A GAP ANALYSIS

Community acceptance of energy storage projects

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PROJECT 4.6 - SOCIAL ACCEPTANCE OF ENERGY STORAGE SYSTEMS

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INTRODUCTION

Community acceptance of energy storage projects is a topic that has not been extensively researched. However, community acceptance is an issue that needs to be addressed in order to implement energy storage projects successfully in the future. Energy storage technologies are emerging; they can generate many benefits, such as increased employment, additional clean energy integration, power in times of blackouts, and cost savings (Energy Storage Association, 2017). Because of this, it is important to prepare the public to encourage the acceptance of these projects. When conceptualizing community acceptance, we can define it as focusing on the acceptance of energy projects in relation to "local stakeholders, particularly residents and local authorities" (Wüstenhagen, Wolsink, & Bürer, 2007, p. 2685). With this research, the objective is to gain a better understanding of the public perceptions of energy storage. There are many different factors that influence the public's acceptance of energy projects (e.g. location, scale, and technology), but different factors have different impacts at different times.

Individuals residing in Kitchener-Waterloo participated in a web-based survey to provide a Southwestern Ontario perspective with respect to community acceptance of energy storage projects. The participants were asked to provide information regarding their thoughts and opinions on energy storage. Afterwards, the participants were given information about a hypothetical energy storage project; they were subsequently asked to provide their thoughts and opinions on this. The survey design aims to provide insight on the level of acceptance of energy storage, and on how thoughts on energy storage change once the participants are provided with more information. In summary, this study aims to begin to provide information on what the public knows about energy storage, their concerns, beliefs, and opinions on energy storage and on a hypothetical community battery energy storage project. With this information, we start to get insight into where we are, and where we need to be in order to successfully integrate future energy storage projects into communities.

LITERATURE REVIEW

A literature review was undertaken to better understand the research that has been completed on the general public's thoughts, beliefs and opinions on energy storage. The purpose of this literature review was to:

- identify what conditions need to be met for a community to be considered "ready" for energy storage projects;
- better understand energy storage literature in regards to community acceptance; and
- identify what is missing to justify the purpose of the primary research (surveying the population of Kitchener-Waterloo).

The literature review includes grey and academic literatures. A wide variety of sources were reviewed and synthesized to further examine what research has been completed on energy (storage), community acceptance, and public awareness of energy storage. Because there is limited research on energy storage specifically, much of the literature reviewed below looks at projects involving energy technologies other than energy storage, but which can be considered analogous to energy storage projects in some respects.

FACTORS INFLUENCING ENERGY TECHNOLOGY ACCEPTANCE

Attitudes regarding energy projects depend on a variety of different factors. Common factors identified within the literature include location, culture, the particular technology, and the scale on which it is being implemented (Bertsch, Hall, Weinhardt, & Fichtner, 2016). However, these factors have different impact in different cases. Thus, there is not one generic set of conditions that can be applied universally to analyze community acceptance of energy projects.

There is a notable change in the overall attitudes of the public depending on where the energy project is located. In an article that conducted a mass survey on opinions on energy projects, German and American public concerns differed. In Germany, the location of the project was the biggest concern. By contrast, in America, the procedural and distributional justice elements were the most significant concern arising from energy projects (Bertsch et al., 2016). Bertsch et al., also found that respondents who are more educated were generally more accepting of energy projects in their community, and if the development was farther away from their home the members of the community would be more likely to accept it (Bertsch et al., 2016).

Other studies reveal that local opposition to energy projects can lead to over-spending, delays and dismissal of necessary energy projects (De Best Waldhober, Peuchen, & Weeda, 2013). In a case study on hydrogen energy storage in the Netherlands, for instance, it was noted that there are very limited studies assessing the public's knowledge and opinions on energy projects (De Best Waldhober et al., 2013). Indeed, the lack of research on the public's acceptance, beliefs and knowledge is a reoccurring theme in the literature on energy storage and renewable energy projects.

Community acceptance was identified as one of the key requirements for successful energy projects in the UK (Eswarlal et al., 2014). Effective and early public engagement to increase local knowledge was highlighted as the key factor to encourage public acceptance of energy projects. In an article assessing various different case studies on wind and solar farms, it was noted that it is crucial for decision-makers to assess community acceptance before and after the project is completed (Delicado, Figueiredo, & Silva, 2016). However, early stage participation can address the public's concerns and alleviate these concerns (Heiskanen et al., 2008). In an Australian gas plant case study, the local community opposed the project because the members of the community had close social interactions and personal relationships that led them to collectively oppose the project. The best way to alleviate the opposition in this case was to ensure effective public participation in order to increase local knowledge (Anderson & Schirmer, 2015).

Community opposition to energy projects can occur because of the lack of knowledge and awareness of the energy technologies (Hammami, Triki, & others, 2016). Public perceptions were very skewed in an article published on multiple wind and solar projects in Italy. There was limited transparency in the projects and limited data to evaluate the communities' acceptance (Delicado et al., 2016).

In a meta-analysis of energy projects in Europe, one of the key factors that shapes social acceptance was found to be the uncertainties (lack of knowledge and awareness) around energy projects (Heiskanen, et. al, 2004). In a Netherlands hydrogen storage case study, individuals severely lacked knowledge on the technology, and when interviewed, the participants provided quite uninformed opinions (De-Best Waldhober, 2013). Interviewees were more accepting and interested in the technology once they were provided with more information on hydrogen energy storage (De-Best Waldhober, 2013). A geothermal case study in Italy, moreover, concluded that the public was aware what geothermal energy was, but was unable to describe or provide any information about the technology itself (Pellizzone, Allansdottir, De Franco, Muttoni, & Manzella, 2017). Results from a study of four bioenergy projects in the UK showed that many members of the public were not primarily concerned about having their input into the project; instead, they were concerned about having sufficient information (Eswarlal et al., 2014). These studies suggest that, in order for projects to be successful, the public needs to know why the particular project is relevant and why it is emerging. In addition, the public must know about the specific project that is being implemented in their community.

During the literature review process, it became evident that the amount of Canadian literature on the topic of social acceptance is small. A carbon capture and storage project in Alberta was dismissed due to local opposition, because the area in which the project was proposed had very strong generational history. Generational history means that multiple generations of families have lived in the same community, therefore creating strong place attachment (Boyd, 2017). In Ontario, members of two different communities opposed the construction of a natural gas plant in their neighbourhoods because they felt like 'it did not fit' in with the character of the neighbourhood and its preexisting homes. It was only after construction began that the government assessed public opinion and decided to relocate the natural gas plants. This conflict cost the government approximately $1.1 billion (Morrow, 2016). These case studies reveal that even Canada is affected by local opposition to energy projects.

Energy Storage Canada argues that energy storage is going to be a very relevant part of the Ontario electricity grid in the future (Energy Storage Canada, 2017).

However, there is limited literature assessing community acceptance of energy storage projects. Furthermore, there is even less information on the knowledge the general public has on energy storage. The majority of the published literature assesses the impacts of renewable energy projects, and although they can be analogous to energy storage in terms of scale, assessment of the impacts of energy storage projects would be helpful going forward. This study thus aims to gain a better understanding of the public's beliefs and opinions on energy storage.

METHODS

This study seeks to begin to better understand the general public's overall knowledge, opinions and acceptance of energy storage technologies. The first step was to determine the method to collect the data. A web-based survey was chosen as the most suitable method for data collection. Web-based surveys are very time- and cost-efficient, and are also more appropriate when the researcher is aiming to get responses from a large population (Illieva, et. al., 2002). This survey was conducted in Kitchener-Waterloo, with members of the general public over the age of 18. According to the 2011 Statistics Canada census, the City of Waterloo's population is 98,780 and the population of the City of Kitchener is 219,153. These areas are growing in population and cover approximately 200km2 (Government of Canada, 2012).

A variety of recruitment methods was used to get interested individuals to complete the online survey. First, 250 recruitment letters were delivered door-to-door to a number of different neighobourhoods in Kitchener-Waterloo. Each of the neighbourhoods varied in age and character, in an effort to secure a diverse sample. Each of the letters was randomly distributed throughout the neighbourhoods. In addition, an online ad was posted on kijiji.ca/Kitchener that advertised the study for 10 days. Lastly, 30 poster ads were posted in public areas in Kitchener-Waterloo (i.e., coffee shops, public parks, bus stops, and libraries). All recruitment methods had the survey URL attached where interested individuals could access the questionnaire. The survey was available

Figure 1) Map of Kitchener-Waterloo (Source: http://ca.epodunk.com/profiles/ontario/kitchener/2001132.html)

Figure 2) Location of Kitchener-Waterloo in Canada (Source:http://mhtlab.uwaterloo.ca/old/facility/locate/kw_map.html)

online for 10 days, after which no one was able to access or complete the questionnaire.

The online questionnaire was divided into three sections. The first section consisted of introductory demographic questions, including gender, age, and income. The second section focused on the respondent's general knowledge or concerns with energy storage and energy related issues. The questions asked the participants about their initial thoughts on energy storage, if they have heard about it, and what kind of energy storage technologies they have previously heard about. Throughout the second section of the questionnaire, participants were asked to share their thoughts regarding energy storage. The third section of the questionnaire involved a hypothetical community energy storage project. The respondents were provided with information on energy storage, in addition to some context regarding a specific lithium-ion battery energy storage project that could potentially be implemented in their community. This section aimed to provide information and insight on how the public feels about energy storage projects in a southwestern Ontario context. Questions in the second and third section were very similar in efforts to effectively analyze the changes in respondents' thoughts and opinions after being provided with information on energy storage.

RESULTS

As described in the methods section, the recruitment methods included 250 recruitment letters that were delivered to households, a Kijiji ad, and 30 public flyers. There were 42 complete responses to the online survey. A survey was considered complete when the participant navigated themselves through all of the pages of the survey. Therefore, even though they might have left some questions blank, it was still considered complete. The Kijiji ad was most successful recruitment method, garnering 25 of the 42 responses. Ten people responded to a letter delivered to their doorstep, and five reacted to a public flyer. The two respondents who selected the 'other' option for how they heard about the survey indicated they heard of the survey by word-of-mouth.

In all, 55% of the respondents identified as female, and 45% identified as male. The bulk of the respondents were aged 55-64 (29%) or 25-34 (29%). The least number of respondents identified themselves as 65+ (7%). Figure 4 provides full details. Regarding annual household income, the majority of the respondents' households made more than $110,001 before taxes (26%) or under $50,000 (55%). Summary data for household income can be found in Figure 3.

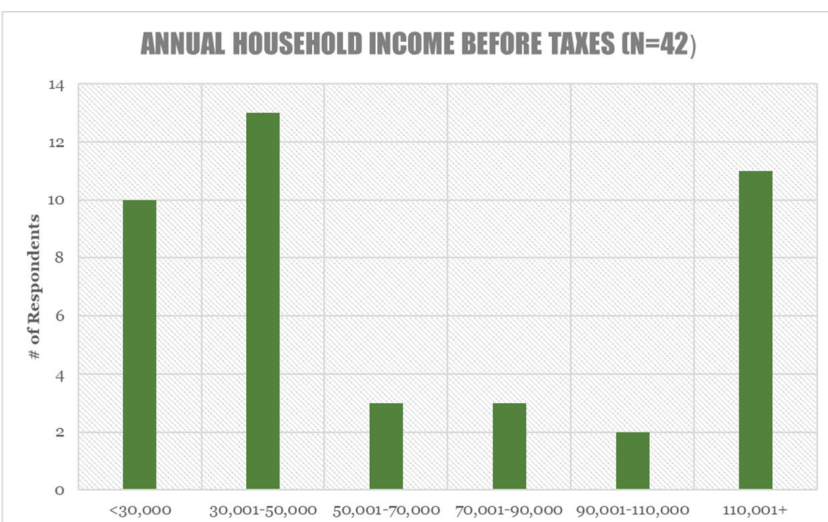

Figure 3) Respondent's Household Income, Before Tax

Figure 4) Age Distribution of Respondents

In the second section of the survey participants were asked about their concerns (or their belief that changes

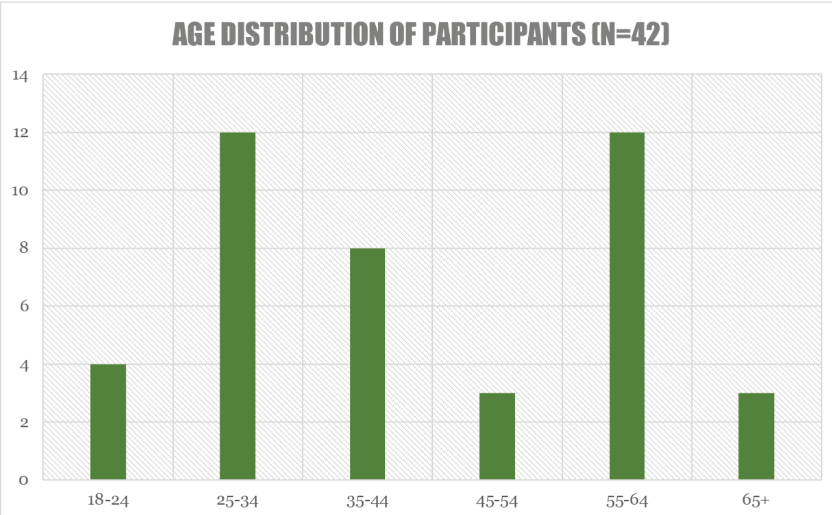

Figure 4) Age Distribution of Respondents

need to be made) with certain energy related issues. These energy related issues included: energy system sustainability, energy prices and costs, level of public engagement in energy policy, level of public engagement on specific energy projects, location of energy infrastructure and the uncertainty of the performance of new energy technologies. The participants were asked to rate their overall concern, where 1=not concerned at all, and 5=very concerned. Overall, the median level of concern for all of the energy related issues was greater than 3 in every case. The topic with the most concern was energy prices and costs, and the topic with the least concern was the uncertainty of the performance and new energy technologies. Summary statistics for each of the energy issues and the level of concern that participants have are found in Table 1.

Table 1) Concern with Energy-Related Issues (1=Not Concerned at All; 5=Very Concerned)

	Mean	Median	St.Dev	Sample Size
Energy system sustainability	3.95	4	1.18	41
Energy prices and costs	4.45	5	0.83	42
Level of public engagement in energy policy decisions	3.43	3	1.13	42
Level of public engagement on specific energy project(s) in your community	3.52	4	1.11	42
Location of energy infrastructure	3.69	4	1.14	42
Uncertainty of the performance of new energy projects/technologies	3.30	3	0.97	40

PERSPECTIVES OF ENERGY STORAGE, PRE-PROMPT

Eleven (26%) participants did not have a response when asked about their initial thoughts on energy storage, or they simply stated that they "have never heard of it" (Respondent 19). Each of the other 33 responses can be summarized into five different themes. (Recognize that some respondents contributed comments that feed into two or three themes below.)

Uncertainty

In regards to the uncertainty among the respondents, ten (24%) of the respondents answered the question with additional questions about energy storage. For example, Respondent 11 said, "I need to learn more about it. Some concerns with the technology in terms of knowledge and understanding…". The majority of these comments asked about the cost of energy storage and who would finance it (e.g., "How much will it cost?", Respondent 32). Another notable uncertainty was where the storage unit would be located and at what scale it could be implemented at (e.g., residential or commercial). However, there was a common theme of general interest to learn more about energy storage for those who did not express any informed opinions about energy storage.

Mentioned real world applications

Eleven (26%) of the respondents answered the question by mentioning real world applications that they thought were related to energy storage. Different respondents mentioned applications such as tidal energy project implemented in the 2000s, the Bruce nuclear power plant, the Tesla Powerwall (Respondent 33), and general technologies such as "big batteries" (Respondent 15), lithium-ion, and lead acid batteries. However, the overall knowledge and understanding of how or if these applications related to energy storage was not noted in their responses.

Mentioned renewable energy

A notable amount of responses associated energy storage with the use of renewable energy such as wind turbines and solar panels. Eleven (26%) respondents mentioned renewables or green energy as their initial thought associated with energy storage. For example, Respondent 23 said, "the battery storage of wind and solar energy". A few respondents noted that energy storage goes hand-in-hand with the successful application of wind and solar energy, or simply stated that it is battery storage for green energy.

Informed about how energy storage operates

There were some responses in which participants revealed that they knew how energy storage operated. Fourteen (33%) respondents mentioned that it is used to store energy to reduce peak demand in the daytime when energy is needed the most (or to "store energy for the future"). The most informed response on energy storage was the following:

> There is peak and off peak times when energy is being consumed. Generally, in off-peak time there is more power being created than is being used, so I believe that energy storage would be how we could capture that overflow to use during peak times. Also, energy storage could be referring to alternative energy producing ideas like windmill or solar; where do we store the energy that is captured by those ideas. (Respondent 41)

Mentioned the need

Lastly, five respondents mentioned that they think that there is a need for energy storage, regardless of if they knew how it operated or not. Respondent 33 also said that "Energy storage is the only way to make energy sources like wind and solar a viable option." One other respondent indicated that they were aware of the need for energy storage because "current storage methods are inadequate to fulfill energy needs" (Respondent 13).

Participants were also asked several questions regarding their knowledge, thoughts and opinions on energy storage in general. More than half (57%) of the respondents claimed that they had not previously heard of energy storage. Subsequently, the respondents were asked if they had heard of specific energy storage technologies before (i.e., thermal, pumped hydro, flywheels, flow batteries, and compressed air). Details are in Figure 5.

Out of all the mentioned ES technologies, thermal storage was the technology the respondents claimed to be most familiar with (47%). Technologies including pumped hydro, flywheels and compressed air had around the same level of awareness across all respondents (26%-28%). Respondents were given the option to list another energy storage project that they have heard of that was not mentioned. Only five respondents filled out the "other" comment box. Four out of the five responses indicated battery storage; one coupled with solar panels. The other response was tidal energy storage. Out of 42 respondents, 17 claimed to have not heard of any of the technologies listed, although 24 respondents claimed to have never heard of energy storage before in the previous question.

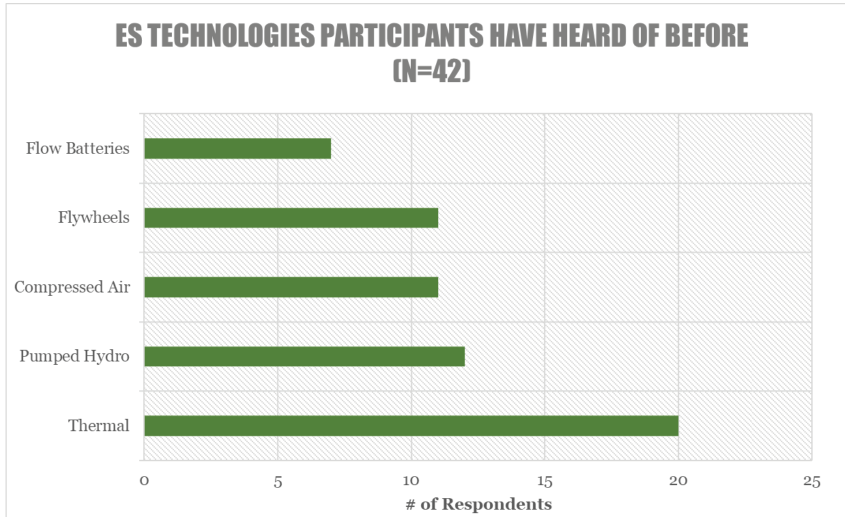

Figure 5) Respondents' Awareness of Energy Storage Technology, Pre-Prompt

Respondents were then asked to rank their overall level of knowledge on energy storage. The majority of the respondents claimed that they were not knowledgeable on energy storage, meaning that they had not heard of it before (38%). Thirty percent of respondents who said that they were slightly knowledgeable responded that they had heard of it before. Twenty-one percent of respondents had heard of specific applications of energy storage technologies. Ten percent of respondents considered themselves educated on energy storage, while no respondents

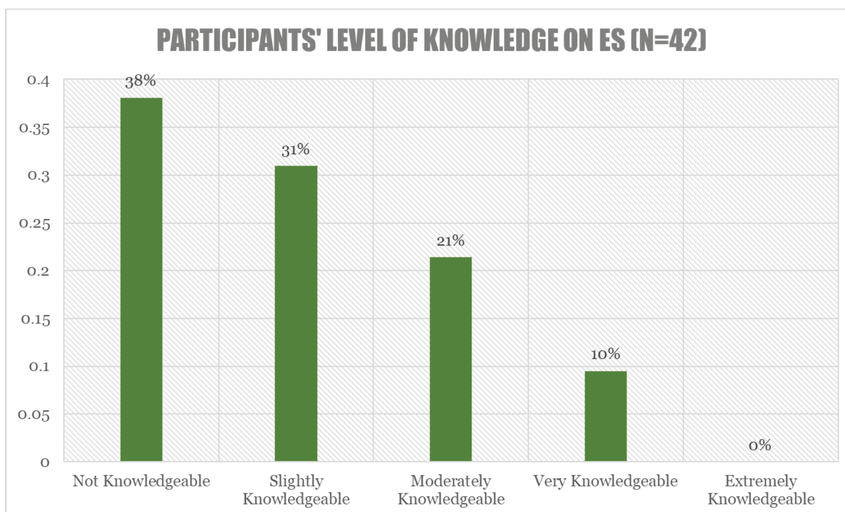

Figure 6) Respondents' Level of Knowledge of Energy Storage, Pre-Prompt

considered themselves an expert. Summary data of the respondents' overall knowledge of energy storage can be found in Figure 6.

Respondents were then asked to rank their beliefs on energy storage in general (not tied to a specific technology), by being presented various descriptive words (e.g. user-friendly and expertise required, or sustainable and unsustainable). There was one respondent out of the 42 who left this section blank. Summary statistics were used to summarize all of the responses. For all of the descriptive words mentioned, the average values fell somewhere in the middle range (between 2 and 4). In summary, the sample believed that energy storage was safe, efficient, reliable, sustainable, aesthetically pleasing, and expertise required. It was not concluded whether or not the sample thought energy storage was expensive or cost effective, because the mean fell right in the middle at a value of 3.0, and the median value was 3. Summary statistics can be found in Figure 7on what respondents thought about energy storage.

RESPONDENT PERCEPTIONS OF ENERGY STORAGE, PRE-PROMPT

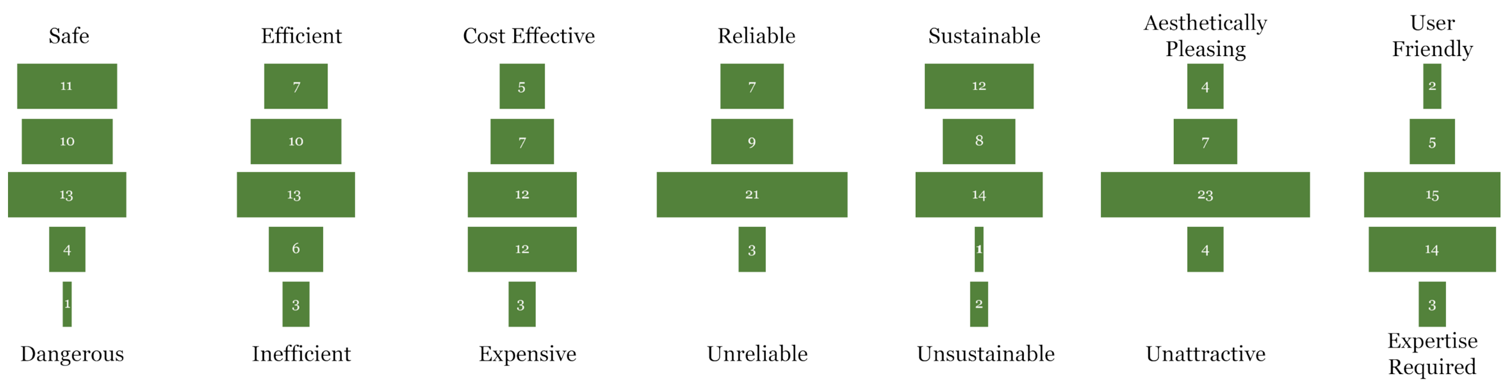

Figure 7) Respondents' Perceptions of Energy Storage, Pre-Prompt

PERSPECTIVES ON ENERGY STORAGE, POST-PROMPT

In the third section of the survey, the participants were given information on energy storage and on a specific hypothetical community battery energy storage project that could potentially be implemented into their community. The hypothetical project consisted of a community lithium-ion battery that would power up to 150 homes. When asked if they had heard of this type of project before, 81% of the respondents said no, meaning that only 19% of respondents had heard of this project before. Out of those 19%, the extent of their knowledge of this application is unknown. However, respondents were asked if they had heard of the project before and in what context. When summarizing all of the respondents' answers to the context in which they have heard of battery energy storage, the majority of the participants mentioned the Tesla Powerwall, or smaller battery units that are used for residential or commercial applications rather than a larger, community scale battery project. One respondent mentioned how they have previously heard of something similar to this project, but only implemented in California or in the Pacific Islands. When respondents were asked about their immediate thoughts on the hypothetical project, eight (19%) of the respondents left the question blank. Each of the other 34 responses were categorized into one of several themes.

Support

Nineteen (45%) respondents mentioned their overall support and interest in this type of project. A few mentioned that they think it would be helpful in a neighbourhood setting for potential blackouts during ice storms, and how each neighbourhood would have "its own power" to "keep electricity costs down" (Respondent 33). Many participants simply mentioned that they were interested to learn more about it, that it was a well thought-out idea, and that the project itself is "thinking outside the box" (Respondent 12). For example, Respondent 6 said "it is a great idea and needs to be explored".

Concerned

Eleven (26%) of the respondents expressed their concern about the battery storage project. Each of the 11 "concerned" responses can be broken down into three subthemes: cost, performance, and reliability. Some responses did fall within more than one theme.

The majority of respondents mentioned their concern with the costs of the project (maintenance, capital costs, and funding). A few respondents were concerned with the cost of the project compared to the 10-year anticipated lifespan of the battery. The majority of the respondents who mentioned the cost of the project, were interested to know if it was the city or the neighborhood paying for the project and how long it would take to pay off. One respondent indicated that the project sounded like a good idea only if it would cost less than what was indicated in the survey (Respondent 21).

A group of respondents mentioned how the Canadian climate and the lithium ion battery technology could be a large concern for its potential application in a community. It was noted that the level of concern stemmed from Canada's harsh winters, and how this application would not be able to withstand temperatures below -20 degrees Celsius. One respondent mentioned that they believe the lithium ion battery technology is "unstable", and that other battery applications "do not have the same application for failure" (Respondent 24).

Many respondents mentioned how they thought it was a cool idea *if* there was no risk of explosion or chance of failure in the battery unit. By contrast, there were respondents who believed that it seems "safe and environmentally sound" (Respondent 23), and did not think the risk of explosion would be very dangerous in reality.

Neutral or Uncertain

Lastly, there were four respondents (9%) who did not express any concern or support for the project. These respondents answered the question with more information they would like to know (e.g. cost breakdown) or simply said they were interested to learn more about the project.

As in the second section of the survey, the participants were given a series of descriptive words and were asked to rank their beliefs in regards to the specific project. There were three respondents who decided to leave all of their responses blank. Summary statistics were used to summarize all of the responses. For all of the descriptive words mentioned, the average values fell somewhere in the middle range (between 2 and 4). In summary, the sample thought that the battery energy storage project was safe, efficient, expensive, reliable, sustainable, aesthetically pleasing, and expertise required. Summary statistics can be found in Figure 8.

Participants were then asked if would they accept this project in their community. The participants were asked to rank their likeliness of acceptance from 1-5, with 1 being very unlikely and 5 being very likely. Two respondents decided not to answer. Overall, the majority of the respondents (62%) were somewhat or very

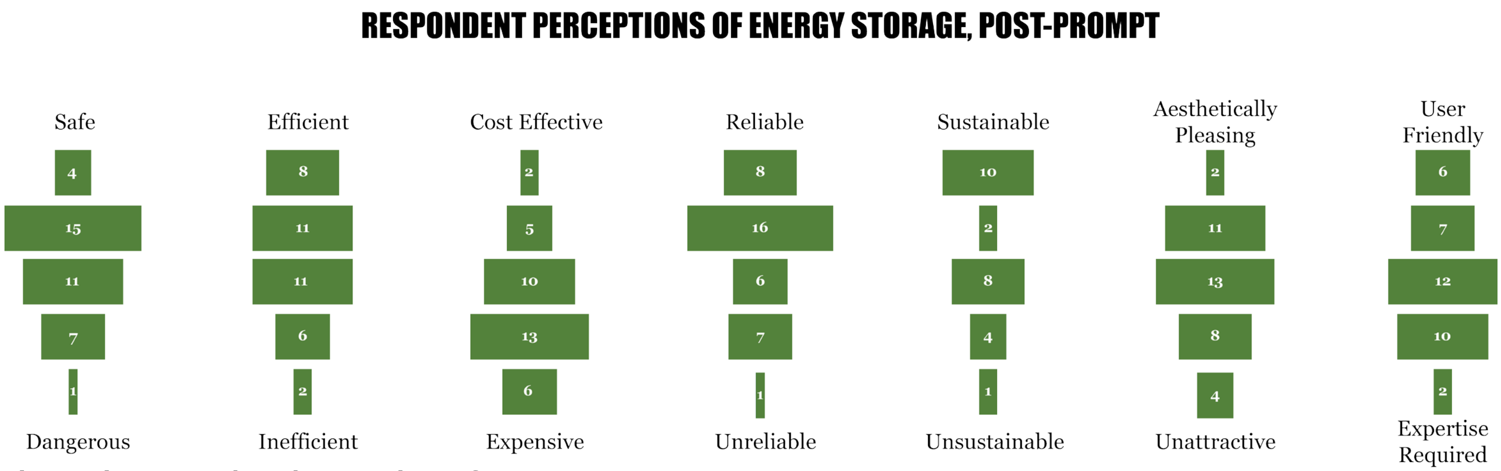

Figure 8) Respondents' Perceptions of Energy Storage, Post-Prompt

likely to accept this project in their community and about 24% of respondents were "neutral". Summary data on the likeliness of the participants accepting this project in their community can be found in Figure 9.

Furthermore, participants were asked if they would prefer a different energy storage technology in their community and why. Out of the 42 respondents, five of the respondents indicated that they would prefer another technology other than the community battery project. Most of the respondents who preferred another project in their community did not suggest another technology. Rather, they shared their concerns with the proposed project itself and the downfalls of lithium ion battery storage (e.g., risk of exploding). One respondent, however, did mention how they like the idea of compressed air storage instead. Finally, one respondent commented on their lack of concern for electricity blackouts, and stated that their community would not need an energy storage project in their community

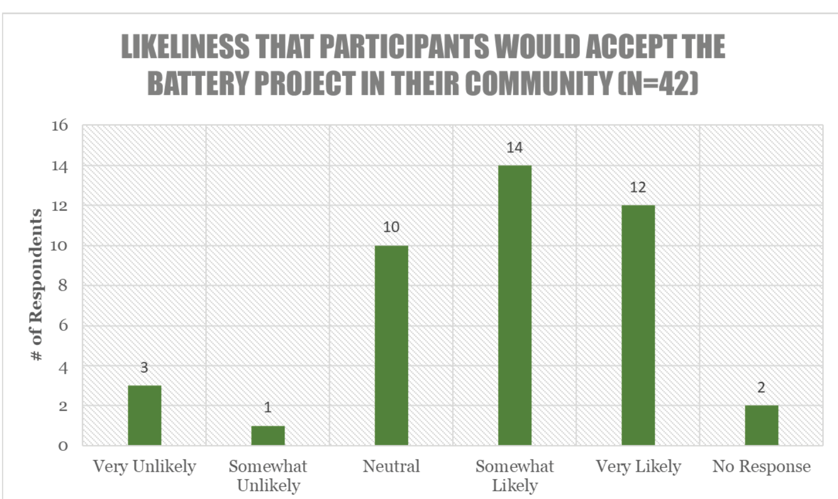

Figure 9) Respondent Acceptance of Proposed Battery Project

in the first place.

To conclude the survey, participants were asked about what other information they would like to know or be provided before this project would be implemented in their community. Nineteen (45%) of the participants did not provide a response for this question. Each of the responses from the other 23 participants was divided into four general themes.

Cost

Eleven (26%) respondents mentioned that they would like to be provided with more information on the cost breakdowns of the project. Cost breakdown concerns mentioned information needed on how it was funded (either by taxpayers or companies) or much how it charged for each unit of energy stored. In regards to the cost, some respondents mentioned that knowing the cost of alternative energy storage methods in comparison to this project would be valuable. Example responses included "cost to consumer" (Respondent 12), "cost breakdown" (Respondent 3), and "Cost. How much and who would bear the costs" (Respondent 11).

Life cycle of the battery

Five of the respondents mentioned the 10-year life cycle of the battery and wanted to know more information about the disposal of the battery, how much it would cost, or how it would be replaced. For example, Respondent 36 said "the life cycle of the battery would be the greatest question".

Operation and maintenance of the battery

The majority of the responses (33%) mentioned that they wanted more information on how the unit operated, how it was maintained, and how efficient the project would be once it is implemented. Another notable response is participants wanted more detail about the safety measures in the project before it was to be implemented. For example, Respondent 24 stated, "…composition of battery, who is monitoring, how often it is being monitored, who do you call if you suspect a problem, what constitutes a problem for an observer…".

Location of the battery

Related to the safety measures, a few respondents (14%) mentioned that they would like to know the exact location of the battery unit in case it were to explode or have any other negative effects on the immediate community. For example, Respondent 15 said:

> Depends where it would be located. Selfish I realize but I wouldn't want this thing on the boulevard in front of my house for example (I would change my answer for #18 [the acceptance question] to Very Unlikely if it was to be located at or near my property).

DISCUSSION

Data from Statistics Canada on the Kitchener-Waterloo population show that the sample is not an exact representation of the Kitchener/Waterloo population. When looking at the gender of the 42 respondents, the sample had 54% males and 45% females. This is relatively close to the actual percentages of males and females in Kitchener/Waterloo (49% male and 51% female). The median age was similar across the 42 respondents when compared to the 2011 Canadian census data. The median age of both the Kitchener and Waterloo population was approximately 37 years, and the median age group of the respondents was 35-44 years. Additionally, the median income of families in the City of Waterloo was not available. The median income of households in the City of Kitchener is 2011 was $79,020. The median income throughout the respondents was $30,001-$50,000, meaning that the respondents who answered this survey generally fell on average lower than the median income levels of the population. However, there was notable "clusters" of respondents with respect to income. Twenty-three respondents fell within the lower income brackets (<$50,000), eleven respondents reported that their household income was above $110,000, and only eight respondents had annual household incomes between $50,001 and $110,000. In short, the sample size only captured a small portion of the Kitchener/Waterloo population and had very few respondents that would be considered "middle income", though it did capture both males and females, with the accurate median age of the population. Summary statistics from Statistics Canada 2011 on Kitchener/Waterloo and the study sample appear in Table 2.

Table 2) Kitchener/Waterloo Demographics

	Population	Median Age (yrs)	Median Income	Male (%)	Female (%)
Kitchener	219,153	37.2	$79,020	48.9	52.2
Waterloo	98,780	37.6	N/A	49.4	50.5
Kitchener & Waterloo	317,933	37.4	$79,020	49.2	51.4
Sample Size from Study	42	35-44	$30,001-$50,000	54.8	45.2

When analyzing the results of the questionnaire, it can be concluded that in general the respondents lack knowledge on energy storage. With respect to what "types" of respondents considered themselves most knowledgeable on energy storage in the first section of the questionnaire, no one considered themselves very knowledgeable (experts) on energy storage. When the respondents were asked about their initial thoughts on energy storage, a notable amount of the responses were questioning energy storage rather than providing informed opinions on energy storage. This indicated that these participants generally had little knowledge about energy storage, and were uncertain about the costs, risks, the application and benefits that energy storage could potentially have when implemented.

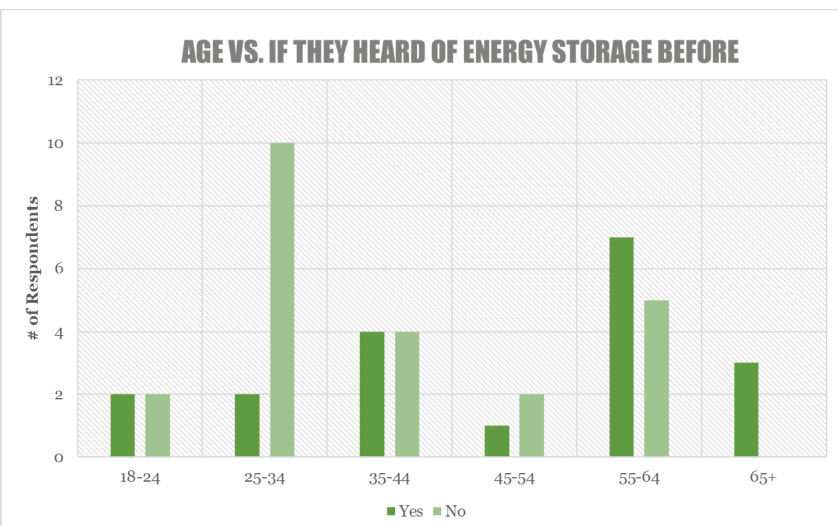

Figure 10) Respondent Age / Prior Awareness of Energy Storage

However, when we try to capture the group of respondents who did consider themselves knowledgeable on energy storage, in Figure 10, the majority of the respondents aged 25-34 said that they had never heard of energy storage before, and more than half of the respondents who were aged 55-64 had heard of energy storage prior to the study. However, for the few respondents who considered themselves "moderately knowledgeable" or "very knowledgeable", the majority were over the age of 34. The majority (five) of the moderately knowledgeable respondents were age 55+. This suggests that there was a positive relationship between age and knowledge of energy storage. When looking at all 42 respondents, the older respondents in general considered themselves more knowledgeable on energy storage. A summary table comparing age and knowledge can be found in Respondent Age / Knowledge of Energy Storage.

Table 3) Respondent Age / Knowledge of Energy Storage

	Not Knowledgeable	Slightly Knowledgeable	Moderately Knowledgeable	Very Knowledgeable	Extremely Knowledgeable
18-24	1	1	2	0	0
25-34	6	6	0	0	0
35-44	4	1	1	2	0
45-54	1	1	1	0	0
55-64	4	3	3	2	0
65+	0	1	2	0	0

In regards to household income and the respondents' knowledge on energy storage, the majority of the respondents that considered themselves moderately knowledgeable reported their annual household income as being under $50,000. In contrast, out of the four respondents who considered themselves very knowledgeable, half of them had an income above $90,000. This suggests that the respondents who were participating in the survey were respondents who were well educated (still in school), and therefore did not have a higher income. In addition, the majority of the higher income individuals considered themselves not or slightly knowledgeable. There is no clear relationship between income and knowledge of energy storage in this study. A summary table comparing income and knowledge can be found in Table 4.

Table 4) Respondent Income / Knowledge of Energy Storage

	Not Knowledgeable	Slightly Knowledgeable	Moderately Knowledgeable	Very Knowledgeable	Extremely Knowledgeable
<$30,000	4	1	3	2	0
$30,001-$50,000	4	5	4	0	0
$50,001-$70,000	2	0	1	0	0
$70,001-$90,000	2	1	0	0	0
$90,001-$110,000	1	0	0	1	0
$110,001 +	3	6	1	1	0

Within the questionnaire, there was a question asking the respondents to rank their overall acceptance of the hypothetical project. Forty-one out of the 42 individuals responded to this question. A table summarizing the overall acceptance of the project can be found in Table 5.

As mentioned in the results, when participants were asked to explain their initial thoughts on the project, 19 of the respondents were considered "supportive" and 11 respondents were "concerned" about the proposed community battery energy storage project. For this section, the sample size will be 30 because 12 respondents either had no response or were "neutral" in reaction to the hypothetical project.

Demographics

As the responses were further analyzed, the data were compared to the age, income, and knowledge of the respondents. Overall, the majority of the respondents that were concerned about the project were aged 25-34 or 55-64. The majority of the supportive respondents were aged 35-44 or 55-64. There is no strong relationship between age and reaction to the proposed project. In regards to the income of the

Table 5) Summary of Project Acceptance

Acceptance	Count (n=41)
Very Unlikely	3
Somewhat Unlikely	1
Neutral	10
Somewhat Likely	14
Very Likely	13

respondents, the respondents who were concerned were either low income or higher income. However, there were very few respondents in the sample who were middle income. It was found that majority of the respondents who were supportive of the project were lower income (less than $50,000). In summary, there was no distinct relationship between the support and concern for the project in regards to the respondent's income or age. Summary tables can be found in Table 6 and Table 7.

Table 6) Respondent Age / Support for Proposed Project

	Supportive (n=19)	Concerned (n=11)
18-24	2	0
25-34	3	6
35-44	5	1
45-54	2	1
55-64	6	3
65+	1	0

Table 7) Respondent Income / Support for Proposed Project

	Supportive (n=19)	Concerned (n=11)
<$30,000	3	5
$30,001-$50,000	5	4
$50,001-$70,000	0	2
$70,001-$90,000	2	1
$90,001-$110,000	0	1
$110,001 +	1	6

Knowledge of Energy Storage

It is notable that all of the respondents who considered themselves very knowledgeable on energy storage were supportive of the proposed project. All of the respondents who were concerned about this project were not knowledgeable on energy storage. Although there are quite a few respondents who were not knowledgeable and are supportive of the project, the few respondents who considered themselves knowledgeable were supportive as well. It can be suggested that there is a positive relationship between knowledge of energy storage and the acceptance of the proposed project. Respondents who considered themselves more knowledgeable on energy storage were more likely to have a supportive response to the energy storage project. A summary table can be found in Table 8.

Information Needs

Table 8) Respondent Prior Knowledge of Energy Storage / Support for Proposed Project

	Supportive (n=19)	Concerned (n=11)
Not Knowledgeable	9	3
Slightly Knowledgeable	4	7
Moderately Knowledgeable	4	1
Very Knowledgeable	2	0
Extremely Knowledgeable	0	0

When the participants were asked about what additional information with which they would like to be provided before the project were to be implemented in their community, respondents mentioned they needed information about the costs, life cycle of the battery, operation and maintenance of the battery, and the location of the battery unit. When summarizing all of the responses, participants' incomes and ages were compared to their information needs. When looking at the participants who wanted more information on the cost breakdown of the project, the majority of them were aged 55-64, however these participants fell within various different income brackets. With these data, it can be suggested that the older demographic is more concerned with the costs of the project.

For information regarding the life cycle of the battery, the majority of the respondents were in the lower income bracket of $30,001-$50,000, and the ages varied among the responses. However, there were only five respondents who mentioned the life cycle of the battery, so it is harder to suggest what type of demographic would be most concerned with the life cycle. Most of the responses mentioned the operation or maintenance of the battery unit (including safety measures). The majority of the respondents who mentioned the operation of the battery were lower income individuals (<$30,000), and they were in all age cohorts. Finally, respondents who mentioned that they wanted to know the exact location of the battery unit were higher income individuals ($110,000+). This is a notable relationship because it could be suggested that respondents who have a higher income are more concerned about the aesthetics or safety of their home and community.

Lastly, let us look at the changes in thoughts and opinions the respondents had on energy storage before and after being provided information about a specific energy project. We see that the opinions did not change much. When referring to the summary table (Table 9), you can see that most of the responses had no change (0 value), or a -1 or +1 change meaning that their reaction changed slightly, but not dramatically. The summary statistics stayed relatively the same when the participants reacted to the information they were given on the community battery project. A summary table can be found in figure 10.

Table 9) Changes in Perceptions, Pre- and Post-Prompt

	-4	-3	-2	-1	No Change	1	2	3	4		*No Response*
Dangerous	0	2	1	11	14	6	2	0	0	Safe	*6*
Inefficient	1	1	1	5	11	11	5	1	0	Efficient	*6*
Expensive	1	3	5	8	8	9	0	0	1	Cost-effective	*7*
Unreliable	0	2	1	7	9	15	2	0	0	Reliable	*6*
Unsustainable	0	1	2	6	12	10	1	0	0	Sustainable	*10*
Unattractive	0	0	7	8	10	9	1	0	0	Aesthetically Pleasing	*7*
Expertise Required	0	0	0	5	16	7	5	2	0	Use Friendly	*7*

LIMITATIONS OF THE STUDY

The study has methodological limitations. When examining the existing literature, study limitations are not uncommon in research trying to gain insight on the public acceptance of energy storage projects. First, the sample size is small, and it does not necessarily represent the entire Kitchener-Waterloo population. Although the results in regards to the lack of knowledge of energy storage align with the majority of the literature's findings, it is not reasonable to conclude that the 42 responses accurately represent the community acceptance and public perceptions of energy storage projects nationally in Canada, let alone in Kitchener-Waterloo. Second, 60% of the respondents responded to the online Kijiji ad posted. This may pose a limitation on the study because this type of recruitment method dominated and may have attracted particular kinds of respondents (e.g., lower income). Finally, because a web-based survey was used to collect data, this type of methodology has its own limitations. For some of the closed-ended questions, respondents did not have the chance to openly respond and give their feedback on their knowledge on energy storage. In addition, web-based surveys do not allow the researcher to read body language or have an in-depth conversation addressing the respondent's beliefs, concerns and perceptions on energy storage. For future research, in-depth interviews with the general public may present advantages that this study was unable to provide.

CONCLUSIONS

At a time when energy storage is emerging in Canada and around the world, it is worth knowing what needs to be in place to encourage the acceptance of these projects at a community level. Community acceptance was identified as one of the most influential topics that determines the success of integrating an energy project into a community. This research aims to begin to assess the public's perspective on energy storage in the hope of encouraging successful implementation of potential of energy storage projects in the future. The main objective of this paper was to start to conduct a gap analysis on where the public is now and where it needs to be in regards to the community acceptance of energy storage.

When analyzing the results of the survey, it is evident that there is a lack of awareness among the respondents. The majority of the respondents did not have an understanding of what energy storage was, its applications, or how it operated. The literature recognized that the majority of respondents lack the basic knowledge and understanding of energy storage and how it works. Unfortunately, this is also the case in the survey results in the Kitchener-Waterloo population. Although a few respondents did have a general idea of what energy storage was, about half of the participants claimed that they have never heard of energy storage before. In addition, when they were asked about their first associations with energy storage, many provided uninformed opinions and simply stated they were not aware of what it was. However, when participants were asked about their concern for energy issues, the majority of the respondents recognized the concerns for all of these mentioned topics (e.g. energy prices, energy sustainability, public engagement, etc.).

However, once the sample was provided context on an energy storage project, the majority of the respondents were interested and supportive of the project. All of the respondents who considered themselves moderately or very knowledgeable were supportive of the project. This supports the literature's hypothesis that with increased knowledge, local acceptance will increase as well. All of the respondents who were concerned about the project once they were given information, initially considered themselves not knowledgeable on energy storage. Considering the responses from the sample, participants lacked the knowledge of the overall benefits that energy storage will bring but did however express interest in knowing more about it. This might be an indication that the survey did not provide enough information and clarity on the project, and that with more information provided, these respondents may become supportive of the project.

In summary, in order for a community to be considered "ready" for potential energy storage projects in the future, communities must have knowledge on the project and energy storage itself in order to be more likely to accept the project in their immediate neighborhoods. Community knowledge can be increased by effective public engagement from decision makers and project developers.

RECOMMENDATIONS

The objective of this research was to gain a better understanding of the public's knowledge, opinions and concerns with energy storage projects to help encourage community acceptance of potential energy storage projects in the future. The gap analysis suggests that there is still a considerable amount of improvement that must be made in order to consider the Kitchener/Waterloo population completely "ready" for these types of projects in their communities. When analyzing and comparing the results of the literature and the results of the survey, it is evident that the results from the sample do align with the results in the existing research conducted on community acceptance of energy projects. The majority of the respondents lack the fundamental knowledge on energy storage, and if decision makers in the future provide information on energy storage projects, the likelihood of acceptance of these projects will in theory increase. Thus, an increase in public engagement on the projects (providing more information in regards to cost, location, operation, and life cycle of the battery) will increase the knowledge of the public on energy storage.

Although the study concluded that the respondents were, in total, uninformed about energy storage and that they were generally interested in learning more about it, we can also see differences within the sample that create different clusters of respondents. It is interesting to note the different clusters of respondents who have different information needs moving forward with the energy storage project (e.g. the higher income respondents were most concerned about the location of the project). This result can support the literature finding that it is hard to determine specific factors that foster the community acceptance of energy storage projects. When going forward with energy storage projects in the future, decision makers need to be aware that different demographic profiles may be more concerned or interested in knowing different aspects of the project. With this being said, when engaging with the public on community projects, transparency should be a top priority to ensure all members of the community are educated and knowledgeable on every aspect of the project.

In regards to future work that can be completed for preparing the public for potential future energy storage projects, effective public engagement techniques should be put in place in order to increase the local knowledge on energy storage. Increasing the knowledge of the public is the first step so the public can then make informed opinions on potential energy storage projects in their communities. In order to determine what effective public engagement means and what techniques could be best practiced, additional research needs to be conducted. Once public engagement techniques are implemented, research would benefit from doing more in-depth interviews to get a more detailed response from the general public on their thoughts and opinions on energy storage projects. With these steps, the public can be more prepared for potential energy storage projects, and risks for community opposition can be limited.

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