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Public Awareness and Opinion on Deep Geothermal Energy in the Context of Shale Gas Exploration in the Province of Québec, Canada

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ABSTRACT

As deep geothermal energy is not currently widely known, except in regions where it is being exploited, public outreach and acceptance associated with this energy is a key factor for its development. In fall 2013, an Internet-based public awareness and opinion survey of Québec province residents was conducted to investigate their opinion about energy with a focus on their knowledge and opinion about deep geothermal energy. The survey was conducted after a strong public protest against shale gas in the province.

Québec's population recognized the challenge of developing renewable energies. However, geothermal energy was more or less known. Among the respondents who had already heard of geothermal energy, only less than 17% knew the difference between shallow and deep geothermal energy. After reading a text describing deep geothermal energy exploitation, 67% of the respondents supported its use to produce electricity in the province, and 64% would be in favor of a pilot project in their region.

Shale gas exploration intensified in 2010 in southern Québec leading to a strong public protest and debate in the province. In that context, oil and gas exploration activities have almost been stopped since 2011. Thus, the survey also looked at the impact of the shale gas controversy on public opinion about deep geothermal energy since hydraulic fracturing may be involved to stimulate reservoirs in the context of a deep geothermal energy project.

After learning that hydraulic fracturing is sometimes required for a deep geothermal energy project, 56% of the respondents supported the use of deep geothermal energy to produce electricity in the province and 52% of them would support a pilot project in their region. Survey results also revealed a similar decrease of acceptance among respondents located in the region where shale gas exploration was more intense and which is propitious to the production of deep geothermal energy. Thus, even in the case of a pilot project in their region knowing that hydraulic fracturing could be used, most of the respondents were still favorable to such a project.

1. INTRODUCTION

Deep geothermal energy consists in extracting heat stored in the earth crust that is used, among other things, in district heating systems or to generate electricity. It offers an opportunity, in regions of the world without volcanic activities, to continuously produce base load electricity from a renewable source with almost no emissions of greenhouse gas (GHG). Thus, it is a renewable energy that has a potential in helping to tackle climate change. In the province of Québec, the use of deep geothermal energy to produce electricity could be useful in some regions that are not connected to the main grid. Electricity supplies distributed through Québec main grid are almost exclusively generated by hydroelectric sources (MERN, 2013). On the other hand, autonomous grids rely, most of the time, on power plants that burn fossil fuels and, consequently, emit GHG into the atmosphere (Hydro-Québec, 2014). Therefore, some preliminary research is undertaken to evaluate the potential of using deep geothermal energy to produce electricity in the province. Obviously, along with this kind of research, a social acceptability strategy based on public accurate and current awareness and opinion data should be prepared (Dowd *et al.*, 2011).

In order to get information about public awareness and acceptance of deep geothermal energy in the province, a public awareness and opinion survey of Québec residents was conducted in fall 2013. In southern Québec, shale gas exploration began a in the 2000s and speeded up in 2010. A strong public protest and debate began in the province, leading to a quasi-total stop of oil and gas exploration activities since 2011. Thus, the survey also looked at the impact of the shale gas controversy in the province on public opinion about deep geothermal energy since it is sometimes necessary to use hydraulic fracturing to tap energy from the earth crust.

As deep geothermal energy is currently not widely known, except in some regions where it is being exploited, public outreach and acceptance associated with this energy is a key factor for its use. One of the many conditions for this energy to be tapped and used is support from local populations, which could be gained by informing the public in order for them to understand this "new" energy. However, being informed does not guarantee that the public will be favorable to the deployment of the use of deep geothermal energy.

2. GENERAL CONTEXT

In the province of Québec, deep geothermal studies are currently focussed on sedimentary basins located in the south of the province (Figure 1). These basins are of particular interest as past oil and gas exploration provided useful data for geothermal potential evaluation. Previous studies on the basins showed thermal anomalies that could lead to temperature sufficiently high to produce electricity from geothermal (Majorowicz and Minea, 2013; Majorowicz and Minea, 2012; Raymond *et al.*, 2012).

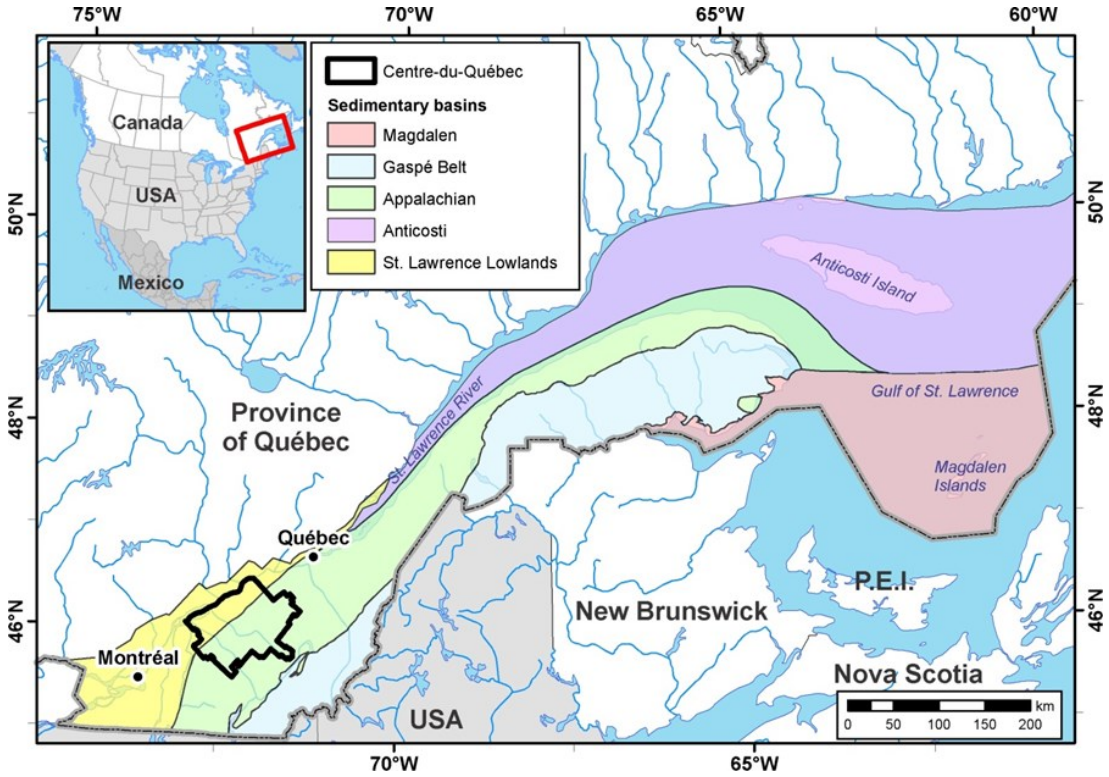

Figure 1: Sedimentary basins in the south of the Province of Québec. The black line outlines the Centre-du-Québec region. P.E.I.: Prince Edward Island.

3. METHODOLOGY

The main objectives of the survey were to understand: (1) the most important energy related issues in the province as perceived by the Québec residents, (2) their opinion regarding the production of different energy sources in Québec, (3) their level of knowledge concerning various energies, including deep geothermal energy, (4) their opinion regarding the use of deep geothermal energy in the province as well as the establishment of a pilot project in their region in the context of the possible use of hydraulic fracturing, (5) their concerns about the use of this energy, and the opinion of the Centre-du-Québec region residents more specifically.

In order to achieve these objectives, a bilingual (French/English) Internet-based survey was created by the INRS team in coordination with survey experts from Leger, a major Canadian survey institute. The survey was inspired by other surveys on geothermal or renewable energy in general conducted around the world (Hobman and Ashworth, 2013; Tampakis *et al.*, 2013; Lagache, 2012; Oil and Gas Services Association of Quebec, 2012). Some questions were open-ended, but most of them were multiple-choice questions with an "I don't know / I prefer not to answer" option available. In this paper, only the open-ended questions are specified, when needed. The survey was composed of 15 questions and a series of demographic questions useful for statistical interpretations. The survey enclosed six parts:

1. Energy issues in Québec;
2. Energy production in the province;
3. Awareness of deep geothermal energy;
4. Acceptability of deep geothermal energy in Québec;
5. Use of hydraulic fracturing in the context of a deep geothermal energy project;
6. Concerns about the use of deep geothermal energy.

Léger conducted the survey, using its online survey panel, a representative sample of Québec's population (French and English-speaking adults, male and female, 18 years old and more) with 1,353 respondents (220 English-speaking adults and 1,133 French-speaking adults) from November 25 to December 1st, 2013. By comparison, a probability sample of the same size would yield a margin of error of ±2.7 per cent, 19 times out of 20. The average interview length was 11 minutes.

Representative samples of the Québec population were obtained by weighting the raw data of the study in order to reflect the actual distribution of population by region, age, sex, mother tongue, education, etc. In addition to conducting the survey, Léger also analyzed the results of the survey using different statistical tests, including proportion tests from independent samples. In Table 1, "n" represents the actual number of respondents. To highlight the differences between the subgroups studied, significant proportion variations are presented in red if they are significantly superior and in blue if they are significantly inferior.

An oversampling of the Centre-du-Québec region (300 respondents), located between Québec City and Montréal (Figure 1), was made to verify if deep geothermal energy was better known and/or more accepted in this region compared to the rest of the province. This region is of particular interest because it is propitious to the production of deep geothermal energy. Also, this region might host a deep geothermal energy pilot project in the long term. In addition, this region is also where shale gas exploration and the resulting debate largely took place in the province. In this paper, only the main differences between the Centre-du-Québec region and the rest of the province are mentioned, when needed.

Since it was presumed that few people would have heard about deep geothermal energy, parts of the survey were designed to inform the respondents (Carr-Cornish and Romanach, 2012). Thus, a text with a diagram provided to the respondents explained deep geothermal energy and, in particular, the difference between shallow and deep geothermal energy (Appendix 1). At a further step in the survey, another text explained that, sometimes, hydraulic fracturing is necessary for a deep geothermal energy project. This second text stressed the fact that hydraulic fracturing for deep geothermal energy is different than in the context of shale gas exploitation (Appendix 2). In order to evaluate whether the opinion of the respondents toward deep geothermal energy was firmly anchored and if knowing that it is sometimes necessary to use hydraulic fracturing influenced their opinion, respondents were asked twice about their opinion on deep geothermal energy and the idea of a pilot project in their region: once following the explanation of deep geothermal and once following the text about hydraulic fracturing.

4. RESULTS

Many aspects can influence public acceptance of a project. The following considerations are limited to the aspect of providing targeted information to one particular audience. The results show, in part, what needs to be explained to the general public in the province of Québec to increase public awareness of the use of deep geothermal energy and to eventually have a potential deep geothermal energy pilot project accepted by the local community. No predictive value can be given to such survey, especially since public awareness of deep geothermal energy is low and, therefore, public opinion is subject to rapid change.

4.1 General energy aspects

When asked on what they considered to be the three most important issues in Québec, only 4% of the respondents mentioned spontaneously a topic linked to energy (open-ended question). The first issue was health (32%), the second was economy (31%) and the third was education (18%). Following that first question, respondents were asked what issues related to energy was the most important in Québec and what would be the second. Three issues related to energy stood out from the others: (1) cost of energy in general (electricity, gas, etc.) for 61% of the respondents, (2) renewable energy development for 43% of them, and (3) environmental impacts related to energy production and use for 40% of them (percentage given for the first and second choices together).

The survey also sought to understand respondents' opinion on Québec's objectives relating to renewable and fossil energies. 52% of the respondents chose the answer stating "In my opinion, when it comes to renewable energy (wind power, biofuels, etc.), Québec's objectives should be to locally produce the maximum amount of renewable energy to export as much of this energy as possible." Therefore, most of the respondents encourage maximum production of local renewable energy potential. At the same time, 47% of the respondents chose the answer stating "In my opinion, when it comes to fossil fuel (oil, gas, etc.), Québec's objectives should be to locally produce only the amount of fossil fuel necessary to meet the province's needs." Thus, respondents were not against production of fossil energy but only to meet local needs. Only 2% of the respondents chose the answer stating "In my opinion, when it comes to renewable energy (wind power, biofuels, etc.), Québec's objectives should be to locally produce no renewable energy whatsoever" compared to 22% who chose the answer stating "In my opinion, when it comes to fossil fuel (oil, gas, etc.), Québec's objectives should be to locally produce no fossil fuel whatsoever."

Then, the respondents were asked on a scale of 0 to 10, where 0 meant they had never heard of a source of energy and 10 meant they knew it very well, to indicate their level of knowledge of several energy sources. It should be specified that it was considered everyone knew hydroelectricity, oil, natural gas and nuclear energy. Thus, it was decided not to test respondents' knowledge on these energies. Results underscored the fact that geothermal energy (shallow and deep) was more or less known as 56% of the respondents said they knew a little or nothing about this energy source (self-rated knowledge between 0 and 5). Concerning wind energy or solar energy, they were known or very well known by 83% and 82% of the respondents respectively (self-rated knowledge between 6 and 10). On average, respondents estimated their level of knowledge on geothermal energy at 4.7 on 10. This must be compared to wind energy and solar energy for which respondents estimated on average their level of knowledge at 7.6 and 7.5 on 10 respectively.

Subsequently, the respondents were asked on a scale of 0 to 10, where 0 meant they strongly disagreed and 10 meant they strongly agreed, to indicate their level of agreement with Québec producing several energy sources on its territory. Hydroelectricity, oil, natural gas and nuclear energy, which were not listed in the previous question, were included in this question. Concerning the energy sources included in the previous question, they were only included in this question if the respondents previously said they knew them (self-rated knowledge of at least 2 on 10). Globally, 67% of the respondents were favorable to geothermal energy (shallow and deep) production in the province (self-declared level of agreement between 6 and 10). On average, they were favorable to geothermal energy production in the province at 7.5 on 10. In the Centre-du-Québec region, respondents were slightly less favorable to geothermal energy production compared to the rest of the province (63%; self-declared level of agreement between 6 and 10). In this particular region, respondents were on average favorable to geothermal energy production in the province at 7 on 10.

Respondents were favorable to solar energy (89%), hydroelectricity (89%) and wind (83%) energy production in the province (self-declared level of agreement between 6 and 10). On average, respondents were favorable to solar energy, hydroelectricity and wind energy production in the province at 8.7, 8.6 and 8.1 on 10 respectively. Concerning other energy sources, for example, 48%, 32% and 14% of the respondents were favorable to oil production, natural gas (including shale gas) production and nuclear energy production respectively (self-declared level of agreement between 6 and 10).

The next question focused on the first and second most important advantage arising from the use of renewable energies as viewed by the respondents. For more than half of Québec's population (53%), the most important advantage arising from the use of renewable energies is the reduction of GHG emissions (percentage given for the first and second choices together). The second most important advantage arising from the use of renewable energies is job creation in the province for 40% of the respondents (percentage given for the first and second choices together).

4.2 Specific issues on deep geothermal energy

Among the respondents who previously said that they knew geothermal energy (self-rated knowledge of at least 2 on 10), 17% of them knew the difference between shallow and deep geothermal energy. The majority of the respondents who said that they knew the difference were able to roughly explain it (open-ended question). For example, 39% of them said that the difference lies in the depth at which the energy is tapped in the ground and 10% of them said that the difference lies in the fact that shallow geothermal produces less heat than deep geothermal. Moreover, 16% of the respondents who said that they knew the difference could not explain that difference in a few words.

After those questions, the survey gave to all the respondents a simplified description of deep geothermal energy that included a diagram (Appendix 1). Following this first explanatory text, 67% of the respondents said they were favorable toward the use of deep geothermal energy to produce electricity in the province. In the Centre-du-Québec region, the proportion was 70%. In addition, 64% of the respondents said they would also support the implementation of a pilot project on deep geothermal energy to generate electricity in their region. In the Centre-du-Québec region, they were 67% (Table 1).

37% of the respondents considered that deep geothermal energy was already used around the world to generate electricity. 6% thought it was not the case and 57% said that they didn't know. Among the 37%, less than half could name the countries or regions where they believed deep geothermal energy was being used to generate electricity (open-ended question).

Table 1: Percentage of the respondents favorable to deep geothermal energy before and after knowing that hydraulic fracturing could be used in the province of Québec.

		After the first text on geothermal energy		After the second text on hydraulic fracturing	
		Province (n=1353)	Centre-du-Québec (n=300)	Province (n=1353)	Centre-du-Québec (n=300)
Use of deep geothermal energy to produce electricity **in the province of Québec**	**Total favourable**	**67%**	**70%**	**56%**	**56%**
	Completely in favour	17%	12%	11%	7%
	Somewhat in favour	50%	57%	45%	48%
	Total opposed	**19%**	**19%**	**32%**	**32%**
	Somewhat against	15%	14%	22%	22%
	Completely against	4%	5%	10%	10%
	I don't know / I prefer not to answer	**14%**	**11%**	**12%**	**12%**
Establishment of pilot project on deep geothermal energy to produce electricity **in their region**	**Total favourable**	**64%**	**67%**	**52%**	**54%**
	Completely in favour	18%	12%	10%	7%
	Somewhat in favour	46%	55%	42%	47%
	Total opposed	**24%**	**20%**	**36%**	**34%**
	Somewhat against	15%	11%	23%	21%
	Completely against	8%	8%	13%	13%
	I don't know / I prefer not to answer	**12%**	**13%**	**12%**	**12%**

The respondents were then asked what conditions must be met to be in favor of a pilot project on deep geothermal energy to generate electricity in their region. For 65% of the respondents, guarantees on respecting and protecting the environment are the necessary condition for the acceptance of such a pilot project in their region.

In a more detailed manner, the results suggested that respondents would view the implementation of a pilot project in their region positively if, among others:

- Environmental protection is ensured (65%);
- Safety guarantees for the employees and nearby communities are given (47%);
- The population is informed and local residents' opinions are taken into account through serious information, consultation and dialogue (46%);

- Guarantees on respecting the landscape are given (35%);
- Guarantees on the long-term future of the geothermal site are given (30%).

It should be noted that only 5% of the respondents chose the proposed answer stating "Whatever the conditions, I would be against this type of project." In the Centre-du-Québec region, they were only 4% to choose this option. It should also be noted that 26% of the respondents chose the proposed answerer stating "Ensure that the project is conducted by a public body (government, university, Hydro-Québec, etc.)." In the Centre-du-Québec region, they were 21% to choose this answer.

Subsequently, a text explained that, within the context of deep geothermal energy projects, it is sometimes necessary to use hydraulic fracturing (also called "fracking"). It outlined that this method is used to re-open fractures in low-permeability rock to allow injected water to circulate and heat up upon contact with the rock. The text stressed that, unlike shale gas production during which hundreds of wells must be drilled and fracked to extract the gas, a deep geothermal facility does not require drilling and fracking numerous wells on a regular basis. It ended by stating that a geothermal facility is built at a specific location for the long term and generally only uses between 2 and 4 wells (Appendix 2). Following this second explanatory text, respondents again expressed their opinion on the use of deep geothermal energy.

Thus, when the possible use of hydraulic fracturing was mentioned, the percentage of respondents favorable toward the use of deep geothermal energy in the province dropped from 67% to 56% (-11%). In the Centre-du-Québec region, the percentage dropped from 70% to 56% (-14%). Concerning the implementation of a deep geothermal energy pilot project to produce electricity in the region of the respondents, the percentage of respondents favorable toward it dropped from 64% to 52% (-12%). In the Centre-du-Québec region, this percentage dropped from 67% to 54% (-13%) (Table 1).

After reading the second text on the possible use of hydraulic fracturing, consequences on the environment were the main arguments given by reluctant respondents toward the implementation of a pilot project in their region. In a more detailed manner, those reluctant toward the implementation of a pilot project in their region said, among others (open-ended question):

- Deep geothermal energy could have negative impacts on the environment (15%);
- They did not have enough information on the subject (9%);
- They had concerns about consequences on health and safety (9%);
- They were against hydraulic fracturing (8%; in the Centre-du-Québec region, they were only 4%);
- There could be a risk of groundwater contamination (7%; in the Centre-du-Québec region, they were 14%);
- The provincial electric utility produces enough electricity (4%; in the Centre-du-Québec region, they were 8%).

The survey ended by asking the respondents, among potential impacts associated with a deep geothermal energy project, what would worry them the most, and what would be their second worry, if this project took place in their region. Pollution of the groundwater was the first concern of the respondents (58%, first and second choices together). The second concern was soil contamination (43%, first and second choices together).

5. DISCUSSION

Contrary to what had been expected, the picture between the entire province and the Centre-du-Québec region was not really different, even if some slight particularities emerged in this region. It doesn't appear that respondents from the Centre-du-Québec region, compared to those from the rest of the province, were less likely to be favorable toward the use of deep geothermal energy, even when knowing that hydraulic fracturing could be used in the context of a pilot project in their region.

5.1 Deep geothermal energy vs other sources of energy

Respondents overwhelmingly supported maximum provincial production of renewable energy for provincial needs and to export as much of this energy as possible. In the Centre-du-Québec, they were more in favor of provincial production of renewable energy for provincial needs only. The gap in acceptance in the province between wind, solar and hydroelectricity, on one hand, and geothermal, on the other hand, is similar to what was found in other surveys conducted in other jurisdictions such as Italia and Australia (Hobman and Ashworth, 2013; Pellizzone *et al.*, 2013; Carr-Cornish and Romanach, 2012; Carr-Cornish *et al.*, 2011).

Besides, renewable energy development was, for the respondents, the second most important issue related to energy. However, knowledge of some renewable energy sources was low. Geothermal energy was known by less than half of Québec's population (43%, self-rated knowledge of 6 on 10 and more). The gap in awareness between wind and solar, on one hand, and geothermal, on the other hand, is similar to what was found in other surveys (Hobman and Ashworth, 2013; Lagache *et al.*, 2013; Pellizzone *et al.*, 2013; Carr-Cornish *et al.*, 2011). Moreover, the fact that more than half of the respondents acknowledged that the most important advantage arising from the use of renewable energies is the reduction of GHG emissions is an interesting result because geothermal energy could be used, in the province, to replace fossil fuel power plants in remote regions that are not connected to the main grid.

Concerning fossil fuels, almost half of the respondents were not against provincial production but only the amount necessary to meet the province's needs. Virtually no respondents were against any provincial renewable energy production compared to almost one quarter of them who were against any provincial fossil fuel production. These results underscored the fact that renewable energy development was of particular importance for Québec's population, at the very last compared to fossil energy development.

5.2 Deep geothermal energy use and pilot project

Even if fewer respondents were favorable toward geothermal energy production compared to solar or wind energy production, they were more favorable toward it than to oil or gas production. Furthermore, a priori, the use of deep geothermal energy to produce electricity received widespread support. Respondents did not generally reject the use of deep geothermal energy or a potential pilot project in their region. In fact, they were, for most of them, quite favorable toward such a project. The eventuality of a pilot project located in the region of the respondents didn't really impact their acceptance toward the use of deep geothermal energy (decrease of only 3%). However, the potential use of hydraulic fracturing had a major influence on respondents acceptance toward deep

geothermal energy (decrease of 11%) and the implementation of a potential pilot project in their region (decrease of 12%). The proportion of respondents favorable to deep geothermal energy or the implementation of a pilot project in their region decreased similarly, taking into account the margin of error, in the Centre-du-Québec region compared to the rest of the province. Therefore, it seems that a sort of NIMBY (Not In My Back Yard) syndrome was a less important obstacle than the concerns linked to hydraulic fracturing.

At the same time, even after reading the short text on the potential use of hydraulic fracturing, most of the respondents remained favorable to the use of deep geothermal energy in the province and the implementation of a pilot project in their region. Therefore, even in the case of a pilot project in their region knowing that hydraulic fracturing could be used, most of Québec's population, including those living in the Centre-du-Québec region, was still favorable to such a project. On the other hand, the fact that the level of acceptance evolved during the survey highlights that the respondents' opinion about the use of deep geothermal energy was not firmly anchored.

In all cases, the proportion of respondents who did not know if they were favorable or not or who preferred not to answer stayed almost the same (between 8% and 15%). Thus, it is the portion of respondents against the use of deep geothermal energy in the province and the implementation of a pilot project in their region that increased more significantly after the second text on hydraulic fracturing. Nevertheless, it should be noted that, of those opposed to a pilot project in their region after learning about hydraulic fracturing, only 13% were totally opposed. Besides, some respondents gave arguments linked to hydraulic fracturing to explain why they were against the implementation of a pilot project in their region knowing that this technology could be used in the context of a deep geothermal energy project (Appendix 3).

Among the respondents that were against the implementation of a pilot project in their region knowing that hydraulic fracturing could be used, it should be note that 33% said they didn't know or preferred not to explain why. This could underscore the fact that some respondents had not enough information on deep geothermal energy and on its long-term effect and consequences to have a specific opinion about it. It should also be noted that many said they were against because they lacked information and needed to know more about the subject. This stresses the fact that people need to have a better understanding of deep geothermal energy to form their own opinion.

5.3 Population main concerns

Potential obstacles toward social acceptability of a deep geothermal energy project are of environmental nature. The main concerns of Québec's population linked to a deep geothermal energy project are pollution of the groundwater and soil contamination. It should be highlighted that, contrary to what could have been expected, the Centre-du-Québec residents were slightly less concerned about the potential pollution of the groundwater compared to the rest of Québec's population. However, the Centre-du-Québec residents were slightly more concerned by the water usage that could result from a deep geothermal energy project compared to the rest of Québec's population. Overall, it was found that residents of the Centre-du-Québec region had a similar opinion to the rest of Québec's population. Nonetheless, they seemed slightly more fearful about the use of hydraulic fracturing.

The survey validated that renewable energy production from deep geothermal was supported by most of Québec's population. Moreover, the latter didn't require that a potential pilot project should be conducted by a public body. However, the promoter would have, as in all projects involving social acceptability, to actively consult and listen the population living near the project. The Centre-du-Québec region, negatively impacted by the shale gas exploration, should receive a particular attention in order to reverse the myths and the concerns associated with this energy.

6. CONCLUSION

Québec's population overwhelmingly supported local production of renewable energy and recognized that the most important advantage arising from the development of renewable energy is the decrease of GHG emissions. Thus, the basis for legitimating a deep geothermal energy pilot project in the province is already in place. This finding is a positive element on which the promotion of a potential pilot project could be based.

Knowledge of some renewable energies, including geothermal energy (shallow and deep), was low in Québec. Respondents were not really aware of the difference between shallow and deep geothermal energy and knew almost nothing about deep geothermal energy. After a short text explaining deep geothermal energy, as a technology to produce electricity, it received support from most of the respondents. The eventuality of a pilot project located in the region of the respondents resulted in a very limited decrease in the level of support. When hydraulic fracturing was introduced, the level of support decreased significantly. However, most of the respondents were still favorable toward deep geothermal energy, even in the case of a pilot project in their region, including in the Centre-du-Québec region.

The comments of those opposed to a pilot project in their region showed that they needed more information about deep geothermal energy to develop an informed opinion on this energy. Deep geothermal energy could be more acceptable to the public if information and consultation campaigns were conducted, among others, to clearly take people's concerns into consideration and provide answers to their questions. In addition, the survey shows that, depending on the information provided, respondents' opinions may change rapidly. The decline in positive views following the presentation of the possible use of hydraulic fracturing was expected, as the controversy on shale gas exploration was, and still is, intense in the province.

The social context in a region where shale gas activities are underway may not seem, at first sight, the best that exists to help a potential deep geothermal project to become accepted by the local community. However, it was found that there was no major difference in the acceptance of such a project in this particular region compared to the rest of the province. Nevertheless, in the case of implementing a deep geothermal project in this region, it would be wise to prepare an information and consultation plan to particularly address the myths and concerns linked with hydraulic fracturing. Furthermore, it might be preferable to avoid hydraulic fracturing when possible to develop deep geothermal energy project and tap this energy.

Overall, the study of deep geothermal potential in Québec is consistent with the population's expectations and will allow to increase Québec's population geothermal knowledge. A priori, this technology should be well accepted in the province.

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APPENDIX 1

Text with a diagram explaining deep geothermal energy provided to the respondents.

Geothermal energy consists of extracting the heat stored in the earth. There are two main types of geothermal energy: shallow and deep geothermal energy.

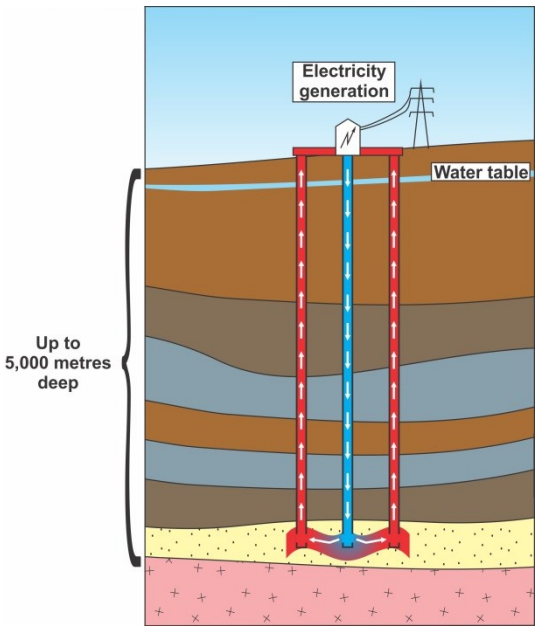
Shallow Geothermal Energy

Shallow geothermal energy consists of using wells that are approximately 100 metres deep to recover low-temperature heat used, among other things, to heat individual homes or businesses.

Deep Geothermal Energy

Deep geothermal energy refers to facilities that require much deeper wells, between 1,000 and 5,000 metres under the earth's surface. Deep geothermal energy allows for the recovery of high-temperature heat used, among other things, to heat a network of buildings or to generate electricity. An electric power plant using deep geothermal energy consists of:

1. Drilling, in general, between 2 and 4 wells up to depths than can reach 5,000 metres;
2. Circulating water between the injection wells (cold water) and the production wells (hot water);
3. Using the heat extracted to generate electricity.



APPENDIX 2

Text explaining that it is sometimes necessary to use hydraulic fracturing to tap energy from the earth crust.

Within the context of deep geothermal energy projects, it is sometimes necessary to use hydraulic fracturing ("fracking"). This method is used to re-open fractures in low-permeability rock to allow injected water to circulate and heat up on contact with the rock.

Unlike shale gas production during which hundreds of wells must be drilled and fracked to extract the gas, a deep geothermal facility does not require drilling and fracking numerous wells on a regular basis. In fact, a geothermal facility is built at a specific location for the long term and generally only uses between 2 and 4 wells.

APPENDIX 3

Examples of answers to the question (open-ended) that asked, “What is the main reason you would be against this type of pilot project on deep geothermal energy to generate electricity in your area?”

- “Risk of groundwater contamination”
- “Unknown risks and consequences in the long term”
- “Potential use of chemical products to frack”
- “Fracking is not always without risks as it can be seen with shale gas”
- “I am against hydraulic fracturing”
- “I have heard very negative reports on fracking in the USA”
- “I don’t know if this would be safe to do”
- “I drink water”