# "Top Down" Estimation of DSM Program Impacts on Natural Gas Usage: Summary of Findings

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# Introduction

Some parties in Ontario have raised concerns about the "bottom up" approach that is currently used to estimate savings from utility DSM programs

- Depends on a number of engineering assumptions
- Leads to controversial and costly regulation

It has been suggested that instead of starting with individual DSM programs that a "top down" approach using econometric methods to estimate savings from utility DSM programs could be used



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# Summary

Pacific Economics Group Research (PEG) was asked to explore whether "top down" estimates of DSM savings could be developed using available data in Ontario

Using available data in Ontario PEG explored many options but was not able to develop a "top down" model that can be used to estimate savings from utility DSM programs

However, we did find some indicative evidence of the impact of DSM spending on gas consumption

*i.e.* 10% increase DSM expenditures

→ 0.56% to 1.05% decline in residential gas consumption

→ 0.34% to 0.89% decline in commercial gas consumption

# Outline

1. "Top Down" Precedents and Experience in the Industry
2. Existing Gas Demand Models in Ontario
3. PEG's Top Down Gas Demand Models and Econometric Results
4. Conclusion and Next Steps

# I. Precedents and Industry Experience

Jurisdictional survey did not find any examples of the “top down” approach proposed in Ontario

However, econometric research on energy conservation and utility DSM programs is extensive

A noteworthy article is “Demand Side Management and Energy Efficiency in the United States,” by David Loughran and Jonathan Kulick

- used an econometric specification that examines the relationship between *changes* in electricity consumption and changes in independent variables, including DSM spending
- findings indicated that DSM expenditures reduce electricity sales by 0.4% to 0.6% per annum



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# II. Existing Gas Demand Models in Ontario

- Enbridge Gas Distribution (EGD) and Union Gas both currently use econometric models to forecast gas usage in regulatory proceedings

- PEG's review found that, while the EGD and Union models may be appropriate for forecasting, they were less suited for developing "top down" estimates of gas savings from their DSM programs

- Top down models require statistically robust estimates of the impact of gas DSM programs on gas consumption

- The EGD and Union models had technical imperfections (serial correlation, heteroskedasticity) that could bias statistical inference on whether gas DSM programs have a significant effect on gas consumption

- These imperfections are less problematic for their current forecasting applications



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# III. PEG's Top Down Models

PEG investigated three approaches to top-down estimation of gas savings

A. New gas demand models

B. Replicate variants of company demand models but include DSM spending as an independent variable

C. Examine the difference between actual gas consumption and gas consumption predicted by gas demand models that exclude DSM as an explanatory variable; a statistically significant difference could be an indicator of the impact of DSM on gas consumption

# A. New Gas Demand Models

PEG used a two-stage approach to modeling gas demand

*First Stage*

- Regress monthly values of gas consumption on heating degree days and final delivered prices for natural gas
- Use these results to develop normalized gas consumption volumes

Separate Regressions for:

| | Enbridge | Union |
|---|---|---|
| Residential | Revenue Class 20 | Revenue Class 01-R |
| | | Revenue Class M2-R |
| Commercial | Revenue Class 12 | Revenue Class 01-C |
| | Revenue Class 48 | Revenue Class M2-C |
| | | Revenue Class 10 |



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# A. New Gas Demand Models (Con't)

*Second Stage*

- Aggregate (normalized) monthly consumption values into annual values
- Results use annual data, since data on some variables (including DSM spending) only available annually
- Regress changes in normalized gas consumption against a variety of other economic and customer characteristic variables that can impact gas consumption
- One variable is utility gas DSM spending in previous year
- Coefficient on DSM variable can represent impact of DSM spending on next year's gas consumption

Both first and second stage regressions also correct for technical imperfections recognized in EGD and Union models

# A. New Gas Demand Models (Con't)

*Second Stage*

Regressions done for residential and commercial customers of both companies

- Residential customers for EGD and Union residential revenue classes stacked in same regression; same for commercial customers
- Necessary to stack revenue classes to have large enough samples to obtain statistically significant results
- Separate constant terms in this regression for EGD and Union to control for differences in EGD and Union company characteristics
- Nevertheless, relatively small sample size only allows estimates of how DSM expenditures impact gas savings for residential customers in Ontario, and commercial customers in Ontario, NOT different estimates of savings for EGD or Union

# A. New Gas Demand Models (Con't)

PEG's **first stage** regressions generally sensible

For all eight revenue classes

- Heating degree days positively related to gas consumption
- Price negatively related to gas consumption
- Highly statistically significant estimates

Regressions also had high R-squared statistics (from 0.68 to 0.92), which measures the percent of change in the dependent variable that is accounted for by change in the independent variables



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# A. New Gas Demand Models (Con't)

PEG explored dozens of **second stage** specifications, with different choices for customer and economic characteristics that impact consumption

Best results for residential customers showed the following explanatory variables had the expected sign and a statistically significant impact on consumption

- Unemployment rate in Ontario (negative impact on consumption)
- Number of customers per household (positive impact)
- Customer 'vintage' (negative impact from more recent customers)
- Number of EcoEnergy evaluations (negative impact on consumption)

However, no regression showed that utility DSM spending had an impact on residential customers' gas consumption

# A. New Gas Demand Models (Con't)

Best results for **second stage** regressions for commercial customers even less satisfactory

Only significant driver of commercial gas consumption was the commercial vacancy rate (negative impact)

No regression showed that utility DSM spending had a negative impact on commercial customers' gas consumption (see Appendix A for results)



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# B. Update Variants of Company Gas Demand Models to Include DSM Spending

PEG also updated variants of the gas demand models the companies use, but added DSM spending as an independent variable

PEG's models corrected for statistical imperfections in company estimates

This approach required estimates of monthly DSM spending

Gas DSM data originally not collected monthly, so these data are less reliable than annual data

Relationship between monthly gas DSM spending and savings also less reliable due to:

- quality of DSM data
- varying relationship during year between expenditures and resulting changes in consumption



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# B. Update Variants of Company Gas Demand Models to Include DSM Spending (Con't)

PEG's specifications using monthly estimates of DSM spending, to increase number of sample observations, had more success (see Appendix B for results)

DSM has a negative and significant impact on gas consumption for all three residential customer classes and for two of five commercial classes

- For Enbridge: a 10% increase in DSM expenditures will be associated with contemporaneous declines in gas consumption of 1.05% for Residential revenue class 20 and 0.84% for Commercial revenue class 12.
- For Union: a 10% increase in DSM expenditures will be associated with contemporaneous declines in gas consumption of 0.77% for Residential 01 customers, 0.56% for Residential M2 customers, and 0.34% for Commercial 01 customers.

# C. Comparisons Between Actual and Predicted Demand

PEG also compared whether there are statistically significant differences between actual and predicted changes in gas consumption for both annual and monthly regressions

Predicted gas demand based on gas demand models that exclude DSM as an explanatory variable

Models also generate confidence intervals around predictions

If actual gas consumption is less than the predicted value and outside of the confidence interval, gas consumption is significantly lower than what's predicted by 'conventional' gas demand model

>>>> this difference could be an indicator of the impact of DSM programs on gas consumption

# C. Comparisons Between Actual and Predicted Demand (Con't)

PEG's final approach also never showed any instances where actual gas consumption was less than the predicted value and outside of the confidence interval

This approach therefore does not provide any indicative, econometric evidence of gas savings from DSM spending

# V. Conclusions

- PEG’s research did not identify any statistical evidence linking utility DSM spending and subsequent declines in gas consumption that is solid enough to develop “top down” estimates of gas DSM savings

- As noted, we are not aware of any DSM plans in the industry that currently use such “top down” estimates

- However, we did find some indicative evidence of the impact of DSM spending on gas consumption
  - Residential customers: 10% DSM Spending→ 0.6% to 1% decline
  - Commercial customers:10% DSM Spending→ 0.3% to 0.8% decline

# V. Conclusions(Con't)

PEG analysis could be improved if better data were available

- Monthly DSM spending by rate class and zone
- Information on when measures were actually installed (and not just $ spent)

More appropriate estimates may also be developed if demand models are estimated separately for participating and non-participating customers (as in California)

However, developing detailed customer-specific data:

- Is more costly
- Would take years to develop sufficient samples
- Would not necessarily yield significant results

# Appendix A: Econometric Results

Table 1

## First Stage Regression: Average Gas Use Per Customer
## Enbridge Revenue Class 20

**VARIABLE KEY**

HDD= Heating Degree Days for Revenue Class 20
P= Residential Total Delivery Price for Revenue Class 20

| EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC | EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC |
|---|---|---|---|---|---|
| **HDD** | 0.288 | 189.775 | **P** | -0.129 | -2.826 |
| Constant | 5.672 | 453.120 | **Trend** | -0.005 | -2.512 |

### Other Results

| | |
|---|---|
| System Rbar-Squared | 0.721 |
| Durbin-Watson Statistic | 1.783 |
| F Statistic | 139.976 |
| Sample Period | 1991-2008 |
| Number of Observations | 216 |



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# Appendix A: Econometric Results

Table 2

## First Stage Regression: Average Gas Use Per Customer
## Enbridge Revenue Class 12

### VARIABLE KEY

HDD= Heating Degree Days for Revenue Class 12
P= Commercial Total Delivery Price for Revenue Class 12

| EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC | EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC |
|---|---|---|---|---|---|
| **HDD** | 0.278 | 143.320 | **P** | -0.263 | -6.947 |
| Constant | 8.842 | 894.565 | **Trend** | 0.031 | 15.107 |

### Other Results

| | |
|---|---|
| System Rbar-Squared | 0.686 |
| Durbin-Watson Statistic | 2.077 |
| F Statistic | 118.41 |
| Sample Period | 1991-2008 |
| Number of Observations | 216 |

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# Appendix A: Econometric Results

Table 3

## First Stage Regression: Average Gas Use Per Customer
## Enbridge Revenue Class 48

**VARIABLE KEY**

HDD= Heating Degree Days for Revenue Class 48
P= Commercial Total Delivery Price for Revenue Class 48

| EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC | EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC |
|---|---|---|---|---|---|
| **HDD** | 0.344 | 355.379 | **P** | -0.055 | -2.812 |
| Constant | 7.324 | 889.740 | **Trend** | 0.012 | 11.511 |

**Other Results**

| | |
|---|---|
| System Rbar-Squared | 0.753 |
| Durbin-Watson Statistic | 1.818 |
| F Statistic | 164.96 |
| Sample Period | 1991-2008 |
| Number of Observations | 216 |



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# Appendix A: Econometric Results

Table 4

**First Stage Regression: Average Gas Use Per Customer**
**Union Revenue Class 01 Residential**

**VARIABLE KEY**

HDD= Heating Degree Days for Revenue Class 01 Residential
P= Total Delivery Price for Revenue Class 01 Residential

| EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC | EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC |
|---|---|---|---|---|---|
| **HDD** | 0.556 | 79.588 | **P** | -0.629 | -17.665 |
| Constant | 5.385 | 362.058 | **Trend** | 0.010 | 6.099 |

**Other Results**

| | |
|---|---|
| System Rbar-Squared | 0.917 |
| Durbin-Watson Statistic | 1.764 |
| F Statistic | 591.97 |
| Sample Period | 1991-2008 |
| Number of Observations | 216 |



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# Appendix A: Econometric Results

Table 5

## First Stage Regression: Average Gas Use Per Customer
## Union Revenue Class 01 Commercial

**VARIABLE KEY**

HDD= Heating Degree Days for Revenue Class 01 Commercial
P= Total Delivery Price for Revenue Class 01 Commercial

| EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC | EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC |
|---|---|---|---|---|---|
| **HDD** | 0.683 | 82.750 | **P** | -0.604 | -21.069 |
| Constant | 6.561 | 831.924 | **Trend** | 0.012 | 9.109 |

**Other Results**

| | |
|---|---|
| System Rbar-Squared | 0.881 |
| Durbin-Watson Statistic | 1.629 |
| F Statistic | 398.48 |
| Sample Period | 1991-2008 |
| Number of Observations | 216 |

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# Appendix A: Econometric Results

Table 6

## First Stage Regression: Average Gas Use Per Customer
## Union Revenue Class M2 Residential

### VARIABLE KEY

HDD= Heating Degree Days for Revenue Class M2 Residential
P= Total Delivery Price for Revenue Class M2 Residential

| EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC | EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC |
|---|---|---|---|---|---|
| **HDD** | 0.296 | 87.312 | **P** | -1.325 | -48.956 |
| Constant | 5.138 | 408.929 | **Trend** | 0.037 | 25.273 |

### Other Results

| | |
|---|---|
| System Rbar-Squared | 0.822 |
| Durbin-Watson Statistic | 1.892 |
| F Statistic | 248.52 |
| Sample Period | 1991-2008 |
| Number of Observations | 216 |

# Appendix A: Econometric Results

Table 7

**First Stage Regression: Average Gas Use Per Customer**
**Union Revenue Class M2 Commercial**

**VARIABLE KEY**

HDD= Heating Degree Days for Revenue Class M2 Commercial
P= Total Delivery Price for Revenue Class M2 Commercial

| EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC | EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC |
|---|---|---|---|---|---|
| **HDD** | 0.406 | 169.847 | **P** | -0.058 | -58.389 |
| Constant | 7.240 | 1419.319 | **Trend** | 0.016 | 17.251 |

**Other Results**

| | |
|---|---|
| System Rbar-Squared | 0.802 |
| Durbin-Watson Statistic | 1.575 |
| F Statistic | 218.74 |
| Sample Period | 1991-2008 |
| Number of Observations | 216 |

# Appendix A: Econometric Results

Table 8

## First Stage Regression: Average Gas Use Per Customer
## Union Revenue Class 10

### VARIABLE KEY

HDD= Heating Degree Days for Revenue Class 10
P= Total Delivery Price for Revenue Class 10

| EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC | EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC |
|---|---|---|---|---|---|
| **HDD** | 0.595 | 252.715 | **P** | -0.248 | -22.629 |
| Constant | 9.035 | 1383.267 | | | |

### Other Results

| | |
|---|---|
| System Rbar-Squared | 0.873 |
| Durbin-Watson Statistic | 1.647 |
| F Statistic | 370.45 |
| Sample Period | 1991-2008 |
| Number of Observations | 216 |



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# Appendix A: Econometric Results

Table 9

## Second Stage Regression: Change in 'Normalized' Gas Use
## Residential Revenue Classes

**VARIABLE KEY**

ID1= Constant for Enbridge Revenue Class 20
ID2= Constant for Union Revenue Class 01 Residential
ID3= Constant for Union Revenue Class M2 Residential
ECOE= EcoEnergy dummy variable
DSM= DSM Spending in previous year
UR= Unemployment Rate
VIN= Customer Vintage
NPHH= Number of People per Household

| EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC | EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC |
|---|---|---|---|---|---|
| **ID1** | -2.641 | -2.545 | **ECOE** | -0.047 | -4.315 |
| **ID2** | -2.494 | -2.509 | **DSM** | -0.009 | -0.496 |
| **ID3** | -2.576 | -2.510 | **UR** | -0.005 | -3.223 |
| | | | **VIN** | 0.259 | 2.026 |
| | | | **NPHH** | 2.385 | 2.550 |

### Other Results

| | |
|---|---|
| System Rbar-Squared | 0.388 |
| Durbin-Watson Statistic | 2.86 |
| F Statistic | 3.18 |
| Sample Period | 1999-2008 |
| Number of Observations | 30 |

# Appendix A: Econometric Results

Table 10

**Second Stage Regression: Change in 'Normalized' Gas Use**
**Commercial Revenue Classes**

**VARIABLE KEY**

ID1= Constant for Enbridge Rate Class 6
ID2= Constant for Union Revenue Class 01 Commercial
ID3= Constant for Union Revenue Class M2 Commercial
ID4= Constant for Union Revenue Class 10
BUC= 2005, 2006 dummy variables
DSM= DSM Spending in previous year
SEGM= Segmentation index
CVR= Commercial Vacancy Rate

| EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC | EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC |
|---|---|---|---|---|---|
| **ID1** | -0.402 | -1.117 | **BUC** | -0.001 | -0.188 |
| **ID2** | -0.315 | -0.831 | **DSM** | 0.017 | 1.320 |
| **ID3** | -0.331 | -0.877 | **SEGM** | 0.343 | 0.900 |
| **ID4** | -0.083 | -0.876 | **CVR** | -0.006 | -3.307 |

**Other Results**

| | |
|---|---|
| System Rbar-Squared | 0.188 |
| Durbin-Watson Statistic | 2.354 |
| F Statistic | 2.00 |
| Sample Period | 1999-2008 |
| Number of Observations | 40 |

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# Appendix B: Econometric Results

Table 11

## Alternate Regression: Monthly DSM Data
## Enbridge Revenue Class 20

**VARIABLE KEY**

P= Total Delivery Price for Revenue Class 20
HDD= Heating Degree Days for Revenue Class 20
FE= Furnace Efficiency Index
ECOE= Eco Energy dummy variable
DSM= DSM Cost for Rate Class 1

| EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC | EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC |
|---|---|---|---|---|---|
| **P** | -0.172 | -1.596 | **ECOE** | -0.023 | -5.266 |
| **HDD** | 0.335 | 34.769 | **DSM** | -0.105 | -18.717 |
| **FE** | -0.328 | -11.045 | | | |
| Constant | 5.691 | 74.654 | **Trend** | 0.027 | 4.112 |

## Other Results

| | |
|---|---|
| System Rbar-Squared | 0.735 |
| Durbin-Watson Statistic | 1.811 |
| F Statistic | 52.69 |
| Sample Period | 1998-2008 |
| Number of Observations | 132 |

# Appendix B: Econometric Results

Table 12

## Alternate Regression: Monthly DSM Data
## Enbridge Revenue Class 12

**VARIABLE KEY**

P= Total Delivery Price for Revenue Class 12
HDD= Heating Degree Days for Revenue Class 12
BUC1= Building Code 2005 dummy variable
BUC2= Building Code 2006 dummy variable
RM= Rate Migration dummy variable
DSM= DSM Cost for Rate Class 6

| EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC | EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC |
|---|---|---|---|---|---|
| **P** | -0.263 | -27.714 | **BUC2** | -0.015 | -10.238 |
| **HDD** | 0.251 | 134.269 | **RM** | -0.005 | -5.012 |
| **BUC1** | -0.015 | -4.370 | **DSM** | -0.084 | -5.232 |
| Constant | 8.237 | 174.744 | **Trend** | 0.083 | 18.350 |

### Other Results

| | |
|---|---|
| System Rbar-Squared | 0.68 |
| Durbin-Watson Statistic | 1.792 |
| F Statistic | 35.69 |
| Sample Period | 1998-2008 |
| Number of Observations | 132 |

# Appendix B: Econometric Results

Table 13

## Alternate Regression: Monthly DSM Data
## Enbridge Revenue Class 48

### VARIABLE KEY

P= Total Delivery Price for Revenue Class 48
HDD= Heating Degree Days for Revenue Class 48
ONTGDP= Ontario GDP
CVR= GTA Commercial Vacancy Rate
DSM= DSM Cost for Rate Class 6
Trend= Time Trend

| EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC | EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC |
|---|---|---|---|---|---|
| **P** | -0.684 | -4.342 | **CVR** | 0.137 | 1.815 |
| **HDD** | 0.301 | 47.370 | **DSM** | -0.021 | -1.176 |
| **ONTGDP** | 2.266 | 4.250 | Trend | 0.003 | 0.169 |
| Constant | 7.328 | 45.301 | | | |

### Other Results

| | |
|---|---|
| System Rbar-Squared | 0.734 |
| Durbin-Watson Statistic | 1.702 |
| F Statistic | 52.63 |
| Sample Period | 1998-2008 |
| Number of Observations | 132 |

# Appendix B: Econometric Results

Table 14

## Alternate Regression: Monthly DSM Data
## Union Revenue Class 01 Residential

**VARIABLE KEY**

P= Total Delivery Price for Revenue Class 01 Residential
HDD1= January Heating Degree Days for Northern Region
HDD2= February Heating Degree Days for Northern Region
HDD3= March Heating Degree Days for Northern Region
HDD4= April Heating Degree Days for Northern Region
HDD5= May Heating Degree Days for Northern Region
HDD9= September Heating Degree Days for Northern Region
HDD10= October Heating Degree Days for Northern Region
HDD11= November Heating Degree Days for Northern Region
HDD12= December Heating Degree Days for Northern Region
NPHH= Number of Persons Per Household
FE= Furnace Efficiency Index
ECOE= Eco Energy dummy variable
DSM= DSM Cost for Rate 01Residential

| EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC | EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC |
|---|---|---|---|---|---|
| **P** | -0.339 | -16.540 | **HDD10** | 0.050 | 22.368 |
| **HDD1** | 0.131 | 50.066 | **HDD11** | 0.102 | 42.915 |
| **HDD2** | 0.130 | 54.414 | **HDD12** | 0.136 | 60.714 |
| **HDD3** | 0.117 | 49.760 | **NPHH** | -0.107 | -0.885 |
| **HDD4** | 0.080 | 38.278 | **FE** | 0.155 | 7.748 |
| **HDD5** | 0.038 | 16.079 | **ECOE** | 0.001 | 0.900 |
| **HDD9** | 0.010 | 3.217 | **DSM** | -0.077 | -10.367 |
| Constant | 4.124 | 1563.138 | | | |

### Other Results

| | |
|---|---|
| System Rbar-Squared | 0.973 |
| Durbin-Watson Statistic | 1.893 |
| F Statistic | 318.58 |
| Sample Period | 1998-2008 |
| Number of Observations | 132 |



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# Appendix B: Econometric Results

Table 15

## Alternate Regression: Monthly DSM Data
## Union Revenue Class M2 Residential

### VARIABLE KEY

P= Total Delivery Price for Revenue Class M2 Residential
HDD1= January Heating Degree Days for Southern Region
HDD2= February Heating Degree Days for Southern Region
HDD3= March Heating Degree Days for Southern Region
HDD4= April Heating Degree Days for Southern Region
HDD5= May Heating Degree Days for Southern Region
HDD9= September Heating Degree Days for Southern Region
HDD10= October Heating Degree Days for Southern Region
HDD11= November Heating Degree Days for Southern Region
HDD12= December Heating Degree Days for Southern Region
NPHH= Number of Persons Per Household
FE= Furnace Efficiency Index
ECOE= Eco Energy dummy variable
DSM= DSM Cost for Rate M2 Residential

| EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC | EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC |
|---|---|---|---|---|---|
| **P** | -0.214 | -10.319 | **HDD10** | 0.053 | 29.520 |
| **HDD1** | 0.137 | 43.947 | **HDD11** | 0.096 | 61.445 |
| **HDD2** | 0.138 | 81.708 | **HDD12** | 0.142 | 109.293 |
| **HDD3** | 0.126 | 69.459 | **NPHH** | -0.038 | -0.204 |
| **HDD4** | 0.084 | 53.539 | **FE** | 0.112 | 9.645 |
| **HDD5** | 0.037 | 28.495 | **ECOE** | -0.001 | -1.515 |
| **HDD9** | -0.007 | -4.970 | **DSM** | -0.056 | -8.587 |
| Constant | 4.129 | 773.148 | | | |

### Other Results

| | |
|---|---|
| System Rbar-Squared | 0.984 |
| Durbin-Watson Statistic | 1.684 |
| F Statistic | 544.56 |
| Sample Period | 1998-2008 |
| Number of Observations | 132 |



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# Appendix B: Econometric Results

Table 16

**Alternate Regression: Monthly DSM Data**
**Union Revenue Class 01 Commercial**

**VARIABLE KEY**

P= Total Delivery Price for Revenue Class 01 Commercial
HDD1= January Heating Degree Days for Northern Region
HDD2= February Heating Degree Days for Northern Region
HDD3= March Heating Degree Days for Northern Region
HDD4= April Heating Degree Days for Northern Region
HDD5= May Heating Degree Days for Northern Region
HDD9= September Heating Degree Days for Northern Region
HDD10= October Heating Degree Days for Northern Region
HDD11= November Heating Degree Days for Northern Region
HDD12= December Heating Degree Days for Northern Region
SEGM= Segmentation Index
DSM= DSM Cost for Rate 01 Commercial

| EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC | EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC |
|---|---|---|---|---|---|
| **P** | -0.125 | -3.948 | **HDD9** | 0.009 | 5.950 |
| **HDD1** | 0.181 | 91.066 | **HDD10** | 0.095 | 71.405 |
| **HDD2** | 0.175 | 145.277 | **HDD11** | 0.135 | 79.792 |
| **HDD3** | 0.162 | 274.763 | **HDD12** | 0.174 | 131.892 |
| **HDD4** | 0.114 | 129.495 | **SEGM** | 0.164 | 0.949 |
| **HDD5** | 0.060 | 78.135 | **DSM** | -0.034 | -3.825 |
| Constant | 5.100 | 736.159 | | | |

**Other Results**

| | |
|---|---|
| System Rbar-Squared | 0.956 |
| Durbin-Watson Statistic | 1.991 |
| F Statistic | 221.43 |
| Sample Period | 1998-2008 |
| Number of Observations | 132 |

# Appendix B: Econometric Results

Table 17

## Alternate Regression: Monthly DSM Data
## Union Revenue Class M2 Commercial

### VARIABLE KEY

P= Total Delivery Price for Revenue Class M2 Commercial
HDD1= January Heating Degree Days for Southern Region
HDD2= February Heating Degree Days for Southern Region
HDD3= March Heating Degree Days for Southern Region
HDD4= April Heating Degree Days for Southern Region
HDD5= May Heating Degree Days for Southern Region
HDD9= September Heating Degree Days for Southern Region
HDD10= October Heating Degree Days for Southern Region
HDD11= November Heating Degree Days for Southern Region
HDD12= December Heating Degree Days for Southern Region
SEGM= Segmentation Index
DSM= DSM Cost for Rate M2 Commercial

| EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC | EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC |
|---|---|---|---|---|---|
| **P** | -0.128 | -6.992 | **HDD9** | 0.014 | 22.459 |
| **HDD1** | 0.163 | 114.384 | **HDD10** | 0.082 | 219.577 |
| **HDD2** | 0.160 | 102.119 | **HDD11** | 0.129 | 113.005 |
| **HDD3** | 0.150 | 221.101 | **HDD12** | 0.158 | 198.070 |
| **HDD4** | 0.106 | 98.564 | **SEGM** | 0.515 | 4.625 |
| **HDD5** | 0.060 | 143.988 | **DSM** | -0.002 | -0.268 |
| Constant | 5.949 | 1229.972 | | | |

### Other Results

| | |
|---|---|
| System Rbar-Squared | 0.968 |
| Durbin-Watson Statistic | 1.891 |
| F Statistic | 309.49 |
| Sample Period | 1998-2008 |
| Number of Observations | 132 |

# Appendix B: Econometric Results

Table 18

## Alternate Regression: Monthly DSM Data
## Union Revenue Class 10 Commercial

### VARIABLE KEY

P= Total Delivery Price for Revenue Class 10 Commercial
HDD1= January Heating Degree Days for Northern Region
HDD2= February Heating Degree Days for Northern Region
HDD3= March Heating Degree Days for Northern Region
HDD4= April Heating Degree Days for Northern Region
HDD5= May Heating Degree Days for Northern Region
HDD9= September Heating Degree Days for Northern Region
HDD10= October Heating Degree Days for Northern Region
HDD11= November Heating Degree Days for Northern Region
HDD12= December Heating Degree Days for Northern Region
SEGM= Segmentation Index
DSM= DSM Cost for Rate 10 Commercial

| EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC | EXPLANATORY VARIABLE | PARAMETER ESTIMATE | T-STATISTIC |
|---|---|---|---|---|---|
| **P** | -0.070 | -3.425 | **HDD9** | -0.002 | -0.504 |
| **HDD1** | 0.152 | 124.821 | **HDD10** | 0.083 | 105.458 |
| **HDD2** | 0.140 | 453.624 | **HDD11** | 0.117 | 458.747 |
| **HDD3** | 0.137 | 175.920 | **HDD12** | 0.136 | 319.824 |
| **HDD4** | 0.090 | 57.349 | **SEGM** | -0.208 | -2.139 |
| **HDD5** | 0.043 | 61.816 | **DSM** | -0.003 | -0.467 |
| Constant | 7.842 | 3622.985 | | | |

### Other Results

| | |
|---|---|
| System Rbar-Squared | 0.94 |
| Durbin-Watson Statistic | 1.825 |
| F Statistic | 157.93 |
| Sample Period | 1998-2008 |
| Number of Observations | 132 |



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