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1 **Request IR-1:**

2
3 **Reference: Exhibit N-1, p. 22, lines 13-15.**

4
5 **Has NS Power revised its operational dispatch planning models to consider lagged average**
6 **temperature and wind speed? Please explain.**

7
8 Response IR-1:

9
10 No, the model used for dispatch planning is different from the one used for long-term peak
11 planning as they produce different forecasted outputs (short term hourly vs long term annual), but
12 the inputs are similar. The operation dispatch load forecast model is an artificial neural network
13 model common to the industry. In addition to several years of hourly load pattern history, it has
14 temperature, wind speed and cloud cover (GHI) as input weather forecast variables. Actual load
15 data is input to the model hourly. Typical day-ahead forecast accuracy has an all-hour mean
16 absolute percent error (MAPE) of 2.5 percent.

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1 **Request IR-2:**

2
3 **Reference: Exhibit N-1, pp. 33-37.**

4
5 **(a) Please confirm that NS Power’s forecast for residential heat pump installations**
6 **assumes that customers installing residential heat pumps will remove (or retire)**
7 **existing heating sources. If not confirmed, please provide an example that**
8 **demonstrates how the forecast accounts for continued operation of existing heating**
9 **sources.**

10
11 **(b) Please provide the analysis that demonstrates that the 2023 residential and**
12 **commercial load forecasts consider the following impacts.**

13 **(i) Continued use of electric resistance heating equipment on cold days.**

14 **(ii) Continued use of fossil or wood heating equipment until failure, then**
15 **replacement with heat pumps.**

16 **(iii) For customers who install heat pumps, loads tend to increase because**
17 **customers are keeping their homes warmer in the winter, cooler in the**
18 **summer, and increasing the floorspace coverage in both seasons. Electric**
19 **resistance appear to be taking advantage of the heat pumps to improve**
20 **comfort, resulting in annual load that is “consistent with or slightly greater**
21 **than” customers who have not yet installed heat pumps.¹**

22
23 **(c) Does NS Power believe that additional market interventions are necessary to achieve**
24 **the level of electrification indicated in its load forecast?**

25 **(i) If so, please provide the supporting analysis.**

26 **(ii) If not, please identify how NS Power will support additional market**
27 **interventions.**

¹ Itron, *Cold Climate Heat Pump Load Study* (July 2022), pp. 17-18. Submitted as Appendix A to NS Power, On-Bill Financing Final Report, M09321 (July 21, 2022).

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1 **(iii) Also if not, please provide NS Power’s estimate of gap between existing**
2 **electrification measures and trends and those included in its load forecast as**
3 **necessary to achieve federal and provincial policy goals for electrification.**

4
5 Response IR-2:

6
7 (a) Confirmed.

8
9 (b)

10 (i) The modeling provided by E3 assumes backup heat will be provided by electric
11 resistance heat as the ability of the heat pump to satisfy the heating requirements
12 of a building declines at colder temperatures (due to declining efficiency).

13 (ii) The stock rollover model assumes existing heating equipment is replaced by heat
14 pumps at end of life with backup provided by electric resistance heat.

15 (iii) There is no specific analysis to support the claim that “loads tend to increase
16 because customers are keeping their homes warmer in the winter, cooler in the
17 summer, and increasing the floorspace coverage in both seasons”. The analysis
18 provided by Itron shows that compared to a sample of homes that are in the all
19 electric rate class, those who install heat pumps have loads that are similar to or
20 slightly higher, and Itron states that “In AE homes it is less clear; while the AE
21 sample load is higher than Rate 3, the differences between the two samples are not
22 large enough to attribute higher AE loads to program participation.” As stated on
23 page 20 of the report², “There are significant potential energy cost savings for
24 customers that adopt heat pump technology. Customer behaviour will influence
25 whether customers obtain those energy cost savings. Some customers may choose
26 whether customers obtain those energy cost savings. Some customers may choose
27

² NS Power Annual and Regulated Financial Statements – On-Bill Financing (P701) – Final Report, July 12, 2022 (M09321).

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1 increased comfort over energy cost savings, increasing electricity consumption for
2 cooling in the summer or warmer heating in the winter.”

3
4 (c) For the purpose of the Load Forecast, NS Power has not assumed market interventions to
5 support electrification, but does assume that sales of primary heating equipment is entirely
6 heat pumps starting in 2030. The Company believes that additional market interventions,
7 like the change of Efficiency One’s (EOne) mandate, could encourage increased
8 electrification. On October 21, 2022, the Nova Scotia government announced changes to
9 the Public Utilities Act³ to enable EOne to focus on administering a suite of programs and
10 services that help Nova Scotians transition their energy end uses from fossil fuels to
11 electricity in a manner that reduces green house gases and electricity. Once EOne begins
12 programs and services under its revised mandate, NS Power will start to incorporate the
13 impacts into its future Load Forecast Reports.

14
15 (i) No analysis on the necessity of intervention has been completed.

16
17 (ii) NS Power fully supports electrification initiatives that reduce economy-wide
18 emissions while lowering overall energy costs for Nova Scotians. The Company is
19 currently working with EOne and stakeholders through the DSMAG to better
20 understand what market interventions are most beneficial to Nova Scotians.

21
22 (iii) NS Power has not conducted a gap analysis for the load forecast.

³ https://nslegislature.ca/legc/bills/64th_1st/1st_read/b228.htm

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1 **Request IR-3:**

2
3 **Reference: Exhibit N-1, p. 42, lines 6-9, Figure 30, p. 43, and p. 77, lines 18-19.**

4
5 **(a) Please provide the system-coincident unmanaged peak impact per vehicle for 2022.**
6 **In other words, perform the same calculation for the system peak hour or, ideally, for**
7 **the top ten system peak hours using equivalent EV charging and available vehicle**
8 **counts.**

9
10 **(b) Please confirm that NS Power has used the peak values included in Figure 30 to**
11 **inform its understanding of potential EV charging impacts on its system peak. If not**
12 **confirmed, please explain how NS Power is estimating future EV charging impacts**
13 **on system peak.**

14
15 **Response IR-3:**

16
17 **(a) Please refer to the table below for the top 10 system peak hours using equivalent EV**
18 **charging and available vehicle counts. As discussed on page 41 of the report, charging**
19 **loads in the sample group peak between 11pm and midnight for reasons that would not**
20 **necessarily apply to the larger population and are not reflected in the coincident peak**
21 **estimate of EVs provided in Figure 30.**

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Date/time	Month	Day	Time	System Load [MW]	Total EV Power (kW)	Available Vehicles
1/11/2022 18:00	1	11	18	2215.7	44.57	84
1/11/2022 19:00	1	11	19	2179.25	67.23	84
1/11/2022 20:00	1	11	20	2146.91	81.81	84
1/11/2022 17:00	1	11	17	2138.07	30.26	84
1/12/2022 9:00	1	12	9	2132.43	12.02	84
1/12/2022 10:00	1	12	10	2112.37	39.98	84
2/15/2022 19:00	2	15	19	2112.01	78.11	86
2/16/2022 8:00	2	16	8	2109.01	39.6	86
1/11/2022 21:00	1	11	21	2108.93	67.85	84
1/15/2022 18:00	1	15	18	2104.85	52.2	84

1

2 (b) Confirmed.

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Request IR-4:

Reference: Exhibit N-1, Figure 44 and p. 62, lines 23-25, p. 64, lines 7-12, and p. 65, lines 10-17.

Is the forecast increase in EV charging, commercial electrification of heating, and solar generation being considered in distribution facilities planning? If so, how?

Response IR-4:

Large loads (>1 MW) and generation (>100 kW) such as rooftop solar are evaluated via distribution system impact studies. These studies determine any network upgrades required prior to the new interconnection connecting to the system. The information from these studies is also used in area planning studies, which determine the long-term investments required due to load growth or aging infrastructure.

For new construction and customer connections, revised standards such as updated transformer sizing charts have been developed to account for the increased load from EVs.

Advanced metering infrastructure (AMI) provides a significant new data source and insight into customer loads and generation. Methods are being developed to use this data to enhance modelling and forecasting on the distribution system via incorporation into NS Power's distribution planning modeling software.

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1 **Request IR-5:**

2
3 **Reference: Exhibit N-1, Sections 4.6 and 10.0.**

4
5 **Please confirm that the 2023 Load Forecast Report does not include any projected reduction**
6 **in system peak from time-varying pricing (TVP) rate offerings.**

7
8 **(a) If confirmed, please provide NS Power's forecast for when it will fulfill the**
9 **commitment that its investment in AMI technology would result in a reduction in**
10 **system peak demand, and thus reduce the amount of necessary system peaking**
11 **capacity.**

12
13 **(b) If not confirmed, please confirm that of the top ten peak event periods during the**
14 **2021-2022 winter, the peak hour occurred outside the peak TOU period on four days**
15 **(Feb 6 PM, Jan 22 PM, Feb 25 mid-day, Jan 22 AM) and that three of those days were**
16 **on weekends, and one was mid-day.**

17
18 **(c) Also if not confirmed, please provide the projected reduction in system peak and the**
19 **analysis supporting that projection, including the basis for the peak impact per**
20 **customer (on a TVP tariff) and the number of customers enrolled.**

21
22 **Response IR-5:**

23
24 **(a) Not confirmed.**

25
26 **(b) The top 10 hourly peaks for the 2021/2022 winter period are in the table below. One peak**
27 **occurred on a weekend and one occurred outside the peak period.**

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Date/Time (hour ending)	Peak (MW)	Weekday?	Peak Period?
2022-01-11 18:00	2216	Yes	Yes
2022-01-11 19:00	2179	Yes	Yes
2022-01-11 20:00	2147	Yes	Yes
2022-01-11 17:00	2138	Yes	No
2022-01-12 09:00	2132	Yes	Yes
2022-01-12 10:00	2112	Yes	Yes
2022-02-15 19:00	2112	Yes	Yes
2022-02-16 08:00	2109	Yes	Yes
2022-01-11 21:00	2109	Yes	Yes
2022-01-15 18:00	2105	No	Yes

(c) Demand reduction associated with TVP rates is provided in Figure 56 (Critical Peak Pricing column). Number of customers required to achieve those savings, and the associated peak impact per customer, will be determined at the conclusion of the TVP pilot with the finalized rates.

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1 **Request IR-6:**

2
3 **Reference: Exhibit N-1, Figure 73, p. 94.**

4
5 **Please confirm that the AMI Weather Normalized values use the 2023 Load Forecast method**
6 **(12-hr temperature lag and wind speed). If not confirmed, please describe the method and**
7 **explain why not.**

8
9 **Response IR-6:**

10
11 **Confirmed.**

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1 **Request IR-7:**

2
3 **Reference: Exhibit N-1, Figures 15-17; Exhibit N-1, M10569, Figures 15-17.**

4
5 **Relative to the 2022 Load Forecast Report,**

6
7 **(a) Please explain the substantial decrease in forecast household compensation/income.**

8
9 **(b) Please compare the post-2021 forecasts in residential customers and population, and**
10 **explain any substantial changes.**

11
12 **(c) Please explain why Figure 17 historical data has been revised (all years for new**
13 **construction, since 2020 for household compensation).**

14
15 **(d) Please identify any other historical data that has been revised and provide an**
16 **explanation. (It is not necessary to identify or explain minor adjustments for recent**
17 **years due to, for example, QA/QC.)**

18
19 **(e) Please explain the substantial increase in new construction and household**
20 **compensation forecasts in Figure 17.**

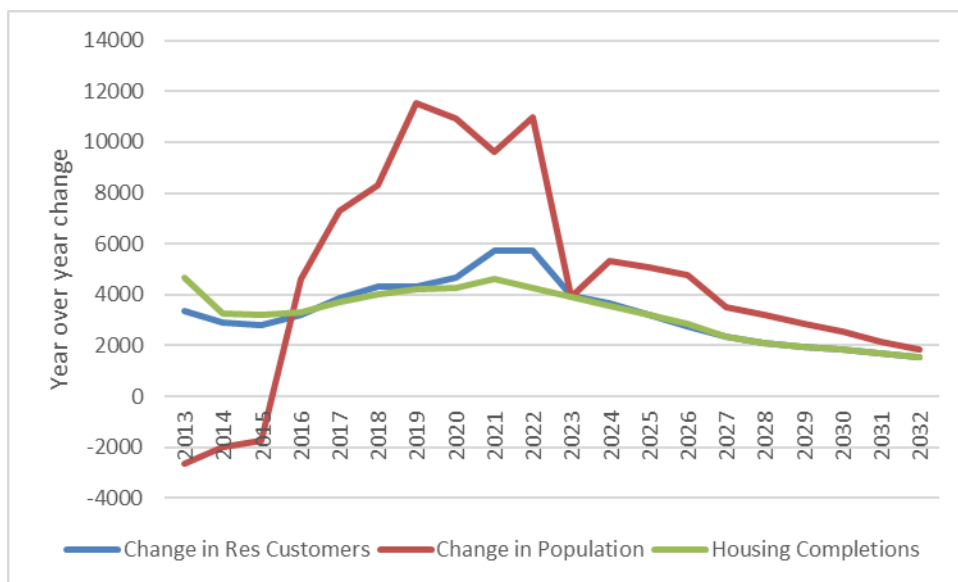
21
22 **Response IR-7:**

23
24 **(a) Please refer to NSUARB IR-4 part (c).**

25
26 **(b) Figure 16 shows the 2023 forecast for change in residential customers and change in**
27 **population. The corresponding figure for the 2022 forecast is shown below:**

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The changes compared to the 2022 forecast include increased population growth and a corresponding increase in housing completions.

(c) Please refer to NSUARB IR-4 parts (b) and (c).

(d) Please refer to NSUARB IR-4 parts (d) and (e).

(e) Please refer to NSUARB IR-4 parts (b) and (c).

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1 **Request IR-8:**

2
3 **Reference: Exhibit N-1, Figure 42; Exhibit N-1, M10569, Figure 40.**

4
5 **Relative to the 2022 Load Forecast Report,**

6
7 **(a) Please explain the substantial increase in the new customer residential sales forecast.**

8
9 **(b) Please explain the substantial increase in the solar impact forecast.**

10
11 **(c) Please explain the shift in forecast DSM attribution from the DSM adjustment to**
12 **DSM captured by end uses.**

13
14 **Response IR-8:**

15
16 **(a) The 2023 customer forecast is driven by increased housing completions compared to the**
17 **2022 forecast report. Please refer to NSUARB IR-4 and CA IR-7.**

18
19 **(b) As discussed on page 44 of the report, the increase in solar installations is a result of recent**
20 **trends, continued rebates, and changes to the commercial net metering program.**

21
22 **(c) The DSM component is consistent with the 2022 forecast. As discussed in Section 4.6 of**
23 **the report, a portion of DSM is captured by the underlying end uses, and this amount is**
24 **reflected in the last column in Figure 42, with the remainder of the forecast DSM savings**
25 **serving as a reduction to load (DSM Adjustment column). As the amount of DSM captured**
26 **by the underlying end uses is determined by the variable coefficient in the regression**
27 **model, the amounts change slightly from year to year.**

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1 **Request IR-9:**

2
3 **Reference: Exhibit N-8, M10569, pp. 4-5; Exhibit N-12, M10569; Exhibit N-1, Attachment 5**
4 **Residential Model.**

5
6 **In his 2022 evidence, Mr. Wilson pointed out potential modeling errors in the residential**
7 **energy model. Mr. Wilson noted that the residential WtXHeat output did not exhibit the**
8 **trend of decreasing Heating Degree Days (HDD).**

9
10 **(a) Please confirm the accuracy of Mr. Wilson's observation that the 2022 residential**
11 **WtXHeat output did not exhibit the trend of decreasing Heating Degree Days (HDD).**
12 **If not confirmed, please provide the analysis that shows otherwise.**

13
14 **(b) Please confirm that NS Power did not respond to this critique in its 2022 rebuttal**
15 **evidence. If not confirmed, please identify the response.**

16
17 **(c) Please confirm that NS Power did not discuss this critique in its 2023 Load Forecast**
18 **Report. If not confirmed, please identify the response.**

19
20 **(d) Please confirm that the 2023 residential WtXHeat output does exhibit a trend of**
21 **decreasing HDD. If not confirmed, please provide the analysis that shows otherwise.**

22
23 **(e) Please describe any changes made by NS Power in its residential load model that**
24 **resulted in the change between the 2022 trend, as referenced in part (a), and the 2023**
25 **trend, as referenced in part (d).**

26
27 **(f) Please state describe any changes made by NS Power to its small general load model**
28 **related to any changes described in part (e).**

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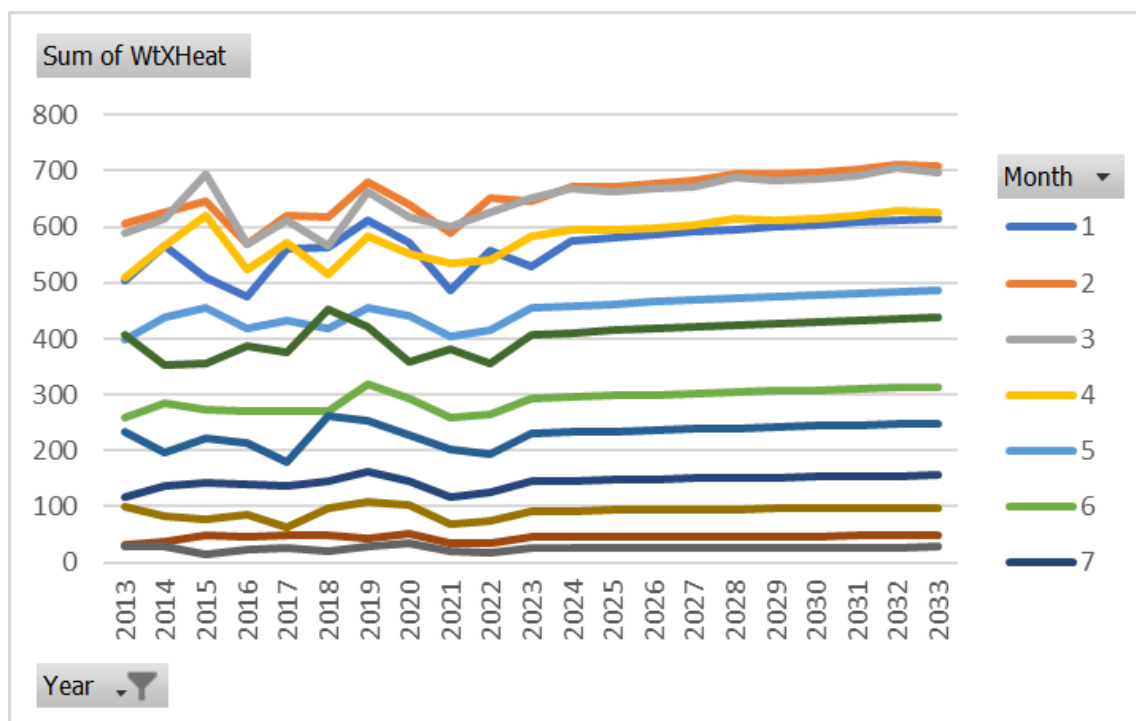
Response IR-9:

(a) Not confirmed. The graph presented by Mr. Wilson shows the overall value of the WtXHeat variable, which includes multiple inputs in addition to HDD such as economics and intensities (which include saturations and efficiencies). An increase or decrease in the overall variable is a result of the changes in all of the underlying components.

(b) Confirmed. Please refer to part (a).

(c) Confirmed.

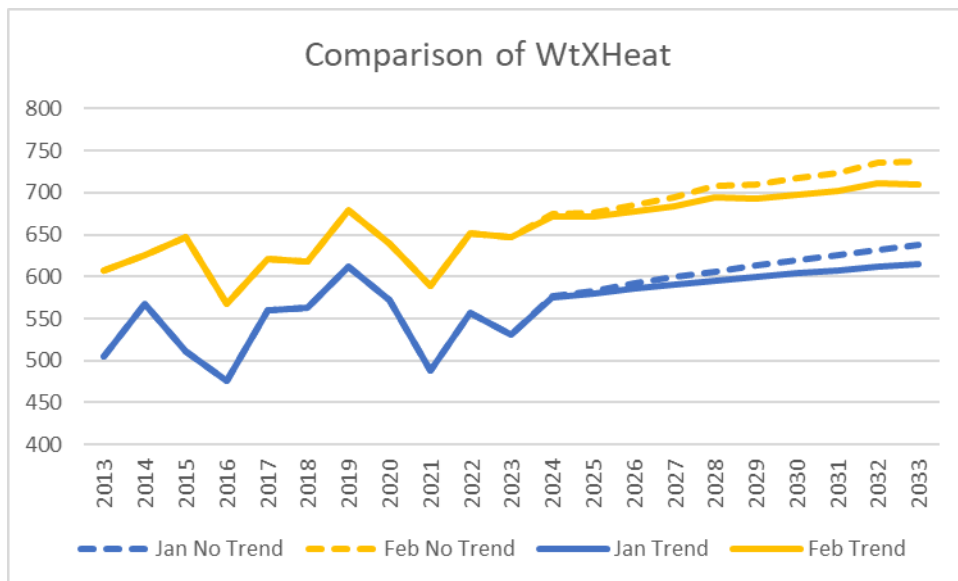
(d) Confirmed. The corresponding graph for the 2023 report is as follows:



If the declining HDD trend is removed, the WtXHeat variable increases as shown in the graph below, which indicates that Mr. Wilson's first observation in this matter is incorrect. However, Mr. Wilson also mentions that "One possible interpretation of these results is

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that the effect of the decreasing number of HDD is almost perfectly offset by additional heat pumps (with a number of other smaller factors also contributing) in the residential customer class and is more than offset by electrification in the small general customer class,” which is, as shown above, the correct interpretation for the behaviour of WtXHeat.



(e) All changes are discussed in the report, the HDD trend is the same as in the 2022 forecast.

(f) All changes are discussed in the report, the HDD trend used in the small general class is the same as in the 2022 forecast and the same as the residential trend.

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Request IR-10:

Reference: Exhibit N-1, Appendix B, pp. 7.

(a) Please confirm that the example calculation of the XHeat value (p. 7) represents the model formula (p. 2). For each of the calculation components below, if not confirmed, please explain how the component is calculated and provide any data that are not included in the filing.

(i) HeatIndex defined by function “g” (p. 2) as the sum of Efurn, HP Heat, Secondary Heat, and Furnace Fans as found in Attachment 1 Residential Intensities, tab “Intensities.”

(ii) HeatUse defined by function “f” (p. 2) as a single variable whose calculation is not supplied in the filing.

(iii) Coefficient defined as “b₁” (p. 2) as an output of the regression calculation (p. 3).

(b) Please confirm that the example calculation of the XCool value (p. 7) represents the model formula (p. 2). For each of the calculation components below, if not confirmed, please explain how the component is calculated and provide any data that are not included in the filing.

(i) CoolIndex defined by function “g” (p. 2) as the sum of Central AC, HP Cool, Room AC as found in Attachment 1 Residential Intensities, tab “Intensities.”

(ii) CoolUse defined by function “f” (p. 2) as a single variable whose calculation is not supplied in the filing.

(iii) Coefficient defined as “b₂” (p. 2) as an output of the regression calculation (p. 3).

(c) Please confirm that the example calculation of the XOther value (p. 7) represents the model formula (p. 2). For each of the calculation components below, if not confirmed,

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1 please explain how the component is calculated and provide any data that are not
2 included in the filing.

3 (i) OtherIndex defined by function “g” as the sum of Water Heat, Cook, Ref/Frz,
4 Wash/Dry, TV, Light, Misc as found in Attachment 1 Residential Intensities,
5 tab “Intensities.”

6 (ii) OtherUse defined by function “f” as a single variable whose calculation is not
7 supplied in the filing.

8 (iii) Coefficient defined as “b₃” as an output of the regression calculation (p. 3).
9

10 (d) If (a-c)(ii) are confirmed, please

11 (i) Explain how HeatUse, CoolUse, and OtherUse are calculated, including an
12 example.

13 (ii) Please provide the models referenced in part (d)(i) and any data that are not
14 included in the filing.

15
16 (e) Please explain why “Dish,” found in Attachment 1 Residential Intensities, tab
17 “Intensities.” is not included in the XOther variable.

18
19 Response IR-10:

20
21 (a)

22 (i) Confirmed.

23
24 (ii) Not confirmed. HeatUse is calculated as

25
$$HeatUse_{y,m} = \left(\frac{HDD_{y,m}}{HDD_{15}} \right) \times \left(\frac{HHSize_{y,m}}{HHSize_{15}} \right)^{HHSizeElas} \times \left(\frac{ResEcon_{y,m}}{ResEcon_{15}} \right)^{HHIncElas} \times \left(\frac{Price_{y,m}}{Price_{15}} \right)^{PriceElas}$$

26
27 Where $HDD_{y,m}$ is the Heating Degree Day¹ for a given month m of the year y ,
28 $HHSize$ is the average household size, $ResEcon$ is Employment Compensation

¹ Throughout the report we use HDD18 which is the largest between 0 and 18-daily average temperature, added to the month. The equation is general enough that HDD base temperature can be changed if necessary.

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divided by House Hold population, *Price* is the price of electricity for the specific customer class. Each variable uses its own elasticity, and the base line year is 2015.

(iii) Not confirmed. Coefficient b_1 is an output of the regression calculation and is given in the table following the quoted text, it is associated to WtXHeat.

(b)

(i) Confirmed.

(ii) Not confirmed. CoolUse is calculated as

$$CoolUse_{y,m} = \left(\frac{CDD_{y,m}}{CDD_{15}} \right) \times \left(\frac{HHSize_{y,m}}{HHSize_{15}} \right)^{HHSizeElas} \times \left(\frac{ResEcon_{y,m}}{ResEcon_{15}} \right)^{HHIncElas} \times \left(\frac{Price_{y,m}}{Price_{15}} \right)^{PriceElas}$$

Where $CDD_{y,m}$ is the Cooling Degree Day² for a given month m of the year y , $HHSize$ is the average household size, $ResEcon$ is Employment Compensation divided by House Hold population, *Price* is the price of electricity for the specific customer class. Each variable uses its own elasticity, and the base line year is 2015.

(iii) Not confirmed. Coefficient b_2 is an output of the regression calculation and is given in the table following the quoted text, it is associated to WtXCool.

(c)

(i) Not confirmed. Dish is also included in the sum.

Please refer to Attachment 1 for monthly multipliers that shape each appliance usage over a 12 month period (different from XHeat and XCool, there is no direct temperature factor that can shape XOther appliances in a year). Referring to the table in the attachment as “*MoMult*” then:

² Throughout the report we use CDD15 which is the largest between 0 and daily average temperature-15, added to the month. The equation is general enough that CDD base temperature can be changed if necessary.

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$$OtherIndex_{y,m} = \sum_{Type} EI_{15}^{Type} \times \frac{\left(\frac{Sat_y^{Type}}{Eff_y^{Type}} \right)}{\left(\frac{Sat_{15}^{Type}}{Eff_{15}^{Type}} \right)} \times MoMult_m^{Type}$$

Where $Type$ is an end-use, Sat_y^{Type} is the saturation (shares) of an end-use of given $Type$ for a particular year y , Eff_y^{Type} is the efficiency of an end-use of given $Type$ for a particular year y , and EI_{15}^{Type} is a reference year (2015) calibration weight per end-use $Type$. The factors:

$$EI_{15}^{Type} \times \frac{\left(\frac{Sat_y^{Type}}{Eff_y^{Type}} \right)}{\left(\frac{Sat_{15}^{Type}}{Eff_{15}^{Type}} \right)}$$

are the annual intensities in the Intensities tab in Attachment 1 - Residential Intensities of the Load Forecast Report for each relevant end-use. For a given month m they need to be multiplied by its own multiplier given in Attachment 1.

(ii) Not confirmed. OtherUse is calculated as

$$OtherUse_{y,m} = \left(\frac{CDays_{y,m}}{30.44} \right) \times \left(\frac{HHSize_{y,m}}{HHSize_{15}} \right)^{HHSizeElas} \times \left(\frac{ResEcon_{y,m}}{ResEcon_{15}} \right)^{HHIncElas} \times \left(\frac{Price_{y,m}}{Price_{15}} \right)^{PriceElas}$$

Where $CDays_{y,m}$ is the number of days for a given month m of the year y , $HHSize$ is the average household size, $ResEcon$ is Employment Compensation divided by House Hold population, $Price$ is the price of electricity for the specific customer class. Each accompanied by its own elasticities. Base line year is 2015.

(iii) Not confirmed. Coefficient b_3 is an output of the regression calculation and is given in the table following the quoted text, it is associated to WtXOther.

(d) Not confirmed. Please refer to the responses for parts (a), (b), and (c) above.

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1 (e) Dish is included in the XOther variable through OtherIndex. Please refer to Attachment 1
2 - Residential Intensities of the Load Forecast Report; all relevant end-uses in the
3 “Intensities” tab add up into major components through the formulas present in the
4 “AnnualIndices” tab. In the AnnualIndices tab the Heating column is part of HeatIndex,
5 Cooling column is part of CoolIndex, and the sum of EWHeat and NonHVAC columns are
6 part of OtherIndex.

Month	EWHeat	ECook	Ref1	Ref2	Frz	Dish	CWash	EDry	TV	Light	Misc	PV
1	0.10	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.10	0.08	0.07
2	0.10	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.08	0.07
3	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.08	0.08
4	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.08	0.09
5	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.10
6	0.08	0.08	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.07	0.08	0.10
7	0.07	0.08	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.07	0.08	0.10
8	0.06	0.08	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.07	0.08	0.09
9	0.07	0.08	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
11	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.08	0.07
12	0.10	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.10	0.08	0.07