom prices to avoid aggressive competition.

Canada and Quebec do not have the power to regulate prices. On another hand, Quebec is part of a Carbon cap and trade market[40] and does apply a "green" tax on fuel[41]. This helps finance many green initiatives, but is aimed more towards energy efficiency than renewable energy[42].

Harmonized governance

At the state level, Hessen reorganized the energy minister by splitting it in two. The biomass energy ministry was merged with the ministry of agriculture, environment, citizen protection and climate change[43]. This logic allows for all biomass stakeholders to work together with the same policies and budgets, including biogas stakeholders.

Gap

In Quebec, the energy transition is a priority and biomass energy is seen as a solution, but biomass is dealt by different ministers and organisations. This gives for ineffective governance of what is fundamental to biomass energy[44].

Supporting municipalities

Cities have access to governmental support. This makes it easier for cities and coops to go forward with biogas projects[45].

Acknowledging assets

Cities do receive support for organic waste management[46], laws have been passed to banning organic waste being sent to landfills[47], a private initiative supports the biogas industry[48] and a governmental program was created to financially support biogas projects fall through[49].

Collective thinking for individual gain

By embracing the energy transition, Germany has seen its energy price lower for the first time in 2014[50]. More and more citizens and villages are autonomous and producing their own energy[51].

Gap

As mentioned before, energy prices in Quebec are very low. This reduces the sens of urgency, making biogas projects seem too complicated, including for municipalities. Therefor, social acceptability for biogas is low[52].

Democratization and decentralization

In sum, Germany's strategy was to democratize and decentralize energy production. This is inline with how renewable energy and technology works: everyone can become an energy producer. This strategy helped Germany empower citizens and developers[53].

Gap

The current situation in Quebec doesn't allow this, as the energy is already abundant, making investment not worth while, as previously mentioned.

Limits of the Germany's solution landscape

The government regulates how much crops can be grown for energy production. Stakeholders are also aware biogas is a limited solution, since it will not be as profitable once the 20 year guaranteed fixed price contract ends. Finally, although biogas can replace natural gas, the energy transition priority remains about energy consumption reduction. Germany seems to be on the right path, but they do have their own challenges, some of which Quebec don't have, like access to abundant hydropower[54].

Quebec may not operate at the same scale, but some solutions could be applied if certain gaps were bridge.

How to bridge the gaps

Here are suggestions how social innovation can bridge gaps in the Quebec landscape[55].

To unlock its biogas potential, a system-led approach at a social level could be key.

At the individual level, citizens must be empowered by the opportunities biogas have to offer. If so, more individuals and developers would be interested in these opportunities, just like in Germany. To reach this goals, stakeholders at a collective level must work together and do their part to help individuals understand the benefits of organic waste collecting and biogas production. This means governments and utility providers must be willing to talk about what sometimes seem to be counterintuitive. For instance, hydropower utilities could promote organic waste collecting.

Relationally, stakeholders must transform how they work and adopt a more holistic approach. The government could harmonize governance of biomass collecting and biomass energy production. Private companies could work with communities to strengthen relationships and cooperation.

At a deeper and more structural level, political parties must make the energy transition a national priority and include stakeholders and communities in the process of policy making, like the Agora Energiewende. In addition, harmonizing laws and policy could make way for faster implementation of necessary biogas infrastructures.

Limits of this system mapping

Although biogas seems like a good solution to reducing GHG emissions, it does have its limits. Interviewed stakeholders in Quebec and Germany have mentioned that biogas does have its flaws as a solution, most of which can be understood as the rebound effect[56].

<u>The rebound effect</u>

It's not because biogas is a solution to GHG emissions reduction from organic waste that organic waste production can be maintained, or worse, increased. This would be counterproductive, since there is a cost to managing organic waste. The goal is to reduce energy consumption AND organic waste production.

The same goes for GHG emissions reduction from the replacement of natural gas with biogas. It has been noticed that some companies maintain their level of GHG emissions and use biogas to increase the company's production capacity. In other words, they are able to maintain GHG emissions and increase productivity because they now have access to an additional (carbon neutral) source of energy.

The rebound effect also applies to geopolitical tensions caused by power production.

For example, a developing country might want to divest for foreign fossil fuels by producing its own biogas. This can cause local tensions as crops are now grown for energy and not food. In consequence, local communities are fighting to buy food at an affordable price, as the increase in demand for crops increases the price of food[57].

To prevent the rebound effect, it is trivial to keep in mind that the energy transition is part of a larger strategy: reduction of energy need, and energy autonomy.

Key insights and lessons learned

This project began with a shallow understanding of what the energy transition was about and what it involved. Initially, the energy transition seemed easy and the only thing that had to be done was to build more solar and wind farms. But this happened to be false.

Throughout the research and mapping process, many lessons were learned, two[58] of which were fundamental in truly understanding what the energy transition is about, what it involves but also what is being done and most importantly, why it is being done a certain way more than an other.

The first important key insight is that the energy transition is not only about avoiding an **environmental crisis** (i.e. climate change from GHG emissions). It is also about avoiding an economic crisis. Indeed, our linear economy does not seem to be adaptable to climate change since a major part of it is still fuelled by a non-renewable energy source.

The second important key insight is that the energy transition is also about a market share transition.

As we've seen in the solution landscape, individuals and local communities can become energy producers. This means they are autonomous from centralized producers (i.e. the City of Saint-Hyacinthe is no longer dependant of Alberta's natural gas).

According to those interviewed for this project, market share transition is a major challenge in itself. There are billions of dollars at play and if individuals and communities become autonomous, this could mean a major loss in profit for these few major power producers, which will then have impact on governmental income and local employment and more.

What's next?

This project will be transformed into a case study[59] during the summer of 2019. Before doing so, more research will be done to complete and confirm information found in this project. This will be done with the support of two supervisors[60,61].

The goal of the case study will be to offer an opportunity to teach and learn many valuable concepts to system mapping one's biogas landscape. These concepts include, but are not limited to, system thinking and mapping, management of innovation, principles of sustainability, management models of social innovation, energy management, circular economy, regional systems, social business models and more.

In addition, participants will be encouraged to share their findings amongst stakeholders. This could lead stakeholders to share a more common understanding about the system they are evolving in, where they can have impact and where the levers for change are.

Conclusion

This project focused on the energy transition in Quebec and the particular challenge of unblocking its biogas potential. Although there are many assets in place, major gaps must be bridged in order to adapt existing solutions to Quebec's solution landscape. Moreover, deeper underlying factors are preventing the Quebec biogas industry from expanding, one of which is the availability and reliability of two low-cost energy sources: natural gas and hydropower. This projects gives an overview of why a system led approach is necessary to unlock Quebec's biogas industry.

Furthermore, this project was limited to the biogas industry in Quebec and is only another step towards increasing our understanding of the broader challenge at stake: the energy transition on a global scale.

Finally, although this project contains verified data, more data would need to be verified to make this project a solid case for the industry. However, this project offers hints towards which system led solutions could be explored by stakeholders.