Projecting Total Energy Use...
How Good Are We?

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MaGrann Associates

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Columbia Gas of Ohio
Data
Observations
Questions
Conclusions?
Indicator of relative performance

- Other homes
- Code
- Marketing
- Programs & incentives

Asset rating (model)

- Verified construction
- Standardized reference
- Standardized occupant assumptions
Billing Summary

Bill Date
Thank you for your payment of $220.59

Current Period Charges
Gas
Electric

Total New Charges
Total Amount Due on 02/22/2013

01/31/2013

$184.53
$114.54
$299.07
$299.07

General Information

Next scheduled meter reading: February 28, 2013
PECO, 2301 Market St, Philadelphia, PA 19103-1380. If you have any
questions or concerns, please call 1-800-494-4000 before the due date.
Si tiene alguna pregunta, favor de llamar al numero 1-800-494-4000 antes de
la fecha de vencimiento.

Customer Self Service - Manage Your Account 24/7

Message Center
New charges contain estimated total state taxes of $0.02, including $7.01 for
State Gross Receipts Tax.

Your estimated electric price to compare is $0.0869 per kWh.

The amount of this bill will be automatically deducted from your bank account
on Feb 22, 2013.
How Good Are We At Projecting Total Energy Use?
Act./Proj. 97% ±1% in weather adjusted program evaluation
Actual vs REM Total Cost

Actual Cost vs REM Projection

\[ y = 0.7038x + 545.01 \]

\[ R^2 = 0.2915 \]
Variability of Actual vs. REM Projected Total Cost
## Monthly Bill Impact

<table>
<thead>
<tr>
<th>$ Over / Month</th>
<th>% Homes Lower</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>59%</td>
</tr>
<tr>
<td>$17</td>
<td>70%</td>
</tr>
<tr>
<td>$33</td>
<td>79%</td>
</tr>
<tr>
<td>$50</td>
<td>86%</td>
</tr>
<tr>
<td>$67</td>
<td>91%</td>
</tr>
<tr>
<td>$83</td>
<td>94%</td>
</tr>
</tbody>
</table>
Actual vs REM Annual Gas Usage

Actual Usage (CCF) vs REM Estimate

y = 0.888x + 99.923
R² = 0.5433

Actual = Proj.
Actual vs REM Annual Electricity Usage

$y = 0.6272x + 4252.3$

$R^2 = 0.1966$
What else?

Something about the building characteristics or the rating?
# Potential correlations with error

*Error = % difference from prediction*

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENERGY STAR version</td>
<td>-0.07</td>
<td>No correlation</td>
</tr>
<tr>
<td>HERS score</td>
<td>-0.05</td>
<td>No correlation</td>
</tr>
<tr>
<td>House size (CFA)</td>
<td>-0.21</td>
<td>Some correlation</td>
</tr>
<tr>
<td>A/C efficiency</td>
<td>0.06</td>
<td>No correlation</td>
</tr>
<tr>
<td>Number of A/Cs</td>
<td>0.02</td>
<td>No correlation</td>
</tr>
<tr>
<td>Furnace efficiency</td>
<td>-0.06</td>
<td>No correlation</td>
</tr>
<tr>
<td>Number of furnaces</td>
<td>0.01</td>
<td>No correlation</td>
</tr>
<tr>
<td>Water heater efficiency</td>
<td>-0.21</td>
<td>Some correlation</td>
</tr>
<tr>
<td>Number of DHWs</td>
<td>-0.07</td>
<td>No correlation</td>
</tr>
</tbody>
</table>
A word about **Pearson’s Co-efficient**

- (+) Correlates with higher values
- (-) Correlates with lower values
- 0: No correlation
- +0.25: Stronger correlation
- +0.5: Stronger correlation
- -0.25: Stronger correlation
- -0.5: Stronger correlation
Potential correlations with error
(Error = % difference from prediction)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation</th>
<th>Correlation Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENERGY STAR version</td>
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</tr>
</tbody>
</table>
But what about behavior and demographics?

“Occupant intensity”

- Families, seniors, adults/children, age, etc.
- Size of home?
- Validity of “bedrooms +1”?
In our sample of 590*

- Family w/Children, 177
- Adults No Children, 279
- >2 Adults/Adult Children, 91
- Seniors, 14
- Uncategorized, 29

*Homes with demographic overlay available
<table>
<thead>
<tr>
<th></th>
<th>Error</th>
<th>Actual Cost</th>
<th>Projected Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Family</strong></td>
<td>+0.13</td>
<td>+0.24</td>
<td>+0.16</td>
</tr>
<tr>
<td>Adults only(^1)</td>
<td>-0.14</td>
<td>-0.19</td>
<td>-0.01</td>
</tr>
<tr>
<td>Seniors(^2)</td>
<td>-0.02</td>
<td>-0.03</td>
<td>-0.02</td>
</tr>
<tr>
<td><strong>Number of Children</strong></td>
<td>+0.15</td>
<td>+0.26</td>
<td>+0.17</td>
</tr>
<tr>
<td>Number of Adults(^3)</td>
<td>+0.04</td>
<td>+0.13</td>
<td>+0.13</td>
</tr>
</tbody>
</table>

\(^1\) Adults only: ≤2  
\(^2\) Seniors: Note small “n” (14)  
\(^3\) Number of Adults: Includes children ≥18

**Is it all about the kids?**
Other ways to look at behavior and demographics

Builders target specific market segments

- What can we learn by looking at variation by builder?
Variability by **Builder**

(% difference from prediction)
“Move-up” builder
231 homes; median 4,274 sf
Variability by Builder
(% difference from prediction)
Affordable builders
102 homes; median 2,304 sf
Variability by Builder
(% difference from prediction)
“Starter home” builder
159 homes; median 2,490 sf
Hmm, what’s different?

- **Appliances**
  - Efficiency if not builder supplied?
  - But raters are using appropriate defaults
## Median total usage by category

<table>
<thead>
<tr>
<th>Median Data</th>
<th>Sq.Ft.</th>
<th>kWh Proj.</th>
<th>kWh Act.</th>
<th>CCF Proj.</th>
<th>CCF Act.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Move-Up</td>
<td>4,274</td>
<td>14,460</td>
<td>11,866</td>
<td>694</td>
<td>736</td>
</tr>
<tr>
<td>Affordables</td>
<td>2,304</td>
<td>7,043</td>
<td>9,930</td>
<td>534</td>
<td>676</td>
</tr>
<tr>
<td>Starter</td>
<td>2,490</td>
<td>10,991</td>
<td>9,759</td>
<td>513</td>
<td>484</td>
</tr>
</tbody>
</table>
So... back to behavior and demographics?

“Occupant intensity”
- Families, seniors, adults/children, age, etc.
- Size of home?
- Validity of “bedrooms +1”?
So...
back to behavior and demographics?

“Occupant intensity”
  – Families, seniors, adults/children, age, etc.
  – Size of home?
  – Validity of “bedrooms +1”?
  – Time at home
    • Heating/cooling & lighting
    • Plug loads
## TV Power Consumption (W)

<table>
<thead>
<tr>
<th>Screen Size</th>
<th>LED</th>
<th>LCD</th>
<th>CRT</th>
<th>Plasma</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 inches</td>
<td>15</td>
<td>18</td>
<td>65</td>
<td>---</td>
</tr>
<tr>
<td>17 inches</td>
<td>18</td>
<td>20</td>
<td>75</td>
<td>---</td>
</tr>
<tr>
<td>19 inches</td>
<td>20</td>
<td>22</td>
<td>80</td>
<td>---</td>
</tr>
<tr>
<td>20 inches</td>
<td>24</td>
<td>26</td>
<td>90</td>
<td>---</td>
</tr>
<tr>
<td>21 inches</td>
<td>26</td>
<td>30</td>
<td>100</td>
<td>---</td>
</tr>
<tr>
<td>22 inches</td>
<td>30</td>
<td>40</td>
<td>110</td>
<td>---</td>
</tr>
<tr>
<td>24 inches</td>
<td>40</td>
<td>50</td>
<td>120</td>
<td>---</td>
</tr>
<tr>
<td>30 inches</td>
<td>50</td>
<td>60</td>
<td>---</td>
<td>150</td>
</tr>
<tr>
<td>32 inches</td>
<td>55</td>
<td>70</td>
<td>---</td>
<td>160</td>
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<tr>
<td>37 inches</td>
<td>60</td>
<td>80</td>
<td>---</td>
<td>180</td>
</tr>
<tr>
<td>42 inches</td>
<td>80</td>
<td>120</td>
<td>---</td>
<td>220</td>
</tr>
<tr>
<td>50 inches</td>
<td>100</td>
<td>150</td>
<td>---</td>
<td>300</td>
</tr>
</tbody>
</table>

[http://energyusecalculator.com/electricity_lcdleddisplay.htm](http://energyusecalculator.com/electricity_lcdleddisplay.htm)
Conclusions

HERS appears to be predicting total usage (cost) accurately over large numbers of homes
But with lots of individual variation, and there will always be outliers

In fact, most households are performing close to or better than projected
But some demographic characteristics appear to skew results

When it comes to total usage, “occupant intensity” may warrant more study
  – Assumptions associated with family size (specifically kids)
  – Assumptions related to plug loads and behavior

But the conclusions are not really about the asset rating or savings
They’re about additional opportunities in post occupancy engagement!
Thank you

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