

- 1 **Q. Please provide the details of all econometric and other models used to develop the**
2 **two most recent load forecasts. Please include the following in Excel file format,**
3 **where applicable.**
4
- 5 **(a) Model specifications, statistical measures and all source data.**
6
7 **(b) Clearly identify and document the source of all the model data.**
8
9 **(c) All reports associated with those forecasts.**
10
11 **(d) Clearly indicate the extent to which energy efficiency improvements through**
12 **Conservation Demand Management (CDM) programs or “naturally occurring”**
13 **equipment turnover, or related customer response is incorporated into the load**
14 **forecasts.**
15
- 16 **A.** (a) Attachment A to this response provides details of all econometric models, including
17 source data, used to develop Newfoundland Power’s most recent load forecast.
18 Attachment A is available in Excel format on Newfoundland Power’s stranded
19 website at <https://ftp.nfpower.nf.ca>.
20
21 Attachment B to this response provides the results of the April 2018 Customer,
22 Energy and Demand Forecast filed with the Board as part of Newfoundland Power’s
23 *2019/2020 General Rate Application*.
24
- 25 (b) See part (a) above.
26
27 (c) See part (a) above.
28
29 (d) Naturally occurring equipment turnover is embedded in the econometric equations
30 provided in Attachment A to this response. In addition, the econometric models
31 include a variable to account for savings arising from the CDM programs offered to
32 Domestic and General Service customers. Newfoundland Power manually adjusts
33 forecast results to reflect the impact of future CDM programs.

1 Table 1 summarizes the CDM adjustments applied to the Company's most recent
 2 forecast.
 3

Table 1
Conservation Demand Management Programs
Cumulative Forecast Reductions (GWh)

	2018	2019	2020	2021	2022	2023
Domestic Service Rate 1.1	20.1	36.1	32.0	31.9	31.9	31.1
General Service 0-100 kW (110 kVA) Rate 2.1	2.6	5.2	8.1	9.6	9.6	8.5
General Service 110 kVA (100kW)–1000 kVA Rate 2.3	3.3	6.7	10.3	12.2	12.2	10.8
General Service 1000 kVA and Over Rate 2.4	1.4	2.9	4.5	5.4	5.4	4.7
Total	27.4	50.9	54.9	59.1	59.1	55.1

**Econometric Models Relating to
Newfoundland Power's Customer, Energy and Demand Forecast**

Domestic Electric Space Heating Penetration Model

	Penetration Rate	Oil Heating Costs	Electric Heating Costs	Electric / Oil Ratio	Dummy - 2017	Dummy - 2001 - 2017
1991	76.9%	\$1,393.62	\$1,356.70	0.9735	0	0
1992	75.1%	\$1,301.92	\$1,363.18	1.0471	0	0
1993	74.1%	\$1,295.46	\$1,349.42	1.0417	0	0
1994	71.0%	\$1,192.95	\$1,337.70	1.1213	0	0
1995	71.2%	\$1,187.60	\$1,323.17	1.1141	0	0
1996	74.8%	\$1,185.61	\$1,296.42	1.0935	0	0
1997	72.9%	\$1,269.58	\$1,353.52	1.0661	0	0
1998	64.0%	\$1,097.81	\$1,381.00	1.2580	0	0
1999	58.6%	\$1,084.81	\$1,385.55	1.2772	0	0
2000	69.6%	\$1,450.68	\$1,367.40	0.9426	0	0
2001	78.8%	\$1,459.67	\$1,336.81	0.9158	0	1
2002	82.9%	\$1,269.82	\$1,303.72	1.0267	0	1
2003	85.5%	\$1,414.39	\$1,311.06	0.9269	0	1
2004	87.7%	\$1,454.94	\$1,351.19	0.9287	0	1
2005	89.7%	\$1,713.04	\$1,447.60	0.8450	0	1
2006	89.0%	\$1,854.13	\$1,502.27	0.8102	0	1
2007	89.5%	\$1,865.14	\$1,528.74	0.8196	0	1
2008	92.6%	\$2,192.93	\$1,515.99	0.6913	0	1
2009	93.0%	\$1,598.56	\$1,570.60	0.9825	0	1
2010	93.9%	\$1,804.46	\$1,513.10	0.8385	0	1
2011	93.6%	\$2,100.79	\$1,502.83	0.7154	0	1
2012	94.9%	\$2,276.51	\$1,497.40	0.6578	0	1
2013	95.0%	\$2,009.68	\$1,554.03	0.7733	0	1
2014	94.3%	\$2,022.73	\$1,505.91	0.7445	0	1
2015	92.4%	\$1,592.34	\$1,530.56	0.9612	0	1
2016	92.1%	\$1,424.02	\$1,494.70	1.0496	0	1
2017	92.1%	\$1,622.98	\$1,407.01	0.8669	1	1

Source:

- Penetration Rate: Percent of new customers installing electric space heat. Data originates from Newfoundland Power's Customer Service System.
- Oil Heating Costs: Furnace oil prices originate from Statistics Canada. The analysis is based on an equivalent home using 17,000 kWh/yr. for space heating.
- Electricity Heating Costs: Cost of heating a home with electric baseboard. Electricity prices reflect electricity prices approved by the Public Utilities Board. The analysis is based on using 17,000 kWh/yr.
- Electric/Oil Ratio: Electricity Heating Costs divided by Oil Heating Costs
- Dummy 2017: Variable used to reconcile 2017 model estimation to actual.
- Dummy - 2001 - 2017: Variable introduced to reflect increased regulations with respect to furnace oil tanks.

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.934323403
R Square	0.872960222
Adjusted R Square	0.856389816
Standard Error	0.040884986
Observations	27

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	3	0.26418628	0.088062093	52.68188527	1.8403E-10
Residual	23	0.038446387	0.001671582		
Total	26	0.302632667			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	0.995514725	0.079878554	12.46285364	1.03466E-11	0.83027335	1.1607561	0.83027335	1.1607561
Electric / Oil Ratio	-0.262746259	0.072084882	-3.644956491	0.001352417	-0.4118652	-0.1136273	-0.4118652	-0.1136273
Dummy - 2017	0.020955534	0.042151412	0.497149052	0.6238031	-0.0662413	0.10815237	-0.0662413	0.10815237
Dummy - 2001 - 2017	0.132313413	0.023793131	5.560992187	1.17294E-05	0.08309357	0.18153325	0.08309357	0.18153325

Domestic Customer Conversion Model

	Conversions	Oil Heating Costs	Electric Heating Costs	Electric / Oil Ratio	Dummy 2002 - 2004	Dummy 2016
1991	-100	\$1,393.62	\$1,356.70	97.35	0	0
1992	-350	\$1,301.92	\$1,363.18	104.71	0	0
1993	-493	\$1,295.46	\$1,349.42	104.17	0	0
1994	-626	\$1,192.95	\$1,337.70	112.13	0	0
1995	-747	\$1,187.60	\$1,323.17	111.41	0	0
1996	-348	\$1,185.61	\$1,296.42	109.35	0	0
1997	-228	\$1,269.58	\$1,353.52	106.61	0	0
1998	-547	\$1,097.81	\$1,381.00	125.80	0	0
1999	-321	\$1,084.81	\$1,385.55	127.72	0	0
2000	313	\$1,450.68	\$1,367.40	94.26	0	0
2001	260	\$1,459.67	\$1,336.81	91.58	0	0
2002	302	\$1,269.82	\$1,303.72	102.67	1	0
2003	294	\$1,414.39	\$1,311.06	92.69	1	0
2004	243	\$1,454.94	\$1,351.19	92.87	1	0
2005	146	\$1,713.04	\$1,447.60	84.50	0	0
2006	129	\$1,854.13	\$1,502.27	81.02	0	0
2007	283	\$1,865.14	\$1,528.74	81.96	0	0
2008	710	\$2,192.93	\$1,515.99	69.13	0	0
2009	441	\$1,598.56	\$1,570.60	98.25	0	0
2010	275	\$1,804.46	\$1,513.10	83.85	0	0
2011	449	\$2,100.79	\$1,502.83	71.54	0	0
2012	357	\$2,276.51	\$1,497.40	65.78	0	0
2013	402	\$2,009.68	\$1,554.03	77.33	0	0
2014	350	\$2,022.73	\$1,505.91	74.45	0	0
2015	-84	\$1,592.34	\$1,530.56	96.12	0	0
2016	41	\$1,424.02	\$1,494.70	104.96	0	1

Source:

- Conversions: Represents the net number of customers converting to/from electric space heating. Data originates from the analysis of changes in customer usage in Newfoundland Power's Customer Service System.
- Oil Heating Costs: Furnace oil prices originate from Statistics Canada. The analysis is based on an equivalent home using 17,000 kWh/yr. for space heating.
- Electricity Heating Costs: Cost of heating a home with electric baseboard. Electricity prices reflect electricity prices approved by the Public Utilities Board. The analysis is based on using 17,000 kWh/yr.
- Electric/Oil Ratio: Electricity Heating Costs divided by Oil Heating Costs
- Dummy 2016: Variable used to reconcile 2016 model estimation to actual.
- Dummy - 2002 - 2004: Variable introduced to reflect increased conversions related to fuel tank spills.

Note: Forecast is prepared early each spring. Conversion data for the previous year are not known until mid year.

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.850189988
R Square	0.722823016
Adjusted R Square	0.685026154
Standard Error	217.8311749
Observations	26

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	3	2722309.859	907436.6197	19.12388985	2.47831E-06
Residual	22	1043909.256	47450.42074		
Total	25	3766219.115			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>	<i>Upper 95.0%</i>
Intercept	1857.197311	256.7109617	7.23458515	3.00551E-07	1324.811362	2389.583261	1324.811362	2389.583261	2418.605247
Electric / Oil Ratio	-19.61663982	2.684573311	-7.307172332	2.56702E-07	-25.18410411	-14.04917553	-25.18410411	-14.04917553	-11.53342796
Dummy 2002 - 2004	307.1878517	134.1766355	2.289428786	0.032015661	28.92254098	585.4531624	28.92254098	585.4531624	597.9576142
Dummy 2016	242.8378388	224.6468254	1.080976054	0.291415539	-223.0511622	708.7268398	-223.0511622	708.7268398	292.2616784

Domestic Average Use Model (kWh)

	Average Usage	Market Share (t)	Marginal Price Index (t)	Marginal Price Index (t-1)	Income /Customer (t)	CDM Impact	Dum - 2017
1978	11,539	30.3%	87.65	85.11	102.69	1	0
1979	11,882	32.0%	90.70	87.65	103.29	1	0
1980	11,753	33.6%	90.05	90.70	98.02	1	0
1981	12,084	35.5%	86.51	90.05	100.35	1	0
1982	12,062	37.2%	99.64	86.51	100.16	1	0
1983	12,288	38.9%	101.19	99.64	94.69	1	0
1984	12,501	40.7%	106.08	101.19	94.26	1	0
1985	12,588	42.6%	120.93	106.08	96.13	1	0
1986	12,860	44.3%	113.56	120.93	97.50	1	0
1987	13,143	45.8%	110.01	113.56	103.41	1	0
1988	13,671	47.4%	106.28	110.01	107.64	1	0
1989	14,206	48.8%	99.74	106.28	108.71	1	0
1990	14,930	49.8%	97.20	99.74	107.01	1	0
1991	15,147	50.7%	103.90	97.20	103.78	1	0
1992	15,065	51.3%	104.36	103.90	103.97	1	0
1993	15,010	51.6%	103.19	104.36	101.91	1.31	0
1994	14,923	51.8%	102.38	103.19	102.28	1.51	0
1995	14,753	51.8%	100.94	102.38	98.65	1.70	0
1996	14,797	52.0%	99.30	100.94	95.54	2.06	0
1997	14,814	52.3%	104.51	99.30	92.23	2.40	0
1998	14,640	52.7%	105.51	104.51	92.80	2.64	0
1999	14,609	52.6%	106.08	105.51	95.76	2.79	0
2000	14,721	53.1%	104.12	106.08	95.80	2.87	0
2001	14,927	53.8%	102.03	104.12	99.70	3.03	0
2002	15,144	54.6%	100.00	102.03	100.00	3.16	0
2003	15,322	55.5%	100.75	100.00	98.35	3.23	0
2004	15,443	56.5%	105.62	100.75	96.98	3.39	0
2005	15,309	57.4%	111.85	105.62	95.37	3.89	0
2006	15,096	58.2%	115.77	111.85	100.45	4.32	0
2007	15,211	59.1%	116.03	115.77	106.62	5.06	0
2008	15,416	60.2%	117.31	116.03	110.65	5.39	0
2009	15,574	61.3%	118.22	117.31	116.80	5.66	0
2010	15,801	62.4%	116.05	118.22	118.12	6.42	0
2011	15,978	63.4%	116.03	116.05	120.13	8.16	0
2012	15,876	64.5%	116.11	116.03	123.40	10.14	0
2013	16,010	65.5%	118.41	116.11	125.11	11.58	0
2014	16,206	66.4%	115.60	118.41	125.80	13.55	0
2015	16,157	67.1%	117.34	115.60	128.60	16.42	0
2016	15,986	67.8%	112.71	117.34	124.25	20.08	0
2017	15,866	68.5%	109.10	112.71	121.78	26.00	1

Source:

Average Usage:	Weather adjusted average use (kWh) per domestic customer. Data originates from Newfoundland Power's Customer Service System. Weather data provided by Environment Canada.
Market Share (t):	Percent of domestic customers using electricity as their primary space heating fuel. Data originates from Newfoundland Power's Customer Service System.
Marginal Price Index (t):	Index of the real Marginal price of electricity in the current year adjusted for inflation. Based on electricity rates approved by the Public Utilities Board. Consumer Price Index provided by the Conference Board of Canada.
Marginal Price Index (t-1):	Index of the real Marginal price of electricity in the previous year adjusted for inflation. Based on electricity rates approved by the Public Utilities Board. Consumer Price Index provided by the Conference Board of Canada.
Income /Customer (t):	Index of Household Disposable Income per domestic customer in the current year adjusted for inflation. Customer data originates from Newfoundland Power's Customer Service System. Household disposable income and Consumer Price Index is provided by the Conference Board of Canada
CDM Impact:	Index of the impact of Conservation Demand Management Programs on Domestic energy. Data provided by takeCharge
Dummy 2017:	Variable used to reconcile 2017 model estimation to actual.

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.993458103
R Square	0.986959002
Adjusted R Square	0.984587912
Standard Error	175.4885014
Observations	40

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	6	76912967.33	12818827.89	416.2468752	1.26201E-29
Residual	33	1016275.066	30796.21411		
Total	39	77929242.4			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	8615.024468	585.389711	14.71673367	4.67489E-16	7424.040146	9806.00879	7424.040146	9806.00879
Market Share (t)	19533.85564	570.6153518	34.23296548	2.3168E-27	18372.92998	20694.7813	18372.92998	20694.7813
Marginal Price Index (t)	-24.86338961	6.902761437	-3.60194827	0.001025005	-38.90716335	-10.81961588	-38.90716335	-10.81961588
Marginal Price Index (t-1)	-23.48625644	7.29661074	-3.21878983	0.002886157	-38.33132261	-8.641190273	-38.33132261	-8.641190273
Income /Customer (t)	11.52340005	5.035132097	2.288599352	0.028639124	1.279346778	21.76745333	1.279346778	21.76745333
CDM Impact	-93.87171673	13.03310591	-7.202559187	2.94561E-08	-120.3877701	-67.35566338	-120.3877701	-67.35566338
Dum - 2017	271.2292389	268.1456897	1.011499529	0.319136805	-274.3172687	816.7757464	-274.3172687	816.7757464

Rate 2.1 Customer Model

	GS Customers (t)		Domestic Customers (t)	Dummy 2012	Dummy 2017
1983	16887		140,668	0	0
1984	17151	264	143,707	0	0
1985	17311	160	146,655	0	0
1986	17546	235	149,771	0	0
1987	17858	312	153,075	0	0
1988	18171	313	156,907	0	0
1989	18680	509	160,537	0	0
1990	18780	100	164,019	0	0
1991	18954	174	167,217	0	0
1992	18963	9	170,418	0	0
1993	18994	31	172,942	0	0
1994	19137	143	175,797	0	0
1995	19073	-64	177,431	0	0
1996	19175	102	179,375	0	0
1997	19381	206	181,168	0	0
1998	19573	192	182,324	0	0
1999	19495	-78	183,921	0	0
2000	19640	145	185,287	0	0
2001	19660	20	186,828	0	0
2002	19663	3	188,925	0	0
2003	19747	84	191,314	0	0
2004	19901	154	193,912	0	0
2005	20160	259	196,412	0	0
2006	20176	16	198,568	0	0
2007	20335	159	201,045	0	0
2008	20546	211	204,204	0	0
2009	20806	260	207,335	0	0
2010	21025	219	211,091	0	0
2011	21182	157	214,515	0	0
2012	21590	408	218,290	1	0
2013	21798	208	221,995	1	0
2014	22013	215	224,824	1	0
2015	22148	135	227,455	1	0
2016	22334	186	229,815	1	0
2017	22522	188	231,639	1	1

Source:

- GS Customers (t): Rate 2.1 customer data originates from Newfoundland Power's Customer Service System.
- Domestic Customers (t): Domestic customer data originates from Newfoundland Power's Customer Service System.
- Dummy 2012: Variable used to adjust for the movement of Domestic customers to General Service.
- Dummy 2017: Variable used to reconcile 2017 model estimation to actual.

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.994756329
R Square	0.989540154
Adjusted R Square	0.988527911
Standard Error	160.2373772
Observations	35

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	3	75300437	25100145.82	977.571629	9.08667E-31
Residual	31	795956.53	25676.01706		
Total	34	76096394			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	9619.349068	261.11447	36.83958672	3.6786E-27	9086.802601	10151.9	9086.802601	10151.89554
Domestic Customers (t)	0.053806958	0.0014508	37.08748481	3.0014E-27	0.050848008	0.056766	0.050848008	0.056765908
Dummy 2012	278.8910397	102.03324	2.733335021	0.01026452	70.79286616	486.9892	70.79286616	486.9892133
Dummy 2017	159.9700001	175.83863	0.909754589	0.36997146	-198.655249	518.5952	-198.655249	518.5952491

Rate 2.1 Sales Model (MWh)

	GS Sales (t)	GDP-SS (t)	Price 2002\$ (t)	Dummy 2017	CDM (t)	Cust (t)
1984	503,040	7,566	110.29	0	100.0	17,151
1985	520,704	7,770	118.71	0	100.0	17,311
1986	536,728	8,011	115.28	0	100.0	17,546
1987	550,938	8,330	111.28	0	100.0	17,858
1988	575,880	8,646	109.39	0	100.0	18,171
1989	605,489	8,795	102.41	0	100.0	18,680
1990	634,764	8,929	102.84	0	100.0	18,780
1991	636,974	8,841	107.47	0	100.0	18,954
1992	632,676	8,925	110.46	0	100.0	18,963
1993	631,529	8,938	109.34	0	100.0	18,994
1994	632,193	9,082	108.59	0	100.0	19,137
1995	632,321	9,199	107.31	0	100.0	19,073
1996	627,500	8,936	105.88	0	100.0	19,175
1997	638,341	9,149	107.07	0	100.0	19,381
1998	642,535	9,299	107.65	0	100.0	19,573
1999	653,132	9,611	107.92	0	100.0	19,495
2000	662,615	9,824	105.02	0	100.0	19,640
2001	669,835	10,062	101.80	0	100.0	19,660
2002	681,428	10,439	100.00	0	100.0	19,663
2003	690,974	10,684	99.02	0	100.0	19,747
2004	701,161	10,733	103.51	0	100.0	19,901
2005	707,832	11,015	107.18	0	100.0	20,160
2006	710,050	11,232	109.88	0	100.0	20,176
2007	719,173	11,473	108.86	0	100.0	20,335
2008	727,522	11,815	104.99	0	100.0	20,546
2009	731,927	11,944	106.11	0	100.0	20,806
2010	741,176	12,312	102.69	0	100.1	21,025
2011	759,384	12,741	103.40	0	100.5	21,182
2012	767,907	13,041	107.98	0	101.0	21,590
2013	776,221	13,223	106.47	0	101.7	21,798
2014	784,754	13,377	99.46	0	102.6	22,013
2015	794,534	13,661	98.34	0	104.0	22,148
2016	797,115	13,624	90.87	0	106.0	22,334
2017	795,059	13,474	87.72	1	109.0	22,522

Source:

- GS Sales (t): Weather Adjusted Rate 2.1 energy sales. Data originates from Newfoundland Power's Customer Service System. Weather data provided by Environment Canada.
- GDP-SS (t): Service Sector Gross Domestic Product provided by the Conference Board of Canada.
- Price 2002\$ (t): Index of the real Average price of electricity in the current year adjusted for inflation. Based on electricity rates approved by the Public Utilities Board. Consumer Price Index provided by the Conference Board of Canada.
- Dummy 2017: Variable used to reconcile 2017 model estimation to actual.
- CDM (t): Index of the impact of Conservation Demand Management Programs on Rate 2.1 energy. Data provided by takeCharge.
- Cust (t): Number of Rate 2.1 customers. Data originates from Newfoundland Power's Customer Service System.

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.99416
R Square	0.988354105
Adjusted R Square	0.986274481
Standard Error	9464.332062
Observations	34

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	5	2.12852E+11	42570395192	475.25615	3.719E-26
Residual	28	2508060279	89573581.39		
Total	33	2.1536E+11			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>ower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	651107.0184	220990.0672	2.946318025	0.0064124	198429.39	1103784.7	198429.4	1103784.65
GDP-SS (t)	6.854555227	4.181843139	1.639122989	0.1123771	-1.711562	15.420673	-1.71156	15.42067258
Price 2002\$ (t)	-1261.994648	474.7133588	-2.658435085	0.0128301	-2234.401	-289.58841	-2234.4	-289.5884139
Dummy 2017	18190.12508	15589.73519	1.166801415	0.2531322	-13744	50124.25	-13744	50124.24999
CDM (t)	-9067.638276	1806.947467	-5.018208024	2.639E-05	-12769	-5366.2742	-12769	-5366.27418
Cust (t)	50.28334244	5.9124743	8.504619198	3.022E-09	38.172188	62.394497	38.17219	62.39449702

**Customer, Energy and Demand Forecast
April 2018**