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March 31, 2022

Commercial Energy Consumers Association of British Columbia
c/o Owen Bird Law Corporation
P.O. Box 49130
Three Bentall Centre
2900 – 595 Burrard Street
Vancouver, BC
V7X 1J5

Attention: Mr. Christopher P. Weafer

Dear Mr. Weafer:

Re: FortisBC Inc. (FBC)

2021 Long-Term Electric Resource Plan (LTERP) and Long-Term Demand-Side Management Plan (LT DSM Plan) (Application) – Project No. 159924

Response to the Commercial Energy Consumers Association of British Columbia (CEC) Information Request (IR) No. 2

On August 4, 2021, FBC filed the Application referenced above. In accordance with the regulatory timetable established in British Columbia Utilities Commission Order G-24-22 for the review of the Application, FBC respectfully submits the attached response to CEC IR No. 2.

If further information is required, please contact the undersigned.

Sincerely,

FORTISBC INC.

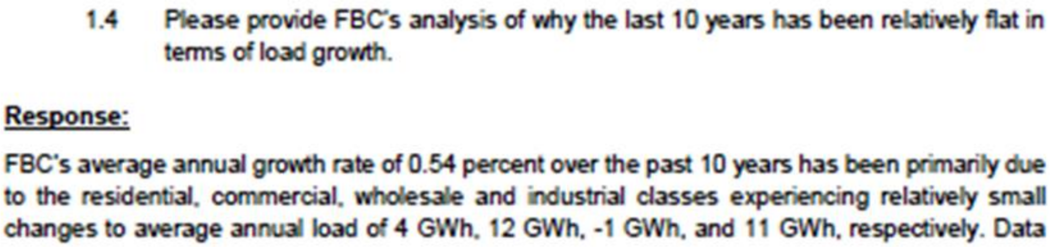
Original signed:

Diane Roy

Attachments

cc (email only): Commission Secretary
Registered Parties

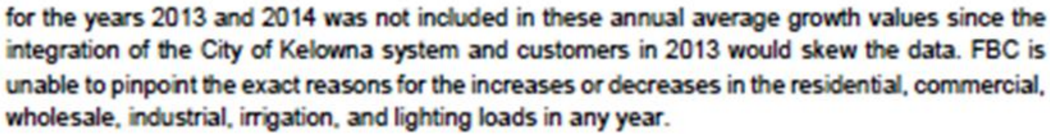
61. Reference: Exhibit B-9, CEC 1.1.4



1.4 Please provide FBC's analysis of why the last 10 years has been relatively flat in terms of load growth.

Response:

FBC's average annual growth rate of 0.54 percent over the past 10 years has been primarily due to the residential, commercial, wholesale and industrial classes experiencing relatively small changes to average annual load of 4 GWh, 12 GWh, -1 GWh, and 11 GWh, respectively. Data



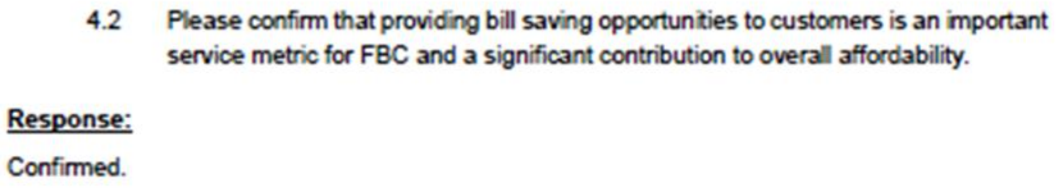
for the years 2013 and 2014 was not included in these annual average growth values since the integration of the City of Kelowna system and customers in 2013 would skew the data. FBC is unable to pinpoint the exact reasons for the increases or decreases in the residential, commercial, wholesale, industrial, irrigation, and lighting loads in any year.

61.1 What activities, if any, does FBC regularly take to assess the performance of its load forecasting? Is this undertaken by rate class? Please explain.

Response:

FBC monitors the forecast performance (in terms of variance to actuals) each year by rate class. The forecast is also submitted each year for the Annual Review process to set rates, which is reviewed by the BCUC and interveners.

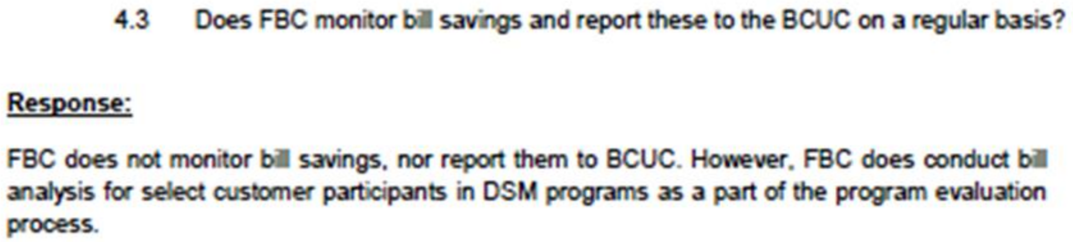
62. Reference: Exhibit B-9, CEC 1.4.2 and 1.4.3



4.2 Please confirm that providing bill saving opportunities to customers is an important service metric for FBC and a significant contribution to overall affordability.

Response:

Confirmed.



4.3 Does FBC monitor bill savings and report these to the BCUC on a regular basis?

Response:

FBC does not monitor bill savings, nor report them to BCUC. However, FBC does conduct bill analysis for select customer participants in DSM programs as a part of the program evaluation process.

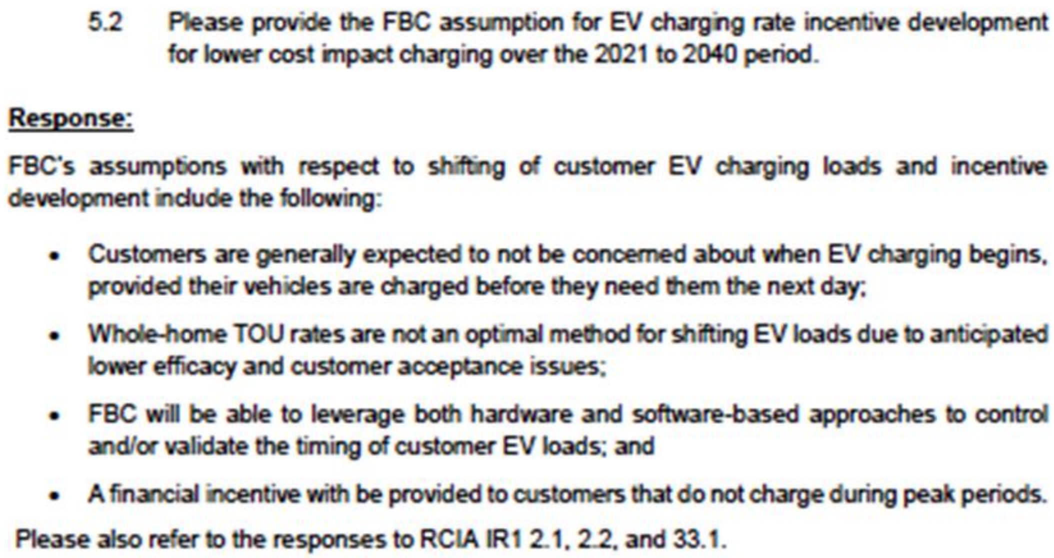
62.1 If FBC does not report the bill savings information to the BCUC, in what ways does FBC utilize bill savings information, and bill savings opportunities, as a service metric?

Response:

One goal of DSM program design is that DSM programs and offers should result in customer bill savings or other benefits. FBC frequently reviews bill savings as part of DSM program evaluations. The data may be used to evaluate gross to net adjustments and/or troubleshoot measure adoption.

For some program evaluations, FBC also surveys participating customers on their experience and satisfaction with DSM programs. Customer feedback on their perceived savings is often gathered. FBC may then amend programs based on reviewing both the quantitative bill savings and qualitative customer feedback.

63. Reference: Exhibit B-9, CEC 1.5.2



5.2 Please provide the FBC assumption for EV charging rate incentive development for lower cost impact charging over the 2021 to 2040 period.

Response:

FBC's assumptions with respect to shifting of customer EV charging loads and incentive development include the following:

- Customers are generally expected to not be concerned about when EV charging begins, provided their vehicles are charged before they need them the next day;
- Whole-home TOU rates are not an optimal method for shifting EV loads due to anticipated lower efficacy and customer acceptance issues;
- FBC will be able to leverage both hardware and software-based approaches to control and/or validate the timing of customer EV loads; and
- A financial incentive with be provided to customers that do not charge during peak periods.

Please also refer to the responses to RCIA IR1 2.1, 2.2, and 33.1.

63.1 Please elaborate on why whole-home TOU rates are anticipated to have lower efficacy, and provide the evidence supporting this position.

Response:

Software-based solutions are anticipated to have greater efficacy and customer acceptance than whole-home TOU rates due to the practical considerations outlined in the Application at page 43:

> This approach is easier to implement for both FBC and customers than the other options, provides the flexibility for utility control or customer control (which allows FBC to implement program changes over time if required, including demand response), and has no direct cost impacts on EV customers.

These factors have led FBC to assume that 50 percent of EV charging can be shifted from peak demand periods. This rate is much higher than results seen in TOU programs that currently exist in other jurisdictions.[1]

63.1.1 Please explain whether FBC's evidence relating to efficacy explicitly considered the need for EV charging.

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[1] https://www.energy.gov/sites/prod/files/2016/12/f34/CBS_Final_Program_Impact_Report_Draft_20161101_0.pdf - See Major Findings, pp 67-69.

Response:

The issues of efficacy and customer acceptance as discussed in the response cited is within the context of addressing EV load by either TOU rates or via a software-based solution and as such was explicitly related to EV charging.

63.2 Please explain why whole-home TOU rates are anticipated to have customer acceptance issues and provide the evidence supporting this position.

Response:

Please refer to the responses to CEC IR2 63.1 and 63.1.1. FBC has assumed that whole-home TOU rates will have lower efficacy and acceptance compared to a software approach, since the latter targets only the less time-of-day-sensitive EV loads and not all loads within the home.

63.2.1 Please explain whether FBC's evidence relating to customer acceptance explicitly considered the need for EV charging.

Response:

Please refer to the response to CEC IR2 63.1.1.

63.3 Please confirm that a whole-home TOU rate could be optional.

Response:

FBC confirms that a whole-home TOU rate would be optional, although FBC expects that a whole-home TOU rate would be less effective than its proposed software-based approach for EV charging load shifting, as discussed in the response to CEC IR 63.1.

63.4 Please describe any benefits that whole-home TOU rates might have for FBC and please consider the possibility of customers becoming more familiar with the concept of TOU rates and improving their acceptance.

Response:

Within the context of the LTERP, any measure, including time-based rates, that is successful in shifting some load from peak periods helps to move load-resource balance capacity gaps to later in the planning horizon. In general, reductions in electricity demand during peak periods can lead to deferral of new investments or upgrades in distribution, transmission, and generation facilities, as well as avoidance of higher prices or demand charges from supply resources. Although FBC's power supply resources do not vary significantly over short periods of time, and infrastructure is generally adequate, should emerging loads begin to stress the system, such peak-demand avoidance could lead to reductions in FBC's overall cost of service, which benefits all customers when the reductions are passed on through rates. If and when customers are more accepting of time-based rates, and peak demands are effectively managed, these associated benefits can be maximized.

63.5 Please describe the hardware and software-based approaches that FBC will leverage.

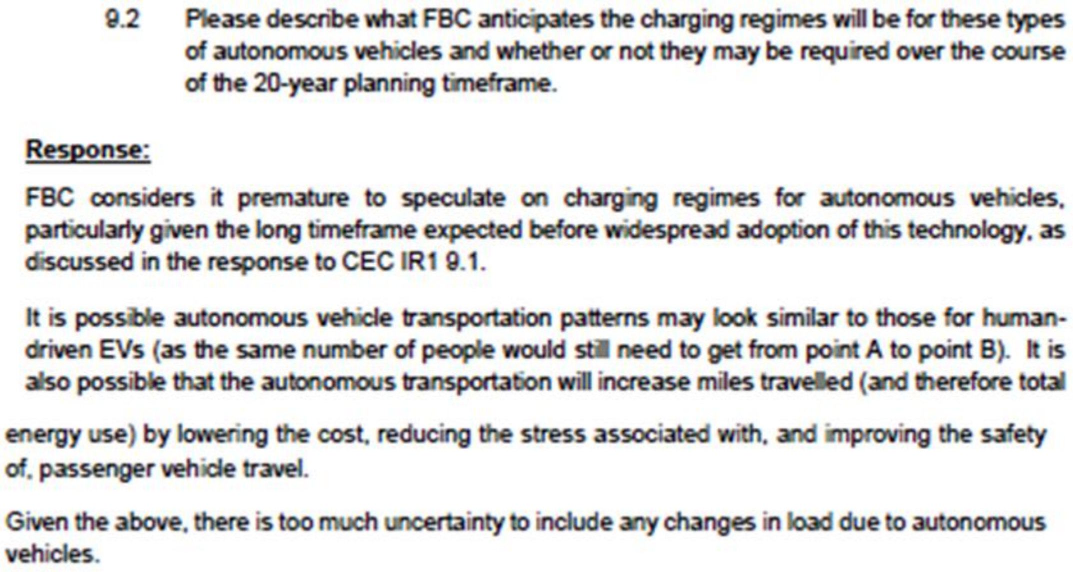
63.5.1 When will FBC undertake to do this?

Response:

In January 2022, FBC launched a demand response (DR) pilot program for residential customers within the Kelowna area which included EV chargers as one of the targeted end-uses. This pilot program for shifting customer EV charging loads uses a hardware-based approach through the use of DR commands sent to the customer's EV charger to manage when a customer charges their EV (customers are still able to override if they so choose).

FBC is also investigating software-based tools for shifting EV loads, which would likely control or at least validate when a customer is charging their EV based on information received directly from the customer's EV itself, and not necessarily based on controlling a particular type of DR-capable charger. No timeline has yet been established for evaluating software-based approaches; however, FBC intends to continue to investigate potential software-based approaches throughout 2022.

64. Reference: Exhibit B-9, CEC 1.9.2



9.2 Please describe what FBC anticipates the charging regimes will be for these types of autonomous vehicles and whether or not they may be required over the course of the 20-year planning timeframe.

Response:

FBC considers it premature to speculate on charging regimes for autonomous vehicles, particularly given the long timeframe expected before widespread adoption of this technology, as discussed in the response to CEC IR1 9.1.

It is possible autonomous vehicle transportation patterns may look similar to those for human-driven EVs (as the same number of people would still need to get from point A to point B). It is also possible that the autonomous transportation will increase miles travelled (and therefore total energy use) by lowering the cost, reducing the stress associated with, and improving the safety of, passenger vehicle travel.

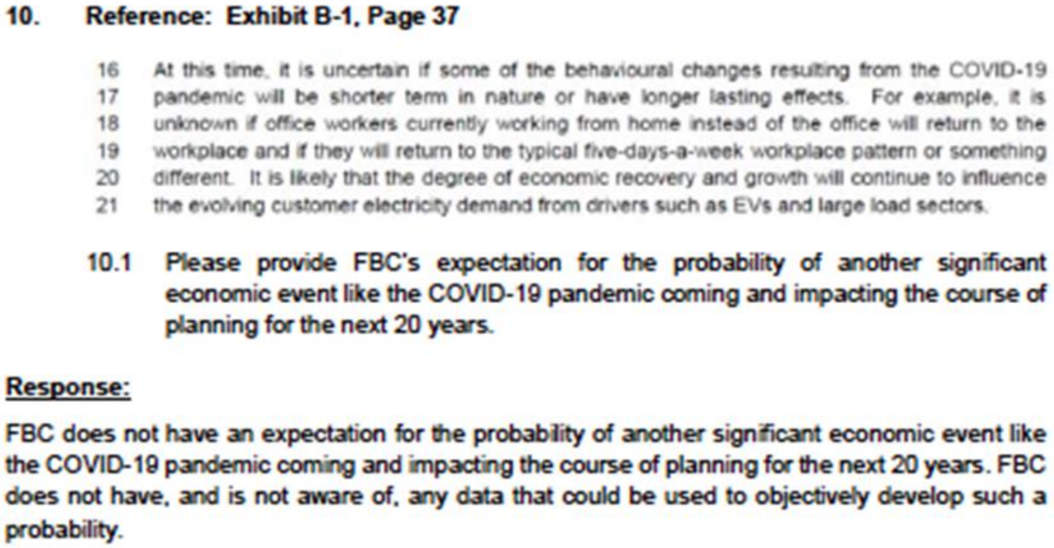
Given the above, there is too much uncertainty to include any changes in load due to autonomous vehicles.

64.1 Does FBC consider that work-from-home practices that were developed during COVID-19 will likely have an impact on electric load over the next 10 years, either by reducing the need to move from point A to point B or any other reason? Please review any impacts FBC has seen, or expects to see, and provide quantification where possible.

Response:

FBC believes it is too early to determine whether there will be any lasting impacts to electric load resulting from the COVID-19 pandemic. Although FBC has observed some decrease in direct current fast charger (DCFC) usage during the pandemic, it is difficult to determine how much of this decrease is related to practices like work-from-home as compared to the travel restriction measures that have been periodically implemented throughout the pandemic.

65. Reference: Exhibit B-9, CEC 1.10.1 and 10.2



10. Reference: Exhibit B-1, Page 37

At this time, it is uncertain if some of the behavioural changes resulting from the COVID-19 pandemic will be shorter term in nature or have longer lasting effects. For example, it is unknown if office workers currently working from home instead of the office will return to the workplace and if they will return to the typical five-days-a-week workplace pattern or something different. It is likely that the degree of economic recovery and growth will continue to influence the evolving customer electricity demand from drivers such as EVs and large load sectors.

10.1 Please provide FBC's expectation for the probability of another significant economic event like the COVID-19 pandemic coming and impacting the course of planning for the next 20 years.

Response:

FBC does not have an expectation for the probability of another significant economic event like the COVID-19 pandemic coming and impacting the course of planning for the next 20 years. FBC does not have, and is not aware of, any data that could be used to objectively develop such a probability.

10.2 Please confirm that the future forecasting FBC is using appears to have 20 years of unwavering growth and no anticipation of a possible future disruption.

Response:

FBC does not expect to see "20 years of unwavering growth and no anticipation of a possible future disruption". Rather, FBC expects that the future growth will occur within the uncertainty bands as discussed in Section 5 of Appendix F.

FBC's Reference Case load forecast is based on the growth of intrinsic historical load drivers per the BAU load forecast plus EV charging impacts and highly certain large loads. It is considered a snapshot of a moment in time and represents FBC's current expectations for future load growth. However, FBC's future load growth will change over time, the combined impacts of various load drivers will change, and new load forecasts will be developed in future LTERPs.

65.1 Please explain how extreme weather events can be expected to impact FBC's electric load. For instance, do wildfires or floods typically result in increases or decreases to FBC's load and if so, please quantify the analysis by year for the periods FBC has done analysis. If FBC has not done this analysis, can it provide analysis to answer this question?

Response:

Extreme weather events such as wind or snow storms that cause damage to FBC's infrastructure typically decrease FBC's electric load for short periods by limiting the ability of FBC to supply electricity to its customers until the damage is repaired. FBC has not performed an analysis on the overall impact of these disruptions, but expects that they would not be material from a long-term resource planning perspective.

In contrast, extreme weather events such as heat waves or arctic outbreaks, can cause short-term, temporary increases in loads. It is during these temperature extremes that FBC experiences its winter and summer peak demands. In these cases, there is typically no damage to infrastructure, but more energy is used to heat or cool customer premises. A recent example is the June 2021 heat dome; FBC provides some analysis of the impacts of this event in the responses to BCUC IR1 21.2 and 21.3.

65.2 Please explain whether or not FBC expects that extreme weather events will likely impact the course of planning over the next 20 years.

65.2.1 If yes, please explain how FBC has accounted for such events in their planning.

65.2.2 If no, please explain why not.

Response:

FBC expects that extreme weather events resulting from climate change will likely impact the course of planning over the next 20 years.

As discussed in the response to BCOAPO IR1 6.2.2, FBC expects that climate change, including extreme weather events, may have impacts on all key aspects of long-term planning, including government policies and FBC's climate goals, supply resources, customer requirements, and system infrastructure over the LTERP planning horizon. FBC discusses these potential impacts in the following LTERP sections, which are further expanded upon below:

- Section 2.2 – government policies and FBC's climate goals;
- Section 5.1.1 - temperature and precipitation pattern changes on FBC's supply resources;
- Section 4.1 – potential changes to customers' annual energy and peak demand load requirements through load scenarios; and
- Section 6.6 - transmission and distribution infrastructure.

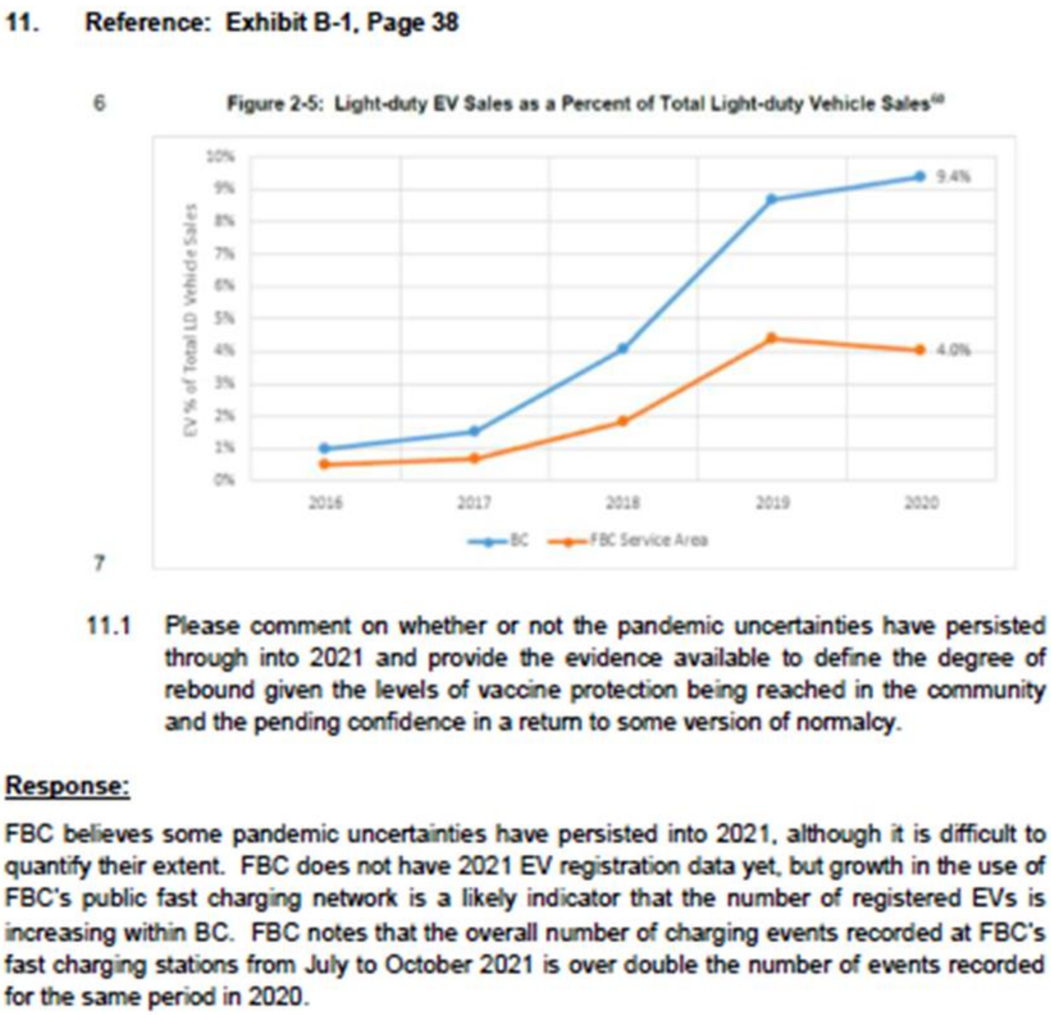
FBC expects that further developments in government policies and its own climate goals will continue to evolve and be accounted for in future LTERPs and long-term plans.

As discussed in the response to BCUC IR1 18.1, FBC is monitoring developments regarding climate change impacts on water availability as it relates to FBC's supply resources. FBC may undertake or collaborate with other entities in future studies and make adjustments as appropriate in a future LTERP, once there is more information regarding the potential impacts on its supply from climate change.

FBC explored potential changes to customers' load requirements resulting from climate change within its load scenarios, as discussed in Section 4. With regard to the impacts on customer loads due to extreme weather events (such as the June 2021 heat dome event, as discussed in the response to BCUC IR1 21.4), FBC is currently reviewing its 1 in 20 peak demand forecast method. This will include working with other regional utilities regarding issues related to climate change, to determine if any change in method is warranted at this time.

Finally, extreme weather is already impacting FBC's long-term planning related to its transmission and distribution infrastructure. As discussed in the responses to BCUC IR1 24.1 and 24.4, FBC has been building climate resiliency for its electricity system using its standards and practices over time and is in the process of developing a roadmap for climate change adaptation, with wildfires, flooding, and extreme weather events being considered the highest risks for the FBC service territory. As discussed in Section 6.6 and BCOAPO IR1 6.2, depending on the potential risks associated with climate change, system infrastructure adaptation measures could result in installation of new equipment, the use of new technologies, changes to FBC operating procedures, and updates to FBC's design standards. Further, depending on the specific climate change impacts, there may be a need for resiliency measures and additional infrastructure capacity to address higher customer peak demand.

66. Reference: Exhibit B-9, CEC 1.11.1



11. Reference: Exhibit B-1, Page 38

Figure 2-5: Light-duty EV Sales as a Percent of Total Light-duty Vehicle Sales[60]

11.1 Please comment on whether or not the pandemic uncertainties have persisted through into 2021 and provide the evidence available to define the degree of rebound given the levels of vaccine protection being reached in the community and the pending confidence in a return to some version of normalcy.

Response:

FBC believes some pandemic uncertainties have persisted into 2021, although it is difficult to quantify their extent. FBC does not have 2021 EV registration data yet, but growth in the use of FBC's public fast charging network is a likely indicator that the number of registered EVs is increasing within BC. FBC notes that the overall number of charging events recorded at FBC's fast charging stations from July to October 2021 is over double the number of events recorded for the same period in 2020.

66.1 When can FBC expect to have 2021 EV registration data?

66.1.1 If FBC already has the 2021 EV registration data or will have it in the near future, please provide it, and please provide it by month.

Response:

FBC expects to receive 2021 EV registration data sometime in Q2 2022.

66.2 Does FBC have any evidence that charging at fast charging stations is price sensitive? Please explain and provide any evidence FBC has available.

Response:

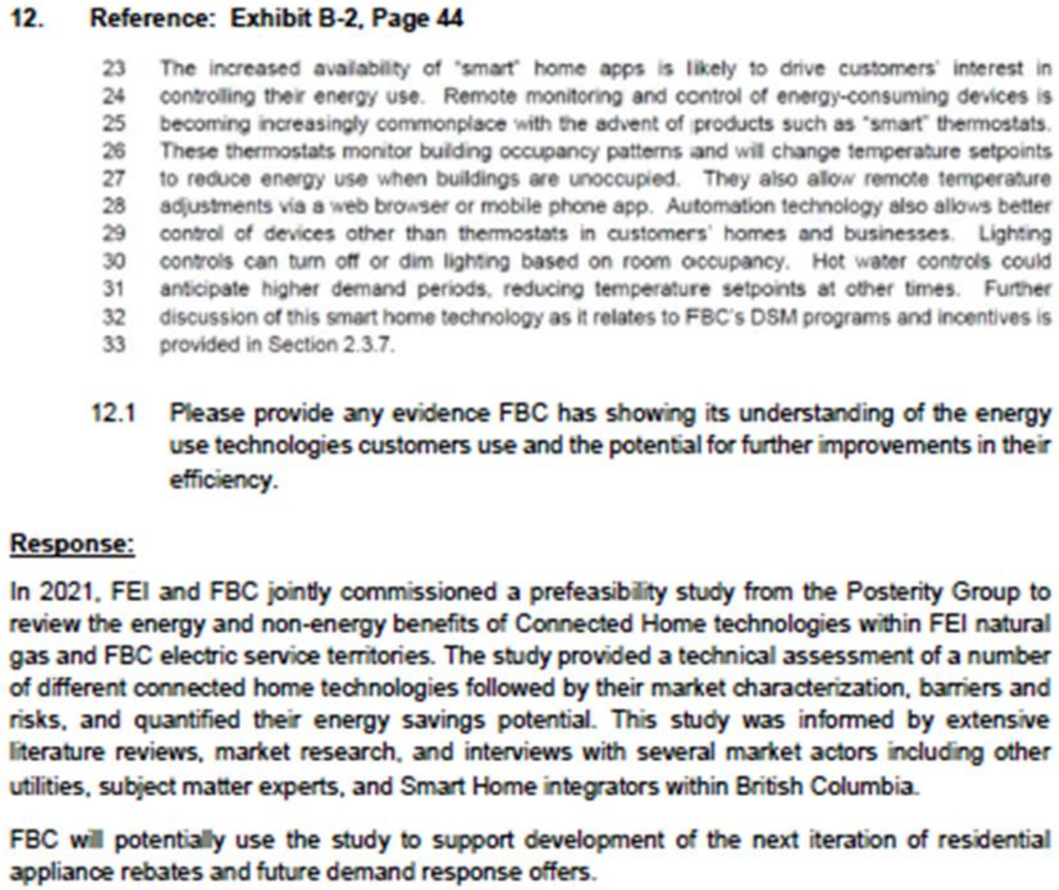
Given the relatively low number of public fast charging stations deployed today and the significant speed advantage they offer over Level 2 chargers, FBC expects that customers are generally not very price-sensitive at this time. As additional public fast charging stations are deployed and competition increases, FBC expects that customers will become more price-sensitive with respect to which fast charging stations they elect to use.

66.3 Is it fair to conclude that the increase in charging at FBC stations provides an indication that the current pricing for FBC charging is proving to be reasonably attractive for charging customers, whatever their reasons may be for seeking the charging?

Response:

It is difficult to assess the attractiveness of pricing at FBC DCFC stations based on charging rates alone. At this time, FBC believes that the demand for high-speed travel charging is likely to be quite inelastic as there are limited alternatives for customers to choose from in many locations. However, FBC notes that the current pricing, assuming that customers can charge at or near the peak rate of the charging station, results in “fuel” costs that are reasonable as compared to gasoline.

67. Reference: Exhibit B-9, CEC 1.12.1



12. Reference: Exhibit B-2, Page 44

The increased availability of "smart" home apps is likely to drive customers' interest in controlling their energy use. Remote monitoring and control of energy-consuming devices is becoming increasingly commonplace with the advent of products such as "smart" thermostats. These thermostats monitor building occupancy patterns and will change temperature setpoints to reduce energy use when buildings are unoccupied. They also allow remote temperature adjustments via a web browser or mobile phone app. Automation technology also allows better control of devices other than thermostats in customers' homes and businesses. Lighting controls can turn off or dim lighting based on room occupancy. Hot water controls could anticipate higher demand periods, reducing temperature setpoints at other times. Further discussion of this smart home technology as it relates to FBC's DSM programs and incentives is provided in Section 2.3.7.

12.1 Please provide any evidence FBC has showing its understanding of the energy use technologies customers use and the potential for further improvements in their efficiency.

Response:

In 2021, FEI and FBC jointly commissioned a prefeasibility study from the Posterity Group to review the energy and non-energy benefits of Connected Home technologies within FEI natural gas and FBC electric service territories. The study provided a technical assessment of a number of different connected home technologies followed by their market characterization, barriers and risks, and quantified their energy savings potential. This study was informed by extensive literature reviews, market research, and interviews with several market actors including other utilities, subject matter experts, and Smart Home integrators within British Columbia.

FBC will potentially use the study to support development of the next iteration of residential appliance rebates and future demand response offers.

67.1 Please provide a copy of the study, or a link to the study.

Response:

Please refer to Attachment 67.1 for a copy of Posterity's Connected Homes Prefeasibility Study.

67.2 FBC states that it will potentially use the study to support development of the next iteration of residential appliance rebates and future demand response offers. What studies are available to support commercial activities and offers, and will FBC commission or make use of such studies? Please explain.

Response:

FBC is not aware of any available study specifically targeting commercial connected appliances. However, many demand response standards and protocols being pursued for residential appliances under the ENERGY STAR label would also apply to commercial appliances. FBC is not planning to commission a study solely targeting commercial-scale connected appliances at this time.

FBC is sponsoring a study through CEATI[2] to explore energy efficiency retrofits for small (under 10,000 square feet) commercial buildings. This study will investigate the potential for integrating building heating/ventilation/air-conditioning control systems, sensors, intelligent optimization systems, and lighting controls in buildings that typically are not equipped with direct digital control systems. The emphasis of this study is on technologies that are nearly commercial and proven to save energy, but require incentive funding to gain adoption in small commercial buildings. This study is planned to begin in Q2 2022.

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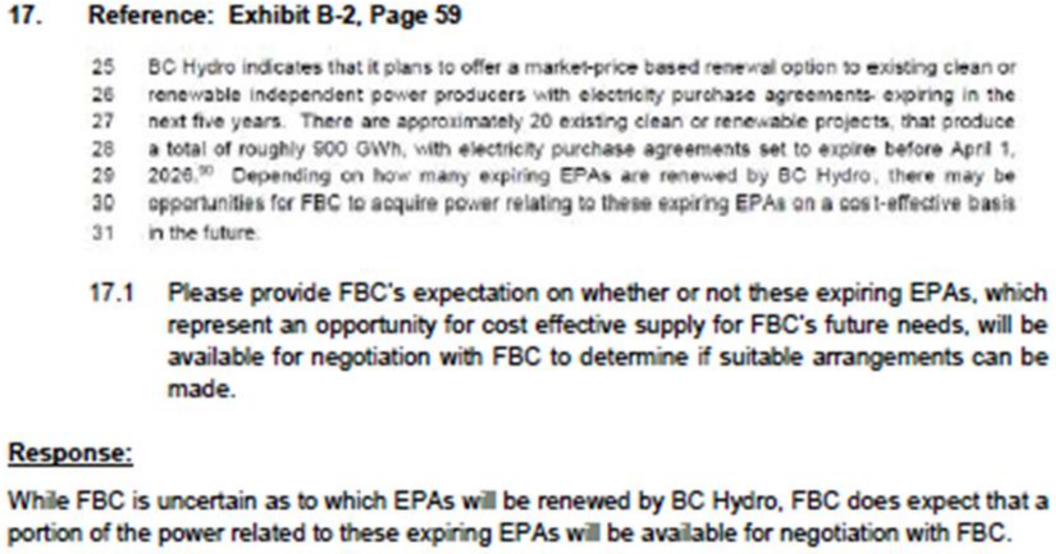
[2] The Centre for Energy Advancement through Technological Innovation: www.ceati.com.

68. Reference: Exhibit B-9, CEC 1.17.1



17. Reference: Exhibit B-2, Page 59

BC Hydro indicates that it plans to offer a market-price based renewal option to existing clean or renewable independent power producers with electricity purchase agreements expiring in the next five years. There are approximately 20 existing clean or renewable projects, that produce a total of roughly 900 GWh, with electricity purchase agreements set to expire before April 1, 2026.[30] Depending on how many expiring EPAs are renewed by BC Hydro, there may be opportunities for FBC to acquire power relating to these expiring EPAs on a cost-effective basis in the future.

17.1 Please provide FBC's expectation on whether or not these expiring EPAs, which represent an opportunity for cost effective supply for FBC's future needs, will be available for negotiation with FBC to determine if suitable arrangements can be made.

Response:

While FBC is uncertain as to which EPAs will be renewed by BC Hydro, FBC does expect that a portion of the power related to these expiring EPAs will be available for negotiation with FBC.

68.1 Would it be reasonable to expect that about half the 900 GWh might be available to FBC? Please explain why or why not.

Response:

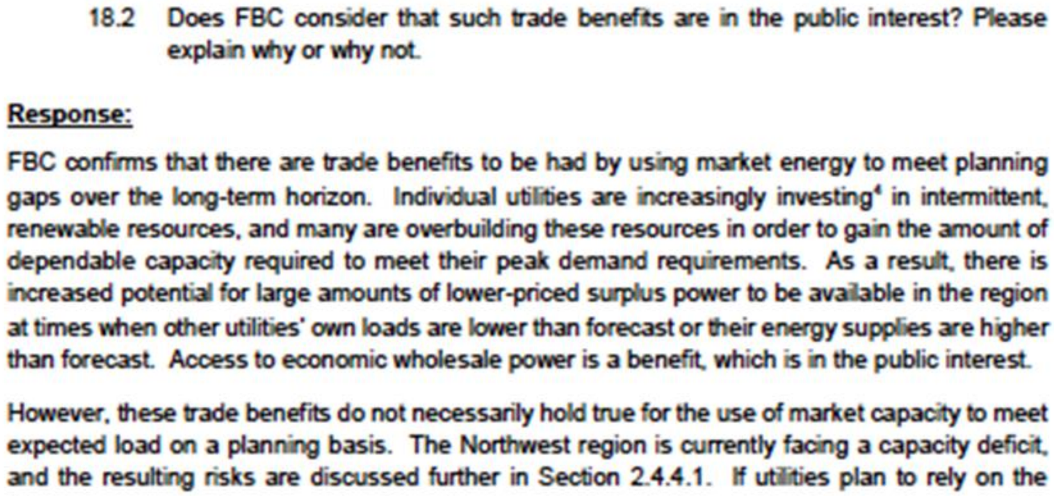
FBC confirms that it would expect at least half of the 900 GWh might be available to FBC, with a significant portion from the Brilliant Expansion Project. Please also refer to the response to BCOAPO IR1 44.1.

68.2 Please confirm that FBC would expect to acquire power at market rates from these EPA resources. Please explain.

Response:

Not confirmed. Rather than assuming that a pure market-based rate would be appropriate, FBC would consider multiple factors when negotiating a contract rate with any of the expiring EPAs. These factors include the risk profile of the organization offering the EPA, other options the owner of the generation may have, the characteristics of product offered (e.g., whether it is firm or non-firm, whether it is 100 percent clean, etc.), the location of the generation, and the potential length of contract.

69. Reference: Exhibit B-9, CEC 1.18.2

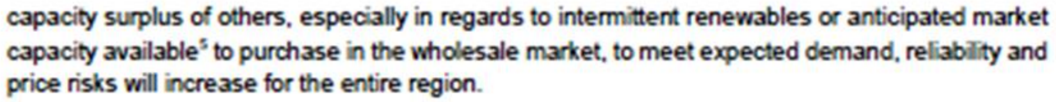


18.2 Does FBC consider that such trade benefits are in the public interest? Please explain why or why not.

Response:

FBC confirms that there are trade benefits to be had by using market energy to meet planning gaps over the long-term horizon. Individual utilities are increasingly investing[4] in intermittent, renewable resources, and many are overbuilding these resources in order to gain the amount of dependable capacity required to meet their peak demand requirements. As a result, there is increased potential for large amounts of lower-priced surplus power to be available in the region at times when other utilities' own loads are lower than forecast or their energy supplies are higher than forecast. Access to economic wholesale power is a benefit, which is in the public interest.

However, these trade benefits do not necessarily hold true for the use of market capacity to meet expected load on a planning basis. The Northwest region is currently facing a capacity deficit, and the resulting risks are discussed further in Section 2.4.4.1. If utilities plan to rely on the



capacity surplus of others, especially in regards to intermittent renewables or anticipated market capacity available[5] to purchase in the wholesale market, to meet expected demand, reliability and price risks will increase for the entire region.

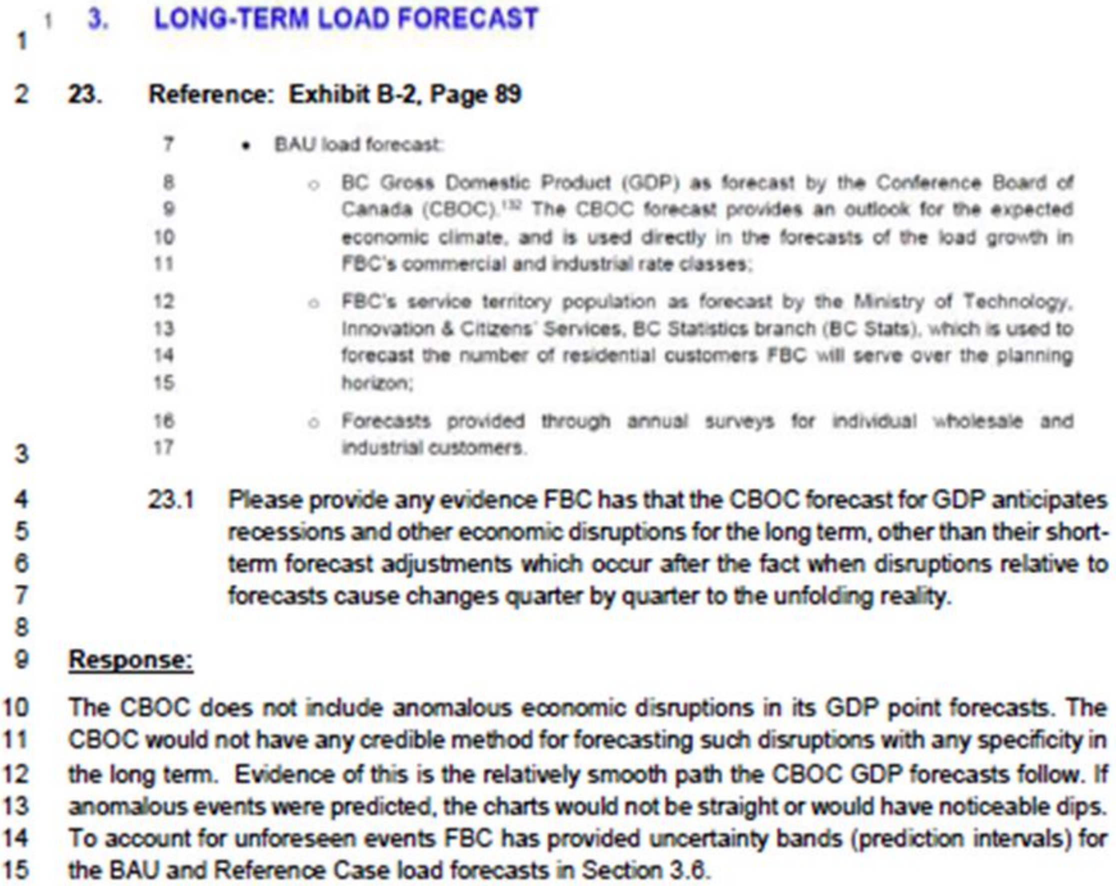
69.1 Does FBC expect that climate change and extreme weather events will impact the available energy from intermittent renewables over the next 20 years? Please explain why or why not.

69.1.1 If yes, please explain how it has been factored in and provide quantification.

Response:

Please refer to the response to BCUC IR2 56.1.

70. Reference: Exhibit B-9, CEC 1.23.1



3. LONG-TERM LOAD FORECAST

23. Reference: Exhibit B-2, Page 89

- BAU load forecast:
  - BC Gross Domestic Product (GDP) as forecast by the Conference Board of Canada (CBOC).[132] The CBOC forecast provides an outlook for the expected economic climate, and is used directly in the forecasts of the load growth in FBC's commercial and industrial rate classes;
  - FBC's service territory population as forecast by the Ministry of Technology, Innovation & Citizens' Services, BC Statistics branch (BC Stats), which is used to forecast the number of residential customers FBC will serve over the planning horizon;
  - Forecasts provided through annual surveys for individual wholesale and industrial customers.

23.1 Please provide any evidence FBC has that the CBOC forecast for GDP anticipates recessions and other economic disruptions for the long term, other than their short-term forecast adjustments which occur after the fact when disruptions relative to forecasts cause changes quarter by quarter to the unfolding reality.

Response:

The CBOC does not include anomalous economic disruptions in its GDP point forecasts. The CBOC would not have any credible method for forecasting such disruptions with any specificity in the long term. Evidence of this is the relatively smooth path the CBOC GDP forecasts follow. If anomalous events were predicted, the charts would not be straight or would have noticeable dips. To account for unforeseen events FBC has provided uncertainty bands (prediction intervals) for the BAU and Reference Case load forecasts in Section 3.6.

70.1 Please describe how FBC's load is typically affected by anomalous economic disruptions, and provide graphic evidence to support the explanation.

Response:

Given that anomalous economic conditions would affect FBC's various customer classes in different ways, FBC is unable to define the impacts that would result from a generic anomalous economic disruption. Historical economic disruptions have had different causes and impacted segments of society in different ways, and are not necessarily representative of any future economic disruption.

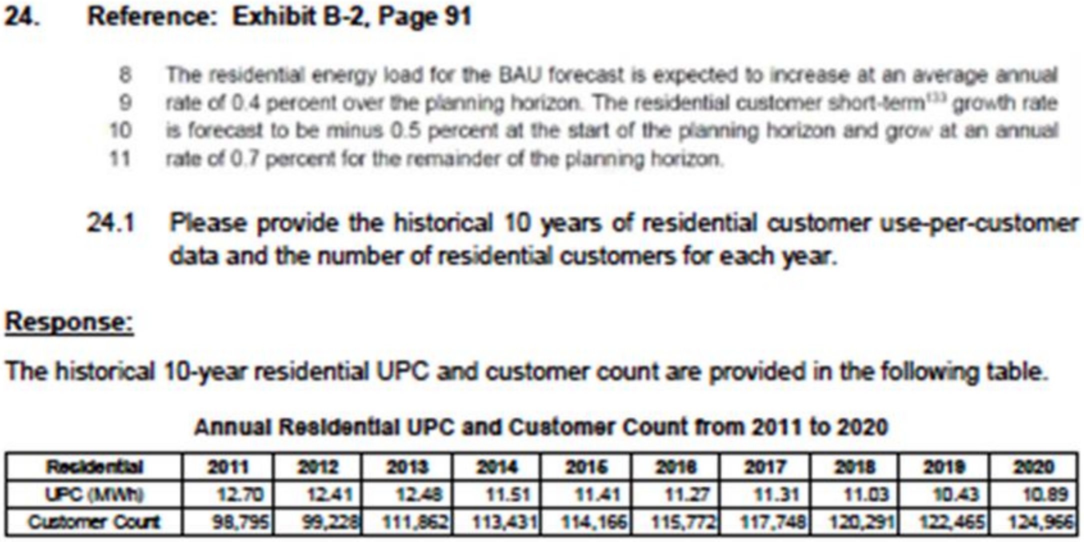
Notwithstanding the above, in general terms, reduced provincial economic activity would typically be expected to reduce commercial and industrial energy sales somewhat (but may have little to no impact on residential energy sales).

70.2 Please explain whether or not load can be expected to rebound quickly, or over the longer term after a deep recession or other significantly deep anomalous event, and please provide graphic evidence to support the explanation.

Response:

Please refer to the response to CEC IR2 70.1.

71. Reference: Exhibit B-9, CEC 1.24.1



24. Reference: Exhibit B-2, Page 91

8 The residential energy load for the BAU forecast is expected to increase at an average annual
9 rate of 0.4 percent over the planning horizon. The residential customer short-term[133] growth rate
10 is forecast to be minus 0.5 percent at the start of the planning horizon and grow at an annual
11 rate of 0.7 percent for the remainder of the planning horizon.

24.1 Please provide the historical 10 years of residential customer use-per-customer data and the number of residential customers for each year.

Response:

The historical 10-year residential UPC and customer count are provided in the following table.

Annual Residential UPC and Customer Count from 2011 to 2020

Residential	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
UPC (MWh)	12.70	12.41	12.48	11.51	11.41	11.27	11.31	11.03	10.43	10.89
Customer Count	98,795	99,228	111,862	113,431	114,166	115,772	117,748	120,291	122,465	124,966

71.1 Please provide an explanation for FBC's declining UPC since 2011.

Response:

The historical residential UPC is influenced by many factors including DSM programs, customer behaviour changes, housing types, building codes, and the COVID-19 pandemic, among others. FBC is unable to identify what specific attributes may have caused decreases or increases in the residential UPC with any certainty. Please refer to the response to BCOAPO IR2 58.2.1 for a table of historical DSM impacts.

71.2 In Appendix F, page 7 of the Application, FBC states that the continuation of declining UPC is not realistic and has held UPC constant for the remainder of the planning horizon. Please provide evidence to support the concept that electrification of end uses can be expected to offset declining UPC and can reasonably be expected to result in a stable UPC.

71.2.1 Please provide examples of electrification of end-uses to which FBC is referring.

71.2.2 Please provide a quantified forecast of end-uses being electrified forecast out year by year for their contribution to flattening the UPC.

Response:

FBC considers it reasonable to expect that electrification (either normal course organic electrification as modeled in Appendix F – Long-Term Load Forecast, or from specific drivers as modelled by Navigant in Appendix H – Load Scenarios Assessment Report), largely due to government policies which promote electrification at provincial and municipal levels, will offset the declining residential UPC. FBC expects that electrification will increase electricity usage for purposes such as space heating, hot water heating, and cooking that have been historically served by natural gas or other fuels. Provincial action plans such as the CleanBC Roadmap and CleanBC Better Homes may increase access to electricity, which will increase the residential UPC over time. Many communities in the FBC service area are also committing to reach 100 percent renewable energy by 2050. For example, the West Kootenay Renewable Energy plan currently includes nine communities within the region committed to this goal.

In addition, many businesses are now offering more flexible work options since the COVID-19 pandemic began, allowing employees to work from home on a part- or full-time basis, which increases home energy usage.

FBC is unable to quantify the exact impacts of these factors on the residential UPC and, therefore, chose to hold the UPC constant starting in 2024.

71.2.3 Please provide estimated end-use electrifications being implemented for residential customer over the last ten years.

Response:

As FBC only receives total consumption meter readings from residential customers, it is unable to identify specific end-use applications, such as those related to electrification, within homes.

71.3 Please confirm that FBC's electrification scenarios have not double counted the impact of electrification by keeping the UPC stable throughout the planning period.

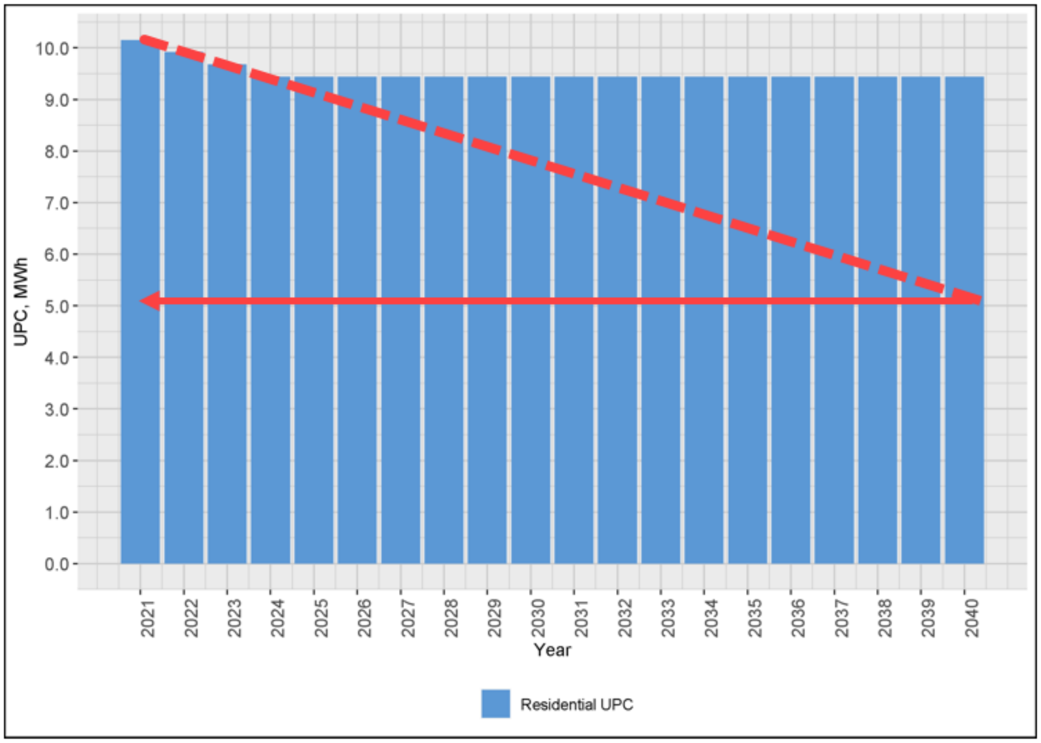
Response:

FBC confirms that the electrification scenarios have not double counted the impact of electrification.

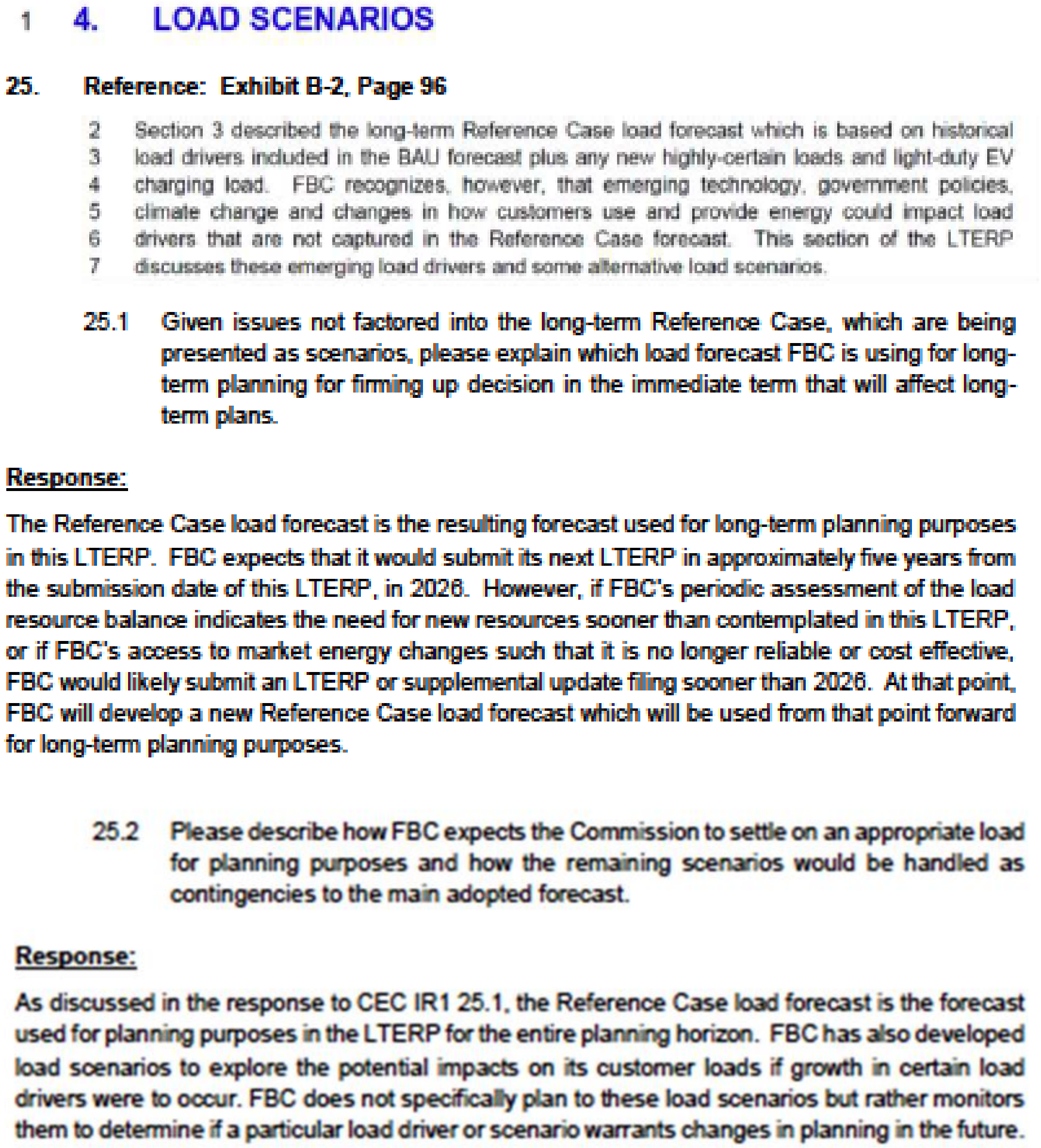
The stable UPC in the BAU forecast from 2024 to 2040 is not the result of an electrification scenario but rather a recognition that the organic decline in the recent historical use rates cannot realistically continue at the same rate for the duration of the LTERP. The various electrification scenarios are driven by discrete assumptions other than organic growth and are incremental to the BAU forecast.

Figure F-6 (reproduced below) extends the short-term UPC trend through to the end of the forecast period. If current trends were to continue, a residential UPC of approximately 5 MWh per year would result, which is 46 percent of the actual residential UPC recorded in 2020. FBC does not consider this low value to be realistic.

Figure F-6: Residential UPC (MWh)



72. Reference: Exhibit B-9, CEC 1.25.1 and 1.25.2



4. LOAD SCENARIOS

25. Reference: Exhibit B-2, Page 96

Section 3 described the long-term Reference Case load forecast which is based on historical load drivers included in the BAU forecast plus any new highly-certain loads and light-duty EV charging load. FBC recognizes, however, that emerging technology, government policies, climate change and changes in how customers use and provide energy could impact load drivers that are not captured in the Reference Case forecast. This section of the LTERP discusses these emerging load drivers and some alternative load scenarios.

25.1 Given issues not factored into the long-term Reference Case, which are being presented as scenarios, please explain which load forecast FBC is using for long-term planning for firming up decision in the immediate term that will affect long-term plans.

Response:

The Reference Case load forecast is the resulting forecast used for long-term planning purposes in this LTERP. FBC expects that it would submit its next LTERP in approximately five years from the submission date of this LTERP, in 2026. However, if FBC's periodic assessment of the load resource balance indicates the need for new resources sooner than contemplated in this LTERP, or if FBC's access to market energy changes such that it is no longer reliable or cost effective, FBC would likely submit an LTERP or supplemental update filing sooner than 2026. At that point, FBC will develop a new Reference Case load forecast which will be used from that point forward for long-term planning purposes.

25.2 Please describe how FBC expects the Commission to settle on an appropriate load for planning purposes and how the remaining scenarios would be handled as contingencies to the main adopted forecast.

Response:

As discussed in the response to CEC IR1 25.1, the Reference Case load forecast is the forecast used for planning purposes in the LTERP for the entire planning horizon. FBC has also developed load scenarios to explore the potential impacts on its customer loads if growth in certain load drivers were to occur. FBC does not specifically plan to these load scenarios but rather monitors them to determine if a particular load driver or scenario warrants changes in planning in the future.

72.1 Please explain what information FBC will rely on to determine if its load scenario drivers indicate a need for new resources sooner than contemplated and the criteria for how such a decision may be made.

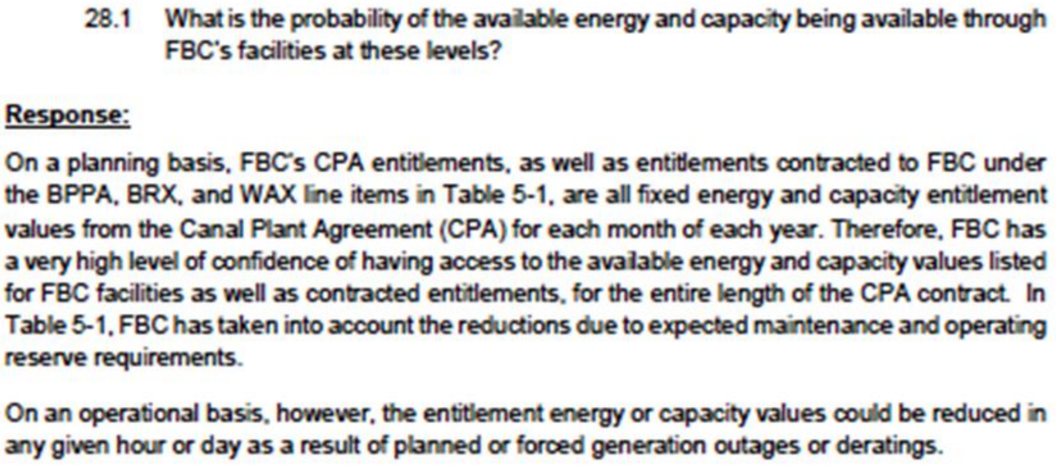
72.1.1 How often is this information examined, and what internal group is responsible for monitoring the load drivers?

Response:

FBC regularly monitors various sources of load driver information that may have impacts on its customer loads, therefore potentially affecting the load-resource balance and need for new resources. For example, FBC tracks customer rooftop solar PV installations on a monthly basis through its Net Metering program to determine if they are growing at a rate similar to that included in the load scenarios. As other examples, FBC periodically monitors EV registration data for its service area to help determine the growth rate of EVs, and any developments regarding the potential for large load customers, such as cannabis production and data centre facilities. FBC also monitors and analyzes temperature data for its service area on an annual basis to determine if any trends are developing that might impact customers' load requirements.

This information is monitored by several different departments within FBC, including Operations and Engineering, Business Innovation, Load Forecasting, and Energy Solutions, and is coordinated by the Resource Planning group. All of this information is reflected in the FBC long-term load forecast, which is updated on an annual basis. The load forecast is then compared to FBC's existing resources and planned DSM levels to determine an updated load-resource balance. FBC is then able to determine if and when new resources might be needed and, if they are, if this need will be sooner than contemplated in this LTERP.

73. Reference: Exhibit B-9, CEC 1.28.1 and 28.3

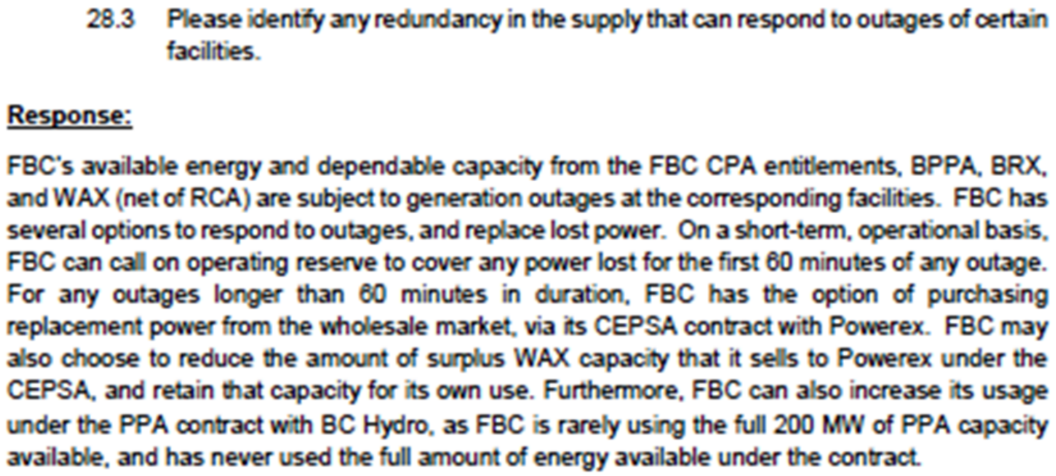


28.1 What is the probability of the available energy and capacity being available through FBC's facilities at these levels?

Response:

On a planning basis, FBC's CPA entitlements, as well as entitlements contracted to FBC under the BPPA, BRX, and WAX line items in Table 5-1, are all fixed energy and capacity entitlement values from the Canal Plant Agreement (CPA) for each month of each year. Therefore, FBC has a very high level of confidence of having access to the available energy and capacity values listed for FBC facilities as well as contracted entitlements, for the entire length of the CPA contract. In Table 5-1, FBC has taken into account the reductions due to expected maintenance and operating reserve requirements.

On an operational basis, however, the entitlement energy or capacity values could be reduced in any given hour or day as a result of planned or forced generation outages or deratings.



28.3 Please identify any redundancy in the supply that can respond to outages of certain facilities.

Response:

FBC's available energy and dependable capacity from the FBC CPA entitlements, BPPA, BRX, and WAX (net of RCA) are subject to generation outages at the corresponding facilities. FBC has several options to respond to outages, and replace lost power. On a short-term, operational basis, FBC can call on operating reserve to cover any power lost for the first 60 minutes of any outage. For any outages longer than 60 minutes in duration, FBC has the option of purchasing replacement power from the wholesale market, via its CEPSA contract with Powerex. FBC may also choose to reduce the amount of surplus WAX capacity that it sells to Powerex under the CEPSA, and retain that capacity for its own use. Furthermore, FBC can also increase its usage under the PPA contract with BC Hydro, as FBC is rarely using the full 200 MW of PPA capacity available, and has never used the full amount of energy available under the contract.

73.1 How can climate change elements such as wildfires and flooding be expected to impact the availability of FBC's capacity resources? Please explain.

Response:

Climate change events include, but are not limited to, wildfires, extreme heat, flooding,[3] tornadoes, and atmospheric rivers. Each has the potential to negatively impact the availability of FBC's capacity resources if the events result in a forced generation outage or equipment/facility derating. There are two primary ways in which this could occur.

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[3] FBC capacity entitlements are based on historical flows and therefore are not exposed to risk from real changes in hydrology flows. For example, in a high flow scenario (e.g., a flood) the entitlement would not increase with the hydrology, nor would the entitlement be reduced in a low flow scenario (e.g., a drought). However, flooding could damage electrical infrastructure.

First, a generation facility could be directly affected. An example would be a nearby wildfire threatening or damaging a facility and causing disruption to plant operations. A reduction or curtailment of plant output would result in a reduction of FBC's CPA capacity entitlement.

The other way is through adverse impacts to transmission infrastructure such as high voltage transmission lines, substations, and transformers, which connect FBC's generation facilities to the overall system. Compromised transmission equipment could reduce or isolate a facility's access to the electrical grid, which would force the curtailment of its output (i.e., a forced generation outage). Some examples of this occurring could be through a landslide washing out a section of power line, or extreme heat damaging critical components of a substation.

73.1.1 Please explain how FBC accounts for these risks.

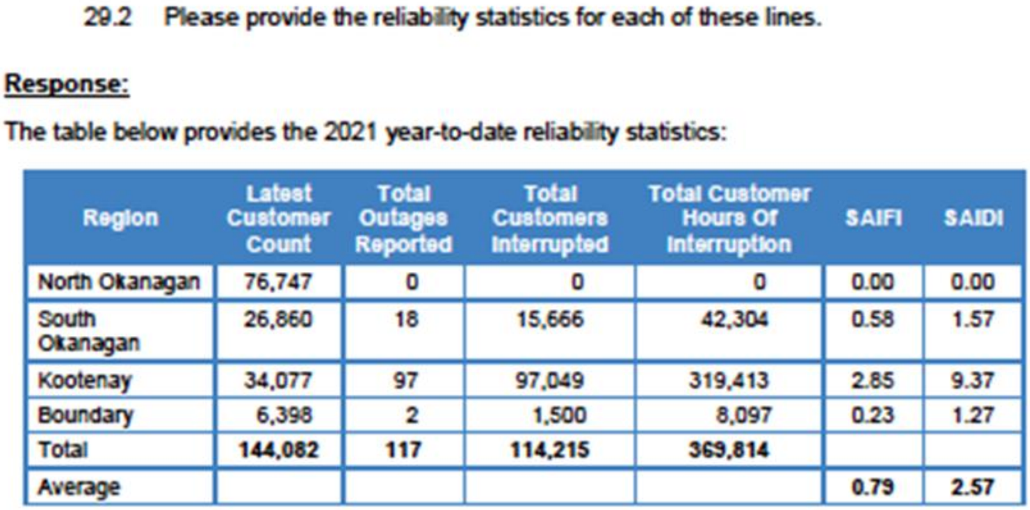
73.1.2 Is the redundancy in supply adequate to meet such events? Please explain.

Response:

FBC addresses the risks of forced capacity resource outages, whether due to climate change events or otherwise, through the following contractual arrangements:

- the CPA, which ensures that the Entitlement Parties receive reserve sharing through any reserve sharing groups that BC Hydro participates in;
- the CEPSA agreement, which FBC can use to purchase replacement power from the wholesale market for outage durations longer than 60 minutes;
- the CEPSA agreement, though which FBC can adjust the amount of surplus WAX capacity it releases to Powerex on a day ahead basis, or on a real-time basis in the case of a forced WAX unit outage;
- the PPA agreement, under which FBC can schedule an additional 25 MW in any hour on a real-time basis, and up to the full 200 MW allowance on a day-ahead basis; and
- the Imbalance Agreement, which outlines the manner in which FBC defaults to BC Hydro supply in the case of a system-to-system imbalance between FBC and BC Hydro.

74. Reference: Exhibit B-9, CEC 1.29.2



29.2 Please provide the reliability statistics for each of these lines.

Response:

The table below provides the 2021 year-to-date reliability statistics:

Region	Latest Customer Count	Total Outages Reported	Total Customers Interrupted	Total Customer Hours Of Interruption	SAIFI	SAIDI
North Okanagan	76,747	0	0	0	0.00	0.00
South Okanagan	26,860	18	15,666	42,304	0.58	1.57
Kootenay	34,077	97	97,049	319,413	2.85	9.37
Boundary	6,398	2	1,500	8,097	0.23	1.27
Total	**144,082**	**117**	**114,215**	**369,814**		
Average					**0.79**	**2.57**

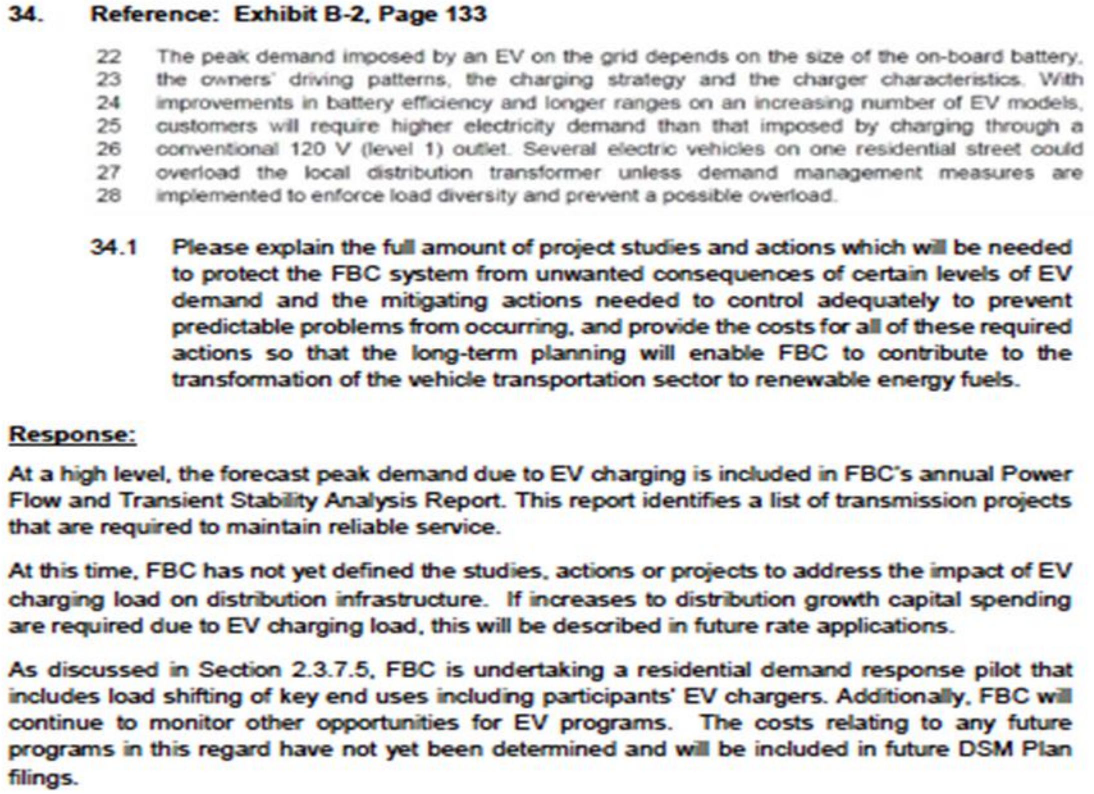
74.1 The Kootenay Region appears to have had a significant number of interruptions relative to the other regions. Please explain why this has occurred and whether or not FBC is undertaking to make any changes in this region due to these results.

Response:

The Kootenay Region has the highest relative proportion of rural to urban customers in FBC's service area. These rural customers are often fed from distribution stations supplied from radial transmission lines which pass through challenging and heavily treed terrain. Distribution substations and transmission lines in other regions of FBC's service territory more typically have multiple redundant lines and interconnection points. In 2021, for the Kootenay Region, tree contacts on transmission lines caused 69 percent of all the non-normalized customer-hours of interruption on the transmission system. These transmission system outages caused a loss of supply to downstream distribution stations resulting in FBC customer outages.

To reduce the risk of tree-contact outages on transmission lines, FBC has initiated a multi-year project which involves reaching out to landowners to establish agreements to access and harvest trees outside the existing rights of way for 30 Line (from Nelson to the Coffee Creek Substation), 32 Line (from Creston to Crawford Bay), and 19 Line (the Slocan Valley) to reduce the number of tree-related outages.

75. Reference: Exhibit B-9, CEC 1.34.1



34. Reference: Exhibit B-2, Page 133

The peak demand imposed by an EV on the grid depends on the size of the on-board battery, the owners' driving patterns, the charging strategy and the charger characteristics. With improvements in battery efficiency and longer ranges on an increasing number of EV models, customers will require higher electricity demand than that imposed by charging through a conventional 120 V (level 1) outlet. Several electric vehicles on one residential street could overload the local distribution transformer unless demand management measures are implemented to enforce load diversity and prevent a possible overload.

34.1 Please explain the full amount of project studies and actions which will be needed to protect the FBC system from unwanted consequences of certain levels of EV demand and the mitigating actions needed to control adequately to prevent predictable problems from occurring, and provide the costs for all of these required actions so that the long-term planning will enable FBC to contribute to the transformation of the vehicle transportation sector to renewable energy fuels.

Response:

At a high level, the forecast peak demand due to EV charging is included in FBC's annual Power Flow and Transient Stability Analysis Report. This report identifies a list of transmission projects that are required to maintain reliable service.

At this time, FBC has not yet defined the studies, actions or projects to address the impact of EV charging load on distribution infrastructure. If increases to distribution growth capital spending are required due to EV charging load, this will be described in future rate applications.

As discussed in Section 2.3.7.5, FBC is undertaking a residential demand response pilot that includes load shifting of key end uses including participants' EV chargers. Additionally, FBC will continue to monitor other opportunities for EV programs. The costs relating to any future programs in this regard have not yet been determined and will be included in future DSM Plan filings.

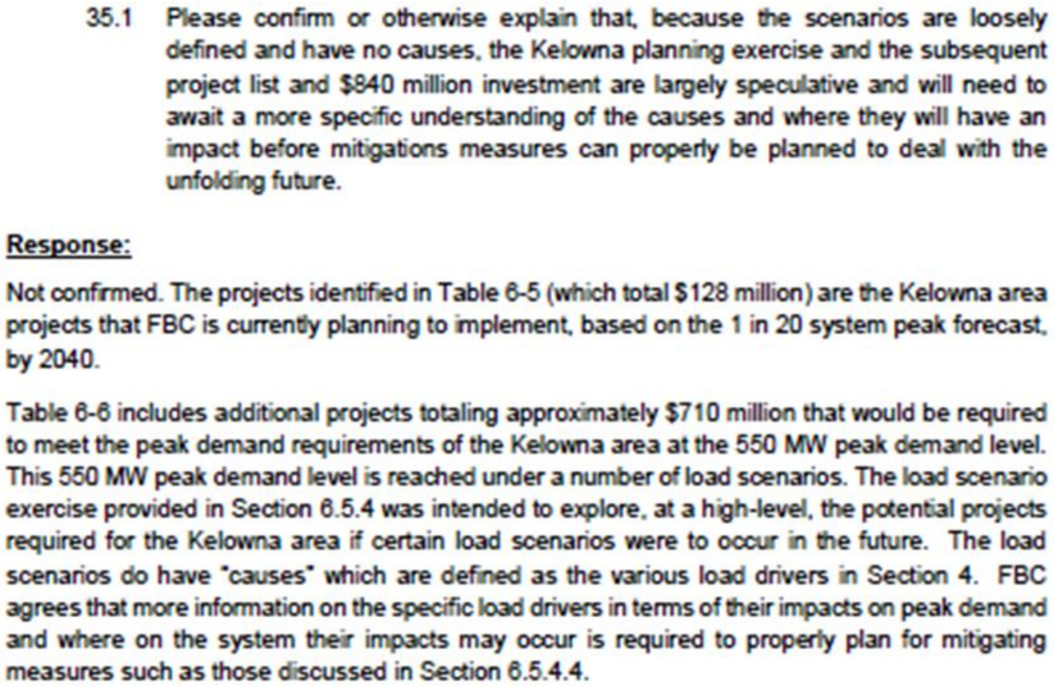
75.1 Does FBC expect to see a significant level of EV charging on commercial premises? Please explain and provide quantification where available.

75.1.1 If yes, when does FBC expect this to occur, and what actions, if any, will FBC undertake to mitigate the impacts?

Response:

Although FBC does expect to see increased levels of EV charging on commercial premises, FBC is unable to provide further detail at this time as to when this will occur. FBC generally expects the impacts resulting from EV charging at commercial premises to have a smaller impact on utility infrastructure as residential areas, due mainly to how utility infrastructure is designed and sized for serving commercial customer loads.

76. Reference: Exhibit B-9, CEC 1.35.1



35.1 Please confirm or otherwise explain that, because the scenarios are loosely defined and have no causes, the Kelowna planning exercise and the subsequent project list and $840 million investment are largely speculative and will need to await a more specific understanding of the causes and where they will have an impact before mitigations measures can properly be planned to deal with the unfolding future.

Response:

Not confirmed. The projects identified in Table 6-5 (which total $128 million) are the Kelowna area projects that FBC is currently planning to implement, based on the 1 in 20 system peak forecast, by 2040.

Table 6-6 includes additional projects totaling approximately $710 million that would be required to meet the peak demand requirements of the Kelowna area at the 550 MW peak demand level. This 550 MW peak demand level is reached under a number of load scenarios. The load scenario exercise provided in Section 6.5.4 was intended to explore, at a high-level, the potential projects required for the Kelowna area if certain load scenarios were to occur in the future. The load scenarios do have "causes" which are defined as the various load drivers in Section 4. FBC agrees that more information on the specific load drivers in terms of their impacts on peak demand and where on the system their impacts may occur is required to properly plan for mitigating measures such as those discussed in Section 6.5.4.4.

76.1 Please explain when and how FBC will undertake to acquire the greater information that is needed to properly plan for the mitigating measures.

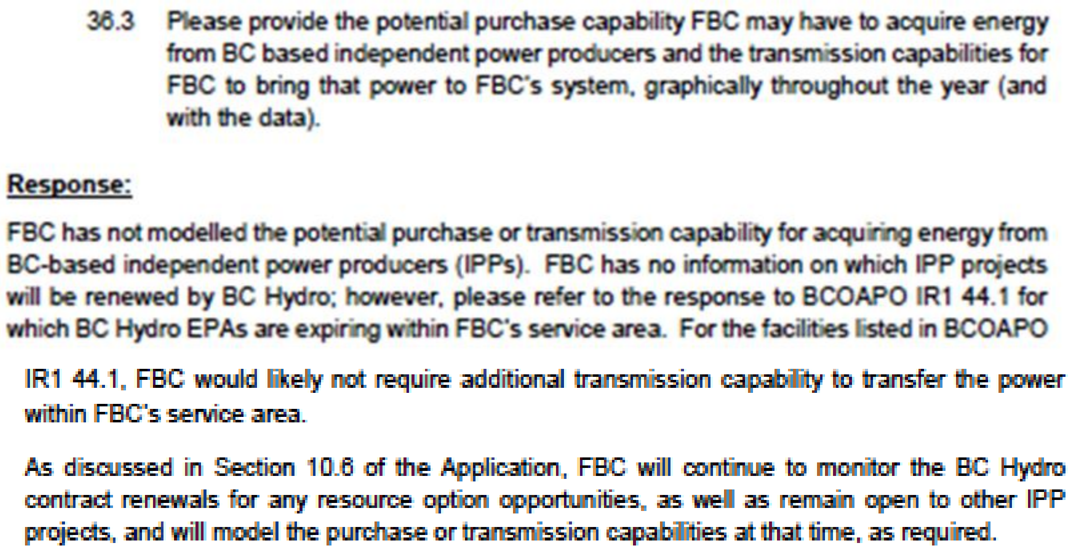
Response:

FBC requires more historical data relating to the load drivers identified in Section 4 in order to confidently identify their impact on peak load. This is the typical planning process for FBC and each year the forecast is updated as the impacts are better understood and the mitigating measures can be planned for the near future.

With respect to EV loads, FBC is already working to acquire additional information on the potential impact of these loads, which includes piloting demand response control for EV loads as a mitigating measure, as described in the response to BCSEA IR2 21.1.

Finally, FBC notes that electrification of any existing non-electric end-uses could place capacity constraints on FBC's system and drive significant transmission capacity upgrades (which typically have much longer development timeframes). FBC will continue to monitor this during periodic load forecast updates and identity any resulting projects in future LTERP filings.

77. Reference: Exhibit B-9, CEC 1.36.3



36.3 Please provide the potential purchase capability FBC may have to acquire energy from BC based independent power producers and the transmission capabilities for FBC to bring that power to FBC's system, graphically throughout the year (and with the data).

Response:

FBC has not modelled the potential purchase or transmission capability for acquiring energy from BC-based independent power producers (IPPs). FBC has no information on which IPP projects will be renewed by BC Hydro; however, please refer to the response to BCOAPO IR1 44.1 for which BC Hydro EPAs are expiring within FBC's service area. For the facilities listed in BCOAPO IR1 44.1, FBC would likely not require additional transmission capability to transfer the power within FBC's service area.

As discussed in Section 10.6 of the Application, FBC will continue to monitor the BC Hydro contract renewals for any resource option opportunities, as well as remain open to other IPP projects, and will model the purchase or transmission capabilities at that time, as required.

77.1 Do FBC and BC Hydro ever work cooperatively to manage the IPP renewals such that the energy produced is optimized to the utility using it? Please explain.

Response:

The IPP renewal process is not managed cooperatively, but rather is competitive in nature. BC Hydro has several different mechanisms for acquiring electricity from IPPs, such as competitive calls, standard or open offers, and bilateral arrangements.[4] FBC procures IPP power by way of bilateral arrangements.

However, under the CPA, the physical output from certain IPP/entitlement plants, such as Brilliant, Brilliant Expansion, and Waneta Expansion, is optimized at a provincial level.[5]

77.2 Has FBC considered that BC Hydro as a supplier under its PPA with FBC might negotiate obtaining energy and/or capacity for FBC and provide it through additional terms in a renegotiated PPA or addendum to the current PPA? Please explain.

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[4] https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/corporate/independent-power-producers-calls-for-power/independent-power-producers/energy-procurement-practices.pdf.

[5] Per Section 5.1 of the LTERP, 'Under the CPA, BC Hydro takes into its system all power actually generated by the Entitlement Parties' respective plants. In exchange for permitting BC Hydro to determine the output of these facilities, the Entitlement Parties are contractually entitled to their respective "entitlements" of energy and capacity from BC Hydro."'

<u>Response:</u>

The PPA represents FBC's access to BC Hydro's low-cost "Heritage Assets" as discussed in Section 2.2.3.3 of the Application and as defined in Schedule 1 of the CEA.[6] Therefore, FBC considers it unlikely that BC Hydro would include or negotiate for supply from other IPP sources within that contract. However, FBC does recognize that, when the PPA with BC Hydro is renewed in 2033, it might be possible to include expanded access to energy and capacity as FBC's share of BC Hydro's Heritage Assets may have changed.

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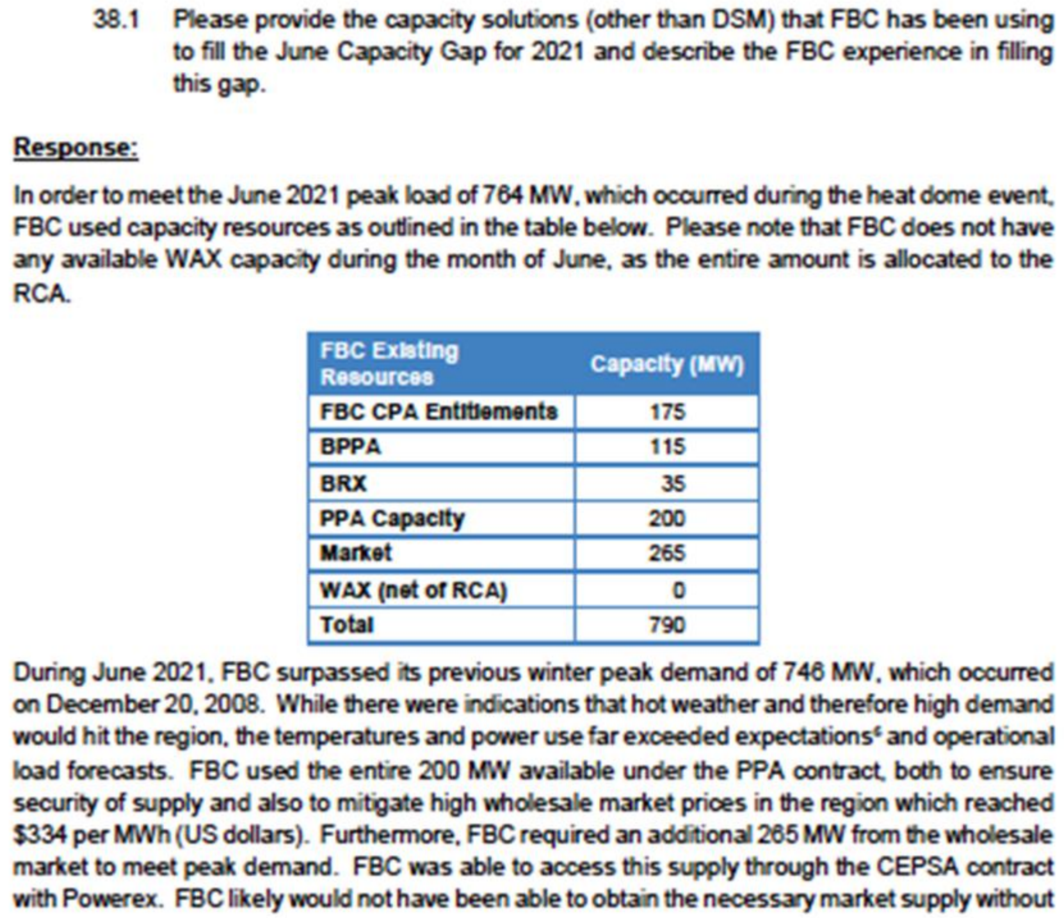
[6] https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/10022_01#Schedule1.

78. Reference: Exhibit B-9, CEC 1.38.1 and 1.38.2



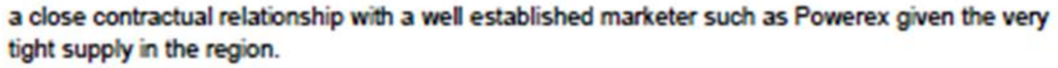
38.1 Please provide the capacity solutions (other than DSM) that FBC has been using to fill the June Capacity Gap for 2021 and describe the FBC experience in filling this gap.

Response:

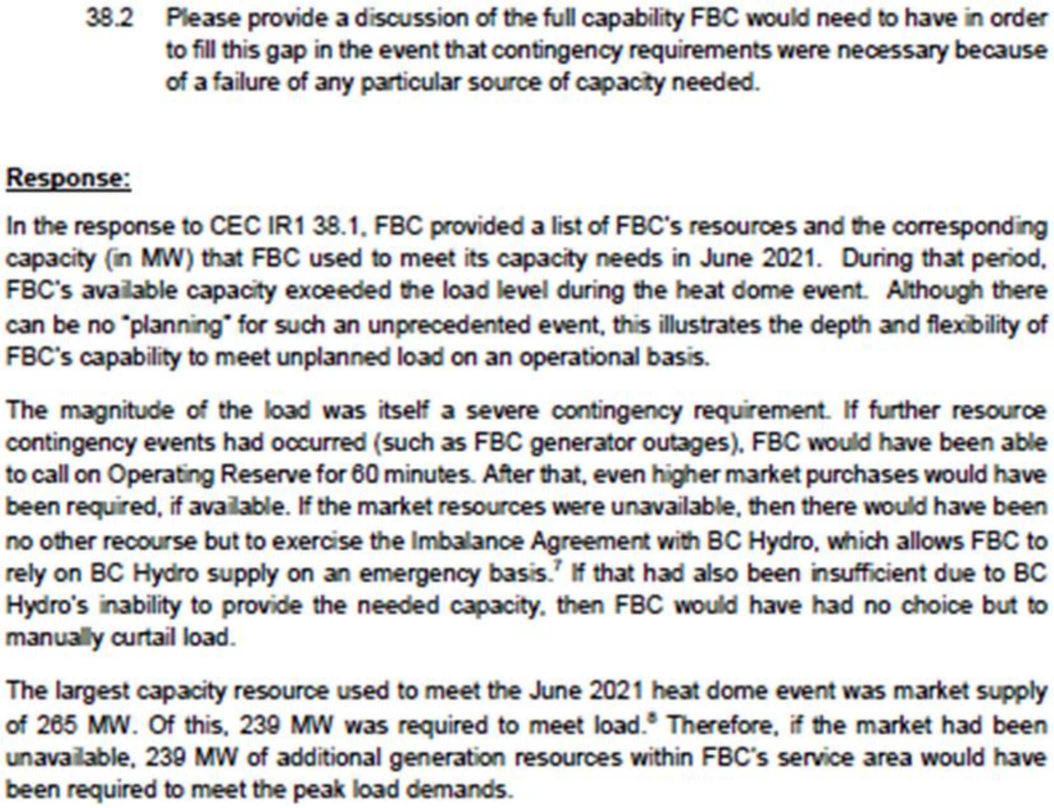
In order to meet the June 2021 peak load of 764 MW, which occurred during the heat dome event, FBC used capacity resources as outlined in the table below. Please note that FBC does not have any available WAX capacity during the month of June, as the entire amount is allocated to the RCA.

FBC Existing Resources	Capacity (MW)
FBC CPA Entitlements	175
BPPA	115
BRX	35
PPA Capacity	200
Market	265
WAX (net of RCA)	0
Total	790

During June 2021, FBC surpassed its previous winter peak demand of 746 MW, which occurred on December 20, 2008. While there were indications that hot weather and therefore high demand would hit the region, the temperatures and power use far exceeded expectations[6] and operational load forecasts. FBC used the entire 200 MW available under the PPA contract, both to ensure security of supply and also to mitigate high wholesale market prices in the region which reached $334 per MWh (US dollars). Furthermore, FBC required an additional 265 MW from the wholesale market to meet peak demand. FBC was able to access this supply through the CEPSA contract with Powerex. FBC likely would not have been able to obtain the necessary market supply without



a close contractual relationship with a well established marketer such as Powerex given the very tight supply in the region.



38.2 Please provide a discussion of the full capability FBC would need to have in order to fill this gap in the event that contingency requirements were necessary because of a failure of any particular source of capacity needed.

Response:

In the response to CEC IR1 38.1, FBC provided a list of FBC's resources and the corresponding capacity (in MW) that FBC used to meet its capacity needs in June 2021. During that period, FBC's available capacity exceeded the load level during the heat dome event. Although there can be no "planning" for such an unprecedented event, this illustrates the depth and flexibility of FBC's capability to meet unplanned load on an operational basis.

The magnitude of the load was itself a severe contingency requirement. If further resource contingency events had occurred (such as FBC generator outages), FBC would have been able to call on Operating Reserve for 60 minutes. After that, even higher market purchases would have been required, if available. If the market resources were unavailable, then there would have been no other recourse but to exercise the Imbalance Agreement with BC Hydro, which allows FBC to rely on BC Hydro supply on an emergency basis.[7] If that had also been insufficient due to BC Hydro's inability to provide the needed capacity, then FBC would have had no choice but to manually curtail load.

The largest capacity resource used to meet the June 2021 heat dome event was market supply of 265 MW. Of this, 239 MW was required to meet load.[8] Therefore, if the market had been unavailable, 239 MW of additional generation resources within FBC's service area would have been required to meet the peak load demands.

78.1 Please explain in detail how the experience of this weather event has impacted FBC's planning for the future, and provide quantification where available for any modifications FBC made or will make to its original plans.

Response:

As a result of the heat dome event in June 2021, FBC changed the LTERP capacity self-sufficiency criteria to be inclusive of June when new resources are required to meet expected seasonal peaks. Prior to the heat dome, June was exempt from this planning assumption. This is a material change to the LTERP planning criteria since June is FBC's most resource-constrained month and adds NPV incremental costs to portfolio C3 of approximately $1.3 million.[7] In the short term, FBC will purchase up to 75 MW of fixed-price market blocks as discussed in the response to BCUC IR1 1.3.

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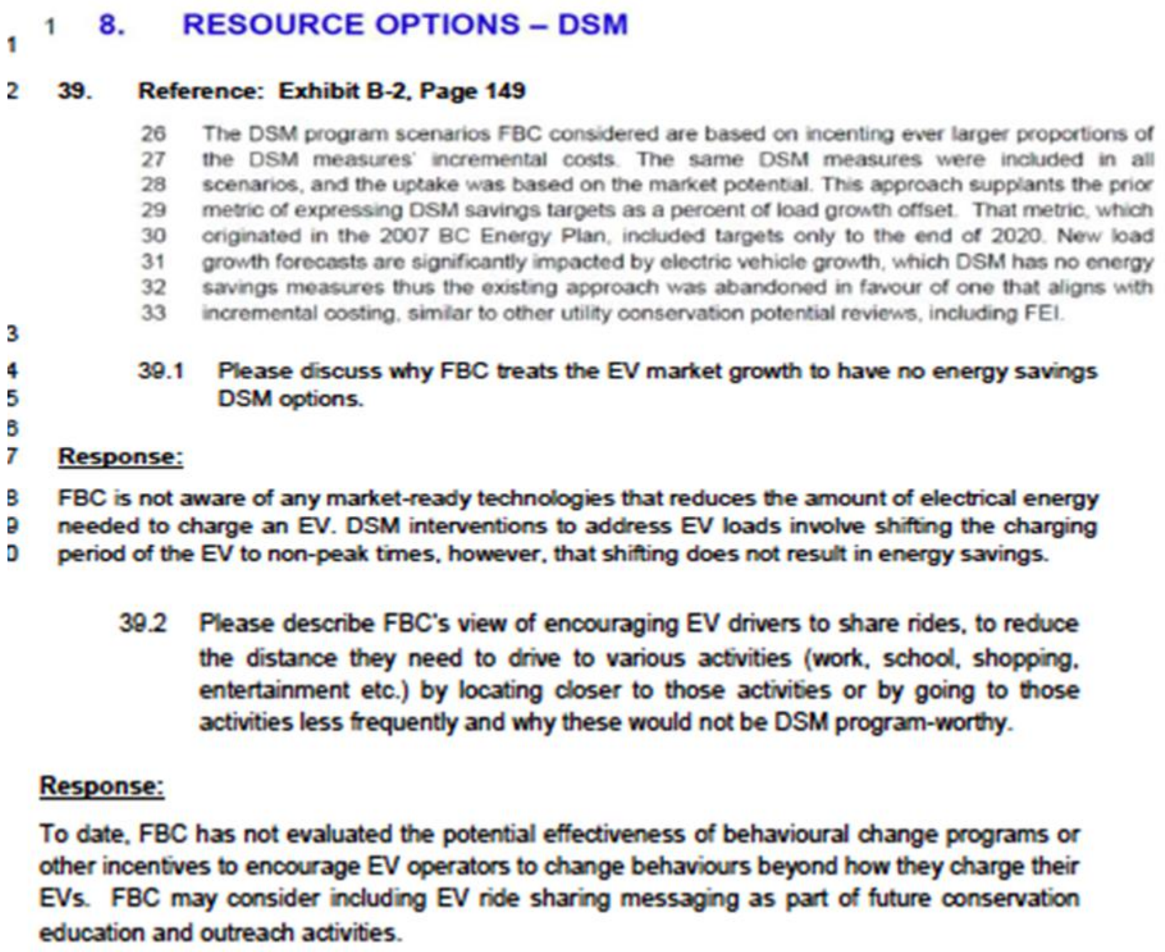
[7] Only Portfolio C3 was examined.

79. Reference: Exhibit B-9, CEC 1.39.1 and 1.39.2



8. RESOURCE OPTIONS – DSM

39. Reference: Exhibit B-2, Page 149

> The DSM program scenarios FBC considered are based on incenting ever larger proportions of the DSM measures' incremental costs. The same DSM measures were included in all scenarios, and the uptake was based on the market potential. This approach supplants the prior metric of expressing DSM savings targets as a percent of load growth offset. That metric, which originated in the 2007 BC Energy Plan, included targets only to the end of 2020. New load growth forecasts are significantly impacted by electric vehicle growth, which DSM has no energy savings measures thus the existing approach was abandoned in favour of one that aligns with incremental costing, similar to other utility conservation potential reviews, including FEI.

39.1 Please discuss why FBC treats the EV market growth to have no energy savings DSM options.

Response:

FBC is not aware of any market-ready technologies that reduces the amount of electrical energy needed to charge an EV. DSM interventions to address EV loads involve shifting the charging period of the EV to non-peak times, however, that shifting does not result in energy savings.

39.2 Please describe FBC's view of encouraging EV drivers to share rides, to reduce the distance they need to drive to various activities (work, school, shopping, entertainment etc.) by locating closer to those activities or by going to those activities less frequently and why these would not be DSM program-worthy.

Response:

To date, FBC has not evaluated the potential effectiveness of behavioural change programs or other incentives to encourage EV operators to change behaviours beyond how they charge their EVs. FBC may consider including EV ride sharing messaging as part of future conservation education and outreach activities.

79.1 Do all EVs require the same amount of energy in order to travel the same distance? Please explain.

Response:

Different EVs require differing amounts of energy to travel the same distance. Similar to how internal combustion engine vehicles have different fuel economy ratings, (i.e., litres per 100 kilometres), EVs also have an efficiency metric, represented by kWh of electricity per 100 kilometres of vehicle distance traveled. The overall energy efficiency of an EV is dependent on numerous factors, including the vehicle motor efficiency, the weight of the vehicle, its passengers and its cargo load, and the general vehicle physical profile (i.e., cross-sectional wind resistance).

79.1.1 If there are differences in energy efficiency, would FBC consider an EV that is more energy efficient than others to be viable for conservation initiatives? Please explain.

Response:

FBC has not evaluated the potential to offer incentives for EVs that are more energy efficient. At this time, many EV buyers are replacing vehicles with internal combustion engines, in which case there are environmental benefits regardless of minor variations in electric vehicle efficiency.

Prior to considering a DSM program targeting more efficient EVs, FBC would need a better understanding of the vehicle being replaced (if any), the baseline and efficient EV energy consumption, the incremental purchase costs between baseline and more efficient EVs, and consideration of whether incentives would change customer purchasing decisions between a baseline and more efficient EV.

79.2 Do all EV chargers have similar charging efficiencies? Please explain.

Response:

EV chargers operating at the same voltage and current levels have similar charging efficiencies, all else equal. Higher charging speeds (e.g., higher voltage and/or current) generally increases the average efficiency. A 2014 study by Sears et al. in the Journal of the Transportation Research Board[8] suggested that Level 2 charging was 3 percent more efficient than Level 1 charging.

79.2.1 If there are differences in charging efficiencies would FBC consider that to be viable for conservation initiatives? Please explain.

Response:

FBC's current understanding of EV charging technology is that there are only minor efficiency differences between different vehicle chargers and vendors. Prior to considering a DSM program targeting EV chargers, FBC would need a better understanding of baseline and efficient EV charger efficiency, the incremental costs between baseline and more efficient EV chargers, and

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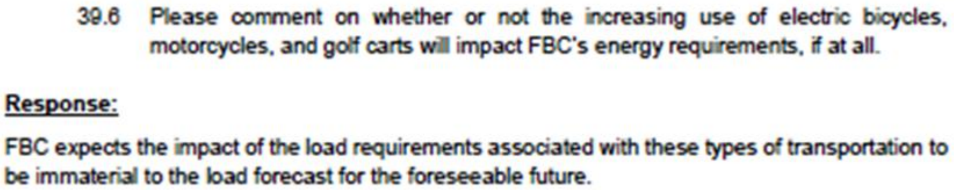
[8] https://www.researchgate.net/publication/272377451_Assessment_of_Level_1_and_Level_2_Electric_Vehicle_Charging_Efficiency

consideration of whether incentives would change customer purchasing decisions between a baseline and more efficient EV charger.

However, FBC is considering whether to provide incentives for chargers with communications capabilities that would allow them to participate in demand response programs.

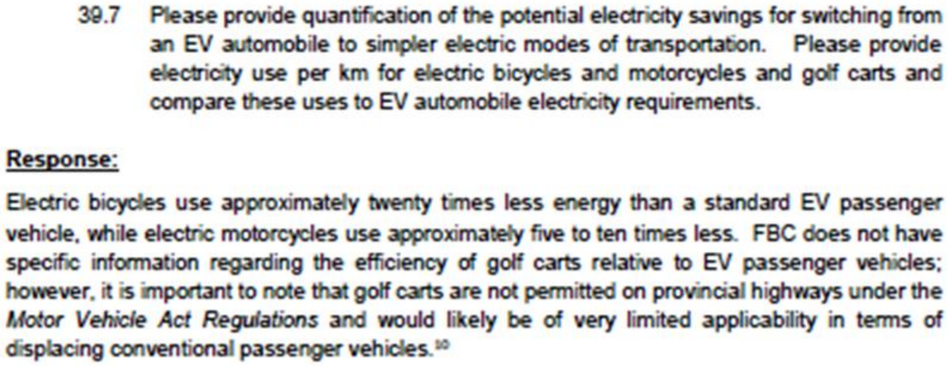
80. Reference: Exhibit B-9, CEC 1.39.6 and 1.39.7 and excerpts from https://news.gov.bc.ca/releases/2020TRAN0109-001308



39.6 Please comment on whether or not the increasing use of electric bicycles, motorcycles, and golf carts will impact FBC's energy requirements, if at all.

Response:

FBC expects the impact of the load requirements associated with these types of transportation to be immaterial to the load forecast for the foreseeable future.



39.7 Please provide quantification of the potential electricity savings for switching from an EV automobile to simpler electric modes of transportation. Please provide electricity use per km for electric bicycles and motorcycles and golf carts and compare these uses to EV automobile electricity requirements.

Response:

Electric bicycles use approximately twenty times less energy than a standard EV passenger vehicle, while electric motorcycles use approximately five to ten times less. FBC does not have specific information regarding the efficiency of golf carts relative to EV passenger vehicles; however, it is important to note that golf carts are not permitted on provincial highways under the *Motor Vehicle Act Regulations* and would likely be of very limited applicability in terms of displacing conventional passenger vehicles.[10]

The Province is increasing e-bike rebates for individuals and businesses to help make electric-powered bikes more affordable and accessible, while also reducing greenhouse gas emissions.

“The popularity of e-bikes is on the rise and our government wants to encourage more people to purchase and ride these bikes,” said Claire Trevena, Minister of Transportation and Infrastructure. “That’s why we are boosting the e-bike rebates for people and businesses. E-bikes are a much cheaper alternative to cars and are a safe way to travel. We look forward to seeing more people using e-bikes for getting around.”

Cargo e-bikes are particularly efficient in delivering materials and goods around the community in a way that reduces operating costs for businesses. They also help reduce large van and truck traffic, and emissions from the movement of goods in community centres.

80.1 Is it fair to consider that people purchasing e-bikes could potentially mitigate some of the effects of EV on the electric system? Please explain.

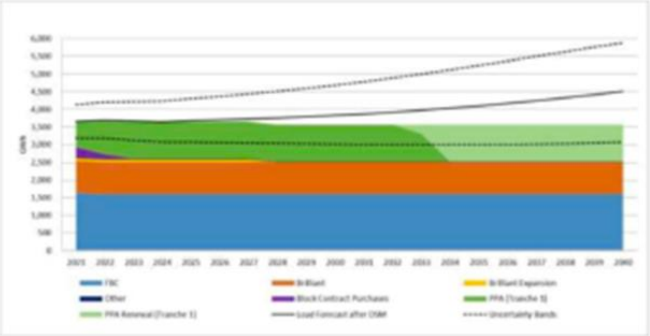
<u>**Response:**</u>

There are numerous changes to the current dominant modes of transportation that could potentially mitigate the effects of EVs on the electric system, including increased use of e-bikes where feasible and practical. Due to the numerous variables associated with e-bike adoption and potential reduced vehicle use, FBC is unable to quantify these potential impacts.

81. Reference: Exhibit B-9, CEC 1.41.1

41. Reference: Exhibit B-2, Page 154

Figure 9-1: Energy Load-Resource Balance after DSM



41.1 Please provide an Energy Load Resource Balance ("E-LRB") graphically as in Figure 9-1 for each of the alternative DSM options with higher incentives.

Response:

The figures below provide the energy LRB for each of the DSM scenarios with higher levels than the Base scenario.

Figure 1: Energy LRB for Medium DSM scenario

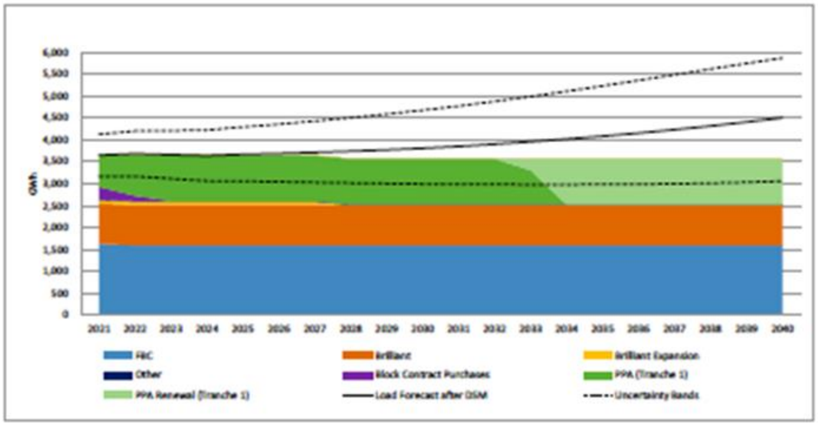


Figure 2: Energy LRB for High DSM scenario

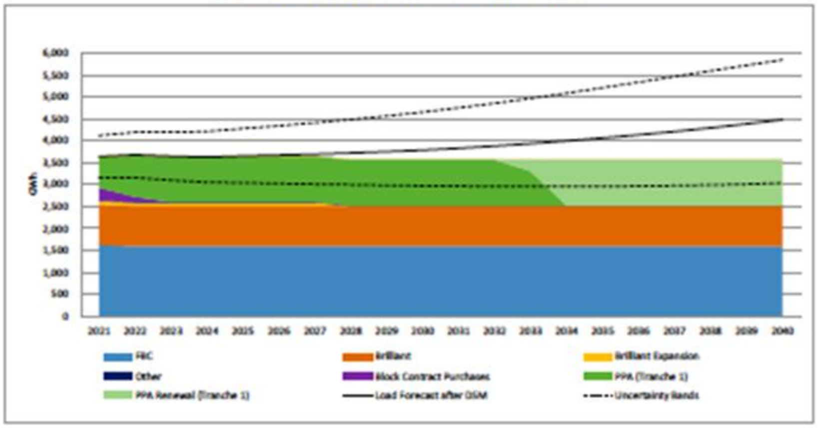
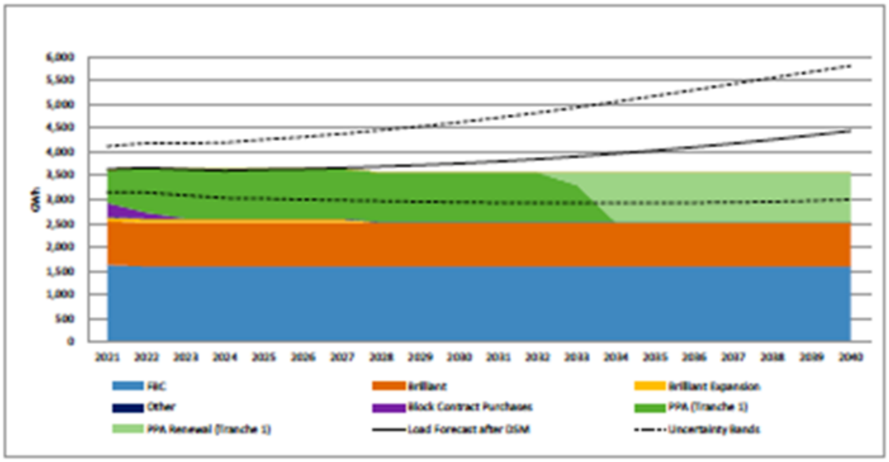


Figure 3: Energy LRB for Max DSM scenario



81.1 The CEC does not observe a significant difference between the medium, high, and max DSM scenarios, nor when compared to the Energy Load resource balance shown in Figure 9-1 of the Application. Please provide the evidence comparing the loads in table form.

<u>Response:</u>

The following tables provide the annual energy load data for the figures with different DSM levels (all units in GWh).

The table below provides the load data for Figure 9-1 of the Application.

LTERP - Figure 9-1

Year	Load forecast before DSM	Base DSM - Cumulative	Load forecast after DSM
2021	3,717.4	62.0	3,655.4
2022	3,787.7	93.2	3,694.5
2023	3,786.9	117.9	3,669.0
2024	3,793.8	144.5	3,649.2
2025	3,854.6	173.8	3,680.8
2026	3,903.9	202.4	3,701.5
2027	3,956.8	230.1	3,726.7
2028	4,012.1	256.7	3,755.4
2029	4,069.8	282.4	3,787.4
2030	4,130.2	306.9	3,823.3
2031	4,195.9	329.5	3,866.4
2032	4,266.3	349.9	3,916.4
2033	4,340.7	368.4	3,972.3
2034	4,419.6	385.2	4,034.3
2035	4,500.8	401.1	4,099.7
2036	4,586.3	416.2	4,170.1
2037	4,677.0	429.4	4,247.6
2038	4,773.7	441.9	4,331.8
2039	4,875.4	453.8	4,421.6
2040	4,983.2	465.3	4,517.9

The table below provides the load data for Figure 1 in the response to CEC IR1 41.1.

CEC IR1 41.1 - Figure 1

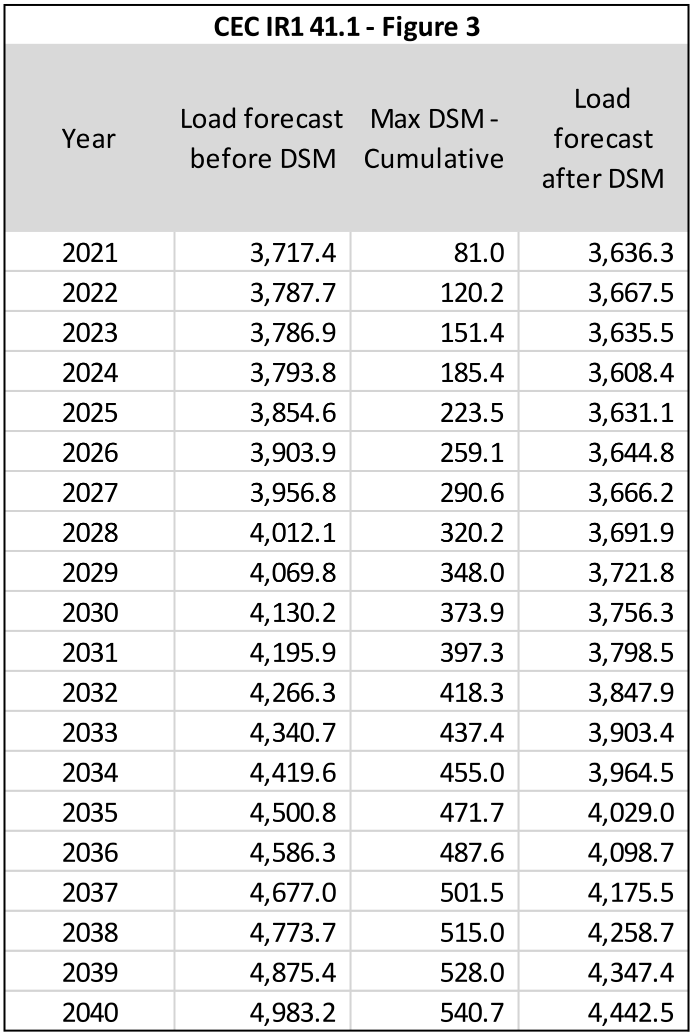
Year	Load forecast before DSM	Medium DSM - Cumulative	Load forecast after DSM
2021	3,717.4	66.8	3,650.6
2022	3,787.7	100.0	3,687.7
2023	3,786.9	126.2	3,660.7
2024	3,793.8	154.2	3,639.6
2025	3,854.6	184.8	3,669.8
2026	3,903.9	214.4	3,689.5
2027	3,956.8	243.0	3,713.8
2028	4,012.1	270.2	3,741.9
2029	4,069.8	296.3	3,773.6
2030	4,130.2	320.8	3,809.4
2031	4,195.9	343.4	3,852.4
2032	4,266.3	363.9	3,902.4
2033	4,340.7	382.5	3,958.3
2034	4,419.6	399.5	4,020.0
2035	4,500.8	415.6	4,085.2
2036	4,586.3	430.8	4,155.4
2037	4,677.0	444.0	4,233.0
2038	4,773.7	456.6	4,317.1
2039	4,875.4	468.6	4,406.8
2040	4,983.2	480.1	4,503.1

The table below provides the load data for Figure 2 in the response to CEC IR1 41.1.

CEC IR1 41.1 - Figure 2

Year	Load forecast before DSM	High DSM - Cumulative	Load forecast after DSM
2021	3,717.4	72.7	3,644.6
2022	3,787.7	108.2	3,679.5
2023	3,786.9	136.2	3,650.6
2024	3,793.8	166.3	3,627.5
2025	3,854.6	199.3	3,655.2
2026	3,903.9	231.0	3,672.9
2027	3,956.8	260.9	3,695.8
2028	4,012.1	289.3	3,722.8
2029	4,069.8	316.2	3,753.6
2030	4,130.2	341.3	3,788.9
2031	4,195.9	364.3	3,831.6
2032	4,266.3	384.8	3,881.5
2033	4,340.7	403.4	3,937.3
2034	4,419.6	420.5	3,999.1
2035	4,500.8	436.6	4,064.2
2036	4,586.3	451.9	4,134.4
2037	4,677.0	465.2	4,211.8
2038	4,773.7	477.9	4,295.8
2039	4,875.4	490.1	4,385.4
2040	4,983.2	501.8	4,481.4

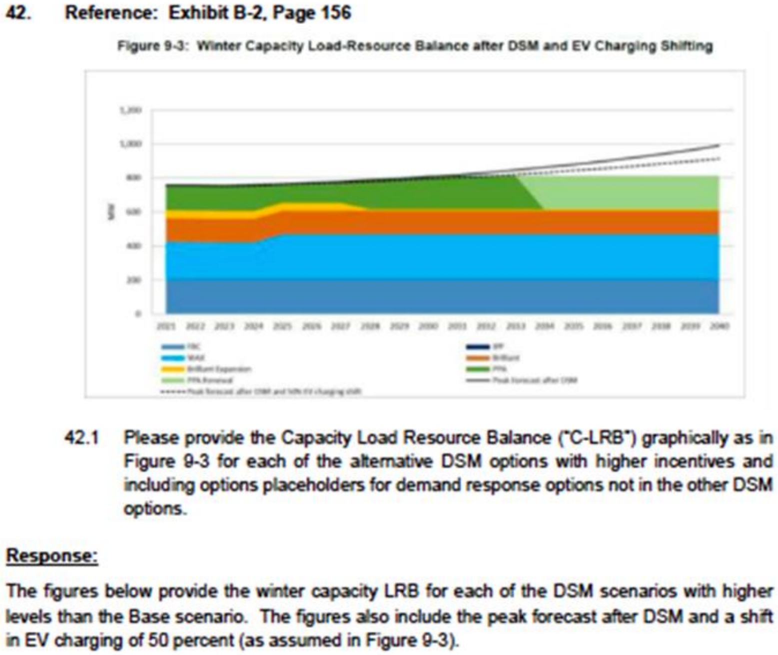
The table below provides the load data for Figure 3 in the response to CEC IR1 41.1.



CEC IR1 41.1 - Figure 3

Year	Load forecast before DSM	Max DSM - Cumulative	Load forecast after DSM
2021	3,717.4	81.0	3,636.3
2022	3,787.7	120.2	3,667.5
2023	3,786.9	151.4	3,635.5
2024	3,793.8	185.4	3,608.4
2025	3,854.6	223.5	3,631.1
2026	3,903.9	259.1	3,644.8
2027	3,956.8	290.6	3,666.2
2028	4,012.1	320.2	3,691.9
2029	4,069.8	348.0	3,721.8
2030	4,130.2	373.9	3,756.3
2031	4,195.9	397.3	3,798.5
2032	4,266.3	418.3	3,847.9
2033	4,340.7	437.4	3,903.4
2034	4,419.6	455.0	3,964.5
2035	4,500.8	471.7	4,029.0
2036	4,586.3	487.6	4,098.7
2037	4,677.0	501.5	4,175.5
2038	4,773.7	515.0	4,258.7
2039	4,875.4	528.0	4,347.4
2040	4,983.2	540.7	4,442.5

82. Reference: Exhibit B-9, CEC 1.42.1



42. Reference: Exhibit B-2, Page 156

Figure 9-3: Winter Capacity Load-Resource Balance after DSM and EV Charging Shifting

42.1 Please provide the Capacity Load Resource Balance ("C-LRB") graphically as in Figure 9-3 for each of the alternative DSM options with higher incentives and including options placeholders for demand response options not in the other DSM options.

Response:

The figures below provide the winter capacity LRB for each of the DSM scenarios with higher levels than the Base scenario. The figures also include the peak forecast after DSM and a shift in EV charging of 50 percent (as assumed in Figure 9-3).

Figure 1: Capacity LRB for Medium DSM scenario

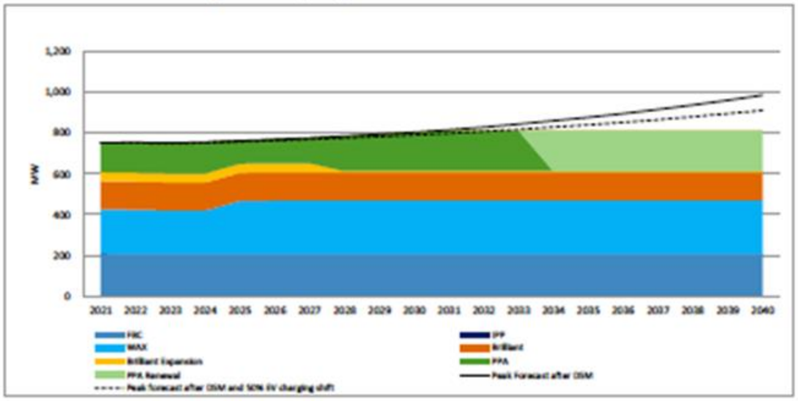


Figure 2: Capacity LRB for High DSM scenario

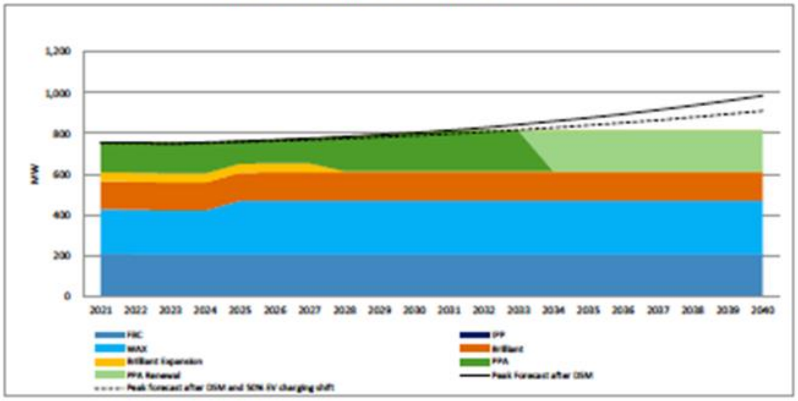
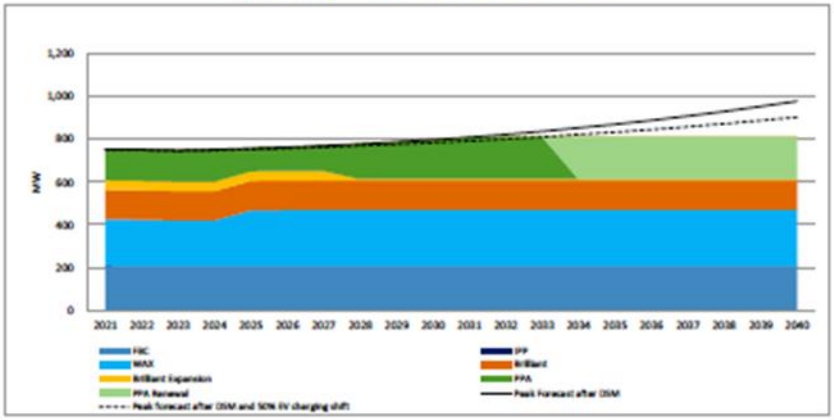


Figure 3: Capacity LRB for Max DSM scenario



82.1 Please provide all the figures including Figure 9-3 in table form.

Response:

The following tables provide the peak load data for the figures with different DSM levels and 50 percent EV charging shift in table form (all units in MW).

The table below provides the load data for Figure 9-3 of the Application.

LTERP - Figure 9-3

Year	Peak forecast before DSM	Base DSM	Peak forecast after DSM	Peak forecast after DSM and 50% EV charging shift
2021	765.8	10.1	755.7	754.2
2022	771.7	14.8	756.9	754.8
2023	772.8	18.5	754.3	751.5
2024	781.1	22.5	758.6	755.0
2025	792.2	26.8	765.4	761.1
2026	803.0	31.0	772.0	766.5
2027	814.6	35.1	779.5	772.4
2028	826.8	39.0	787.8	778.9
2029	839.8	42.8	797.0	785.8
2030	853.5	46.4	807.1	793.3
2031	868.6	49.8	818.9	801.7
2032	885.0	52.8	832.2	811.0
2033	902.6	55.6	846.9	821.1
2034	921.5	58.2	863.3	832.1
2035	941.0	60.7	880.3	843.5
2036	961.8	63.1	898.7	855.6
2037	984.1	65.1	919.0	868.9
2038	1,007.9	67.1	940.8	883.1
2039	1,033.1	69.0	964.2	898.1
2040	1,059.9	70.8	989.2	914.1

The table below provides the load data for Figure 1 in the response to CEC IR1 42.1.

CEC IR1 42.1 - Figure 1

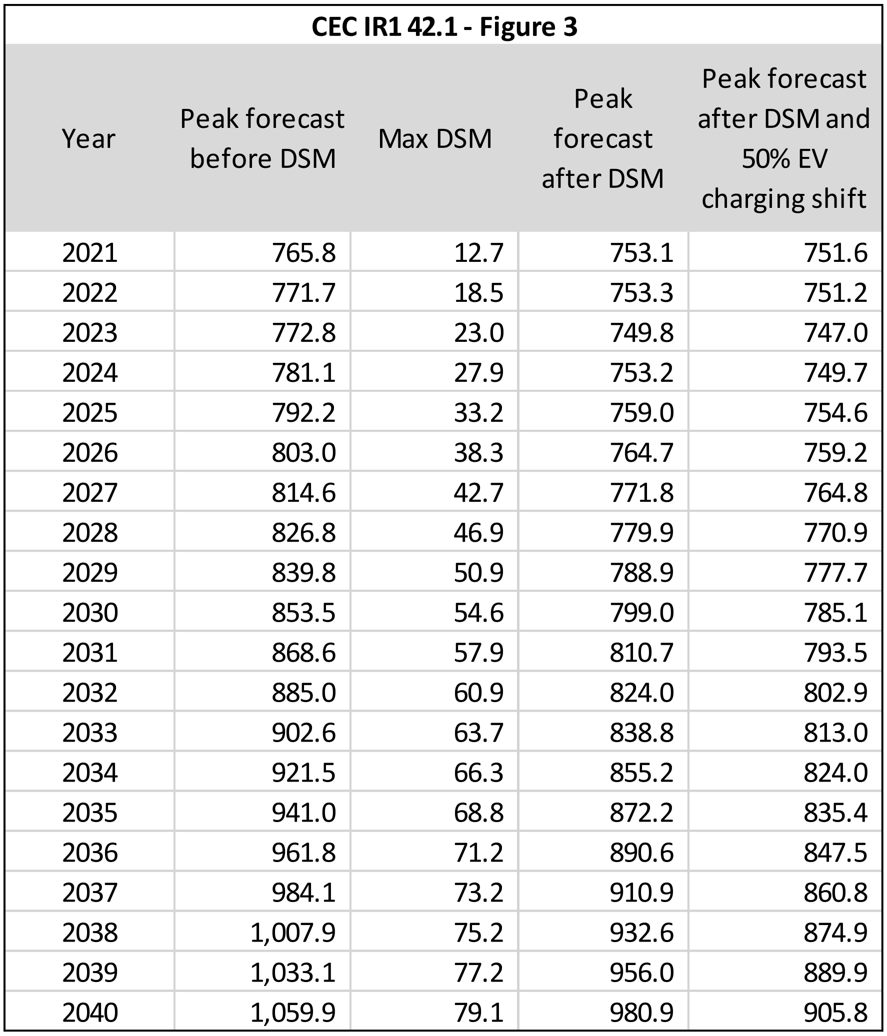
Year	Peak forecast before DSM	Medium DSM	Peak forecast after DSM	Peak forecast after DSM and 50% EV charging shift
2021	765.8	10.8	755.0	753.5
2022	771.7	15.8	756.0	753.9
2023	772.8	19.6	753.2	750.4
2024	781.1	23.7	757.4	753.9
2025	792.2	28.1	764.2	759.8
2026	803.0	32.3	770.7	765.2
2027	814.6	36.4	778.2	771.1
2028	826.8	40.3	786.6	777.6
2029	839.8	44.0	795.8	784.6
2030	853.5	47.5	806.0	792.1
2031	868.6	50.8	817.9	800.7
2032	885.0	53.8	831.2	810.1
2033	902.6	56.5	846.1	820.3
2034	921.5	59.0	862.5	831.3
2035	941.0	61.4	879.6	842.8
2036	961.8	63.7	898.1	855.0
2037	984.1	65.7	918.4	868.4
2038	1,007.9	67.6	940.3	882.6
2039	1,033.1	69.4	963.8	897.7
2040	1,059.9	71.1	988.9	913.8

The table below provides the load data for Figure 2 in the response to CEC IR1 42.1.

CEC IR1 42.1 - Figure 2

Year	Peak forecast before DSM	High DSM	Peak forecast after DSM	Peak forecast after DSM and 50% EV charging shift
2021	765.8	11.6	754.2	752.7
2022	771.7	16.9	754.9	752.8
2023	772.8	20.9	751.9	749.1
2024	781.1	25.3	755.8	752.3
2025	792.2	30.0	762.2	757.9
2026	803.0	34.5	768.5	763.0
2027	814.6	38.7	775.8	768.8
2028	826.8	42.7	784.1	775.1
2029	839.8	46.6	793.2	782.0
2030	853.5	50.2	803.4	789.5
2031	868.6	53.5	815.2	798.0
2032	885.0	56.4	828.5	807.4
2033	902.6	59.2	843.4	817.6
2034	921.5	61.7	859.8	828.7
2035	941.0	64.1	876.9	840.1
2036	961.8	66.4	895.4	852.3
2037	984.1	68.4	915.7	865.7
2038	1,007.9	70.3	937.6	879.9
2039	1,033.1	72.1	961.0	895.0
2040	1,059.9	73.9	986.1	911.0

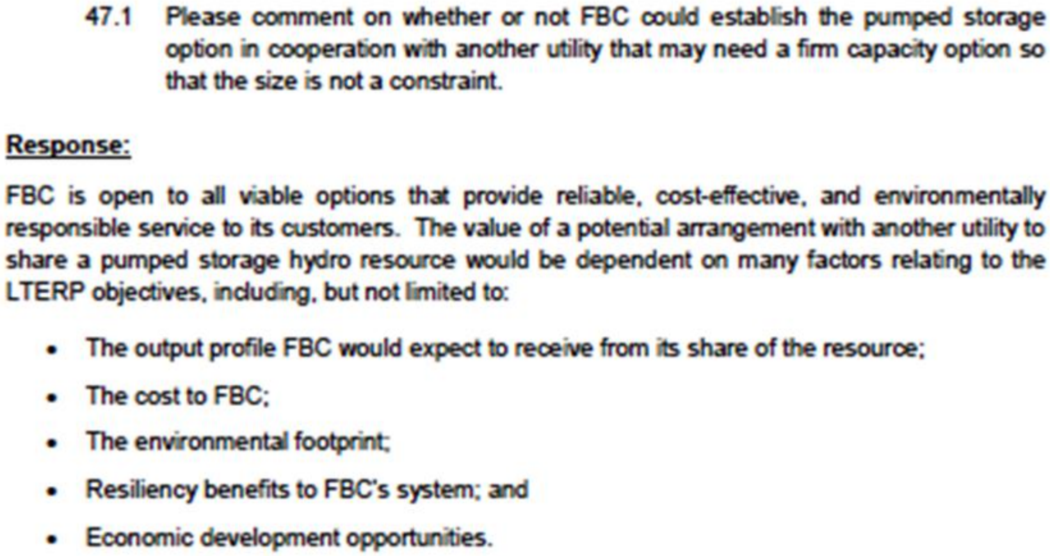
The table below provides the load data for Figure 3 in the response to CEC IR1 42.1.



CEC IR1 42.1 - Figure 3

Year	Peak forecast before DSM	Max DSM	Peak forecast after DSM	Peak forecast after DSM and 50% EV charging shift
2021	765.8	12.7	753.1	751.6
2022	771.7	18.5	753.3	751.2
2023	772.8	23.0	749.8	747.0
2024	781.1	27.9	753.2	749.7
2025	792.2	33.2	759.0	754.6
2026	803.0	38.3	764.7	759.2
2027	814.6	42.7	771.8	764.8
2028	826.8	46.9	779.9	770.9
2029	839.8	50.9	788.9	777.7
2030	853.5	54.6	799.0	785.1
2031	868.6	57.9	810.7	793.5
2032	885.0	60.9	824.0	802.9
2033	902.6	63.7	838.8	813.0
2034	921.5	66.3	855.2	824.0
2035	941.0	68.8	872.2	835.4
2036	961.8	71.2	890.6	847.5
2037	984.1	73.2	910.9	860.8
2038	1,007.9	75.2	932.6	874.9
2039	1,033.1	77.2	956.0	889.9
2040	1,059.9	79.1	980.9	905.8

83. Reference: Exhibit B-9, CEC 1.47.1



47.1 Please comment on whether or not FBC could establish the pumped storage option in cooperation with another utility that may need a firm capacity option so that the size is not a constraint.

Response:

FBC is open to all viable options that provide reliable, cost-effective, and environmentally responsible service to its customers. The value of a potential arrangement with another utility to share a pumped storage hydro resource would be dependent on many factors relating to the LTERP objectives, including, but not limited to:

- The output profile FBC would expect to receive from its share of the resource;
- The cost to FBC;
- The environmental footprint;
- Resiliency benefits to FBC's system; and
- Economic development opportunities.

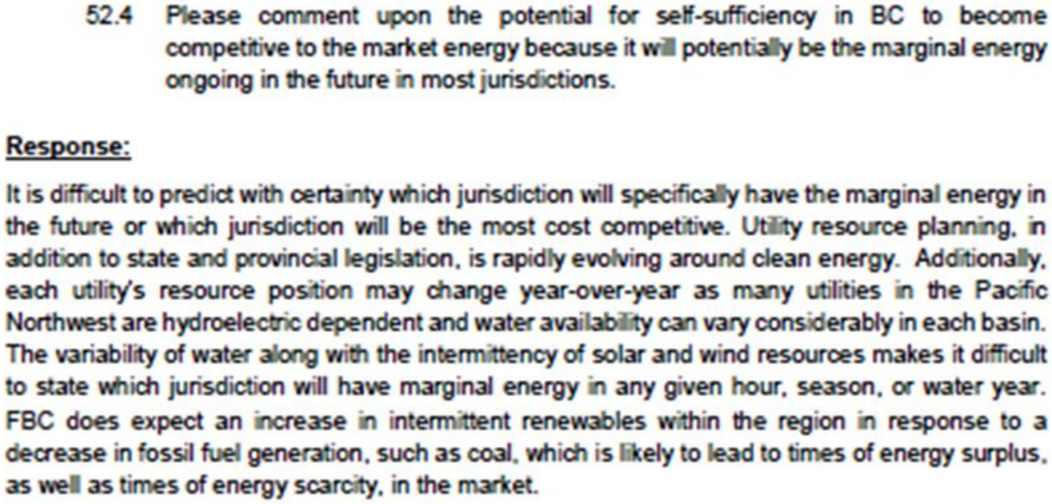
83.1 What other utilities might FBC consider as possible partners in such a venture, and please explain why they would be suitable.

Response:

FBC is open to working with both public and private entities that can provide resource opportunities that align with the listed LTERP objectives.

As one example, large pumped storage hydro projects located in BC with the economies of scale to be cost effective would require consultation and support from BC Hydro, as there are several power supply agreements currently in place between FBC and BC Hydro. Further, the Resource Options Report reflects resources located within BC, BC Hydro is the balancing authority for the province, and the two utilities operate within a similar legislative framework and have a common regulator.

84. Reference: Exhibit B-9, 1.52.4



52.4 Please comment upon the potential for self-sufficiency in BC to become competitive to the market energy because it will potentially be the marginal energy ongoing in the future in most jurisdictions.

Response:

It is difficult to predict with certainty which jurisdiction will specifically have the marginal energy in the future or which jurisdiction will be the most cost competitive. Utility resource planning, in addition to state and provincial legislation, is rapidly evolving around clean energy. Additionally, each utility's resource position may change year-over-year as many utilities in the Pacific Northwest are hydroelectric dependent and water availability can vary considerably in each basin. The variability of water along with the intermittency of solar and wind resources makes it difficult to state which jurisdiction will have marginal energy in any given hour, season, or water year. FBC does expect an increase in intermittent renewables within the region in response to a decrease in fossil fuel generation, such as coal, which is likely to lead to times of energy surplus, as well as times of energy scarcity, in the market.

84.1 Do jurisdictions work cooperatively to ensure there is always adequate energy for the region, even if each utility expects to rely on market energy at some point? Please explain.

Response:

Western North America electricity markets (outside of California and the CAISO) do not have an organized regional transmission organization (RTO) or independent system operator (ISO). Therefore, there is no single authority responsible for ensuring there is adequate energy for the region. While some coordination is provided by WECC, WECC's recommended planning reserve margins are voluntary and non-binding, and thus there is no standard program mandated for the Pacific Northwest region.

Participants in the West have explored the idea of an established market operator for many years. A recent study[9] determined that an organized market for the West, with a day-ahead market and an RTO, would improve coordination and provide economic benefits for the entire region. Since the release of this study, a group of utilities in the West have created the Western Markets Exploratory Group (WMEG), which is evaluating regional market opportunities. As such, there is increased momentum and interest in forming a centralized market in the West.

Due to the current lack of an RTO or ISO in the Pacific Northwest, utilities have instead relied on the Western Resource Adequacy Program (WRAP), which is administered through the Western Power Pool.[10] Participation in the WRAP is voluntary, but as of December 2021 there are 26 participants in the USA and Canada. Program participants disclose their anticipated loads and resources, as well as their import and export commitments for each season. Utility data is evaluated against a WRAP resource adequacy standard, which is currently non-binding (i.e.,

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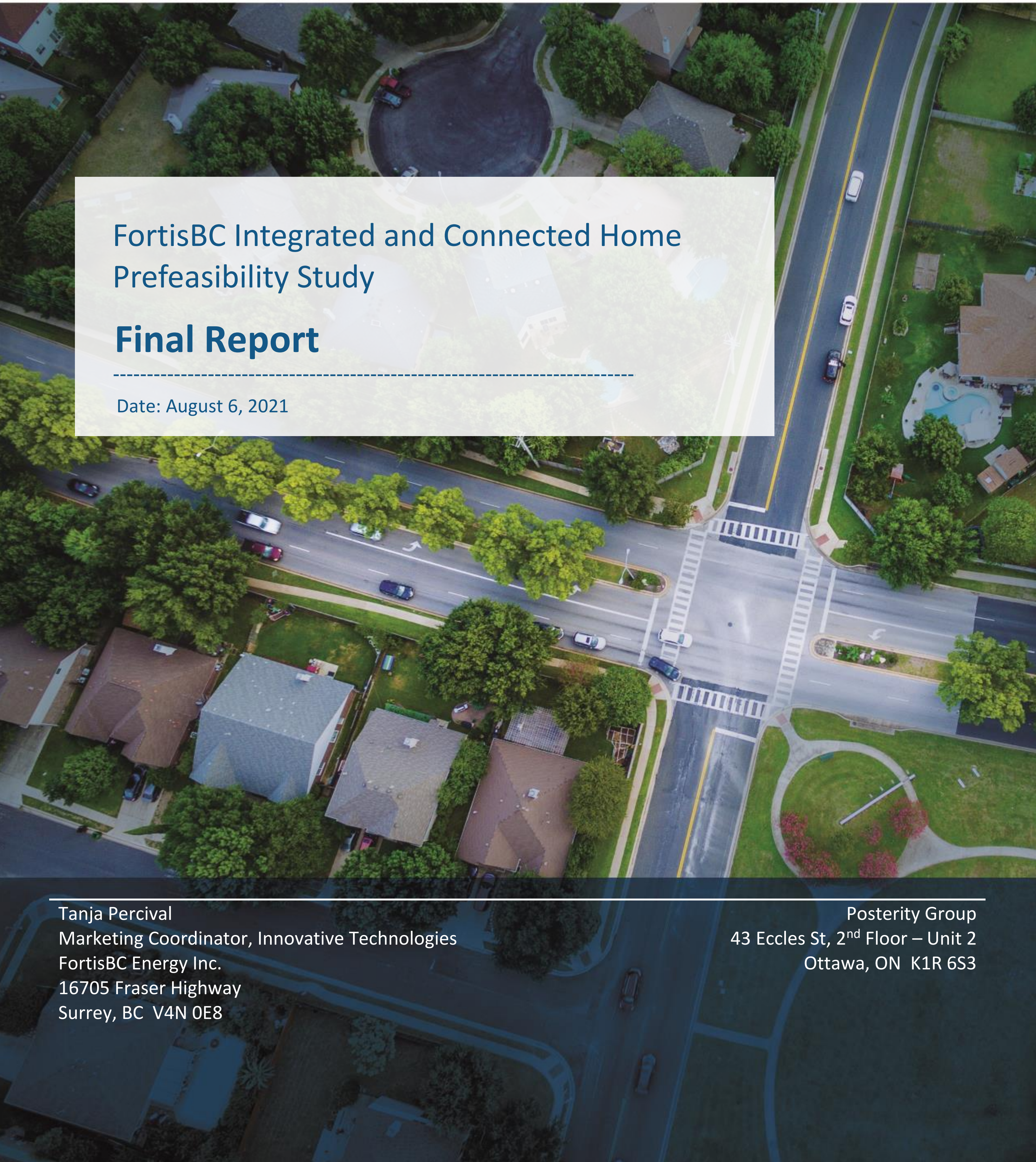
[9] The State-Led Market Study. (July 30, 2021). Energy Strategies.

[10] Formerly the Northwest Power Pool.

there are no penalties for failing to meet the standard). The operational component of the program (yet to be implemented), would provide a means of coordinating resource pooling and sharing between participants, to help increase transparency and cooperation to ensure that there are adequate resources in the region.

Attachment 67.1



FortisBC Integrated and Connected Home Prefeasibility Study

Final Report

Date: August 6, 2021

Tanja Percival
Marketing Coordinator, Innovative Technologies
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Surrey, BC V4N 0E8

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Ottawa, ON K1R 6S3

Contents

Executive Summary

Background

This prefeasibility study aims to characterize the energy and non-energy benefits of Connected Home technologies and estimate their energy savings potential in FortisBC's service area. FortisBC intends to use this study to determine the feasibility of launching a pilot project and using Connected Home technologies as Demand Side Management (DSM) measures.

This study provides a technology assessment of various Connected Home technologies followed by their market characterization, barriers and risks, and quantifies potential energy savings and conservation potential. The study is informed by extensive literature reviews, market research, and interviews with several market actors (utilities, subject matter experts, and Smart Home integrators from BC).

Additionally, this study is an update to Posterity Group's 2018 Connected Home Prefeasibility Study. The market for integrated and Connected Home technologies has matured rapidly since 2018. While the technology types (and many of the leading technologies) have remained the same, the penetration of these technologies in North American homes has greatly increased, as has utility pilot project data which allows us to better understand both energy savings and customer engagement opportunities. For many technologies, the potential energy savings have decreased. This change in expected savings is largely due to user behaviour, as previous estimates relied heavily on manufacturer claims.

Connected Home Technologies

Connected Home technologies, also commonly known as Smart Home technologies, use hardware, software, sensors, and network connectivity to control their environment, allow for remote control over the internet or local networks, and provide varying levels of home automation. Most current users of the Smart Home tech are early adopters, but interest and sales are rapidly growing and are primarily fueled by the technologies' convenience, security, and comfort benefits.

For the purposes of the technology characterization, Connected Home tech is categorized into two groups: Stand-alone technologies and Home Energy Management Systems, defined as follows:

- Stand-alone technologies are ones that can be operated independently, have their own controls, and have energy benefits of their own.
- Home Energy Managements Systems (HEMS) include enabling technologies (such as home hubs, smart speakers, and energy management apps) that do not save energy on their own but facilitate a more interconnected and integrated ecosystem which seems to positively correlate with overall energy savings potential and persistent use.

Current State of the Market

The North American market for consumer-level Connected Home technologies has grown rapidly in the last few years. In 2018, the market was still in its infancy, with most products available for less than ten years. At the time, all Smart Home tech market penetration levels were assumed to be less than 5%, with revenue and penetration rates projected to grow by roughly 20% every year. [1] The current market penetration level for all Smart Home tech is estimated to be around 27%, with revenue and penetration rates projected to grow by 15% to 18% annually over the next four years. [2] Interviewees and market research identified smart speakers, smart TVs, smart thermostats, and smart lighting as the most common and typically the first technologies installed in Canadian and American homes.

Risks and Barriers

There are two prominent risks associated with a utility supporting the use of Smart Home technologies. The first is the issue of interoperability between different devices. Utilities should avoid prescribing a specific product for use as it may not be compatible with the existing or future products in a customer's home. Almost 75% of consumers who said they plan to purchase a Smart Home device consider it essential that it connects seamlessly to other products in their home electronic network. [3] Most brands have now designed their product to connect with Amazon and Google smart speakers and home hubs.

The second most prominent risk is that of incorrect end-user behaviour. End-users should be trained on properly using the technology if they wish to achieve energy savings. Improper use of the technology could result in increased energy use. Current, real-world data from pilot programs have helped utilities understand the overall impact of user behaviour on smart technologies and better estimate energy savings.

Potential Analysis

Exhibit 1 presents the energy saving potential of the most promising Connected Home technologies reviewed in this study. Exhibit 1 also shows how the energy saving potential has changed since the previous report. In many cases, the projected energy savings potentials have decreased. This is largely due to user behaviour, as previous estimates relied heavily on manufacturer claims. Since 2018, the Connected Home field has become more researched, and manufacturer claims are now better aligned with real-world usage.

The potential energy savings of combining multiple Smart Home technologies is slightly lower than the sum of their individual potentials. For the HVAC-related technologies, it is assumed that a smart thermostat will be the main equipment, and smart zoning will be optional add-ons.

Exhibit 1 - Energy Saving Potential of Smart Home Technologies

Technologies	Gas (% Reduction)		Electricity (% Reduction)	
	2018 Report	2021 Report	2018 Report	2021 Report
Connected Thermostats	10%	6%	10%	8%
Smart Lighting			5%	5%
Smart Plugs and Power Strips			5%	5%
Smart Water Heaters	10%	1%	10%	1%
Smart HVAC Zoning Systems	5%	10%	5%	15%
Home Energy Reports	-	1%	-	1%

Exhibit 2 presents the associated costs, simple payback periods, total resource costs (TRC) and modified total resource cost test (MTRC) for the Smart Home technology reviewed.

Exhibit 2 - Technology Associated Costs and Paybacks

	Cost	Simple Payback Period	TRC	mTRC
Communicating Thermostat	$250	6	1.2	5.2
Smart Water Heaters	$240	14.4	0.2	0.5
Smart HVAC Zoning Systems	$900	11.2	0.6	2.4
Smart Lighting (10 bulbs)	$100	4.3	3.1	3.6
Smart Plugs and Power Strips (2 strips)	$100	4.5	2.0	2.3
Home Energy Reports	$40	6.7	1.4	3.2

Exhibit 3 summarizes the Connected Home technologies' annual energy and cost savings across the technical, economic, and market potentials for electricity and natural gas. The savings are for 2030 when the market has matured, and smart tech adoption would have occurred for several years.

Exhibit 3 - Summary Table of Various Potential Savings Scenarios in 2030

	Natural Gas		Electricity	
	Annual Savings (kWh)	Annual Savings ($)	Annual Savings (GJ)	Annual Savings ($)
Technical Potential	3,628,982	30,483,445	580,391	69,647
Economic Potential	3,540,372	29,739,125	563,398	67,608
Low Market Potential	1,244,123	10,450,637	178,287	21,394
Medium Market Potential	2,303,348	19,348,123	350,909	42,109
High Market Potential	2,583,083	21,697,896	500,959	60,115

Opportunities

Based on the potential and payback analysis, several opportunities for intervention by FortisBC for Connected Home technologies in British Columbia can be highlighted:

- For smart thermostats, lighting, power strips, and HVAC zoning the payback period is less than the lifespan of the technology. These technologies are very attractive (4-5 years) for single-family homes that rely on gas only for domestic hot water and use electricity for space heating and cooling.
- Smart thermostats and HVAC zoning are the most cost-effective gas saving technologies, while lighting and power strips are the most cost-effective electricity saving technologies.
- Home Energy Reports without any additional smart technologies have been shown to create energy savings by creating more opportunities for customers to understand their energy usage and engage with the utility company.

- Various Connected Home Packages can be designed to leverage the previously stated opportunities.
- Older existing single-family homes, which make up for more than half of the housing units in FortisBC's service area, are the best contenders for gas savings per home and market potential in all regions.
- Demand response and load management functionalities of smart technologies are important benefits for a utility.

Recommendations

Following the completion of this prefeasibility study and the high-level potential analysis, we recommend the following options to FortisBC for participating in the Connected Home space:

- Programs and/or rebates should focus on the connected thermostat, which are attractive to the largest number of customers and have the highest adoption rates. Smart Home programs could be developed centred around connected thermostats while potentially giving customers the option to adopt additional technologies or packages of technologies. Alternatively, connected thermostat rebates could be tied into other existing programs/rebates, though this approach would likely make evaluation more difficult
- Design packages focused on specific energy saving or customer needs. Two packages – the economic package and the performance package – are recommended for FortisBC to implement with their customers. The packages focus on stacking technologies to enhance savings. They also have to potential to provide customer engagement opportunities through HEMS.
- Commission or participate in a Bring-Your-Own-Device pilot program to promote smart technology adoption and reduce the risk of interoperability issues for the end-user.
- To increase the likelihood of adoption, multiple-technology rebates could be offered, with higher incentives given if 3 or more are installed.
- Proactively plan for how Smart Home data will be collected, stored, and used. Depending on the structure of a program, customers may choose to share their energy data as part of a program or study. Mitigating their privacy and security concerns can be done by ensuring transparency with end-users and providing customers with the opportunity to review and consent to data sharing agreements.

1 Introduction

Connected Home technologies, also commonly known as Smart Home technologies, use hardware, software, sensors, and network connectivity to control their environment, communicate with each other, allow for remote control over the internet or local networks, and provide varying levels of home automation.

This prefeasibility study aims to characterize the energy and non-energy benefits of Connected Home technologies and to estimate their energy savings potential in FortisBC's service area. In addition, FortisBC intends to use this study to determine the feasibility of launching a pilot project and using Connected Home technologies as Demand Side Management (DSM) measures.

This study provides a technology assessment of Connected Home technologies followed by their market characterization, barriers and risks, and quantifies potential energy savings and conservation potential. The study is informed by extensive literature reviews, market research, and interviews with market actors.

Additionally, this study is an update to Posterity Group's 2018 Connected Home Prefeasibility Study. The market for integrated and Connected Home technologies has matured rapidly since 2018. While the technology types (and many of the leading technologies) have remained the same, the penetration of these technologies in North American homes has greatly increased, as has the prevalence of utility pilots and programs focused on both energy savings and customer engagement.

1.1 Study Scope

This study focuses on smart devices with perceived energy or power saving benefits and presents on the following technologies:

- Connected thermostats
- Smart lighting
- Smart plugs and power strips
- Smart water heaters
- Smart HVAC zoning systems
- Smart appliances (i.e. major household appliances)
- Home Energy Management Systems (smart speakers, hubs, apps)
- Home Energy Reports

In addition to the examples of products mentioned above, Smart Home tech includes smart door locks, smart alarms, security cameras, and smart TVs that do not have any energy saving or demand response functionalities.

A modified version of FortisBC's 2021 Conservation Potential Review Study (CPR) model, developed using Posterity Group's Navigator™ Energy and Emissions Simulation Suite, was used to assess consumption and estimate potential savings. The following sectors, vintages, regions, home types, and fuel types were considered when developing the potential analysis of this study:

- Sectors (1): Residential
- Vintages (8): Pre-1950, 1950-1975, 1976-1985, 1986-1995, 1996-2005, 2006-2015, Post-2015 (Existing), New
- Regions (6): Vancouver, Lower Mainland excluding Vancouver, Vancouver Island, Northern BC, Southern Interior, Whistler
- Home Types (3): Single Family Detached/Duplexes, Single Family Attached/Row, Mobile/Other Residential
- Fuel Type (2): Natural Gas, Electricity

1.2 Methodology

Research in support of the technology and market characterization in this study was conducted in two phases:

- **Primary Research:** Four telephone interviews were undertaken to fill gaps in the secondary literature and provide BC-specific market information. Interviewees included a BC Connected Home integrator and installer, utilities with prior experience with Connected Home tech, and supporting research organizations.
- **Secondary Research:** Available secondary literature and data addressing baseline energy use, technology characteristics and market structure was collected and analyzed. Information specific to FortisBC's customer base was taken from FortisBC's 2021 Conservation Potential Review Study (CPR) and Residential End-Use Survey (REUS).

The remainder of this document is presented under the following sections:

- Section 2 **Technology Characterization** describes available types of Smart Home tech, their operation, typical applications, and applicable regulations and standards.
- Section 3 **Market Characterization** presents a characterization of the BC market for Smart Home tech, including a market description, market structure, key market actors, and an analysis of market barriers.
- Section 4 **Savings, Payback, and Potential Assessment** outlines the overall opportunity for Smart Home tech in BC and estimates potential savings.
- Section 5 provides **Utility Risks** associated with supporting the adoption of Smart Home tech**.**
- Section 6 provides **Conclusions and Recommendations.**
- Section 7 provides **Bibliography**.

In many sections, updated findings from the 2018 Prefeasibility Study are highlighted to address new information, potential impacts, and important market or technological changes.

2 Technology Characterization

This section reexamines various Connected Home technologies, their energy savings potential, and non-energy benefits. While the technology types (and many of the leading technologies) have remained the same, our understanding of their impact and integration into a user's home has grown. At the time of the 2018 study, many utilities were performing pilot studies to validate the energy savings claimed by manufacturers. This section integrates the results of these studies and how they impact the benefits associated with Connected Home technologies. Additionally, there has been increased attention on the role of smart speakers and energy management apps in driving customer engagement.

For the purposes of the technology characterization, Connected Home technology is categorized into two groups: stand-alone technologies and Home Energy Management Systems, defined as follows:

- Stand-alone technologies are ones that can be operated independently, have their own controls, and have energy benefits of their own.
- Home Energy Management Systems (HEMS) include enabling technologies (home hubs, smart speakers, and energy management smartphone apps) that do not have energy benefits of their own but facilitate a more interconnected and integrated ecosystem.

In the context of this study, the terms "connected" and "smart" are used interchangeably. When Smart Home products were first introduced, the feature that made them unique was their ability to communicate with external sources (i.e., Home Energy Management System). This meant that a connected device could send information on its performance, time-of-use, or other operating conditions to the central hub to inform users of its status. As new products have entered the Connected Homes market, this definition has evolved. Connected or smart devices are now known as products with network connectivity that can perform sensing, control, and reporting functions through software and algorithms.

A catalogue of currently available Smart Home Technologies, including several specific technologies not discussed in detail in this section, is provided in Appendix A.

2.1 Communication Protocols

Connected Home devices provide the most functionality and energy savings when interacting with each other safely and reliably. To do so, each device needs to speak the same language (protocol).

The advantages and limitations of each protocol are important to understand when selecting devices for a Smart Home Ecosystem. Exhibit 4 outlines five relevant protocols in the Connected Home's space and includes a few examples of products using these protocols. [4] [5] [6] [7] There have been no significant changes in protocols and their capabilities since the previous report.

Exhibit 4 - Connected Home Protocols

Protocol	Description	Compatibility	Mesh Network	Range	Energy Use	Market Penetration
WiFi	Fast and reliable wireless communication	Laptops, TVs, Smartphones	No	Long (25m)	High	High
Bluetooth	A short-range wireless protocol with an adaptive frequency hopping system that detects existing signals, such as WiFi, and negotiates a channel map for the Bluetooth devices to minimize interference.	Phones, Headphones, Speakers	Yes	Short (10m)	Medium (Bluetooth LE (Low Energy) brings energy use down substantially)	Low (in terms of Smart Home devices)
Thread	An open wireless protocol developed by a group of large technology companies designed to allow devices to communicate even when the WiFi network goes down.	Nest, Google devices, Samsung devices, Qualcomm, Osram	Yes	Long (30m)	Low	High
Zigbee	A wireless protocol operating in a mesh network. Zigbee uses devices to relay signals to other devices, strengthening and expanding the network.	Electric AMI meters (including FortisBC), GE appliances, LG devices, Amazon Alexa, Philips Hue lights, WeMo	Yes	Short (10m)	Low	High
Z-Wave	An open-source mesh network protocol. Very similar to Zigbee, the main difference being that Z-Wave is roughly 6 times slower but requires less energy to cover the same range as Zigbee. Z-Wave is one of the most popular protocols in the Smart Home market.	Honeywell products, ADT and First Alert home-security devices,	Yes	Long (30m)	Low	High

2.2 Technology Description

The following section provides a brief description of relevant stand-alone technologies and Home Energy Management Systems. The functions and controls of many of these technologies have not significantly changed since the previous report; however, our understanding of their energy performance has changed as more data has become available. This section briefly highlights the expected energy savings for each technology. A deeper analysis of the changes in energy savings and subsequent impacts compared to the previous report is further discussed in Section 2.3 Energy Performance.

2.2.1 Individual Connected Home Technologies

Stand-alone technologies are ones that can be operated independently, have their own controls, and have energy benefits of their own.

Connected Thermostats

Connected thermostats continue to be one of the most popular Connected Home technologies. They can typically sense the temperature, occupancy, weather conditions, and user patterns to optimize the HVAC functions of a building. Smart thermostats can also provide utilities with detailed data on a home's energy performance and the ability to offer demand response programs and customized service offerings to their customers.

Connected thermostats save energy by optimizing space heating and cooling operations (the largest end-uses in a typical Canadian home). FortisBC's Smart Learning Thermostat Pilot, completed in 2019, reflects savings for smart learning thermostats, a subset of the thermostats on the ENERGY STAR(R) list of qualifying connected thermostats. The pilot study was completed in Kelowna (Southern Interior) and reported weather-normalized space heating savings of 2.61 GJ/home, equivalent to approximately 4% for single-family detached homes based on the tertiary load from FortisBC's 2022 LTGRP and an average in-situ furnace AFUE of 80% from the 2017 REUS.

The FortisBC pilot test results showed more conservative savings than utilities in other jurisdictions. The ENERGY STAR specification for connected thermostats was developed and released by the Environmental Protection Agency (EPA) in 2017 and set savings thresholds of 10% for heating and 8% for cooling, normalized across all US climate zones. [8]

An assumed average energy savings of 6% for cooling and 8% for heating from connected thermostats were used in the model analysis.

Product and Brand Examples: Nest, Ecobee, Mysa, Honeywell, Carrier, Johnson Controls

Smart Lighting

The category of smart lighting encompasses lights, lamps, and switches with two-way communication capabilities. Smart lights can be programmed to turn on and off based on occupancy or time of day and can work with the home's security system. These products incorporate automatic dimming and other advanced functions to reduce light levels and operating hours. Smart lighting can be operated independently using a mobile app; however, optimal convenience and functionality are achieved when the technology is integrated with a Home Energy Management System.

Studies have shown that smart lighting has the potential to save 4-12% of a home's lighting energy use through automation and dimming. The effects of lighting savings largely depend on occupant behaviour and the placement of smart lighting in a home. [9] In the 2018 report, smart lighting savings were indicated to be between 7-27% but were based primarily on manufacturer claims and had not been thoroughly substantiated.

Typically, smart lighting is only placed in commonly used rooms such as the living room, kitchen, and bedroom. Additionally, smart lights also draw power when in standby mode and have the risk of using as much energy as they can potentially save. For this reason, smart lighting should not be used in low-occupancy and low-use areas of a home.

An assumed average energy savings of 5% from smart lighting was used in the model analysis. A conservative estimate was used to avoid overemphasizing the expected savings.

Product and Brand Examples: Philips, Wyze, Insteon, IKEA, GE, Osram, Amazon, Sengled

Smart Plugs and Power Strips

Smart Plugs are generally defined as power outlets with two-way controls. These products rely on time scheduling, motion sensing, or load detection to manage the power supply to devices that are not in use. Smart Plugs integrate with a Home Energy Management System, allowing users to activate and deactivate devices connected to the Smart Plug wirelessly. The features of this technology can be optimized using automation to create further convenience for the end-user.

Advanced power strips (APS) have outlets that can be programmed to turn off plug loads based on room occupancy and peak demand. Smart plugs and APSs can reduce standby power loss (i.e., phantom power) by turning off devices when they have entered standby mode.

Since the energy-saving potential of smart plugs and power strips revolves around managing plug loads, the potential savings can vary widely depending on the number of electronic devices connected. Two technical reference manuals[1] reported savings factors ranging from 4% - 9% for Tier 1 Advanced Power Strips. [9] [10] Similar to smart lighting, the expected savings from smart plugs and power strips had not been fully validated at the time of the previous report. Energy savings were less than previously expected.

An assumed average energy savings of 5% for smart plugs and power strips were used in the model analysis.

Product and Brand Examples: TP-Link, Wyze, Amazon, Belkin, TrickleStar, Embertec

Smart Water Heaters

Smart Water Heaters may employ one or both of two main energy conservation strategies:

- They can save energy by preventing unnecessary (i.e., constant and around-the-clock) heating of water by learning usage patterns of a home and only heat water when demand is anticipated.
- Secondly, they can be equipped with bi-directional controls that allow utilities or third parties to turn them off during peak demand.

There are several smart water heaters available on the market. Existing gas and electric water heaters with storage tanks can both be retrofitted to become smart and grid-connected. The retrofit typically involves installing a controller and a temperature sensor and connecting the water heater to the home's

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[1] State of Minnesota Technical Reference Manual and Mid-Atlantic Technical Reference Manual

network. Smart water heaters can also serve as cost-effective energy storage mediums and load management agents.

Like many Connected Home technologies, the energy saving potential of smart water heaters is highly dependent on user behaviour and difficult to determine. In one study by the Consortium for Energy Efficiency, homes with long periods of no hot water use saw savings of up to 15% (since the water heater shuts off automatically during periods of inactivity), but homes with frequent hot water use saw negligible savings. [11] In another study by Minnesota and Gas Technology Institute, homes had wide variances in energy savings, and in some homes, there was even an increase in energy use. Overall energy savings from water heating controllers was minimal at 1% - 3%. [12]

Due to the strong dependence on user behaviour, it is difficult to quantify expected energy savings. Generally speaking, smart water heater controllers have the potential for energy savings in homes where there are long periods where hot water is not required.

An assumed average energy savings of 1% for smart water heaters was used in the model analysis. A conservative estimate was used as more studies are showing negligible savings with smart water heaters.

Product and Brand Examples: Rheem, Aquanta, Sears/Kenmore, GE, Eccotemp

Smart HVAC Zoning Systems

Smart HVAC zoning systems use room sensors and smart ventilation to relay temperature and occupancy information to a central point (often HEMS or connected thermostats) and manage energy supplied to unoccupied areas of the home. Smart zoning systems include temperature sensors and vents that automatically open and close to regulate the temperature in each room.

The energy-saving potential of Smart HVAC systems varies widely depending on the home itself and the presence of other connected devices. The cooperation of various devices within a home makes it difficult to associate the energy savings to a single technology. For example, smart zoning technologies have the potential to reduce energy consumption by regulating the air flow to individual rooms. In cases where a smart thermostat is already installed, the incremental energy savings of smart zoning could be negligible depending on the application. Smart vents in forced air systems also risk lowering heat exchanger efficiency (as closing vents would increase system pressure and reduce airflow to zones), lowering overall energy savings.

There are a wide range of studies on HVAC zoning technology, all with varying results ranging from 30% to no energy savings. The following two reports by Posterity Group were used to inform the average energy from smart HVAV zoning systems:

- Residential Forced Air HVAC Zone Control Pre-Feasibility Study [13]
- TRM for HVAC Zone Control, "Type 1" Zone-by-Zone Systems [14]

An assumed average energy savings of 15% for cooling and 10% for heating from smart HVAC zone controls were used in the model analysis.

Product and Brand Examples: Keen Home, Johnson Controls, EcoVent, Flair, Alea Lab, Dettson, Primex

Smart Appliances

For this study, appliances refer to the major household equipment: refrigerators, stoves, dishwashers, washing machines, dryers, and microwave ovens. Smart appliances can be controlled remotely and can send alerts to their users. Certain smart appliances can automatically optimize their processes by shifting their operation to off-peak hours.

Smart appliances are not inherently more energy-efficient than conventional appliances, though they are often ENERGY STAR-certified. Smart appliances can reduce energy costs for a typical household by 2% - 9% through load shifting in jurisdictions with Time-of-Use rates. [8] Some smart appliances also have demand response capabilities that can allow utility signals to prescribe their operation time. Dishwashers, clothes dryers, and washing machines offer the highest potential cost-saving benefits.

Smart appliances were not included in the model because they are not inherently more energy-efficient, and any savings range significantly between brand and equipment type. Furthermore, like smart water heaters, smart appliance energy savings are largely dependent on user behaviour. Many pilot projects and studies are showing the negligible energy saving associated with smart appliances.

Product and Brand Examples: LG, Samsung, Whirlpool, Haier

Ancillary Smart Devices

Numerous ancillary devices can contribute to the optimization of a Connected Home. Devices in this category facilitate the regulation of the major components of a building based on occupancy, location within a home, proximity to home and other variables. The products in question include window sensors, occupancy or motion sensors, indoor air quality sensors and any other device whose sole purpose is to inform the Home Energy Management System of the operating conditions of the building. Using automation, users can initiate responses to certain operating conditions to optimize the performance of their homes. These devices alone do not generate energy savings, but they can potentially increase savings when paired with other Smart Home Technologies.

Smart Alarms

The category of smart alarms is comprised of safety and security related products equipped with two-way communication capabilities. These devices include smoke detectors, motion sensors, carbon monoxide detectors, smart doorbells, water leak detectors, etc. The value proposition of products in this category is related to safety and security rather than energy efficiency, thus yielding negligible savings potential.

2.2.1 Smart Home Energy Management Systems

Home Energy Management Systems serve as the central communication hub for various connected devices and often act as the “brain” of a Connected Home. If a user wishes to integrate the operations of different connected devices, they must converge to a central point. Not all products are directly compatible with every HEMS; however, this gap is often mitigated through a proprietary "connection bridge," which acts as a translator to allow the device to be recognized and operated by the HEMS. The ability to integrate a given device within a Connected Home network depends on its communication protocol.

The HEMS discussed below accommodate different protocols to provide users with varying levels of control and visibility of their connected devices. Given the rapid innovation in this sector, the categories defined below continuously blur as developers add functionality to their product lines. Certain HEMS technologies can control different devices and create automated routines, while others simply display information. There have been many developments in the functions and influence of HEMS, especially smart speakers, related to customer engagement and subsequent energy savings. Section 2.4 Non-

Energy Benefits further explores the potential impacts of smart home energy management systems and how utility companies can leverage them.

Home Hubs

A Home Hub is a device that integrates various Smart Technologies into a home automation network and controls two-way communication among them. This hardware can understand different communication protocols to allow seamless integration of different technologies. Products that can connect to a Home Hub include thermostats, light bulbs, outlets, door locks, appliances, motion sensors and many more. In addition to turning these devices on and off, Home Hubs allow users to create automated sequences for their connected devices based on specifically defined variables. Home hubs are often paired with a mobile application to allow users to interact with their Connected Home network remotely. Part of the savings from a home hub originate from the convenience of using a central control interface, and some come from the automation that they enable.

Product and Brand Examples: Samsung SmartThings, Wink Hub, Lowe's Iris Smart Hub.

Home Energy Management Apps

A Home Energy Management Application (HEMA) is a mobile program designed to provide visibility of home energy use and the status of various Smart devices within a home. HEMAs typically receive consumption data from a home's Smart Meter, a device "connection bridge" or a Home Hub. The wireless nature of a mobile application allows users to view their home energy-use remotely.

Mobile applications are generally more limited in their ability to control devices remotely as long-range two-way controls can put a home's network security at risk. A limitation of certain apps is their ability to understand a wide array of protocols. Certain platforms are designed to operate with a specific product line which can create compatibility issues.

Product and Brand Examples: Powerley, Tendril, Smappee, Neurio, Bidgely

Smart Speakers

The category of Smart Home Assistants includes voice-assisted enabling technologies capable of automatically executing specific tasks when prompted by a user. The functionality of a smart speaker is like that of a home hub, meaning it can control and communicate with various smart devices. Much like the other HEMS, smart speakers are not necessarily compatible with all smart devices. The ability to connect a given device to a smart speaker depends on its compatibility or the presence of a "connection bridge." Smart speakers are the fastest growing Smart Home device with a current market penetration of around 40%. [15]

These products' additional features include performing administrative tasks, setting reminders, and making web searches, all of which are done using voice commands. Smart speakers may help reduce energy use by providing a convenient control point for major end-uses (HVAC, Lighting) in a home. A study found that 44% of consumers have used their voice assistant to control another smart device from their home. [16] A more

Product and Brand Examples: Amazon Echo (Alexa), Google Home (Assistant) and Apple HomePod (Siri)

2.3 Energy Performance

This section presents the findings (from literature reviews and primary research) on the energy saving potential of Connected Home technologies and their associated features and benefits. At the time of the previous report, many utilities were performing pilot studies to validate the energy savings claimed by manufacturers. Now, those studies have released substantiated data on the energy savings of many smart technologies. These savings account for any standby load needed to support smart capabilities and how user behaviour can impact savings[2].

Exhibit 5 outlines the energy saving potential and functionalities of several Connected Home technologies. Many of the energy savings listed in Exhibit 5 are lower than reported in the 2018 study. At the time of the 2018 study, there had been very few published pilot studies with validated energy savings. Therefore, the previous report had to rely mostly on potential savings claimed by the manufacturer. Exhibit 6 highlights the difference in expected energy savings since the last report.

The energy savings from Smart Home technologies can vary widely and are highly dependent on user behaviour and the occupancy patterns of a home. The savings potential listed below come from pilot studies and TRMs from US and Canada based utilities. Additionally, the incremental energy savings of connecting multiple Smart Devices is assumed to be less than the sum of their individual energy saving potentials.

Exhibit 5 - Energy Performance Characteristics of Stand-Alone Technologies[3]

Technology	Electricity Saving Potential	Gas Saving Potential	Automation Capability	DR Capability
Connected Thermostats	Annual electric savings potential ranges from 4% - 10%. [9], [10]	Annual gas savings potential ranges from 4% - 10%. [9], [10]	Yes	Yes
Smart Lighting	Electric energy savings range from 4% - 12% per lamp, depending on location and time of use. [8] Average annual household electric savings is around 5% when installed in highly populated areas. [9], [10]	This technology has no potential to generate gas savings.	Yes, when connected to a HEMS.	Yes, when connected to a HEMS.
Smart Plugs Power Strips	Annual electric savings potential ranges from 4% - 9%. [9], [10]	This technology has no potential to generate gas savings.	Yes, when connected to a HEMS.	Yes, when connected to a HEMS.

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[2] User behavior affects can vary greatly from user to user, but pilot study data provides insights into the overall impact of user behaviour on smart technologies.

[3] Exhibit 5 reviews common performance characteristics for each stand-alone technology. Appendix A provides performance characteristics broken down by specific brands.

Smart Water Heaters	Annual electric savings potential ranges from 1% - 15%. [11], [12] Energy savings for this technology are highly dependent on user behaviour.	Annual gas savings potential ranges from 1% - 15%. [11], [12] Energy savings for this technology are highly dependent on user behaviour.	Yes	Yes
Smart HVAC Zoning Systems	Annual electric savings potential ranges from 10% - 15%. [13], [14]	Annual gas savings potential ranges from 10% - 15%. [13], [14]	Yes, when connected to a HEMS.	No
Smart Appliances	Annual electric savings potential ranges from 2% - 9%. [8] Energy savings for this technology is highly dependent on brand and appliance type.	Annual gas savings potential ranges from 2% - 9%. [8] Energy savings for this technology is highly dependent on brand and appliance type.	Yes	Yes, when connected to a HEMS.
Ancillary Smart Devices	This stand-alone technology presents no energy saving potential.	This stand-alone technology presents no energy saving potential.	Yes, when connected to a HEMS.	No
Smart Alarms	This stand-alone technology presents no energy saving potential.	This stand-alone technology presents no energy saving potential.	Yes, when connected to a HEMS.	No

Exhibit 6 highlights the changes in expected energy savings since the 2018 report. Energy savings were adjusted for connected thermostats, smart water heaters, and smart HVAC zoning systems. These adjustments reflect validated energy savings data from various utility studies. The reported energy savings better account for any standby load needed to support smart capabilities and how user behaviour can impact savings.

Exhibit 6 – Energy Savings Comparison Between Reports

Technologies	Gas (% Reduction)		Electricity (% Reduction)	
	2018 Report	2021 Report	2018 Report	2021 Report
Connected Thermostat	10%	6%	10%	8%
Smart Lighting			5%	5%
Smart Plugs and Power Strips			5%	5%
Smart Water Heater	10%	1%	10%	1%
Smart HVAC Zoning Systems	5%	10%	5%	15%
Home Energy Reports	-	1%	-	1%

The basic functionalities of the different Home Energy Management Systems are similar. They provide information regarding real-time energy use, and some allow end-users to create routines through automation. HEMS alone do not realize energy savings; however, they can produce savings through demand response events, automated functions, and continued usage. Exhibit 7 outlines the energy-related benefits of Home Energy Management Systems.

Exhibit 7 - Energy Performance Characteristics of HEMS Technologies

Technology	Energy-Related Benefit
Home Hubs	Provides end-users with a physical hub for connecting various Connected Home technologies. Home hub products can offer physical displays and application-based dashboards for real-time information on energy consumption and end-uses.
Home Energy Management Apps	Provides users with a mobile dashboard for their connected devices. The result is a wireless display of energy use with a varying ability to control devices depending on the protocol used. These applications often operate using only one-way communication to mitigate security concerns related to remote two-way controls.
Smart Speakers	Provides users with voice-activated controls of various Connected Home technologies. These devices offer limited visualization of energy consumption and are less flexible in creating automated sequences.

The energy savings from smart technologies occur when one or more of the following features are used: demand response, automation, and behavioural load profile.

Demand Response

Demand response is a change in electric usage by end-users from their normal consumption patterns in response to changes in electricity costs, time of day, or total grid load. Employed strategies seek to adjust the demand for power instead of adjusting the supply. This function can be performed using automation or by a utility if the end-user has granted them control and permission. In some jurisdictions (e.g. Ontario and California), 3rd party aggregators can assemble portfolios of flexible loads (distributed across many contracted customers) and bid these "negative" resources into local wholesale energy markets, providing a revenue stream to owners of grid-responsive equipment beyond pure energy savings.

The advanced metering infrastructure (AMI) necessary for demand response is not widely installed on natural gas systems. Therefore, demand response is used primarily for electric energy savings and less applicable for gas energy savings.

Example of Demand Response: Appliances operating only during off-peak times, smart thermostats, water heater controllers, and smart plugs set back temperature/consumption during peak periods.

Automation

Automation can be defined as the execution of predetermined activities (also known as routines) with minimal user intervention. In other words, automation is a sequence of events predefined by the end-user to achieve a specific outcome. Automation is mostly coordinated using a Home Energy Management System to allow different connected technologies to interact and operate in unity.

Ancillary Smart devices and manual programming can enhance the benefits of automation through geofencing and functions known as If This Then That (IFTTT). Geofencing is a function that creates a virtual geographic boundary that can be used by software to trigger a response when a mobile device enters or leaves the area. When this information is paired with IFTTT, users can enable specific functions to be automated as soon as they enter or leave their homes.

Example of Automation: Activate bedroom lighting, set a smart thermostat to cooler temperatures at night and gradually increase the temperature in the morning.

Behavioural Load Profile (BLP)

The behavioural load profile is a function of the energy use in a home throughout a given day. These profiles vary widely between households as they are entirely dependent on occupancy and the behaviour of tenants. Behaviour load profiles are often integrated with automation features to increase potential energy savings. Many smart technology brands are developing algorithms that can better integrate automation with behaviour load profiles. While BLPs have no direct energy savings, they can allow utilities to forecast energy needs better. Occupants who do not typically set back thermostats or turn off lights in unoccupied rooms have a greater potential for energy savings by using smart technologies.

Example of Behavioural Load Profile: With consumer data, utilities can understand load profiles between different home types and even different occupants, such as office workers, shift workers, retirees, singles, or families.

2.4 Non-Energy Benefits

There are several non-energy benefits that Connected Home technologies offer to end-users, including some utilities can leverage. Non-energy benefits are often the primary drivers that attract consumers to smart devices. While the role of energy savings and subsequent cost savings has become increasingly important to consumers, it alone does not encourage consumer adoption. The following non-energy benefits have all been cited as driving consumer adoption:

Convenience

Convenience is at the forefront of the value proposition for many Connected Home technologies (especially HEMS). The ability to create routines through automation creates significant convenience for users who take full advantage of this feature. The extent to which homeowners utilize automation is directly proportionate to the added value of a given device. The ability to remotely activate/deactivate devices is convenient as homeowners can be assured that devices are not left on by mistake.

A 2016 study done by Kelton Global and NEST found convenience to be customers' top priority (54%). [17] A 2020 study of 1,500 US adults, all of whom had at least one Wi-Fi enabled device in their home, found 74% listed "creating a more convenient living experience" as the reason for purchasing their device. [18]

Comfort

A significant non-energy benefit of Smart Home technology is increased occupant comfort. Many devices in the Smart Home realm are intended to manage appliances based on variables like occupancy, time of day, and weather. The consideration of these variables can lead to minor changes in the operation of lights, fans, blinds, or other equipment to provide the optimal environment for the end-user. This aspect of Connected Home technology is often pitched as the value proposition of a device when product developers cannot substantiate actual energy savings.

Pacific Gas and Electric Company reported that 50% of their survey respondents stated that Smart Home technology increased the level of comfort in their homes. [17]

Safety and Security

The value proposition of certain Connected Home technologies is geared towards safety and security. By emphasizing occupancy sensors, leak detectors, surveillance cameras, locks and other safety features, brands are entering the Connected Home’s arena by addressing these non-energy issues. The ability to monitor your home and activate locks remotely is perceived as a major security benefit.

Surveys by Icontrol Networks and Shelton Group (2015) found that 90% of homeowners buy HEMS for security reasons. [17] In British Columbia, Telus entered the smart technology market in 2018 with the acquisition of a smart security company. They have since expanded their products to include energy-saving smart tech, but their primary focus is on home security. [19]

Engagement

The potential for end-user engagement is a significant non-energy benefit of Smart Home technologies (especially HEMS) for utilities. Exposing users to their real-time energy consumption can lead to opportunities for education and performance improvements. Utilities are uniquely positioned to offer a central hub for their customers, providing them with visualizations of real-time energy use and information on available programs to improve their relative energy performance. The following section further explores how utility companies can leverage Home Energy Management Systems to increase customer engagement and potentially improve energy savings.

2.4.1 Leveraging Home Energy Management Systems

Home Energy Management Systems, particularly smart speakers, offer utilities an opportunity to increase customer engagement and potentially improve energy savings. Customers primarily want two things from utilities through their HEMS: personalized advice on saving money and learning more about their energy usage. Customers want tailored energy efficiency tips from their utility that will help them save money. They want the advice to reflect their unique home characteristics and energy consumption patterns, so they can be sure it’s relevant for them and provide ways to save energy and money.

Due to their popularity, voice-activated smart speaker or virtual assistant platforms are quickly becoming a key interface for a range of smart home systems and devices. Customers are familiar with smart speakers, generally report positive experiences with them, and according to a 2019 Residential Utility Customer Survey, they want to interact with their utilities via this channel. [20] For utilities, these devices represent an important way to engage with customers, empower them with relevant information, and help them create smart home systems that can successfully manage their energy use. E Source research shows that 60% of smart speaker owners said they’re “probably” or “definitely” interested in a utility app that makes use of voice-activated skills. [21]

At present, Amazon and Google dominate the smart home virtual assistant market and provide open-platform systems that make them well suited to utility needs. Amazon’s Alexa and Google Assistant can each control more than 5,000 smart home devices from thousands of brands, and the number of supported languages and features offered is continually expanding. [21] Apple HomeKit with Siri is also compatible with several brands and devices, but they currently do not have the same compatibility breadth as Amazon and Google.

Exhibit 8 provides a non-exhaustive list of smart product brands and their compatibility with Amazon, Google, and Apple. For all brands compatibility may vary across their products, with newer products offering greater compatibility and more features.

Exhibit 8 - Smart Device Brands with Voice-Activated Smart Speaker Compatibility

Brands	**Voice-Activated Smart Speaker**		
	Amazon	Google	Apple
Aquanta	x		
Belkin	x	x	x
Carrier	x	x	x
Eccotemp	x	x	
Ecobee	x	x	x
Embertec	x	x	
GE	x	x	x
Haier	x	x	x
Honeywell	x	x	x
Insteon	x	x	x
Johnson Controls	x	x	x
Kenmore	x		
LG	x	x	
Mysa	x	x	x
Nest	x	x	x
Osram	x	x	x
Philips	x	x	x
Rheem	x	x	
Sengled	x	x	x
TP-Link	x	x	x
TrickleStar	x	x	x
Whirlpool	x	x	
Wyze	x	x	x

2.5 Key Takeaways

Key Takeaways

- The protocols, primary technology features, and non-energy benefits of smart technologies have not significantly changed since the previous prefeasibility study, conducted in 2018.
- While the role of energy savings and subsequent cost savings has become increasingly important to consumers, it alone does not encourage consumer adoption. Convenience and comfort are still the largest drivers of customer adoption.
- Energy-savings have been validated by utility pilot programs. These savings account for any standby load need to support smart capabilities and how typical user behavior trends impacts savings. Overall, energy-savings have been lower then previous reported but still create opportunities for cost-effective energy savings.
- Voice-Activated Smart Speakers offer utilities an opportunity to increase customer engagement and potentially improve energy savings. Customers want to interact with their utilities through HEMS to receive personalized advice on how to save money and to learn about their energy usage.

3 Market Characterization

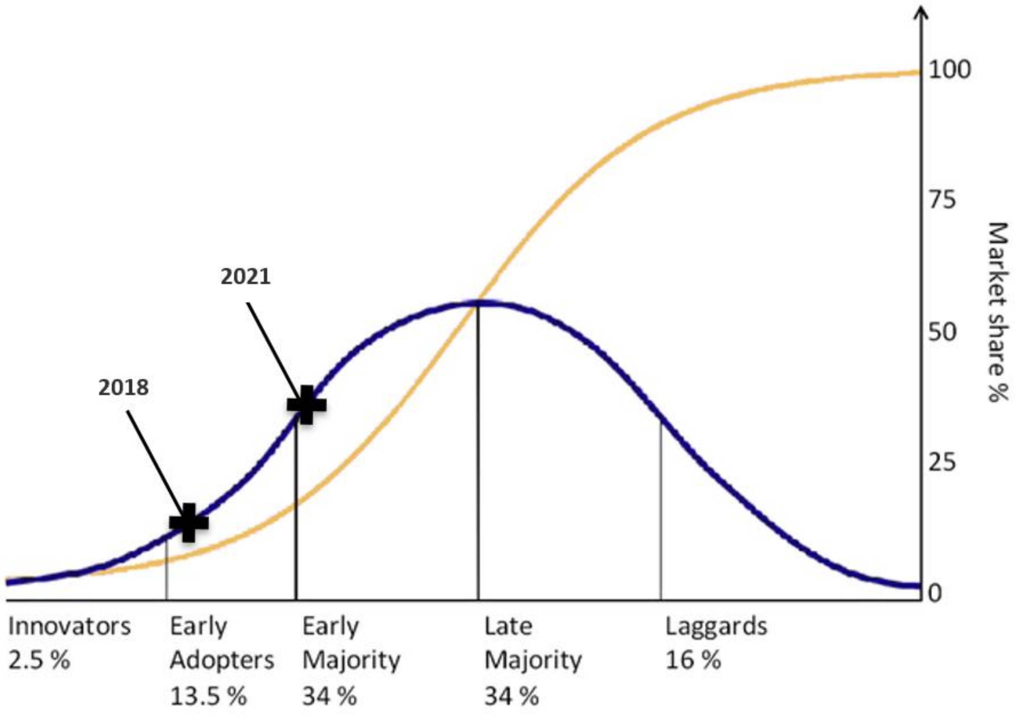
This section describes current market conditions and the supply chain for Connected Home technologies. It also discusses target markets for the technologies and barriers to uptake. The information presented in this section is sourced from literature reviews and interviews with local BC integrators and utilities.

3.1 Current State of the Market

The market for consumer-level Connected Home technologies has grown rapidly in the last few years. In 2018, the market was still in its infancy, with most products available for less than ten years. At the time, all Smart Home devices (both energy related and non-energy related technologies) market penetration levels were assumed to be less than 5%, with revenue and penetration rates projected to grow by roughly 20% every year. [1] The current market penetration level for all Smart Home devices is estimated to be around 27%, with revenue and penetration rates projected to grow by 15% to 18% annually over the next four years. [2]

The adoption of many new technologies follows the Roger's socioeconomic technology adoption curve. With their historic and current market penetration, Smart Home technologies were mapped on the diagram (See Exhibit 9), demonstrating that Smart Home technology has likely moved out of the early adopter's phase and into the early majority phase. The group known as the early majority is interested in the technology but wants cost-effective products that meet their needs. This curve is indicative of the market at large and may be different for British Columbia. Not enough data is available for the region to provide information specific to FortisBC customers.

Exhibit 9 - Current State of Smart Home Technology Adoption

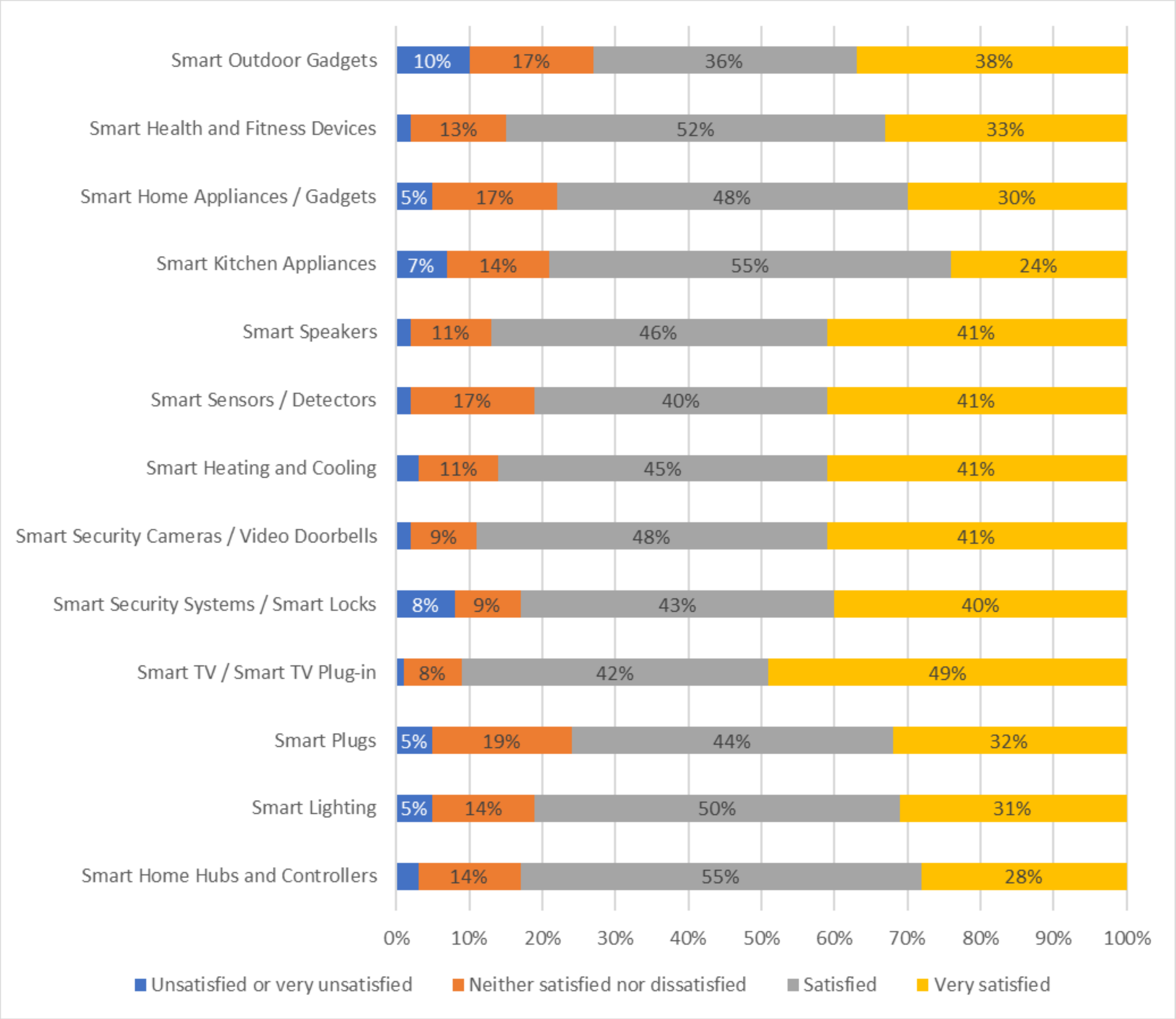


Interviewees and market research identified smart speakers, smart TVs, smart thermostats, and smart lighting as the most common and typically the first technologies installed in Canadian and American homes. A survey by Security.org, a non-profit focused on Smart Home security, interviewed over 600 individuals to better understand Smart Home technology usage, satisfaction, and purchase intent. Exhibit 10 shows the market penetration of Smart Home technologies based on the purchaser's age, and Exhibit 11 shows the customer's satisfaction with the technologies. [15]

Exhibit 10 - Smart Home Technology Market Penetration by Purchaser's Age [15]

	18 - 29	30 - 44	45 - 60	60+
Smart Home Hubs and Controllers	32%	29%	19%	17%
Smart Lighting	32%	39%	20%	22%
Smart Plugs	21%	26%	20%	22%
Smart TV / Smart TV Plug-in	70%	74%	70%	71%
Smart Security Systems / Smart Locks	22%	18%	12%	14%
Smart Security Cameras / Video Doorbells	26%	31%	24%	27%
Smart Heating and Cooling	18%	24%	18%	14%
Smart Sensors / Detectors	15%	17%	11%	14%
Smart Speakers	47%	50%	41%	39%
Smart Kitchen Appliances	15%	15%	9%	9%
Smart Home Appliances / Gadgets	2%	20%	12%	20%
Smart Health and Fitness Devices	28%	26%	20%	18%
Smart Outdoor Gadgets	13%	10%	5%	7%
None of the Above	7%	5%	12%	16%

Exhibit 11 - Customer Satisfaction of Smart Technologies [15]



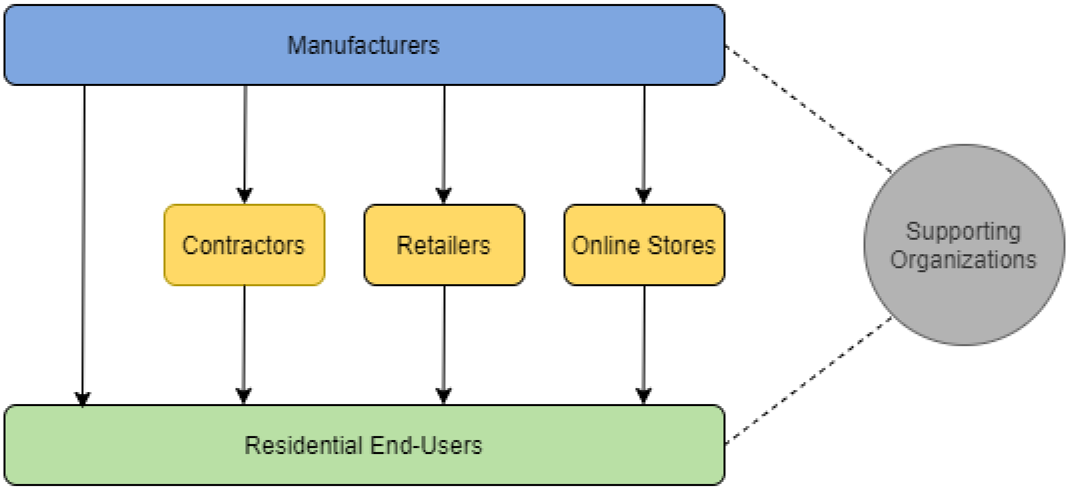
3.2 Supply Chain Structure

Consumer-level Smart Home technologies in British Columbia and the rest of North America are typically distributed through a relatively simple supply chain, illustrated in Exhibit 12.

- End-users typically purchase the products at large retail stores (Walmart, Home Depot, Lowe's, Best Buy, etc.), online stores, or local electronics stores.
- These sellers typically source the products directly from the manufacturer
- Customers typically install products such as lighting, speakers, thermostats, hubs, and power strips on their own. For more complex Smart Home technology, such as smart HVAC zoning systems and smart water heaters, customers typically rely on contractors for installation.

- Some products (e.g. Keen vents, MySmartBlinds) are sold directly to end-users through the manufacturer's website.
- Industry organizations such as CEE and CSA Group support manufacturers in specifications and standards development, and utilities such as BC Hydro and FortisBC support end-users in adopting and testing Smart Home products (e.g. FortisBC's smart thermostat pilot program, BC Hydro's Powerley HEMS pilot).

Exhibit 12 - Supply Chain Structure of Smart Home Tech in British Columbia



3.3 Key Market Actors

3.3.1 Manufacturers

The Connected Home space is constantly evolving and growing; while the frequency of new players has decreased, many new products are still entering the market each year. Exhibit 13 includes a non-exhaustive list of major manufacturers of various Smart Home technologies.

Exhibit 13 - Major Manufacturers of Smart Home Technologies[4]

Technology	Manufacturers
Connected Thermostats	Nest, Ecobee, **Mysa**, Honeywell, Carrier, **Johnson Controls**
Smart Lighting	Philips, **Wyze**, Insteon, IKEA, GE, Osram, **Amazon, Sengled**
Smart Plugs and Power Strips	TP-Link, **Wyze, Amazon**, Belkin, TrickleStar, Embertec
Smart Water Heaters	Rheem, Aquanta, Sears/Kenmore, **GE, Eccotemp**

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[4] Manufacturers that have been added since the previous report are in bold.

Smart Appliances	LG, Samsung, **Whirlpool, Haier**
Smart HVAC Systems	Keen Home, **Johnson Controls**, EcoVent, Flair, Alea Lab, **Dettson, Primex**
Home Hubs	Wink, Samsung, Lowe's, **Logitech, TP-Link, Google**
Home Energy Management Apps	Powerley, Tendril, Smappee, Neurio, Bidgely
Voice-Assisted Enabling Technologies	Amazon, Google, Apple, **Bose**

3.3.2 Distributors / Retailers

Connected Home technologies are typically purchased at large retail stores (Walmart, Home Depot, Lowe's, Best Buy, etc.), online stores, or local electronics stores. The retailers typically procure the items directly from the manufacturers. As a result, the retailers play an essential role in the consumers' decision-making process, as their marketing and shelf-space allocations impact customers' buying decisions. In some cases, the retailers also provide education and installation support to their customers, impacting the level of success customers will have in installing and effectively using the products.

Recently, telecommunication companies have entered the market by making Smart Home security and technology bundles available to their customers. For example, in late 2018, TELUS created their SmartHome Security and Automation Department, which provides its customers with smart security systems and home automation. From interviews with both TELUS and BC Hydro, it appears TELUS had emerged as one of the largest Smart Home and smart security retailers in the BC market.

3.3.3 Supporting Organizations

BC Hydro and FortisBC play an essential role in promoting the energy efficiency benefits of Smart Home technologies in BC, including rebates for smart thermostats and smart plugs in the past.

In the rest of Canada and the US, various organizations support the adoption and standardization of Smart Home technologies. These organizations include but are not limited to the Consortium for Energy Efficiency (CEE), Continental Automated Buildings Association (CABA), Energy Systems Integration Facility (ESIF) at NREL, and Energy Star. The primary roles of these associations in supporting the Smart Home technology market are:

- Developing product specifications and open protocols that manufacturers can use to develop connected technologies and
- Working with utilities and other organizations to quantify savings and benefits of the technologies
- Help establish required energy-saving Smart Home energy management system features designed to deliver cost savings as well as user convenience
- accelerates the efficient transition to future Smart Home energy systems and devices

3.4 Jurisdictional Scan

This section identifies pilot projects implemented by utilities in British Columbia, the rest of Canada, and the US. Smart Home programs have become increasingly popular with utilities, but the design varies based on the program's overall objectives. Most Smart Home projects focus on energy efficiency or demand response but may also include load management facilitation or customer education. Exhibit 14 lists known Smart Home Programs and the program's described purpose. [20]

Exhibit 14 - Smart Home Programs[5]

	Purpose						
Utility	Energy Efficiency	Demand Response	Utility Research	Education	Revenue Generation	Customer Satisfaction	Load Shifting
AEP Ohio (E)	X	X		X			
Alabama Power (E)	X	X	X		X	X	
Alectra Utilities (E)	X	X	X				
BC Hydro (E)	X	X		X			
BGE (E, G)	X			X			
CenterPoint Energy (E, G)	X	X					
ComEd (E)	X	X	X				
Con Edison (E, G)	X	X					
Dominion Energy (E, G)	X				X		

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[5] The subscripts designate the type of energy services provided by the utility. (E) = electric. (G) = natural gas.

DTE Energy (E, G)	X	X		X			
Duke Energy (E, G)	X	X		X	X		
Efficiency Vermont (E)	X	X	X				
Georgia Power (E)	X	X	X		X	X	
Pacific Gas and Electric Co. (E, G)	X	X	X				
Pepco (E)	X	X					
Reliant (E)		X	X	X	X		
Sacramento Municipal Utility (E)	X	X			X		
SDG&E (E, G)		X					
SMECO (E)	X						
Southern California Edison (E)	X		X	X			X
SRP (E)	X						

3.4.1 British Columbia

BC Hydro – Home Energy Management App Pilot

BC Hydro was re-interviewed by the consulting team as part of this study and interviewed for the previous 2018 report. In 2018, BCH was running a Home Energy Management pilot using the Powerly app platform. The pilot program had 600 participants, divided into three groups. One group was given the Powerley app only, showing the customers their smart meter's home energy data. The second group was given the app and a home hub, which allowed the customers access to more granular energy use data in real-time. Finally, the third group had the app, home hub, and several Smart Home technologies, giving the customers control and automation functionality.

The pilot began in the winter of 2017/2018 and ran for more than a year until the end of the next winter season. They compared the energy use between the three groups and received various feedback from customers on their behaviours. The results were that the first two groups, which had more regular access to their energy data but no other Smart Home technologies, saw an average energy savings of 2%. The third group, which had energy use data and several Smart Home technologies, saw energy savings between 5% – 8%. [21]

3.4.2 Canada

Alectra Utilities – Residential Energy Management Program [20]

Alectra Utilities, in Ontario, administered the Residential Energy Management pilot program with Rogers Communications and offered participants packages that included smart thermostats, touch pads, smart plugs, door sensors, and motion sensors. The pilot sought to evaluate energy savings, bill reduction, and customer satisfaction from Smart Home technologies. The project ran from 2015 to 2018 and achieved average electric savings of 1.5% in the summer and 8% in the winter.

Hydro One – Bring Your Own Thermostat Pilot Program [22]

In Ontario in 2015, Hydro One administered a Home Energy Management System – Bring Your Own Thermostat (BYOT) pilot program that was designed to evaluate the demand response and energy efficiency impacts, time-of-use impacts, and cost-effectiveness of smart thermostats. As a result, 1,440 customers were offered incentives for participating in demand response events. The pilot delivered an estimated reduction of 5.5% of average annual gas consumption (0.2 cubic meters per day), which was lower than anticipated. However, customer satisfaction with the pilot and engagement with their smart thermostats was found to be high.

Hydro Ottawa - MiGen Transactive Grid Program [23]

From 2019 to 2020, Hydro Ottawa administered the MiGen Transactive Grid program. It was designed to study how customers use devices relating to Solar Generation, Storage, and Home Energy Management Systems. The project's focus was not on energy savings but the role various devices can play regarding control and flexibility in managing distribution systems, especially when demand fluctuates.

3.4.3 United States

Several US utility companies have various Smart Home technology pilot programs; however, two utilities have launched programs working with builders to create fully-equipped Smart Homes in order to understand the effects on energy consumption and demand.

Alabama Power – Alabama Power's Smart Neighborhood Program

Alabama Power's program is a planned community of single-family homes with all-electric Smart Home devices and appliances. Each home is equipped with the following smart technologies:

- High-efficiency heat pumps and water heaters
- Smart thermostats
- HEM and smart security systems
- Smart refrigerators, dishwashers, washers, and dryers

- Induction cooking ranges
- LED Lighting
- High-efficiency windows

The program's objective is to study how more efficient building codes affect residential load shape, integrate residential distributed energy resources, and how fully equipped Smart Homes affect energy consumption and demand. Unlike a typical rebate program, most of the developments are in the presale phase. Contractors included these efficient features in the construction and price of the home. Homebuyers must agree to participate in a two-year study as part of purchasing the home.

CenterPoint Energy

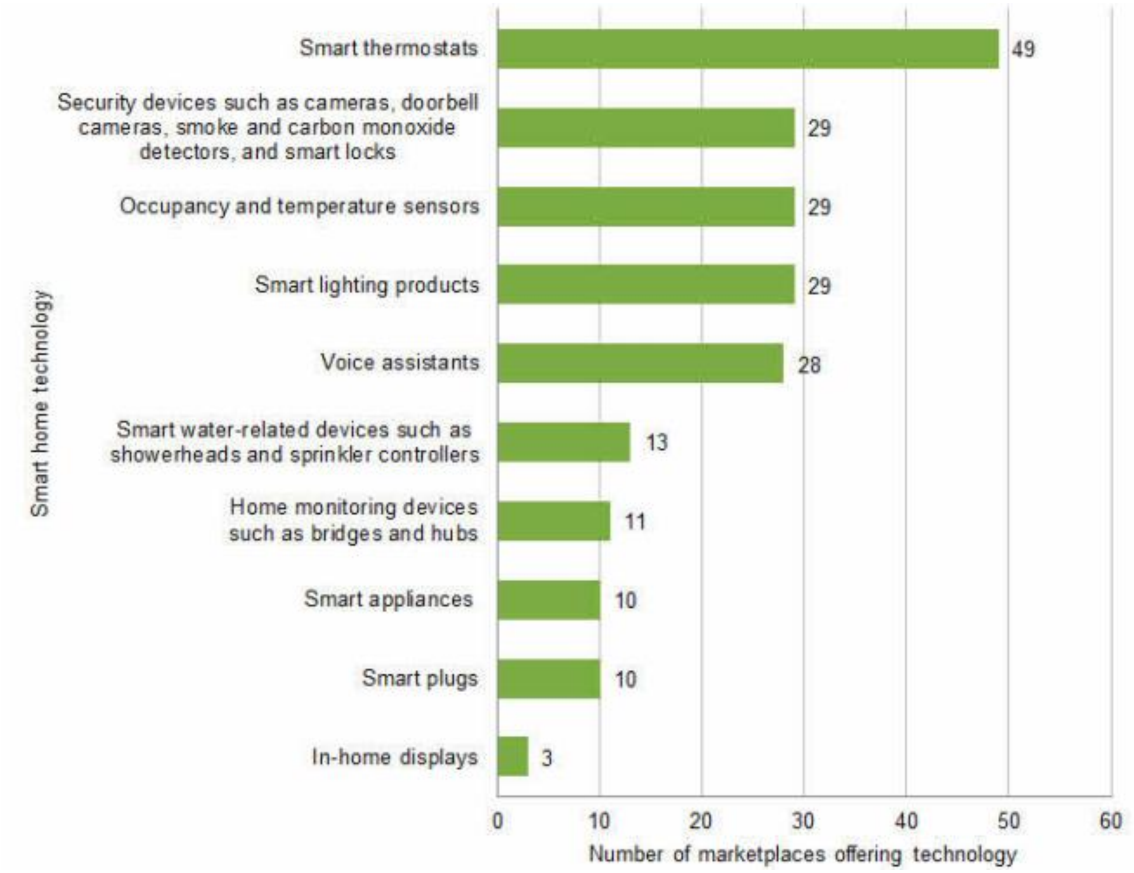
CenterPoint Energy launched a three-phase new-construction Smart Home pilot project. The first phase entailed building 50 homes in 2020, with plans to add 30 more homes in 2021. Builders will outfit the homes with smart technologies and create a pipeline of demand response ready homes. New homes come equipped with a controller, occupancy sensors, smart switches, smart outlets, smart thermostats, smart lamps, smart breaker panels, and an electric vehicle (EV)–ready circuit breaker.

In phase 2, participants will learn how to control their systems, which the utility will monitor throughout the program. Lastly, in phase 3, the utility will evaluate the homes' performance. The utility is hoping to flatten the load curves of participating homes with minimal impact on customer comfort.

Utility Online Marketplaces

Online marketplaces have increasingly become a standard feature offered by utilities. They offer customers a straightforward way to purchase energy-efficient and connected devices. A report by ESource scanned 53 utility marketplaces and found that the most featured connected devices are smart thermostats, sensors, home security devices, and smart lighting. [20] Exhibit 15 shows the full results of the marketplace scan.

Exhibit 15 - Marketplace Scan of 53 US Utilities [20]



3.5 Target Market

Connected Home technologies will best benefit customers who reside in high-energy use (older and larger), single-family homes. To reap the full potential of the products, the ideal customer would not be intimidated by technology and will engage in learning about and using the products. In addition, homes with high vacancy, irregular occupancy schedules, and poor insulation can also realize large energy savings from Smart Home products. The ideal target markets have not changed since the previous study.

3.6 Regulations and Standards

Currently, there are minimal regulations in British Columbia and Canada around Smart Home technology or products that fall under the broader Internet of Things (IoT) category. Any new legal issues have centred around security and privacy. BC Hydro noted several regulatory constraints associated with their Powerley pilot project. Specifically, the interviewee emphasized the need for data to be carefully handled and that customer consent would be explicitly required if their data is to leave Canada and is being stored in the US.

Many of the supporting organizations mentioned earlier have developed standards and testing to help alleviate the general public's concerns about security and privacy and establish energy savings criteria.

CEE has developed optional connected criteria and specifications for various smart devices, including washing machines, room air conditioners, and smart thermostats. Specifications are continually being updated and developed in line with technologies as they advance. The EPA has finalized the development of the ENERGY STAR Smart Home Energy Management Systems (SHEMS) Version 1.0 specification, which establishes required energy-saving SHEMS features designed to deliver cost savings and user convenience. [24]

3.7 Barrier Analysis

In the context of Smart Homes Technologies, a few common challenges continue to act as barriers to widespread adoption. While many of the barriers to adoption remain the same since the last study, two barriers – high capital cost and value proposition – are no longer regularly expressed as barriers to adoption.

The growing market and advances in technology have reduced the capital costs for many Smart Home technologies, making them more affordable for the average consumer. Additionally, more and more customers see the value proposition from a convenience and savings standpoint of Smart Home technologies.

The remaining market barriers are discussed in detail below.

Interoperability

Each connected device uses a default communication protocol and often comes with its own operating platform or application. As a result, customers assessing different components for their Connected Home ecosystems must be aware of the compatibility of each device to ensure that they work together. Interoperability is regularly stated as a barrier in research papers and pilot studies on Connected Home technologies. The issue of interoperability was echoed by interviews conducted as part of this project.

An in-depth analysis of seven popular Smart Home platforms[6] completed by Lockheed Martin Energy found that each device was, on average, compatible with only 12% of other devices. This means that the customer's choice is reduced significantly after their first HEM technology purchase. [25] Almost 75% of consumers who said they plan to purchase a Smart Home device consider it essential that it connects seamlessly to other products in their home electronic network. The report states interoperability demand is stronger than brand loyalty, with fewer than 40% saying it is vital that a future smart device purchase be the same brand as their current products. [3]

Only about 20% of all Smart Devices are compatible with multiple systems (but not all systems). While customers can still buy and operate incompatible products, the user experience suffers as they need to interact with many devices separately and may not leverage all the benefits of products. Recently, manufacturers have focused on increasing compatibility with home hubs and voice-activated smart speakers. Nearly all smart devices can connect with Amazon and Google smart speakers regardless of their protocols.

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[6] Lowes Iris, Belkin WeMo, SmartThings, Nest, Wink, Insteon and Apple HomeKit

Data Ownership

The issue of data ownership is another barrier regularly stated in the literature and by interviewees. In addition, there are legal issues that must be addressed to ensure that customers and utilities are protected from undesirable outcomes resulting from access to their information. Home Energy Management Systems are data-driven; they rely on access to information that certain customers may deem to be sensitive.

Apart from Smart Thermostats, most stand-alone technologies have a limited capacity to record and store data. However, HEMS can present a vulnerability in terms of data security and management. Depending on the type of HEMS used, a customer's information may be shared with an external database without an explicit warning. While customers may be reluctant to provide access to their energy data, product developers are actively seeking out this data to inform future development efforts and validate existing systems' energy savings.

The final report on a HEMS pilot study performed in 2018 by NYSERDA [25] outlines the following recommendations for data management:

Create a database for storing participant data - This database can automate the measurement and validation of energy savings and reduce program evaluation costs.

Provide customers access to data – Access to data can be given in the form of reports and dashboards. These customer engagement resources can produce persistent savings by keeping energy efficiency at the customer's top-of-mind.

Privacy and Security

Concerns about privacy and security are listed among the top obstacles to customer adoption of HEMS. Various surveys found that 65% to 82% of respondents were concerned about keeping their personal information secure. [17], [26] Another 2016 study found that 70% of Smart Home devices used unencrypted network services, and 80% of devices failed to demand a minimum password strength. [17] Recently, many manufacturers have been creating security patch updates to help fight against the latest threats emerging on the market.

These privacy and security issues may discourage specific customers from installing smart devices; however, one survey showed that privacy and security concerns had minimal effect on stopping consumers from buying these devices. The survey found that 70% of consumers had at least one or more connected devices, even with privacy and security concerns. [26]

All interviewees for this project emphasized the importance of ensuring data safety and security to alleviate customer concerns around data privacy and security.

Device Failure and Reliability

Another barrier to the widespread adoption of Smart Home technologies is related to the reliability of these devices. In some cases, product malfunction, system update issues, and connection failures have contributed to the lackluster adoption of Smart Home technologies. By adding more components, smart technologies increase the chance of a part breaking compared to standard technologies.

The use of certified Installers and the provision of installation manuals, FAQs and troubleshooting guides for DIY installers may mitigate this risk.

3.1 Key Takeaways

Key Takeaways

- Market penetration of smart technologies has increased from <5% to 27% since the previous report. Revenue and market penetration rates are projected to grow by 15% to 18% annually over the next four years.
- Recently, telecommunication companies have entered the market by making smart home security and technology bundles available to their customers. Otherwise there has been little change in the supply chain and market actors.
- Since the previous report, there have been many new utility pilot programs established. Many are still ongoing, but some have sufficient data to capture energy savings.
- Interoperability, data ownership, privacy, and reliability all remain potential barriers to consumer adoption; however, capital costs and customer value proposition are no longer significant barriers.

4 Savings, Payback and Potential Assessment

This section summarizes potential energy savings for various Smart Home technologies at both the unit and utility scale.

4.1 Methodology

A modified version of FortisBC's 2021 Conservation Potential Review Study (CPR) model, developed using Posterity Group's Navigator™ Energy and Emissions Simulation Suite, was used to assess consumption and estimate potential savings.

The CPR followed these key steps to perform the analysis:

1. **Determine the current (Base Year) customer base and their energy consumption.**
2. **Develop reference case energy consumption forecast.**
3. **Characterize Connected Homes energy conservation measures.**
    a. Select a set of applicable Smart Home technology measures.
    b. For each measure, review and collect data on energy savings, costs, useful life, and the baseline equipment or technology that it should be compared with (if applicable).
    c. Use the data to characterize the technology's energy savings potential, cost-effectiveness, and financial attractiveness.
    d. Use the data as inputs to the energy model for each sector.
4. **Estimate technical savings potential.**
    a. For each measure, determine its technical applicability (i.e. how many buildings or facilities can this measure be applied to, considering only technical barriers).
    b. Determine the measures' current market penetration (i.e. how many buildings or facilities have already installed a measure).
    c. Estimate the measures' reference adoption – their natural uptake rate in the absence of incentives or utility program intervention.
    d. Input all data into the energy model for each sector and develop a hypothetical estimate of the technically feasible energy savings potential within FortisBC's service territory.
5. **Estimate economic savings potential.**
    a. Screen each measure for cost-effectiveness from FortisBC's perspective by determining whether each measure's benefit to cost ratio is 1.0 or above (pass) or if it is below 1.0 (fail) for two cost-effectiveness tests: TRC and MTRC.
    b. Update the technical potential model with only the TRC-passing measures, removing measures that are not cost-effective.
    c. Estimate the economic savings potential of all cost-effective measures applied to all technically feasible buildings in the customer base.

   d. Repeat steps 5b and 5c using the MTRC screen. This study presents findings from two economic (and subsequent market potential) models: One with TRC as the economic screen and one with MTRC.

6. **Estimate market savings potential.**
   a. Estimate market potential assuming low-, medium- and high-potential scenarios for customer adoption.

The model used the following six measures, or Smart Home technologies, to estimate consumption and potential energy savings:

- Communicating Thermostat
- Smart Water Heaters
- Home Energy Reports
- HVAC Zoning
- Lighting
- Smart Plugs and Power Strips

4.2 Scenarios

This section describes the various scenario considerations developed to capture the effects of Smart Home technologies on energy consumption. This section presents the base year (2019) natural gas use from the 2021 CPR along with the technical, economic, and market scenarios.

4.2.1 Baseline Scenario

For this model, the residential sector is divided into three segments, six regions, and eight housing vintages (See Exhibit 16).

Exhibit 16 - Residential Sector Segments, Regions, and Vintages

	Segments (3)	**Regions (6)**	**Vintages[7] (8)**
Residential Sector	• Single Family Detached/Duplexes • Single Family Attached/Row • Mobile/Other Residential	• Vancouver • Lower Mainland excluding Vancouver • Vancouver Island • Northern BC • Southern Interior • Whistler	• Pre-1950 • 1950-1975 • 1976-1985 • 1986-1995 • 1996-2005 • 2006-2015 • Post-2015 (Existing) • New

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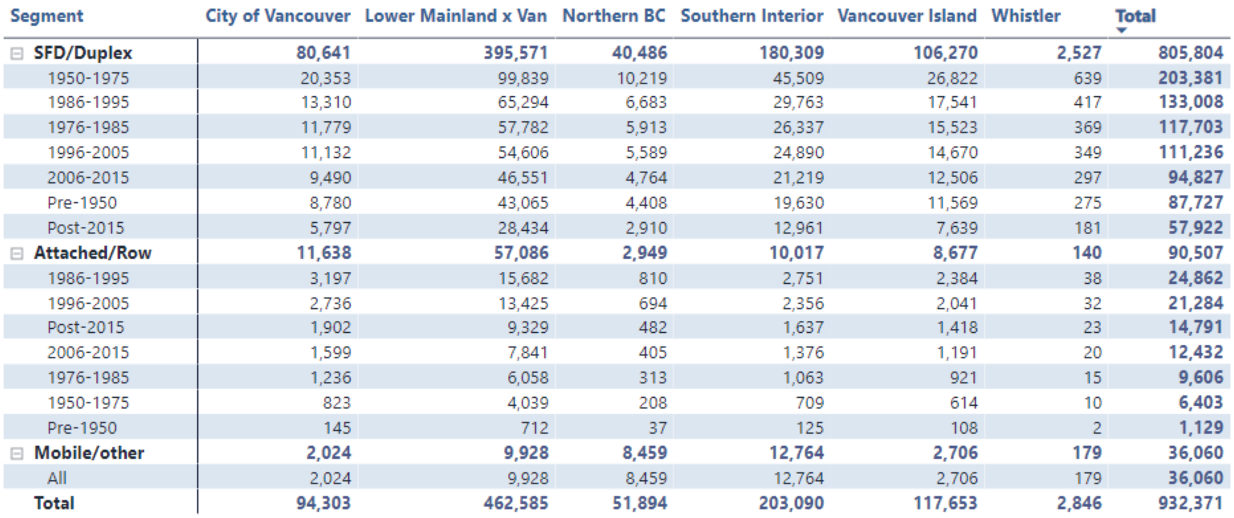
[7] The residential sector has vintages to define time periods when residential dwellings are built. Existence Categories also apply to the residential vintages, as there is conversion of existing dwellings into new homes (i.e., renovations). ‘New’ residential dwellings do not appear until the first year of the reference case.

The number of homes is presented in Exhibit 17 by segment, region, and vintage. As shown in the table, the largest number of residential accounts in 2019 were:

- SFD / duplex type homes (806k out of 933k total)
- In Lower Mainland x Vancouver region (463k out of 933k total)
- Homes built between 1950 and 1975 (210k out of 933k total)

Exhibit 17 - Number of Residential Dwellings in 2019



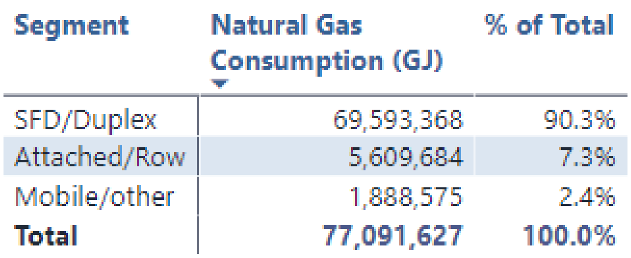
Segment	City of Vancouver	Lower Mainland x Van	Northern BC	Southern Interior	Vancouver Island	Whistler	Total
⊟ **SFD/Duplex**	**80,641**	**395,571**	**40,486**	**180,309**	**106,270**	**2,527**	**805,804**
1950-1975	20,353	99,839	10,219	45,509	26,822	639	**203,381**
1986-1995	13,310	65,294	6,683	29,763	17,541	417	**133,008**
1976-1985	11,779	57,782	5,913	26,337	15,523	369	**117,703**
1996-2005	11,132	54,606	5,589	24,890	14,670	349	**111,236**
2006-2015	9,490	46,551	4,764	21,219	12,506	297	**94,827**
Pre-1950	8,780	43,065	4,408	19,630	11,569	275	**87,727**
Post-2015	5,797	28,434	2,910	12,961	7,639	181	**57,922**
⊟ **Attached/Row**	**11,638**	**57,086**	**2,949**	**10,017**	**8,677**	**140**	**90,507**
1986-1995	3,197	15,682	810	2,751	2,384	38	**24,862**
1996-2005	2,736	13,425	694	2,356	2,041	32	**21,284**
Post-2015	1,902	9,329	482	1,637	1,418	23	**14,791**
2006-2015	1,599	7,841	405	1,376	1,191	20	**12,432**
1976-1985	1,236	6,058	313	1,063	921	15	**9,606**
1950-1975	823	4,039	208	709	614	10	**6,403**
Pre-1950	145	712	37	125	108	2	**1,129**
⊟ **Mobile/other**	**2,024**	**9,928**	**8,459**	**12,764**	**2,706**	**179**	**36,060**
All	2,024	9,928	8,459	12,764	2,706	179	**36,060**
Total	**94,303**	**462,585**	**51,894**	**203,090**	**117,653**	**2,846**	**932,371**

The following exhibits summarize how natural gas is used in the residential sector by segment, vintage, and region.

Natural gas consumption in the residential sector base year is highest:

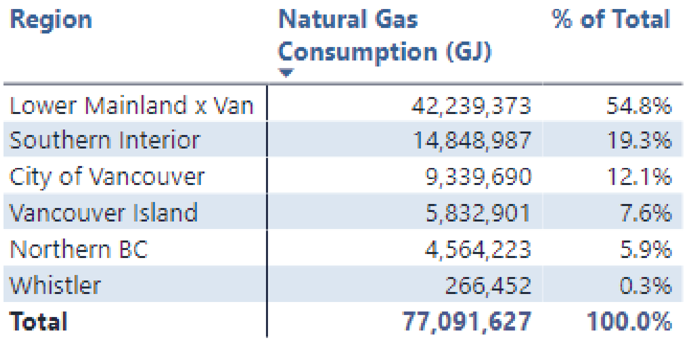
- In single-family detached (SFD)/duplex segment (~90% of consumption)
- In the Lower Mainland excluding Vancouver region (~55%)
- In homes built between 1950 and 1975 (26%)

Exhibit 18 – Residential Natural Gas Consumption (GJ) in 2019 by Segment



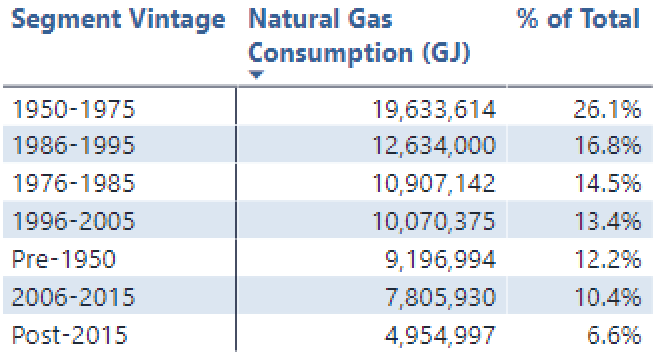
Segment	Natural Gas Consumption (GJ)	% of Total
SFD/Duplex	69,593,368	90.3%
Attached/Row	5,609,684	7.3%
Mobile/other	1,888,575	2.4%
Total	**77,091,627**	**100.0%**

Exhibit 19 – Residential Natural Gas Consumption (GJ) in 2019 by Region



Region	Natural Gas Consumption (GJ)	% of Total
Lower Mainland x Van	42,239,373	54.8%
Southern Interior	14,848,987	19.3%
City of Vancouver	9,339,690	12.1%
Vancouver Island	5,832,901	7.6%
Northern BC	4,564,223	5.9%
Whistler	266,452	0.3%
Total	**77,091,627**	**100.0%**

Exhibit 20 – Residential Natural Gas Consumption (GJ) in 2019 by Vintage



Segment Vintage	Natural Gas Consumption (GJ)	% of Total
1950-1975	19,633,614	26.1%
1986-1995	12,634,000	16.8%
1976-1985	10,907,142	14.5%
1996-2005	10,070,375	13.4%
Pre-1950	9,196,994	12.2%
2006-2015	7,805,930	10.4%
Post-2015	4,954,997	6.6%

4.2.2 Upgraded Scenarios

Six Smart Home technologies were assessed in the model analysis. Exhibit 21 shows the technologies included in this assessment with their estimated energy saving potential. The substantiation of Smart Home technology energy savings has improved since the previous report with real-world data from utility pilot projects.

Exhibit 21 - Technical Conservation Potential of Connected Home Technologies

Technologies	Gas (% Reduction)	Electricity (% Reduction)
Connected Thermostat	Heating - 6%	Cooling - 8%
Smart Lighting		5%
Smart Power Strips		5%
Smart Water Heaters	1%	1%
Smart Zoning Technology	Heating - 10%	Cooling - 15%
Home Energy Reports	1%	1%

The upgraded scenarios are further categorized by their technical, economic and market potentials. Exhibit 22 highlights the differences between technical, economic and market potentials.

Exhibit 22 - Difference Between Technical, Economic, and Market Potential

Constraints	Description	
Technical applicability	Is the measure compatible with the current systems in place in the building or facility? Are there any technical constraints that will prevent installation in specific buildings or facilities? If not, then the measure's hypothetical energy savings can be included in the technical potential. Example: If this is a furnace-related measure, do I have a forced air heating system in my building?	Technical Potential
Cost-Effectiveness	In addition to the technical constraints above: From the utility's perspective, are the energy savings that result from installing the measure financially attractive? Do they provide a return on investment (i.e., the capital and installation costs) based on the economic screen the utility is required to use? If yes, then the measure's hypothetical energy savings can be included in the economic potential.	Economic Potential
Market-related	In addition to the technical and economic constraints above: Are there any constraints related to the market, logistics, or the target customers? Is the measure readily available in the market? Are customers aware of the measure? Realistically, how many customers will have the willingness or interest to install the measure given its costs and benefits? How would the customers' willingness change if the incentives to install these measures increased?	**Market Potential**

Technical and Economic Potential

Technical Potential analysis removes scenarios where installing upgrade measures is not technically feasible. The package of Connected Home tech used in the technical potential analysis includes all devices with energy-saving benefits regardless of cost. Exhibit 23 explains the technical applicability and supporting assumptions of each technology included in the analysis.

Exhibit 23 - Technical Applicability of Smart Home Technology

Technologies	Technical Applicability	Assumptions
Connected Thermostat	87%	Connected thermostats do not work with electric baseboards (~5% of homes) and fireplaces or heater stoves (~5% of homes use this as the main SH source). Several other SH sources (~3%) do not work with connected thermostats. Applicability = 100% - 5% - 5% - 3%= 87%
Smart Lighting	100%	All traditional Lighting can be replaced with smart Lighting[8]
Smart Power Strips	100%	All traditional power strips can be replaced with smart power strips
Smart Water Heaters	86%	Penetration rate of conventional storage-type water heater tanks is 86%.
Smart HVAC Zoning Technology	38%	70% of dwellings have forced air systems, and ~5% have heat pumps. It is assumed that all heat pump systems are central and that half of these dwellings are technically suitable for HVAC zoning controls.
Home Energy Reports	100%	Available for all homes

Economic Potential analysis removes scenarios where installing upgrade measures does not make economic sense. Most Smart Home technologies are likely to be bought as new additions to a household (e.g. smart speakers, hubs, power strips, water heater controllers) and not as a replacement for equipment at its end-of-life. To determine the economic potential benefit/cost ratios were performed to determine the attractiveness of a measure relative to its costs. A measure with a ratio of 1 or higher has benefits that outweigh its costs. Two measure cost tests were used for this study, both expressed as a Benefit/Cost ratio. The results of these tests, the Total Resource Cost (TRC) test and the Modified Total

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[8] The technical applicability is 100% because all lighting can be replaced; however, the Navigator model does not assume all lighting is replaced in the home.

Resource Cost Test (MTRC), can be found in Exhibit 24. All Smart Home technologies but smart water heaters passed the TRC and mTRC tests.

Exhibit 24 - TRC and mTRC Tests for Smart Technologies

Technology	TRC	MTRC
Communicating Thermostat	1.23	5.22
Smart Water Heaters	0.24	0.48
Home Energy Report	1.37	3.20
Smart HVAC Zoning	0.58	2.38
Smart Lighting	3.11	3.57
Smart Plugs and Power Strips	1.99	2.29

Market Potential

The market potential is further divided into the following three achievable potentials based on expected customer participation. The annual participation rate assumptions vary by Smart Home technology and are a combination of qualitative and quantitative research based on cost, expected savings, ease of installation. Participation rate assumptions for the non-thermostat measures were made relative to the communicating thermostat assumptions to reflect relative historical uptake trends, as listed in Exhibit 25.

Exhibit 25 - Participation Rates by Measure

	Annual Participation Rate		
	Low Market Potential	Medium Market Potential	High Market Potential
Communicating Thermostat	5%	10%	15%
Smart Water Heaters	1%	2%	3%
Home Energy Report	2%	4%	6%
Smart HVAC Zoning	1%	2%	3%
Smart Lighting	2.5%	5%	7.5%
Smart Plugs and Power Strips	2.5%	5%	7.5%

4.3 Energy Savings Assessment

Based on the estimates described in previous sections, the following graphs and tables show the results of the various upgraded scenarios.

Exhibit 26 and Exhibit 27 show the predicted natural gas potential savings from 2020 to 2040 when energy savings are created using Smart Home technologies. Natural gas consumption is expected to decrease by approximately 5 million GJ from 2020 to 2040.

Exhibit 26 - Predicted Natural Gas Consumption from 2020 to 2040

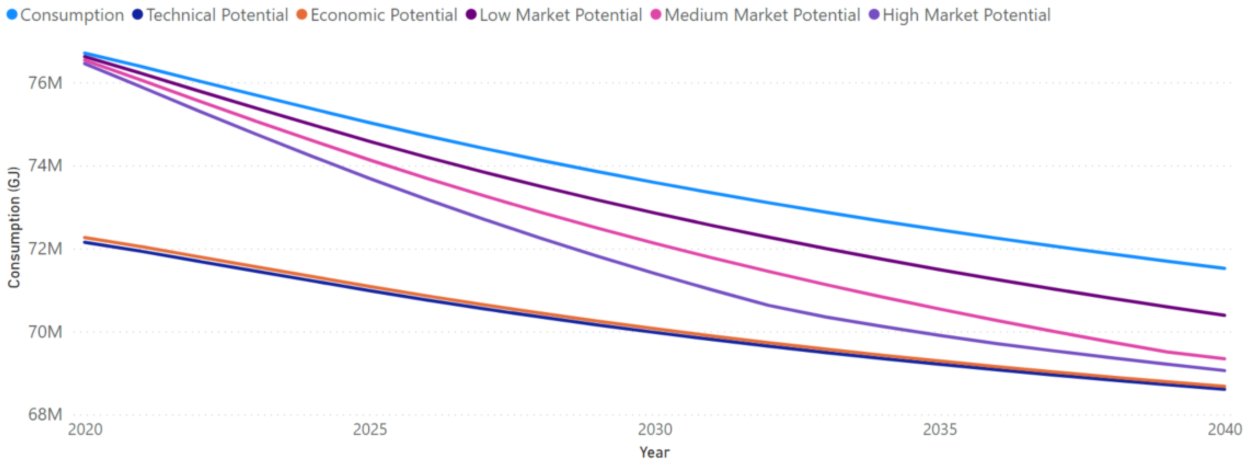


Exhibit 27 - Predicted Natural Gas Savings from 2020 to 2040

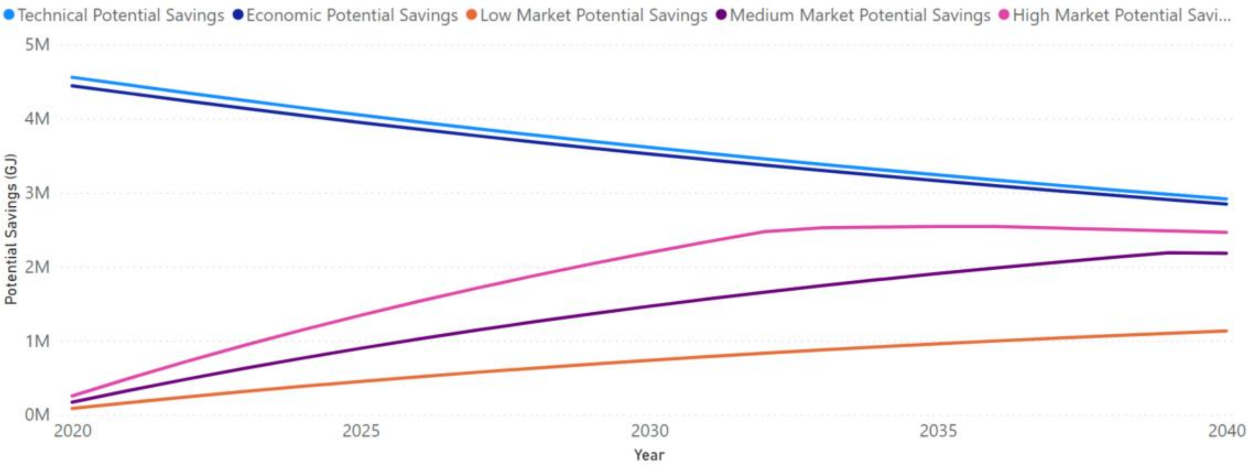


Exhibit 28 and Exhibit 29 show the predicted electricity potential savings from 2020 to 2040 when energy savings are created using Smart Home technologies. Electricity consumption is expected to decrease by approximately 500,000 kWh from 2020 to 2040.

Exhibit 28 - Predicted Electricity Consumption from 2020 to 2040

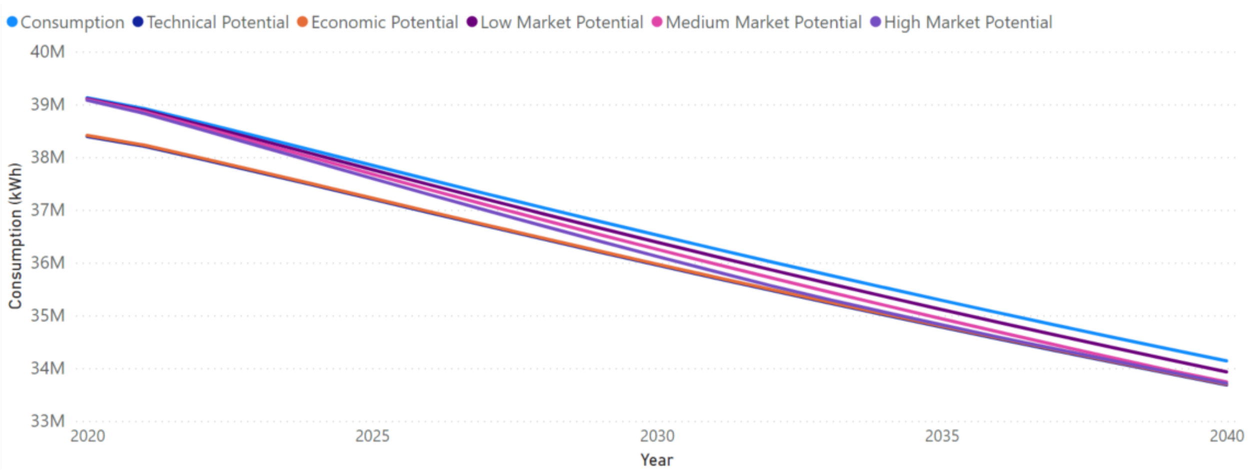


Exhibit 29 - Predicted Electricity Savings from 2020 to 2040

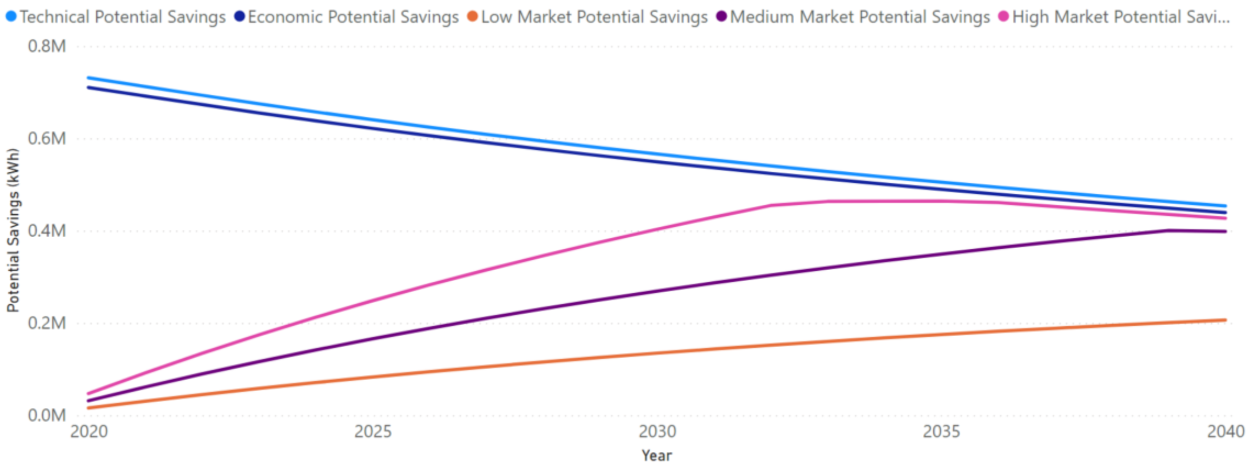
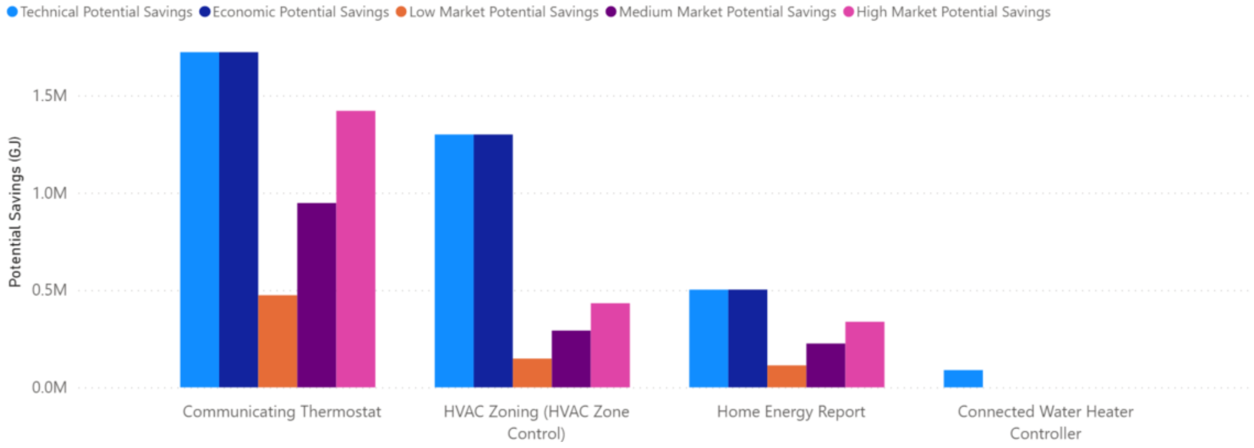


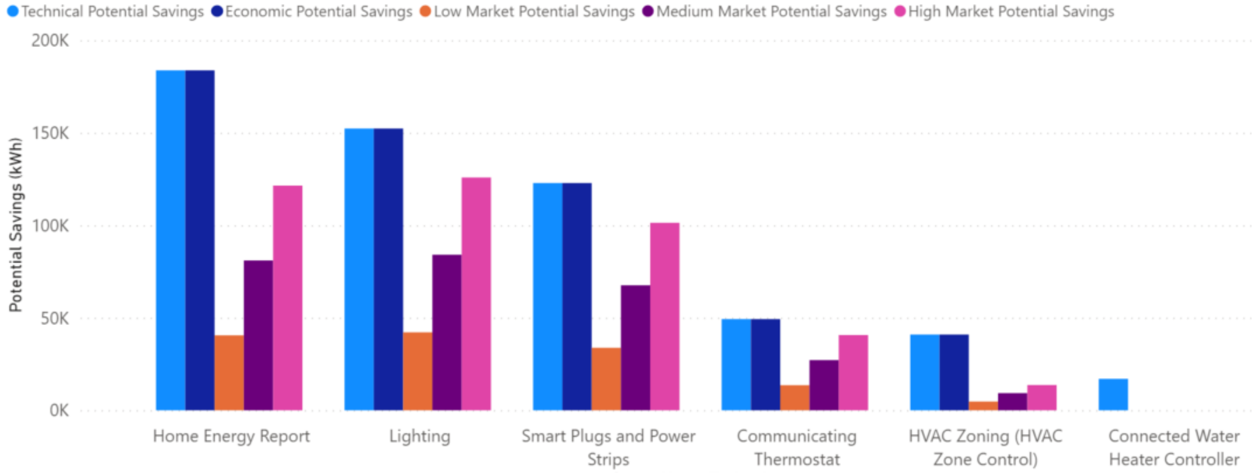
Exhibit 30 and Exhibit 31 show the natural gas and electric potential savings by various Smart Home technologies. The savings are for the year 2030, when the market has matured, and market intervention is assumed to have occurred for several years leading up to this 10-year milestone in the various potential scenarios. For natural gas, connected thermostats, HVAC zoning systems, and home energy reports all show substantial potential savings. While lighting, smart plugs, and home energy reports all show significant potential savings for electricity.

Exhibit 30 - Natural Gas Potential Savings by Smart Home Technology for 2030



Measure	Technical Potential Savings	Economic Potential Savings	Low Market Potential Savings	Medium Market Potential Savings	High Market Potential Savings
Communicating Thermostat	1,721,688	1,721,688	473,445	946,921	1,420,390
HVAC Zoning (HVAC Zone Control)	1,298,954	1,298,881	147,849	291,942	432,227
Home Energy Report	501,785	502,075	112,980	225,338	337,087
Connected Water Heater Controller	88,826	0	0	0	0
Total	**3,611,253**	**3,522,644**	**734,274**	**1,464,201**	**2,189,704**

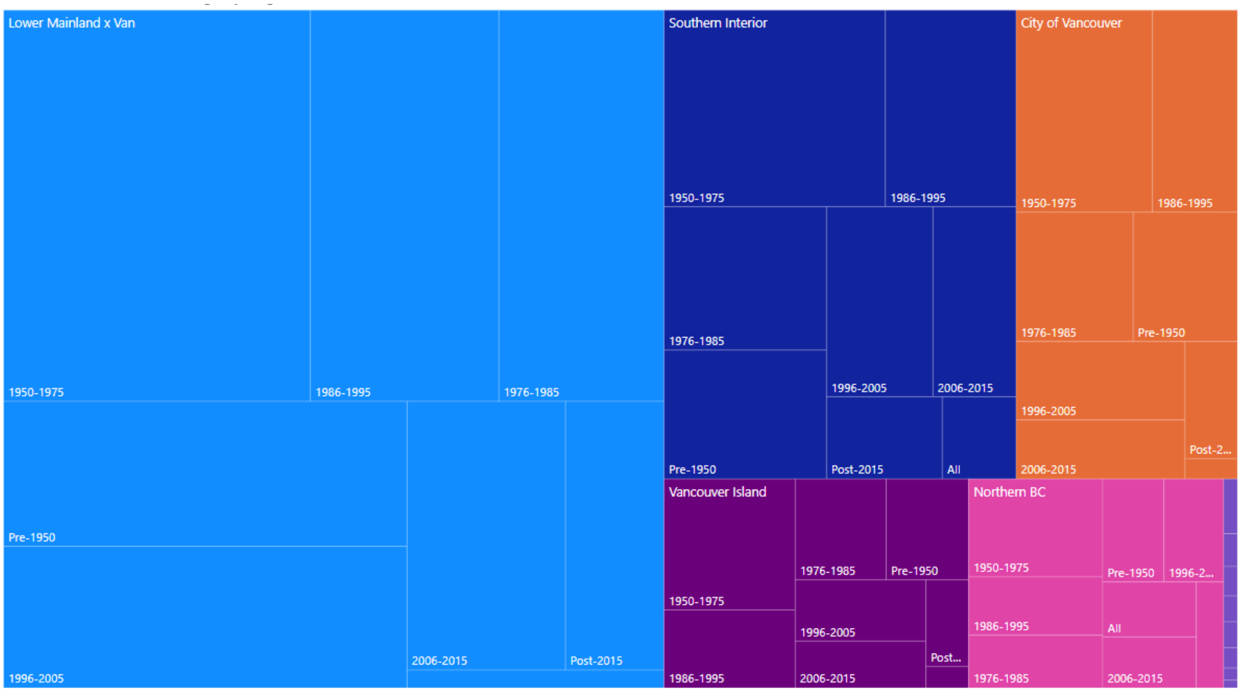
Exhibit 31 - Electricity Potential Savings by Smart Home Technology for 2030



Measure	Technical Potential Savings	Economic Potential Savings	Low Market Potential Savings	Medium Market Potential Savings	High Market Potential Savings
Home Energy Report	183,762	183,763	40,507	80,994	121,463
Lighting	152,328	152,328	42,131	84,084	125,848
Smart Plugs and Power Strips	122,845	122,845	33,779	67,564	101,347
Communicating Thermostat	49,306	49,294	13,556	27,112	40,668
HVAC Zoning (HVAC Zone Control)	40,932	40,931	4,715	9,270	13,662
Connected Water Heater Controller	16,982	0	0	0	0
Total	**566,155**	**549,161**	**134,687**	**269,024**	**402,988**

Exhibit 32 displays the regions and vintages with the most potential savings for natural gas. The “Lower Mainland excluding Vancouver” region and 1950 to 1975 homes have the most potential savings. Similar results were also found for electricity savings. Similar results were found for electricity savings.

Exhibit 32 - Natural Gas Potential Energy Savings by Region and Vintage



The summary of the low market potential scenarios is shown in Exhibit 33. The year 2030 was selected to demonstrate savings as the market will have matured and smart tech adoption would have occurred for several years.

Exhibit 33 - Low Market Potential Savings for 2030

	Natural Gas			Electricity		
	# of Applicable Homes	Annual Savings (GJ)	Annual Savings ($)	# of Applicable Homes	Annual Savings (kWh)	Annual Savings ($)
City of Vancouver	**81,051**	**90,280**	**758,348**	**61,718**	**12,323**	**1,479**
Attached/Row	9,129	7,109	59,718	7,347	1,246	149
Mobile/other	1,235	1,266	10,633	1,563	230	28
SFD/Duplex	70,687	81,904	687,997	52,808	10,847	1,302
Lower Mainland x Van	**397,543**	**391,082**	**3,285,093**	**302,708**	**60,440**	**7,253**
Attached/Row	44,806	30,898	259,542	36,049	6,111	733
Mobile/other	6,060	5,472	45,966	7,666	1,128	135
SFD/Duplex	346,678	354,712	2,979,585	258,992	53,200	6,384
Northern BC	**39,539**	**49,371**	**414,716**	**38,399**	**5,957**	**715**
Attached/Row	2,295	1,761	14,795	1,880	240	29
Mobile/other	5,610	6,291	52,848	7,163	990	119
SFD/Duplex	31,634	41,318	347,073	29,356	4,727	567
Southern Interior	**151,666**	**147,836**	**1,241,822**	**166,719**	**40,367**	**4,844**
Attached/Row	7,444	4,705	39,520	8,435	1,343	161
Mobile/other	7,334	7,492	62,929	11,793	1,898	228
SFD/Duplex	136,888	135,640	1,139,373	146,491	37,126	4,455
Vancouver Island	**88,839**	**53,205**	**446,919**	**83,847**	**15,203**	**1,824**
Attached/Row	6,547	2,577	21,646	5,691	937	112
Mobile/other	2,067	1,044	8,773	2,027	285	34
SFD/Duplex	80,225	49,583	416,500	76,129	13,982	1,678
Whistler	**2,436**	**2,500**	**21,001**	**2,409**	**396**	**48**
Attached/Row	100	82	693	97	9	1
Mobile/other	118	125	1,050	170	20	2
SFD/Duplex	2,218	2,293	19,259	2,141	367	44
Grand Total	**761,074**	**734,274**	**6,167,899**	**655,798**	**134,687**	**16,162**

The summary of the medium market potential scenario is shown in Exhibit 34. The year 2030 was selected to demonstrate savings as the market will have matured and smart tech adoption would have occurred for several years.

Exhibit 34 - Medium Market Potential Savings for 2030

	Natural Gas			Electricity		
	# of Applicable Homes	Annual Savings (GJ)	Annual Savings ($)	# of Applicable Homes	Annual Savings (kWh)	Annual Savings ($)
City of Vancouver	**162,112**	**180,019**	**1,512,158**	**123,440**	**24,624**	**2,955**
Attached/Row	18,267	14,190	119,199	14,697	2,490	299
Mobile/other	2,470	2,532	21,266	3,126	460	55
SFD/Duplex	141,375	163,297	1,371,694	105,617	21,675	2,601
Lower Mainland x Van	**795,097**	**779,783**	**6,550,176**	**605,416**	**120,769**	**14,492**
Attached/Row	89,621	61,620	517,612	72,099	12,213	1,466
Mobile/other	12,120	10,944	91,932	15,333	2,255	271
SFD/Duplex	693,355	707,218	5,940,633	517,985	106,301	12,756
Northern BC	**79,094**	**98,477**	**827,205**	**76,809**	**11,907**	**1,429**
Attached/Row	4,604	3,519	29,557	3,770	483	58
Mobile/other	11,220	12,583	105,696	14,327	1,979	238
SFD/Duplex	63,270	82,375	691,952	58,712	9,445	1,133
Southern Interior	**303,345**	**294,803**	**2,476,348**	**333,440**	**80,540**	**9,665**
Attached/Row	14,900	9,394	78,907	16,872	2,682	322
Mobile/other	14,668	14,983	125,860	23,586	3,794	455
SFD/Duplex	273,776	270,426	2,271,581	292,982	74,064	8,888
Vancouver Island	**177,681**	**106,091**	**891,166**	**167,704**	**30,380**	**3,646**
Attached/Row	13,097	5,139	43,166	11,393	1,872	225
Mobile/other	4,135	2,089	17,546	4,054	569	68
SFD/Duplex	160,449	98,864	830,454	152,257	27,939	3,353
Whistler	**4,899**	**5,028**	**42,233**	**4,853**	**804**	**96**
Attached/Row	212	186	1,559	217	24	3
Mobile/other	236	250	2,100	343	42	5
SFD/Duplex	4,451	4,592	38,574	4,293	737	88
Grand Total	**1,522,227**	**1,464,201**	**12,299,287**	**1,311,663**	**269,024**	**32,283**

The summary of the high market potential scenario is shown in Exhibit 35. The year 2030 was selected to demonstrate savings as the market will have matured and smart tech adoption would have occurred for several years.

Exhibit 35 - High Market Potential Savings for 2030

	Natural Gas			Electricity		
	# of Applicable Homes	Annual Savings (GJ)	Annual Savings ($)	# of Applicable Homes	Annual Savings (kWh)	Annual Savings ($)
City of Vancouver	**243,170**	**269,201**	**2,261,285**	**185,159**	**36,902**	**4,428**
Attached/Row	27,401	21,223	178,277	22,046	3,732	448
Mobile/other	3,706	3,797	31,899	4,689	689	83
SFD/Duplex	212,063	244,180	2,051,109	158,425	32,482	3,898
Lower Mainland x Van	**1,192,646**	**1,166,095**	**9,795,194**	**908,125**	**180,986**	**21,718**
Attached/Row	134,433	92,148	774,047	108,148	18,304	2,197
Mobile/other	18,180	16,416	137,898	22,999	3,380	406
SFD/Duplex	1,040,033	1,057,530	8,883,249	776,977	159,302	19,116
Northern BC	**118,650**	**147,311**	**1,237,411**	**115,219**	**17,844**	**2,141**
Attached/Row	6,910	5,264	44,216	5,660	724	87
Mobile/other	16,830	18,874	158,544	21,490	2,967	356
SFD/Duplex	94,910	123,173	1,034,651	88,069	14,154	1,699
Southern Interior	**455,027**	**440,895**	**3,703,518**	**500,161**	**120,518**	**14,462**
Attached/Row	22,360	14,055	118,063	25,310	4,015	482
Mobile/other	22,003	22,475	188,789	35,378	5,688	683
SFD/Duplex	410,664	404,365	3,396,665	439,473	110,815	13,298
Vancouver Island	**266,521**	**158,661**	**1,332,755**	**251,556**	**45,530**	**5,464**
Attached/Row	19,646	7,686	64,560	17,090	2,806	337
Mobile/other	6,202	3,133	26,319	6,081	853	102
SFD/Duplex	240,674	147,842	1,241,876	228,386	41,871	5,025
Whistler	**7,371**	**7,542**	**63,355**	**7,300**	**1,207**	**145**
Attached/Row	334	292	2,450	344	39	5
Mobile/other	358	375	3,151	515	63	8
SFD/Duplex	6,679	6,876	57,755	6,440	1,104	133
Grand Total	**2,283,385**	**2,189,704**	**18,393,518**	**1,967,521**	**402,988**	**48,359**

Exhibit 36 below summarizes the Connected Home technologies' annual energy and cost savings across the technical, economic, and achievable potentials for electricity and natural gas.

Exhibit 36 - Summary Table of Various Potential Savings Scenarios in 2030

	Natural Gas		Electricity	
	Annual Savings (GJ)	Annual Savings ($)	Annual Savings (kWh)	Annual Savings ($)
Technical Potential	3,611,253	30,334,522	566,155	67,939
Economic Potential	3,522,644	29,590,208	549,161	65,899
Low Market Potential	734,274	6,167,899	134,687	16,162
Medium Market Potential	1,464,201	12,299,287	269,024	32,283
High Market Potential	2,189,704	18,393,518	402,988	48,359

4.4 Cost-Effectiveness Assessment

Total incremental costs for each technology were assumed to be the full cost of the product plus installation. For all technologies, except for smart HVAC zoning systems, the products are typically self installed, and therefore no additional installation costs are needed. All costs were determined via online websites that sell the products in Canada and are shown in Exhibit 37.

Exhibit 37 - Estimated Incremental Costs of Smart Home Devices

Product	Incremental Cost	Product Assumptions
Connected Thermostat	$250	Nest or Ecobee
Smart Bulbs (10 bulbs)	$100	Philips Hue or TECKIN
Smart Water Heater	$240	Aquanta Controller
Smart Power Strip (2)	$100	Embertec or TP-Link
Smart HVAC Zoning	$900	Kenmore Home

Simple payback analysis was performed as part of the cost-effectiveness assessment, which ranged from 4.3 to 16 years for the various scenarios, as described in Exhibit 38. Gas costs of $8.4/GJ and electricity costs of $0.12/kWh were used for the analysis. The payback periods are consistent with New York State Energy Research and Development Authority’s Connected Home pilot study, which estimated the payback period to be between 7 and 12 years. [25]

Payback periods are shortest for existing single-family homes, typically having higher heating and cooling loads than newer homes.

Exhibit 38 - Payback Period for Various Smart Home Technologies

	Communicating Thermostat	Smart Water Heaters	Smart HVAC Zoning	Smart Lighting	Smart Plugs and Power Strips
Attached/Row					
Pre-1950	5.9	13	10.8	4.3	4.6
1950-1975	5.9	13	10.8	4.3	4.6
1976-1985	6.1	14	11	4.4	4.7
1986-1995	6.1	15	11	4.4	4.7
1996-2005	6.7	15	11	4.9	5.1
2006-2015	6.7	15	11.3	4.9	5.1
Post-2015	7	16	11.3	5.1	5.3
SFD/Duplex					
Pre-1950	5.3	13	11.1	3.9	4.2
1950-1975	5.3	13	11.1	3.9	4.2
1976-1985	5.4	14	11.3	3.9	4.2
1986-1995	5.4	15	11.3	3.9	4.2
1996-2005	5.8	15	11.3	4.2	4.5
2006-2015	5.8	15	11.6	4.2	4.5
Post-2015	6	16	11.6	4.4	4.7

4.5 Packages

Two potential packages have been designed using the various smart technologies investigated in this report. The packages combine specific technologies to create energy saving scenarios that FortisBC might utilize. This section reviews how the packages were established, the pros and cons of each package, and includes high-level savings analyses and recommendations for implementation.

4.5.1 Economic Package

The economic package consists of the following smart technologies:

- Communicating thermostat
- Smart lighting
- Smart plugs and power strips
- Home Energy Reports
- Smart Speaker (optional)

This package was created by providing the most “bang for their buck” to the customer. It prioritizes technologies that offer the most energy savings while minimizing costs. The smart technologies that make up this package were determined by the payback period and TRC values (Exhibit 39).

Exhibit 39 - Economic Package Criteria

Technology	TRC	Payback Period
Communicating Thermostat	1.2	5.9
Smart Lighting	3.1	4.3
Smart Plug and Power Strips	2.0	4.6
Home Energy Reports	1.4	5.7
Smart Speaker (optional)	n/a	n/a

The table below (the annual savings potential that can be realized from installing the economic package in the residential sector in FortisBC service areas.

Exhibit 40) presents the annual savings potential that can be realized from installing the economic package in the residential sector in FortisBC service areas.

Exhibit 40 - Economic Package Annual Energy Savings by Home Type

	Gas Savings (GJ)	Electricity Savings (kWh)
Attached/Row	2.5	1530
Mobile/other	2.6	1476
SFD/Duplex	3.6	2149

4.5.2 Performance Package

The performance package consists of the following smart technologies:

- Communicating thermostat
- Smart HVAC Zoning (Type 1)
- Smart Window Coverings
- Motion Sensors
- Home Energy Management System

This package was created by prioritizing energy saving and looks at technology stacking to reduce consumption. It focuses on natural gas heating and electric space cooling as it has the most realized potential for energy savings. It does not include any equipment related to water heating (water heaters, dishwashers, washing machines) as studies have shown smart technologies related to water heating are often negligible due to user behaviour.

The table below (Exhibit 41) presents the annual savings potential that can be realized from installing the performance package in the residential sector in FortisBC service areas.

Exhibit 41 - Performance Package Annual Energy Savings by Home Type

	Gas Savings (GJ)	Electricity Savings (kWh)
Attached/Row	6.8	358
Mobile/other	2.6	175
SFD/Duplex	9.8	855

Package Advantage & Disadvantages

Exhibit 42 highlights the primary advantage and disadvantages of the program options.

Exhibit 42 - Advantages and Disadvantages of Package Options

Package	Advantages	Disadvantages
Economic Package	• Smart devices are likely to have high adoption rates due to short payback periods, low costs, and easy installation. • Smart devices can be self-installed by the customer and would require minimal support from FortisBC. • Smart speakers provide a potential customer engagement opportunity for FortisBC. • Package equipment can be provided by a single installer or set up as “bring your own.”	• The package technologies provide minimal natural gas savings; savings are primarily electric. • As with all smart technologies, customer behaviour plays a role in the effectiveness of energy savings.
Performance Package	• The package creates the largest opportunity for natural gas savings.	• The higher cost and increased installation complexity of the

	• The package can be structured for customers who have already participated in connected thermostat programs. • Home Energy Management Systems (particularly smart speakers) provide a potential customer engagement opportunity for the FortisBC • Potential partnership opportunity with a single installer.	package could result in lower adoption rates. • All smart technologies would need to communicate and work interconnectedly with the HEMS. This may limit the brands that can be used for this package. • As with all smart technologies, customer behaviour plays a role in the effectiveness of energy savings.

Implementation Recommendations

There are two primary considerations for the package implementation: the successful installation and interoperability of the various smart technologies. If the equipment is not installed correctly or does not communicate properly with a HEMS, many potential energy savings may not be realized. To reduce these risks, FortisBC can identify and recommend equipment brands or specifications, work with a single installer, or create a marketplace for the customer to buy necessary smart devices.

5 Utility Risks

This section presents an assessment of risks to future FortisBC market intervention, drawn from the barriers presented in this report and findings from the market actor interviews. Risks are assessed according to FortisBC's Risk Assessment Matrix.

The risk assessment is grouped into two categories: Technical risks and External (market) risks. Two other risk areas included in the Risk Assessment Matrix, organizational risk and project management risk, are not addressed, as these areas would be largely dependent on the design of future market intervention by the utility and by FortisBC's associated resource allocation.

Exhibit 44 assesses the market and technical risks for utility involvement in a Connected Home program. Under each heading, the risk categories outlined in the Risk Assessment Matrix are presented, and the likelihood, severity, and control over these risks are estimated using a 0-5 scale. Specific risks are assigned a ranking according to the guidelines presented in Exhibit 43.

Exhibit 43 – Risk Ranking Guide

Rank	Likelihood	Severity	Control
0	Very Unlikely (<10% likelihood)	No direct impact – i.e., administrative issues	Near-zero control
1	Unlikely (~20% likelihood)	Little impact – i.e., minor delays, small performance shortfall, minor cost impacts	Primarily controlled by others
2	Somewhat Unlikely (~40% likelihood)	Some impact – i.e., significant delays, significant performance shortfall, significant cost overruns	Shared control with FortisBC holding less control than at least one other entity
3	Somewhat Likely (~60% likelihood)	Moderate impact – i.e., threatens program/pilot functionality	Shared control with FortisBC holding more control than any other entity
4	Likely (~80 likelihood)	Major impact – causes reduced program/pilot functionality	Primarily controlled by FortisBC
5	Very Likely (>90% likelihood)	Severe impact – endangers program/pilot viability	Near-total control

Exhibit 44 – Technical and Market Risks Assessment Matrix

Technical Risks						
Risk	Description	Impact	Likelihood	Severity	Control	Notes
Energy Savings	Energy savings have been validated for many smart technologies. User behaviour has been found to play a large role in potential savings.	Expected energy savings could be lower than anticipated.	2	2	1	To capitalize on energy savings a pilot program should focus on: • Homes with the largest potential for energy savings • Integrating user behaviour analytics and education
Interoperability Issues	The first product introduced into a Smart Home can severely limit the compatibility with future additions.	Depending on the program design, homeowners may be left with limited options / selection on which products to bring into their homes.	4	3	3	While interoperability is still a significant issue, many manufactures are working on creating cross-platform interoperability. Program design could consider a Bring-Your-Own-Device approach to allow the market to determine which products to support.
Improper Installation and Integration	Smart Home devices must be correctly installed and integrated with a home's network to unlock the full potential of the technology.	Smart Home devices are not installed / integrated properly, which could result in reduced energy savings.	3	2	4	Tech-savviness can vary widely. To facilitate installation across all levels, FortisBC could take the following approaches: • Self-install • Self-install with remote video assistance • Utility provided installation.

Market Risks						
Risk	Description	Impact	Likelihood	Severity	Control	Notes
Customer Uptake	Customers could demonstrate indifference or resistance to program uptake.	Limited uptake.	2	4	3	Market data shows strong uptake for many smart technologies. Pilot programs should center on established technologies and create incentives for increased adoption of less established technologies.
Customer Behavior	Customers could engage in behaviour that reduces or eliminates energy savings even increases energy consumption.	Energy savings are reduced, eliminated, or energy increases due to the program.	2	5	2	General customer behaviour impacts have been accounted for in newer energy savings data. Behavioural energy conservation education could accompany an incentive program.
Customer Reluctance to Share Data	Customers could be reluctant to participate in a Smart Home program if they are uncertain about what data will be collected and what it will be used for.	Limited uptake.	2	3	3	While privacy is regularly expressed as a concern, new survey data shows it has minimal impact on customer uptake. Potential program details should be clear and transparent regarding what information will be collected and what it will be used for.
Product and Manufacturer Availability	Manufacturers and products are entering and leaving the market.	Products may become obsolete or unsupported by manufacturer.	1	2	2	Market has stabilized, resulting in less risk of unsupported devices. Programs could stay technology-agnostic and opt for the Bring-Your-Own-Device approach.

6 Conclusions and Recommendations

Smart or Connected Home technology is a promising avenue where energy savings, customer engagement and behaviour “nudging” converge. The benefits of Connected Home technologies are best suited for high-energy use (older and larger), single-family homes. To reap the full potential of the products, customers must have frequent and appropriate engagement through a central hub. Utilities can support the deployment of these technologies and influence homeowners by increasing visibility and control of their home’s energy consumption.

Opportunities

Based on the potential and payback analysis, several opportunities for intervention by FortisBC for Connected Home technologies in British Columbia can be highlighted:

- For smart thermostats, lighting, power strips, and HVAC zoning the payback period is less than the lifespan of the technology. These technologies are very attractive (4-5 years) for single-family homes that rely on gas only for domestic hot water and use electricity for space heating and cooling.
- Smart thermostats and HVAC zoning are the most cost-effective gas saving technologies, while lighting and power strips are the most cost-effective electricity saving technologies.
- Home Energy Reports without any additional smart technologies have been shown to create energy savings by creating more opportunities for customers to understand their energy usage and engage with the utility company.
- Various Connected Home Packages can be designed to leverage the previously stated opportunities.
- Older existing single-family homes, which make up for more than half of the housing units in FortisBC’s service area, are the best contenders for gas savings per home and market potential in all regions.
- Demand response and load management functionalities of smart technologies are important benefits for a utility.

Knowledge Gaps

The previous report had several market, technology, and program-related knowledge gaps, many of which have been addressed in this report. Exhibit 45 reviews the knowledge gaps highlighted in the 2018 report and discusses how new information has addressed many gaps.

Exhibit 45 - Addressed Knowledge Gaps

2018 Knowledge Gap	Addressed?	New Information
Due to the lack of substantiated energy savings data for many Smart Home technologies, their energy performance remains uncertain.	Yes	The completion of many pilot projects on Connected Home technologies has led to a better understanding of energy savings. Energy savings were lower than estimated savings based on manufacturer data. This is believed to be primarily due to customer behaviour.
Energy savings from Smart Home technologies will be highly dependent on user behaviour and occupancy patterns of the house. It is unclear if the technologies will result in energy savings or have the opposite effect if end-users focus mainly on the comfort and convenience factors.	Yes	Many pilot projects have released real-world data on the energy savings of many smart technologies. These savings account for any standby load needed to support smart capabilities and the overall impacts of user behaviour on energy savings.
The current market penetration of smart thermostats and other smart technologies in BC is unknown.	Partially Addressed	BC specific market penetration is unknown[9] , but there is now information on market penetration in North America for many individual Smart Home technologies.
Benefits or savings attributed to HEMS apps, hubs, and speakers are uncertain and have not yet been appropriately quantified.	Unable to Address	This is still an area with limited information. BC Hydro has demonstrated that Home Energy Reports have created energy savings without any additional smart technologies. However, benefits, savings, and engagement opportunities specifically related to HEMS apps, hubs and speakers have not been quantified.

The remaining knowledge gaps include:

- Benefits or savings attributed to HEMS apps, hubs, and speakers are uncertain and have not yet been appropriately quantified.
- Quantification of potential demand-response benefits to the utility and residential customers

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[9] Telus Smart Security and Automation department mentioned BC market penetration data during the interview but were unable to provide it for this report.

Recommendations

Following the completion of this prefeasibility study and the high-level potential analysis, we recommend the following options to FortisBC for participating in the Connected Home space:

- Programs and/or rebates should focus on the connected thermostat, which are attractive to the largest number of customers and have the highest adoption rates. Smart Home programs could be developed centred around connected thermostats while potentially giving customers the option to adopt additional technologies or packages of technologies. Alternatively, connected thermostat rebates could be tied into other existing programs/rebates, though this approach would likely make evaluation more difficult
- Design packages focused on specific energy saving or customer needs. Two packages – the economic package and the performance package – are recommended for FortisBC to implement with their customers. The packages focus on stacking technologies to enhance savings. They also have to potential to provide customer engagement opportunities through HEMS.
- Commission or participate in a Bring-Your-Own-Device pilot program to promote smart technology adoption and reduce the risk of interoperability issues for the end-user.
- To increase the likelihood of adoption, multiple-technology rebates could be offered, with higher incentives given if 3 or more are installed.
- Proactively plan for how Smart Home data will be collected, stored, and used. Depending on the structure of a program, customers may choose to share their energy data as part of a program or study. Mitigating their privacy and security concerns can be done by ensuring transparency with end-users and providing customers with the opportunity to review and consent to data sharing agreements.

7 Appendix

7.1 Appendix A - Non-Exhaustive Catalogue of Smart Home Devices[10]

Product	Energy Impact			Fuel Savings		Non-Energy Benefits			DR	Protocol	Readiness in BC
	Gas	Electric	Both	Yes	No	Comfort	Convenience	Safety			
Smart Thermostats											
Carrier WiFi Thermostats https://www.carrier.com/residential/en/us/products/thermostats/wifi-thermostats/			x	x		x	x		x	WiFi	✓
Ecobee Thermostats https://www.ecobee.com/			x	x		x	x		x	WiFi	✓
Honeywell WiFi Thermostats https://yourhome.honeywell.com/en/products/wi-fi-thermostats			x	x		x	x		x	WiFi	✓
Mysa Smart Thermostats https://getmysa.com/?country=CA			x	x		x	x		x	Wifi	✓
Nest Thermostats https://nest.com			x	x		x	x		x	Thread	✓

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[10] Devices that have been added since the previous report are in bold.

Product	Energy Impact			Fuel Savings		Non-Energy Benefits			DR	Protocol	Readiness in BC
	Gas	Electric	Both	Yes	No	Comfort	Convenience	Safety			
Sensibo Sky Thermostats https://sensibo.com/			x	x		x	x		x	WiFi	✓
Tado Smart AC Control https://www.tado.com/ca/		x		x		x	x		x	WiFi	✓
Tado Smart Radiator Thermostats https://www.tado.com/ca/products/smart-radiator-valve			x	x		x	x			WiFi	✓
Wyze Thermostats https://wyze.com/			x	x		x	x		x	Wifi	✓
Home Hubs											
Amazon Echo Show https://www.amazon.ca/Echo-Show-8/			x		x	x	x	x	x	Several	✓
Google Nest Hub https://store.google.com/us/product/google_nest_hub			x		x	x	x	x	x	Several	✓
Hubitat Elevation https://hubitat.com/			x		x	x	x	x	x	Several	✓
Lowe's Iris Hub https://www.lowes.com/pd/Iris-Smart-Hub/1000142105			x		x	x	x	x	x	Several	✗

Product	Energy Impact			Fuel Savings		Non-Energy Benefits			DR	Protocol	Readiness in BC
	Gas	Electric	Both	Yes	No	Comfort	Convenience	Safety			
Samsung SmartThings Hub https://www.samsung.com/us/smart-home/smartthings/			x		x	x	x	x	x	Several	✓
Starling Home Hub https://www.starlinghome.io/			x		x	x	x	x	x	Several	✓
Wink Hub 2 https://www.wink.com/products/wink-hub-2/			x		x	x	x	x	x	Several	✓
Smart Speakers											
Google Home (Google Assistant) https://store.google.com/ca/product/google_home			x		x	x	x	x	x	Thread	✓
Amazon Echo (Alexa) https://www.amazon.ca/Echo-2nd-Generation-Charcoal-Fabric/dp/B0749ZSPN7?th=1&psc=1&source=googleshopping&locale=en-CA&tag=googcana-20&ref=pd_sl_1yc8lv90r0_e			x		x	x	x	x	x	ZigBee	✓
Apple Homepod (Siri) https://www.apple.com/ca/homepod/			x		x	x	x	x	x	AirPlay	✓

Product	Energy Impact			Fuel Savings		Non-Energy Benefits			DR	Protocol	Readiness in BC
	Gas	Electric	Both	Yes	No	Comfort	Convenience	Safety			
Bose Smart Speaker https://www.bose.ca/en_ca/products/speakers/smart_home.html			x		x	x	x	x	x	Wifi	✓
Home Energy Management Apps											
Bidgely (smart meter data disaggregation and energy use reports) http://www.bidgely.com/			x		x		x		x	WiFi	Through Utility
Energy Cost Calculator https://play.google.com/store/apps/details?id=com.sis.EnergyCostCalculator&hl=en_CA&gl=US			x		x		x			Wifi	✓
Neurio (BC company, software and hardware packages) https://www.neur.io/			x		x		x			WiFi	✓
Powerley https://www.powerley.com/			x		x		x			WiFi	✓
Rainforest Automation Eagle-200 (BC company, software and hardware packages) https://rainforestautomation.com/rfa-z114-eagle-200-2/			x		x		x		x	WiFi	✓

Product	Energy Impact			Fuel Savings		Non-Energy Benefits			DR	Protocol	Readiness in BC
	Gas	Electric	Both	Yes	No	Comfort	Convenience	Safety			
Smappee (software and hardware packages) https://www.smappee.com/ca_en/eshop/monitors.html			x		x		x			WiFi	✓
Tendril https://www.tendrilinc.com/			x		x		x		x	WiFi	Through Utility
Wiser https://www.se.com/ca/en/home/smart-home/wiser/wiser-app/			x		x		x		x	Wifi	✓
Smart HVAC Systems											
Alea Labs https://www.alealabs.com/			x	x		x	x			n/a	✗
EcoVent https://www.ecoventsystems.com/			x	x		x	x			ZigBee	✓
Flair https://flair.co/			x	x		x	x			ZigBee	✓
Goodman https://www.goodmanmfg.com/products			x	x		x	x			n/a	✓

Product	Energy Impact			Fuel Savings		Non-Energy Benefits			DR	Protocol	Readiness in BC
	Gas	Electric	Both	Yes	No	Comfort	Convenience	Safety			
Keen Smart Vent System https://keenhome.io/			x	x		x	x			ZigBee	✓
Smart Water Heaters											
Aquanta WH Controller https://aquanta.io/			x	x			x	x	x	WiFi	✓
EcoNet Air and Water Integrated Smart Control by Rheem http://www.rheem.com/EcoNet/Home			x	x			x	x		WiFi	✓
EcoSmart Tankless Water Heaters https://www.ecosmartus.com/products/electric-tankless-water-heater			x	x			x			WiFi	✓
Enovative AutoHot (On-demand hot water recirculation systems) http://www.enovativegroup.com/on-demand-pump-controls-for-homes/			x		x	x	x			n/a	✓
Noritz Connect (WiFi adapter and app that allow wireless control and usage statistics for Noritz water heaters) http://wifi.noritz.com/			x		x	x	x			WiFi	✓

Product	Energy Impact			Fuel Savings		Non-Energy Benefits			DR	Protocol	Readiness in BC
	Gas	Electric	Both	Yes	No	Comfort	Convenience	Safety			
Rheem Smart Water Heater https://www.rheem.com/smartelectric/			x	x						WiFi	✓
Sears / Kenmore https://www.kenmore.com/products/kenmore-smart-water-heater-module/		x		x			x	x		WiFi	✓
Smart Lighting											
GE Link Connected LED https://www.amazon.ca/GE-Wireless-Starter-Connected-Equivalent/dp/B00ZZL5BMG		x		x		x	x	x		ZigBee	✓
IKEA https://www.ikea.com/ca/en/catalog/categories/departments/lighting/36812/		x		x		x	x	x		ZigBee	✓
Insteon https://www.insteon.com/led-bulbs		x		x		x	x	x		ZigBee	✓
Osram https://www.amazon.ca/Sylvania-Smart-Home-Osram-separately/dp/B00R3ID2BG		x		x		x	x	x		ZigBee	✓

Product	Energy Impact			Fuel Savings		Non-Energy Benefits			DR	Protocol	Readiness in BC
	Gas	Electric	Both	Yes	No	Comfort	Convenience	Safety			
Philips Hue https://www2.meethue.com/en-ca		x		x		x	x	x		ZigBee	✓
Sengled https://ca.sengled.com/		x		x		x	x	x		Wifi	✓
TP-Link https://www.tp-link.com/ca/		x		x		x	x	x		Wifi	✓
Wyze https://wyze.com/wyze-bulb.html		x		x		x	x	x		WiFi	✓
Smart Plugs											
Belkin Wemo http://www.belkin.com/us/Products/home-automation/c/wemo-home-automation/		x		x			x	x		WiFi	✓
Currant Smart Outlet https://www.currant.com/smart-outlet		x		x			x	x		Wifi	✓
Embertec http://www.embertec.com/		x		x			x	x		Wifi	✓

Product	Energy Impact			Fuel Savings		Non-Energy Benefits			DR	Protocol	Readiness in BC
	Gas	Electric	Both	Yes	No	Comfort	Convenience	Safety			
TP-Link Smart Plugs https://www.tp-link.com/ca/products/details/cat-5258_HS105.html		x		x			x	x		WiFi	✓
TrickleStar Tier 2 PowerStrip https://www.tricklestar.com/products/t2-advanced-powerstrip.html		x		x			x	x		N/A	✓
Wyze Plugs https://wyze.com/wyze-plug.html		x		x			x	x		Zigbee	✓
Smart Appliances											
GE SmartThinQ Connected Appliances https://www.lowes.ca/articles/how-to-build-a-smart-home-with-lg-smartthinq-appliances_a7634.html			x		x		x	x		WiFi, Bluetooth	✓
LG Smart & Connected Appliances https://www.lg.com/us/discover/thinq			x		x		x	x		WiFi, Bluetooth	✓
Maytag Smart Appliances https://www.maytag.ca/en_ca/connected-appliances.html			x		x		x	x		Wifi	✓

Product	Energy Impact			Fuel Savings		Non-Energy Benefits			DR	Protocol	Readiness in BC
	Gas	Electric	Both	Yes	No	Comfort	Convenience	Safety			
Samsung Connect Home https://www.samsung.com/ca/iot/connect-home-wv530/ET-WV520BWEGCA/			x		x		x	x		WiFi, Bluetooth	✓
Whirlpool Connected Appliances https://www.whirlpool.com/home-innovations/connected-appliances.html			x		x		x	x		WiFi, Bluetooth	✓
Smart Alarms											
Honeywell Lyric Water Leak and Freeze Detector https://yourhome.honeywell.com/en/products/water-alarms/lyric-wi-fi-water-leak-and-freeze-detector		x			x			x		WiFi	✓
Nest Protect Smoke & CO Alarm https://nest.com/ca/smoke-co-alarm/overview/		x			x			x		Thread	✓
Telus Smart Home Security Systems https://www.telus.com/en/smarthome-security		x			x		x	x		Wifi	✓
Wyze Home Monitoring https://wyze.com/home-security-monitoring		x			x		x	x		Wifi	✓

Product	Energy Impact			Fuel Savings		Non-Energy Benefits			DR	Protocol	Readiness in BC
	Gas	Electric	Both	Yes	No	Comfort	Convenience	Safety			
Ancillary Smart Devices											
D-Link DCH-S161 Water Leak Detector https://ca.dlink.com/en/products/dch-s161-mydlink-wi-fi-water-sensor					x			x		Wifi	✓
EKM Smart Sub-Meters https://www.ekmmetering.com/			x		x		x			Ethernet	✓
iGuardStove (Fire Protection) https://iguardfire.com/			x		x			x		WiFi	✓
Remotec ZFM-80 (Smart Switch) https://www.aartech.ca/zfm-80-remotec-zwave-isolated-relay-module.html		X			x		x			Z-Wave	✓
Samsung Smartthings Multipurpose Sensor https://www.samsung.com/ca/smartthings/sensor/smartthings-multipurpose-sensor-gp-u999sjvladb/					x	x	x	x		Zigbee	✓
Wink Door & Window Sensor https://www.homedepot.ca/en/home/p.wink-door--window-sensor.1001096703.html		x			x	x	x	x		Z-Wave	✓

Product	Energy Impact			Fuel Savings		Non-Energy Benefits			DR	Protocol	Readiness in BC
	Gas	Electric	Both	Yes	No	Comfort	Convenience	Safety			
Wink Motion Sensor https://www.homedepot.ca/en/home/p.wink-motion-sensor.1001096704.html			x		x	x	x	x		Z-Wave	✓
ZOOZ Plus 4-in-1 Sensor ZSE40 (Connected device that monitors motion, light, temperature, and humidity) http://www.getzooz.com/zooz-zse40-4-in-1-sensor.html		x			x	x	x	x		Z-Wave	✓

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