

**Exh. JL-5**  
**Dockets UE-170033/UG-170034**  
**Witness: Jing Liu**

**BEFORE THE WASHINGTON  
UTILITIES AND TRANSPORTATION COMMISSION**

**WASHINGTON UTILITIES AND  
TRANSPORTATION COMMISSION,**

**Complainant,**

**v.**

**PUGET SOUND ENERGY,**

**Respondent.**

**DOCKETS UE-170033 and  
UG-170034 (*Consolidated*)**

**EXHIBIT TO  
TESTIMONY OF**

**Jing Liu**

**STAFF OF  
WASHINGTON UTILITIES AND  
TRANSPORTATION COMMISSION**

*Output of Gas Temperature Normalization Models Using Ten Year Data*

**June 30, 2017**

## Output of Natural Gas Temperature Normalization Models Using Ten Year Data

**Dependent Variable: R23UPC**

Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)

Date: 06/01/17 Time: 11:04

Sample (adjusted): 2007M02 2016M12

Included observations: 119 after adjustments

Convergence achieved after 7 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	20.67277	1.860334	11.1124	0
JAN*HDD65	0.140115	0.004151	33.75154	0
FEB*HDD65	0.132474	0.004915	26.95571	0
MAR*HDD65	0.121936	0.004891	24.93314	0
APR*HDD65	0.097543	0.006071	16.06634	0
MAY*HDD65	0.072628	0.009072	8.00585	0
JUN*HDD65	0.039712	0.013705	2.897528	0.0046
SEP*HDD65	0.061756	0.017081	3.615568	0.0005
OCT*HDD65	0.094635	0.00706	13.40508	0
NOV*HDD65	0.133222	0.004906	27.15475	0
DEC*HDD65	0.136416	0.00382	35.71413	0
AR(1)	0.43816	0.090102	4.862934	0
R-squared	0.974643	Mean dependent var		65.7038
Adjusted R-squared	0.972037	S.D. dependent var		39.80323
S.E. of regression	6.655995	Akaike info criterion		6.724299
Sum squared resid	4740.343	Schwarz criterion		7.004547
Log likelihood	-388.0958	Hannan-Quinn criter.		6.838099
F-statistic	373.8917	Durbin-Watson stat		2.151899
Prob(F-statistic)	0			
Inverted AR Roots	0.44			
MAPE	7.593144			

passed chow test

Chow Breakpoint Test: 2012M01

Null Hypothesis: No breaks at specified breakpoints

Equation Sample: 2007M02 2016M12

F-statistic	0.889284	Prob. F(12,95)	0.5604
Log likelihood ratio	12.66844	Prob. Chi-Square(12)	0.3936
Wald Statistic	10.09429	Prob. Chi-Square(12)	0.6077

**Dependent Variable: C31UPC**

Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)

Date: 06/22/17 Time: 09:40

Sample (adjusted): 2007M02 2016M12

Included observations: 119 after adjustments

Convergence achieved after 7 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-72.72542	79.3214	-0.916845	0.3613
JAN*HDD65	0.535239	0.019027	28.13072	0
FEB*HDD65	0.521429	0.02261	23.06185	0
MAR*HDD65	0.475447	0.022562	21.07277	0
APR*HDD65	0.370699	0.028158	13.1648	0
MAY*HDD65	0.292084	0.042419	6.885624	0
JUN*HDD65	0.147718	0.064779	2.280327	0.0246
SEP*HDD65	0.180134	0.080644	2.2337	0.0276
OCT*HDD65	0.325923	0.032952	9.890917	0
NOV*HDD65	0.482597	0.022678	21.28006	0
DEC*HDD65	0.536172	0.017462	30.70457	0
RETAILWHOLESALEEMP	0.760085	0.281773	2.697512	0.0081
AR(1)	0.401859	0.08918	4.506141	0

R-squared	0.963505	Mean dependent var	309.6553
Adjusted R-squared	0.959373	S.D. dependent var	154.4686
S.E. of regression	31.1349	Akaike info criterion	9.817339
Sum squared resid	102754.5	Schwarz criterion	10.12094
Log likelihood	-571.1317	Hannan-Quinn criter.	9.940622
F-statistic	233.206	Durbin-Watson stat	2.201645
Prob(F-statistic)	0		

Inverted AR Roots	0.4
MAPE	7.455767

passed chow test

Chow Breakpoint Test: 2012M01

Null Hypothesis: No breaks at specified breakpoints

Equation Sample: 2007M02 2016M12

F-statistic	1.336485	Prob. F(13,93)	0.2065
Log likelihood ratio	20.38207	Prob. Chi-Square(13)	0.0861
Wald Statistic	16.73899	Prob. Chi-Square(13)	0.2115

**Dependent Variable: I31UPC**

Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)

Date: 06/01/17 Time: 11:12

Sample (adjusted): 2007M02 2016M12

Included observations: 119 after adjustments

Convergence achieved after 6 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	267.9272	25.76427	10.39918	0
JAN*HDD65	0.986238	0.037699	26.16067	0
FEB*HDD65	0.888403	0.044673	19.88684	0
MAR*HDD65	0.820448	0.044143	18.58607	0
APR*HDD65	0.619473	0.053452	11.58933	0
MAY*HDD65	0.346159	0.072917	4.747323	0
OCT*HDD65	0.463431	0.056934	8.139731	0
NOV*HDD65	0.837803	0.043426	19.29278	0
DEC*HDD65	0.95491	0.03449	27.68656	0
TREND	-0.674523	0.323567	-2.084646	0.0395
AR(1)	0.472543	0.088564	5.335637	0

R-squared	0.957004	Mean dependent var	512.9817
Adjusted R-squared	0.953023	S.D. dependent var	292.2506
S.E. of regression	63.34311	Akaike info criterion	11.22289
Sum squared resid	433333.7	Schwarz criterion	11.47978
Log likelihood	-656.762	Hannan-Quinn criter.	11.32721
F-statistic	240.3852	Durbin-Watson stat	2.18852
Prob(F-statistic)	0		

Inverted AR Roots 0.47  
MAPE 12.09198

passed chow test

Chow Breakpoint Test: 2012M01

Null Hypothesis: No breaks at specified breakpoints

Equation Sample: 2007M02 2016M12

F-statistic	1.468037	Prob. F(11,97)	0.1561
Log likelihood ratio	18.32473	Prob. Chi-Square(11)	0.0743
Wald Statistic	16.77179	Prob. Chi-Square(11)	0.1148

**Dependent Variable: C41UPC**

Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)

Date: 06/22/17 Time: 09:49

Sample (adjusted): 2007M02 2016M12

Included observations: 119 after adjustments

Convergence achieved after 6 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1711.8	531.2503	-3.22221	0.0017
JAN*HDD65	3.755138	0.247708	15.15951	0
FEB*HDD65	3.450507	0.294352	11.72238	0
MAR*HDD65	3.732422	0.295201	12.64368	0
APR*HDD65	2.955579	0.368017	8.031084	0
MAY*HDD65	2.854962	0.556734	5.128051	0
JUN*HDD65	2.303097	0.85526	2.692863	0.0082
SEP*HDD65	2.777164	1.063687	2.610885	0.0103
OCT*HDD65	2.695765	0.432192	6.237418	0
NOV*HDD65	3.44842	0.296232	11.64094	0
DEC*HDD65	3.733527	0.226258	16.50116	0
RETAILSALES	0.158286	0.022844	6.928905	0
AR(1)	0.38878	0.089196	4.358705	0
R-squared	0.882866	Mean dependent var		3077.746
Adjusted R-squared	0.869606	S.D. dependent var		1133.868
S.E. of regression	409.4418	Akaike info criterion		14.97027
Sum squared resid	17770110	Schwarz criterion		15.27387
Log likelihood	-877.731	Hannan-Quinn criter.		15.09355
F-statistic	66.57887	Durbin-Watson stat		2.176405
Prob(F-statistic)	0			
Inverted AR Roots	0.39			
MAPE	11.95451			
failed chow test				
Chow Breakpoint Test: 2012M01				
Null Hypothesis: No breaks at specified breakpoints				
Equation Sample: 2007M02 2016M12				
F-statistic	3.481672	Prob. F(13,93)		0.0002
Log likelihood ratio	47.18933	Prob. Chi-Square(13)		0
Wald Statistic	42.44658	Prob. Chi-Square(13)		0.0001

**Dependent Variable: C41TUPC**

Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)

Date: 06/01/17 Time: 11:22

Sample: 2008M11 2016M12

Included observations: 98

Convergence achieved after 5 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11464.4	1549.61	7.398248	0
JAN*HDD65	4.675865	1.776083	2.632684	0.01
FEB*HDD65	5.750789	2.148156	2.677082	0.0088
MAR*HDD65	8.938097	2.036454	4.389049	0
APR*HDD65	7.465197	2.091885	3.568647	0.0006
NOV*HDD65	3.778148	1.577919	2.394387	0.0187
DEC*HDD65	5.109251	1.490453	3.427985	0.0009
AR(1)	0.81333	0.057242	14.20867	0

R-squared	0.729955	Mean dependent var	12688.28
Adjusted R-squared	0.708952	S.D. dependent var	5040.157
S.E. of regression	2719.108	Akaike info criterion	18.7321
Sum squared resid	6.65E+08	Schwarz criterion	18.94312
Log likelihood	-909.8731	Hannan-Quinn criter.	18.81746
F-statistic	34.75401	Durbin-Watson stat	1.795734
Prob(F-statistic)	0		

Inverted AR Roots                   0.81  
MAPE                                   22% calculated manually

failed chow test

Chow Breakpoint Test: 2012M01

Null Hypothesis: No breaks at specified breakpoints

Equation Sample: 2008M11 2016M12

F-statistic	2.210494	Prob. F(8,82)	0.0347
Log likelihood ratio	19.13797	Prob. Chi-Square(8)	0.0141
Wald Statistic	16.85077	Prob. Chi-Square(8)	0.0317

**Dependent Variable: I41UPC**

Dependent Variable: I41UPC  
Method: Least Squares  
Date: 06/22/17 Time: 09:59  
Sample: 2007M01 2016M12  
Included observations: 120

Variable	Coefficient	Std. Error	t-Statistic	Prob.
JAN*HDD65	4.487503	0.752048	5.96704	0
FEB*HDD65	4.487142	0.917277	4.891805	0
MAR*HDD65	4.728834	0.928704	5.091863	0
APR*HDD65	4.287307	1.182202	3.626543	0.0004
MAY*HDD65	4.086941	1.86613	2.190062	0.0306
OCT*HDD65	3.643883	1.458102	2.499059	0.0139
NOV*HDD65	4.556891	0.958727	4.753063	0
DEC*HDD65	4.147649	0.718281	5.77441	0
MFGEMPPSE	62.62282	2.042505	30.65982	0
TREND	-13.48535	4.287691	-3.14513	0.0021

R-squared	0.498555	Mean dependent var	12298.72
Adjusted R-squared	0.457528	S.D. dependent var	2129.031
S.E. of regression	1.57E+03	Akaike info criterion	17.63276
Sum squared resid	2.70E+08	Schwarz criterion	17.86505
Log likelihood	-1047.965	Hannan-Quinn criter.	17.72709
Durbin-Watson stat	2.215055		
MAPE	9.142401		

passed Chow test

Chow Breakpoint Test: 2012M01

Null Hypothesis: No breaks at specified breakpoints

Varying regressors: All equation variables

Equation Sample: 2007M01 2016M12

F-statistic	0.941409	Prob. F(10,100)	0.4992
Log likelihood ratio	10.79634	Prob. Chi-Square(10)	0.3736
Wald Statistic	9.414093	Prob. Chi-Square(10)	0.4933

**Dependent Variable: CI85UPC**

Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)

Date: 06/01/17 Time: 17:06

Sample (adjusted): 2007M02 2016M12

Included observations: 119 after adjustments

Convergence achieved after 5 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	28099.78	2187.621	12.8449	0
JAN*HDD65	48.09349	5.908294	8.139995	0
FEB*HDD65	55.82498	6.87198	8.123565	0
MAR*HDD65	64.83431	6.933489	9.350892	0
APR*HDD65	45.99303	8.804497	5.223811	0
MAY*HDD65	44.9464	13.74399	3.270259	0.0014
JUN*HDD65	52.18787	22.76517	2.292444	0.0238
OCT*HDD65	43.11502	10.23759	4.211442	0.0001
NOV*HDD65	54.53193	7.112949	7.666571	0
DEC*HDD65	57.49996	5.390987	10.66594	0
AR(1)	0.194724	0.095362	2.041957	0.0436
R-squared	0.700959	Mean dependent var		47881.24
Adjusted R-squared	0.67327	S.D. dependent var		19137.61
S.E. of regression	10939.11	Akaike info criterion		21.52596
Sum squared resid	1.29E+10	Schwarz criterion		21.78285
Log likelihood	-1269.795	Hannan-Quinn criter.		21.63027
F-statistic	25.31546	Durbin-Watson stat		1.90356
Prob(F-statistic)	0			
Inverted AR Roots	0.19			
MAPE	17.6156			
passed Chow test				
Chow Breakpoint Test: 2012M01				
Null Hypothesis: No breaks at specified breakpoints				
Equation Sample: 2007M02 2016M12				
F-statistic	1.522173	Prob. F(11,97)		0.1358
Log likelihood ratio	18.94938	Prob. Chi-Square(11)		0.062
Wald Statistic	17.21736	Prob. Chi-Square(11)		0.1016



**Dependent Variable: CI85TUPC**

Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)

Date: 06/01/17 Time: 17:10

Sample: 2008M11 2016M12

Included observations: 98

Convergence achieved after 5 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	48263.73	749.306	64.41125	0
JAN*HDD65	23.93075	2.172677	11.01441	0
FEB*HDD65	16.3777	2.590454	6.322329	0
MAR*HDD65	20.6625	2.641392	7.822579	0
APR*HDD65	19.47349	3.393231	5.738923	0
MAY*HDD65	12.03452	5.040915	2.387367	0.0191
OCT*HDD65	18.80639	4.115796	4.569321	0
NOV*HDD65	22.51361	2.630002	8.560304	0
DEC*HDD65	24.27907	1.936892	12.53507	0
AR(1)	0.165668	0.058083	2.852253	0.0054

R-squared	0.777408	Mean dependent var	55688.29
Adjusted R-squared	0.754643	S.D. dependent var	7682.733
S.E. of regression	3805.528	Akaike info criterion	19.42275
Sum squared resid	1.27E+09	Schwarz criterion	19.68652
Log likelihood	-941.7147	Hannan-Quinn criter.	19.52944
F-statistic	34.14916	Durbin-Watson stat	1.552826
Prob(F-statistic)	0		

Inverted AR Roots                    0.17  
MAPE                                    5.25% calculated manually

passed chow test

Chow Breakpoint Test: 2012M01

Null Hypothesis: No breaks at specified breakpoints

Equation Sample: 2008M11 2016M12

F-statistic	0.870597	Prob. F(10,78)	0.5639
Log likelihood ratio	10.36977	Prob. Chi-Square(10)	0.4087
Wald Statistic	9.201898	Prob. Chi-Square(10)	0.5131

**Dependent Variable: CI86UPC**

Method: Least Squares  
Date: 06/02/17 Time: 10:18  
Sample: 2007M01 2016M12  
Included observations: 120

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1163.643	99.97314	11.63955	0
JAN*HDD65	5.957839	0.178849	33.31216	0
FEB*HDD65	6.142604	0.218149	28.15782	0
MAR*HDD65	6.158423	0.220769	27.8953	0
APR*HDD65	5.609456	0.281032	19.96017	0
MAY*HDD65	5.012933	0.443568	11.30138	0
JUN*HDD65	3.225418	0.769903	4.189383	0.0001
SEP*HDD65	2.832864	0.963414	2.940443	0.004
OCT*HDD65	4.98037	0.345905	14.39809	0
NOV*HDD65	5.663559	0.227346	24.91158	0
DEC*HDD65	6.058316	0.170406	35.55228	0
TREND	-2.173657	0.942682	-2.305822	0.023
R-squared	0.963873	Mean dependent var		3217.623
Adjusted R-squared	0.960193	S.D. dependent var		1738.107
S.E. of regression	346.7812	Akaike info criterion		14.6299
Sum squared resid	12987778	Schwarz criterion		14.90865
Log likelihood	-865.7943	Hannan-Quinn criter.		14.74311
F-statistic	261.9484	Durbin-Watson stat		2.095332
Prob(F-statistic)	0			
MAPE	9.31			

passed chow test

Chow Breakpoint Test: 2012M01

Null Hypothesis: No breaks at specified breakpoints

Varying regressors: All equation variables

Equation Sample: 2007M01 2016M12

F-statistic	1.550721	Prob. F(12,96)	0.1197
Log likelihood ratio	21.26101	Prob. Chi-Square(12)	0.0467
Wald Statistic	18.60865	Prob. Chi-Square(12)	0.0984

**Dependent Variable: CI87UPC**

Method: Least Squares  
Date: 06/02/17 Time: 10:37  
Sample: 2007M01 2016M12  
Included observations: 120

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	130210.6	19896.44	6.544417	0
JAN*HDD65	296.76	40.35027	7.354598	0
FEB*HDD65	328.9654	49.23999	6.680859	0
MAR*HDD65	207.5523	49.83724	4.164603	0.0001
APR*HDD65	214.9441	63.47647	3.386201	0.001
MAY*HDD65	295.679	100.3256	2.947193	0.0039
OCT*HDD65	175.3799	78.29729	2.239923	0.0271
NOV*HDD65	244.3991	51.50559	4.745099	0
DEC*HDD65	270.8343	38.6075	7.01507	0
TREND	1364.482	225.1019	6.061617	0

R-squared	0.555727	Mean dependent var	306934.3
Adjusted R-squared	0.519377	S.D. dependent var	121301.6
S.E. of regression	84094.73	Akaike info criterion	25.59693
Sum squared resid	7.78E+11	Schwarz criterion	25.82922
Log likelihood	-1525.816	Hannan-Quinn criter.	25.69127
F-statistic	15.28836	Durbin-Watson stat	2.106217
Prob(F-statistic)	0		

MAPE 18.78

passed chow test

Chow Breakpoint Test: 2012M01

Null Hypothesis: No breaks at specified breakpoints

Varying regressors: All equation variables

Equation Sample: 2007M01 2016M12

F-statistic	0.749018	Prob. F(10,100)	0.6768
Log likelihood ratio	8.667516	Prob. Chi-Square(10)	0.5639
Wald Statistic	7.490179	Prob. Chi-Square(10)	0.6785

**Dependent Variable: CI87TUPC**

Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)

Date: 06/02/17 Time: 14:44

Sample: 2008M11 2016M12

Included observations: 98

Convergence achieved after 6 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	778590.2	44302.81	17.57429	0
JAN*HDD65	625.1672	50.30682	12.42709	0
FEB*HDD65	550.6467	60.47756	9.104975	0
MAR*HDD65	500.7434	61.90454	8.088961	0
APR*HDD65	383.808	77.16203	4.974052	0
MAY*HDD65	418.8307	104.2954	4.015813	0.0001
OCT*HDD65	376.3787	84.43288	4.457727	0
NOV*HDD65	628.7852	58.26562	10.7917	0
DEC*HDD65	598.2145	44.68386	13.38771	0
TREND	-4405.607	505.3946	-8.717163	0
D87TC	490945.9	42721.29	11.49183	0
AR(1)	0.412186	0.068687	6.00096	0
R-squared	0.931533	Mean dependent var		702738.6
Adjusted R-squared	9.23E-01	S.D. dependent var		287217.6
S.E. of regression	7.98E+04	Akaike info criterion		25.5271
Sum squared resid	5.48E+11	Schwarz criterion		25.84363
Log likelihood	-1238.828	Hannan-Quinn criter.		25.65513
F-statistic	106.371	Durbin-Watson stat		1.420728
Prob(F-statistic)	0			
Inverted AR Roots	0.41			
MAPE	10.83	calculated manually		

failed chow test

Chow Breakpoint Test: 2012M01

Null Hypothesis: No breaks at specified breakpoints

Equation Sample: 2008M11 2016M12

F-statistic	5.278038	Prob. F(12,74)	0
Log likelihood ratio	60.60013	Prob. Chi-Square(12)	0
Wald Statistic	55.435	Prob. Chi-Square(12)	0

**Dependent Variable: II99UPC**

Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)

Date: 06/22/17 Time: 10:31

Sample (adjusted): 2007M02 2016M12

Included observations: 119 after adjustments

Convergence achieved after 5 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	95713.27	10940.21	8.748763	0
JAN*HDD65	297.4861	16.16542	18.40263	0
FEB*HDD65	285.9869	19.2333	14.86936	0
MAR*HDD65	282.9507	19.26728	14.68555	0
APR*HDD65	242.8297	24.07175	10.08774	0
MAY*HDD65	223.8451	36.25028	6.174991	0
JUN*HDD65	188.4589	55.39692	3.401974	0.0009
OCT*HDD65	195.306	24.96411	7.823474	0
NOV*HDD65	275.3802	18.76992	14.67136	0
DEC*HDD65	266.3547	14.70294	18.11575	0
TREND	1252.658	129.426	9.678561	0
AR(1)	0.431238	0.088414	4.877467	0

R-squared	0.920275	Mean dependent var	269675.5
Adjusted R-squared	0.912079	S.D. dependent var	91858.82
S.E. of regression	27237.55	Akaike info criterion	23.35797
Sum squared resid	7.94E+10	Schwarz criterion	23.63821
Log likelihood	-1377.799	Hannan-Quinn criter.	23.47177
F-statistic	112.2826	Durbin-Watson stat	2.217385
Prob(F-statistic)	0		

Inverted AR Roots                    0.43  
MAPE                                        8.639074  
passed chow test  
Chow Breakpoint Test: 2012M01  
Null Hypothesis: No breaks at specified breakpoints

Equation Sample: 2007M02 2016M12

F-statistic	1.602636	Prob. F(12,95)	0.1038
Log likelihood ratio	21.93781	Prob. Chi-Square(12)	0.0382
Wald Statistic	20.4182	Prob. Chi-Square(12)	0.0596