CFL Hours of Use Study
Summary of Approach and Results

July, 2012

Presentation Overview

- Background
- Methodology
  - Sampling
  - Metering
  - Data Cleaning
  - Data Analysis
- Results and Recommendations

Background

GOAL:

To develop a single recommended estimate of average daily hours of use (HOU) for CFLs

COMPONENTS:

Two independent metering studies:

	DTE Energy	Consumers Energy Count on Us
Study timing	Nov 2011– May 2012	Sep 2010 – Mar 2011
Total homes audited	260	51
Total homes metered	101	51
Types of homes metered	Single-family and multi-family	Single-family only
Total loggers installed	500	210
Total loggers used in analysis	439	189

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Sampling

DTE Energy's CFL Metering Study

- Lighting loggers were installed as part of the baseline study in the subset of homes that agreed to participate in the in-home visits
- Sample frame consisted of DTE Energy's electric and combo customers
- Sample was stratified by customer type and region to ensure representativeness of residential customers in DTE Energy's service territory

Customer Type	Sample Frame		Site Visits		Metered Homes	
	#	%	#	%	#	%
Electric Only	1,225,113	69%	179	69%	68	67%
Electric & Gas	548,265	31%	81	31%	33	33%
Total	**1,773,378**	**100%**	**260**	**100%**	**101**	**100%**

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Sampling (Cont.)

Consumers Energy's Metering Study

- Participants were chosen within a 30 mile radius of Grand Rapids, Lansing, Flint, or Saginaw
- Utilized previous 2009 lighting audit participants in the sample (n=61)
- Utilized random sample of electric and combo customers provided by Consumers Energy (n=1,500)

Metering

DTE Energy's CFL Metering Study

- Only households with 1+ CFLs in the interior of the home were recruited for the metering study
- Up to seven loggers were deployed per home targeting high usage rooms with a random selection of CFLs/fixtures to meter within each room

Consumers Energy's CFL Metering Study

- Only households with 1+ CFLs in the interior or exterior of the home were recruited for the metering study
- Up to five loggers were deployed per home. Rooms and fixtures were randomly selected for logging

- Both studies employed Dent ON/OFF lighting loggers

Logger Serial #	Date	Time	Status	Status Code
LC0000001	3/20/2012	9:30:27	TURNED ON	1
LC0000001	3/20/2012	10:00:15	TURNED OFF	0
LC0000001	3/20/2012	10:30:35	TURNED ON	1

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Data Cleaning

Both DTE Energy's and Consumers Energy's data underwent rigorous cleaning and exploration, including:

- Identifying and removing loggers with "bad" data due to in situ logger failure
- Identifying, flagging, and further exploring loggers with unexpected usage profiles (e.g., continuous on-times for extensive periods of time)
- Identifying and flagging loggers with potential "flickering" problems, which might be indicative of improper logger sensitivity calibration
- "Trimming" logs **before** logger installation and **after** logger retrieval

	DTE Energy	Consumers Energy
Total loggers deployed	**500**	**210**
Total loggers retained in the analysis	**439**	**189**
Logger drop rate	**12%**	**10%**

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Data Analysis

Since the metering period did not cover a full year, both studies used (OLS) regression analysis to estimate annualized daily hours of use

- For each logger, a sinusoidal model was fit, of the form:

$$Hd = \alpha + \beta\sin(\theta d) + \varepsilon d$$

Hd = hours of use on day d

θd = angle for day d

α – the intercept

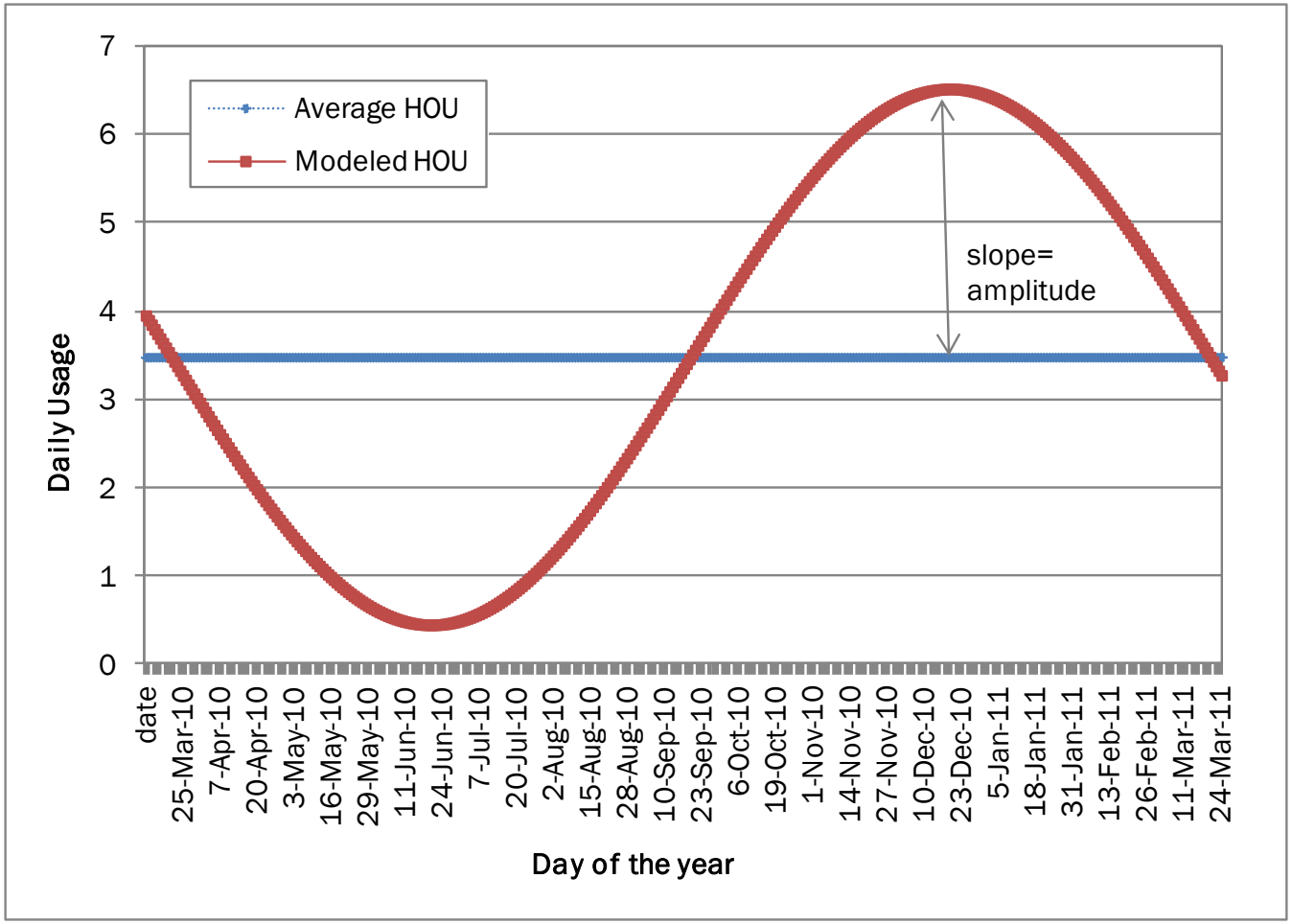
β – the sine coefficient

εd = residual error

- Hours of use were modeled separately for weekends and weekdays:

Data Analysis

Illustration of Sinusoidal Model



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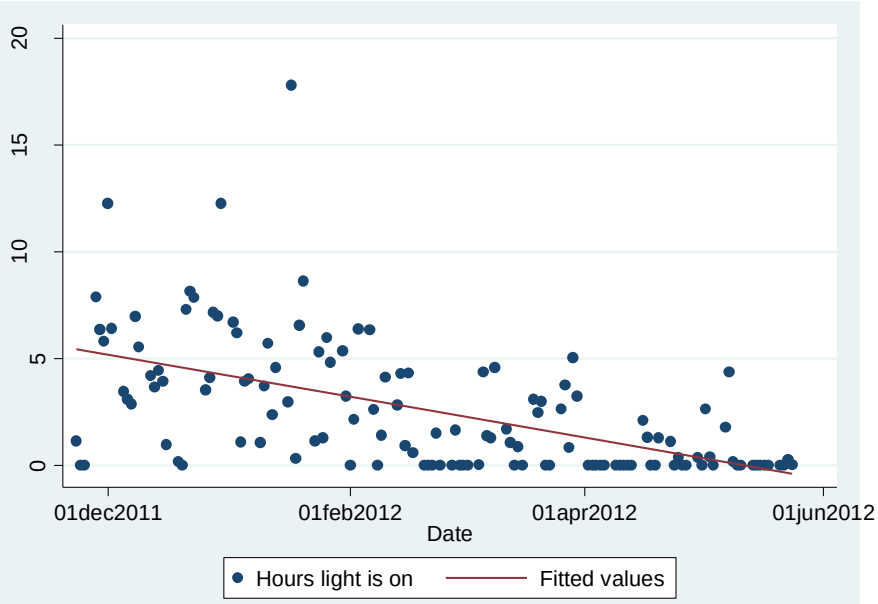
Data Analysis (Cont.)

- Modeled results were explored for goodness of fit using the following indicators:
  - Size of the regression t-statistic (meeting or exceeding the critical values of 1.282)
  - Magnitude of the sine coefficient (slope)
  - The value of the intercept
- Annual daily hours of use for loggers with poor model fits were replaced with un-annualized metered daily HOU averages for the metering period
- Sine coefficients for models with poor fit were replaced with either missing values or zeroes

Data Analysis (Cont.)

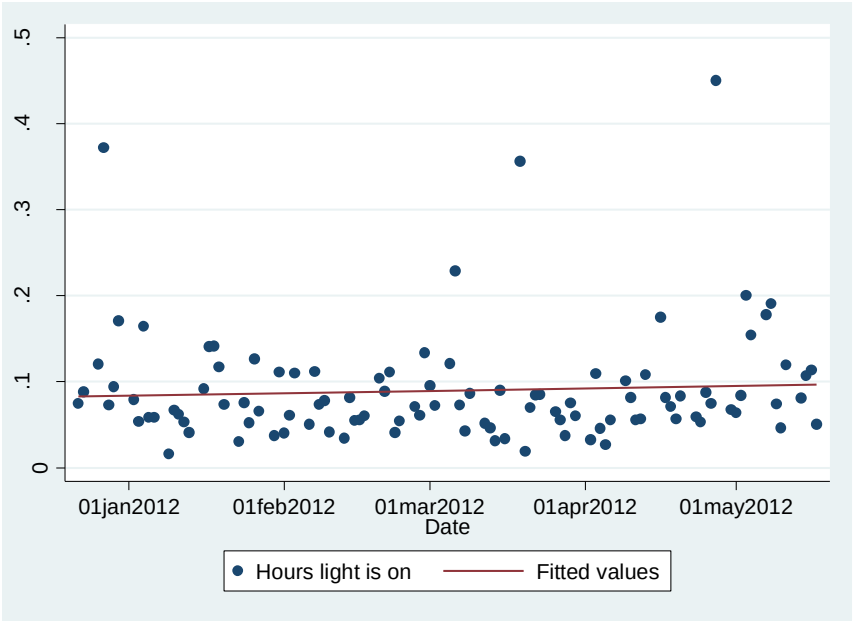
Example of Good Fit and Poor Fit Models

Good Fit Model



t-statistic: 7.65
sine coeff: 2.60
un-annualized HOU: 2.53
annualized HOU: 1.79

Poor Fit Model



t-statistic: -0.89
sine coeff: -0.00
un-annualized HOU: 0.08
annualized HOU: 0.09

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Data Analysis (Cont.)

- Due to different timeframes of the two studies, hours of use were estimates for each study independently
- Within each study, hours of use were estimated by room type. The average daily hours of use for each room were calculated by averaging the weekday and weekend intercepts to the number of each day type in the year
- Room types were adjusted for the two studies to ensure consistency and ability to integrate the data when developing the statewide value
  - Closets in the Consumers Energy's study were reclassified as "Other"
  - Finished and unfinished basements, as well as primary and secondary living areas were grouped in DTE Energy's study
- As part of the DTE Energy's metering study, CFLs in garages and outside were not metered – HOU estimates from the Consumers Energy's study were used

Results

DTE Energy – Estimated HOU by Room

DTE Energy	# of Loggers	Un-annualized HOU (All Days)	Annualized HOU (All Days)
Hallway	34	1.38	1.27
Bathroom	45	1.91	1.92
Laundry room	16	2.27	2.20
Bedroom	82	1.79	1.75
Kitchen	69	4.36	4.17
Dining room	6	3.39	3.13
Office/den	18	2.57	2.46
Basement	54	2.29	2.22
Living space	106	3.66	3.62
Other rooms	9	0.67	0.63
TOTAL	439		

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Results (Cont.)

- By room HOU estimates were weighted by the distribution of CFLs across all baseline study participants (logged and non-logged homes)
- Overall annualized HOU estimate for DTE Energy's service territory is 2.6 hours per day

DTE Energy – Estimated Overall HOU

DTE Energy	# of CFLs	% of CFls by Room	Annualized HOU	Weighted Average HOU
Hallway	203	7%	1.27	0.09
Bathroom	359	13%	1.92	0.24
Laundry room	80	3%	2.20	0.06
Bedroom	525	18%	1.75	0.32
Kitchen	483	17%	4.17	0.70
Dining room	49	2%	3.13	0.05
Office/den	80	3%	2.46	0.07
Basement	350	12%	2.22	0.27
Living space	412	14%	3.62	0.52
Other rooms	64	2%	0.63	0.01
Garage	68	2%	2.34	0.06
Outside	190	7%	3.00	0.20
Total	2,863	100%		
Weighted Annualized Daily HOU				2.60

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Results (Cont.)

Consumers Energy – Estimated HOU by Room

Consumers Energy Count on Us	# of Loggers	Un-annualized HOU	Annualized HOU
Hallway	11	0.85	0.80
Bathroom	20	2.30	2.61
Laundry room	9	1.50	2.05
Bedroom	36	1.64	1.71
Kitchen	23	3.02	2.60
Dining room	3	3.10	2.47
Office/den	10	1.40	1.55
Basement	15	1.25	1.23
Living space	43	1.97	1.77
Other rooms	12	0.61	0.65
Garage	5	1.67	2.34
Outside	2	3.00	3.00
TOTAL	189		

Results (Cont.)

- Weighted by the distribution of CFLs across all study participants
- Overall annualized HOU estimate for Consumers Energy service territory is 1.97

Consumers Energy – Estimated Overall HOU

Consumers Energy Count on Us	# of CFLs	% of CFls by Room	Annualized HOU	Weighted Average HOU
Hallway	45	6%	0.80	0.05
Bathroom	110	14%	2.61	0.37
Laundry room	23	3%	2.05	0.06
Bedroom	138	18%	1.71	0.31
Kitchen	93	12%	2.60	0.31
Dining room	39	5%	2.47	0.12
Office/den	44	6%	1.55	0.09
Basement	70	9%	1.23	0.11
Living space	109	14%	1.77	0.25
Other rooms	23	3%	0.65	0.02
Garage	36	5%	2.34	0.11
Outside	44	6%	3.00	0.17
TOTAL	774	100%		
Weighted Annualized Daily HOU				1.97

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Data Analysis (Cont.)

- The average daily hours of use by room were combined across the two studies in proportion to the each utility's customer base of electric and combo customers (2009 estimates)

	DTE Energy Annualized HOU	% of Customers	Consumers Energy Annualized HOU	% of Customers	Weighted Average Annualized HOU
Hallway	1.27	54%	0.80	46%	1.06
Bathroom	1.92	54%	2.61	46%	2.24
Laundry room	2.20	54%	2.05	46%	2.13
Bedroom	1.75	54%	1.71	46%	1.73
Kitchen	4.17	54%	2.60	46%	3.44
Dining room	3.13	54%	2.47	46%	2.82
Office/den	2.46	54%	1.55	46%	2.03
Basement	2.22	54%	1.23	46%	1.76
Living space	3.62	54%	1.77	46%	2.76
Other rooms	0.63	54%	0.65	46%	0.64
Garage	2.34	54%	2.34	46%	2.34
Outside	3.00	54%	3.00	46%	3.00

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Data Analysis (Cont.)

- Weighted hours of use by room were then weighted by statewide distribution of CFLs across the rooms to arrive at the overall statewide value
- Overall statewide annualized daily hours of use is 2.26

	Weighted Average Annualized HOU	Statewide Distribution of CFLs by Room*	Statewide Annualized Daily HOU
Hallway	1.06	8%	0.08
Bathroom	2.24	12%	0.27
Laundry room	2.13	2%	0.05
Bedroom	1.73	17%	0.30
Kitchen	3.44	13%	0.44
Dining room	2.82	5%	0.14
Office/den	2.03	4%	0.08
Basement	1.76	12%	0.20
Living space	2.76	14%	0.38
Other rooms	0.64	3%	0.02
Garage	2.34	3%	0.07
Outside	3.00	8%	0.23
TOTAL			2.26

** Michigan Residential Baseline Study (2011)*

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Conclusions and Recommendations

- Michigan Statewide daily HOU estimates are in line with the current MEMD value and with other TRMs:

	HOU Estimates
VT TRM 2010	1.81
Regional Technical Forum (PNW)	1.90
CA (DEER)	1.90
Arkansas TRM 2011	2.28
Michigan HOU Estimate	**2.26**
Michigan MEMD	2.30
CT TRM 2011	2.45
Maine TRM 2006	2.70
OH TRM 2010 (draft)	2.85
MA TRM 2012	2.92
Mid-Atlantic TRM 2012	2.98
PA TRM 2012	3.00
NJ TRM 2009 (draft)	3.00
NY TRM 2010	3.20

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Conclusions and Recommendations

- DTE Energy's and Consumers Energy's CFL metering studies validated the currently used MEMD assumption of 840 annual assumed hours of operation for CFLs

- We recommend to continue using the current MEMD estimates and use this study as the basis for the decision