DSM Meeting

November 7, 2016

Available in accessible formats upon request

EXPLORING CONSERVATION RATES

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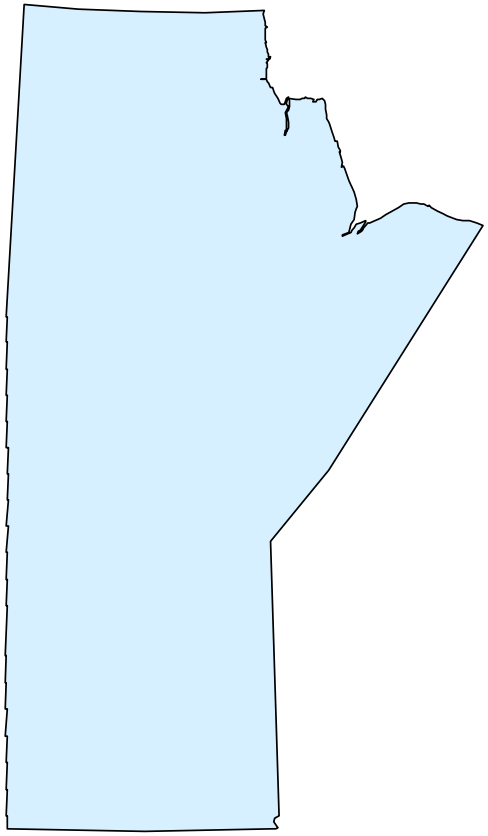
Underlying Criteria

- Revenue Neutral – recover revenue requirement
- Achieve Conservation Objectives – encourage Culture of Conservation and achieve energy savings
- Simplicity – easy to understand
- Fairness – reasonable balance of winners & losers

Energy Conservation Rates
Current Power Smart Plan



- Residential:
  - 160 GW.h by 2030/31
- Commercial:
  - 260 GW.h by 2030/31
- Potential DSM:
  - Total Cost: $30 Million
  - Levelized Utility Cost: ~ 0.4¢ per kW.h

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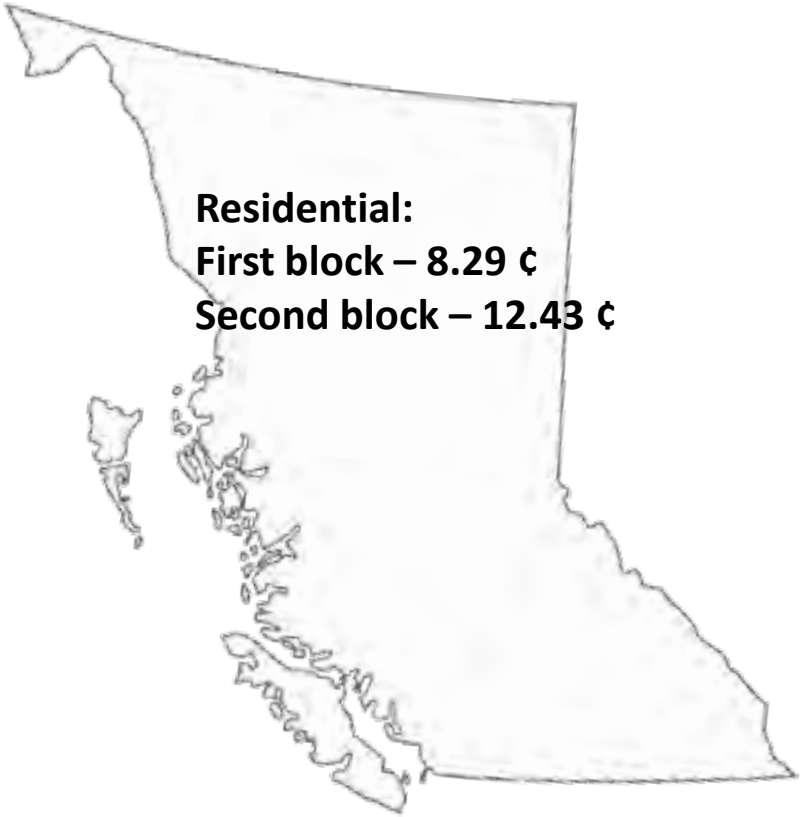
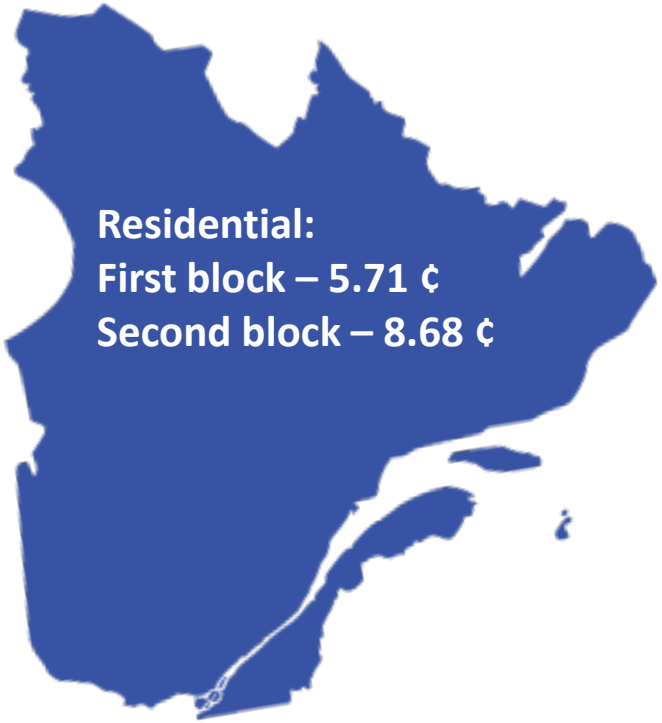
Energy Conservation Rates
Other Jurisdictions





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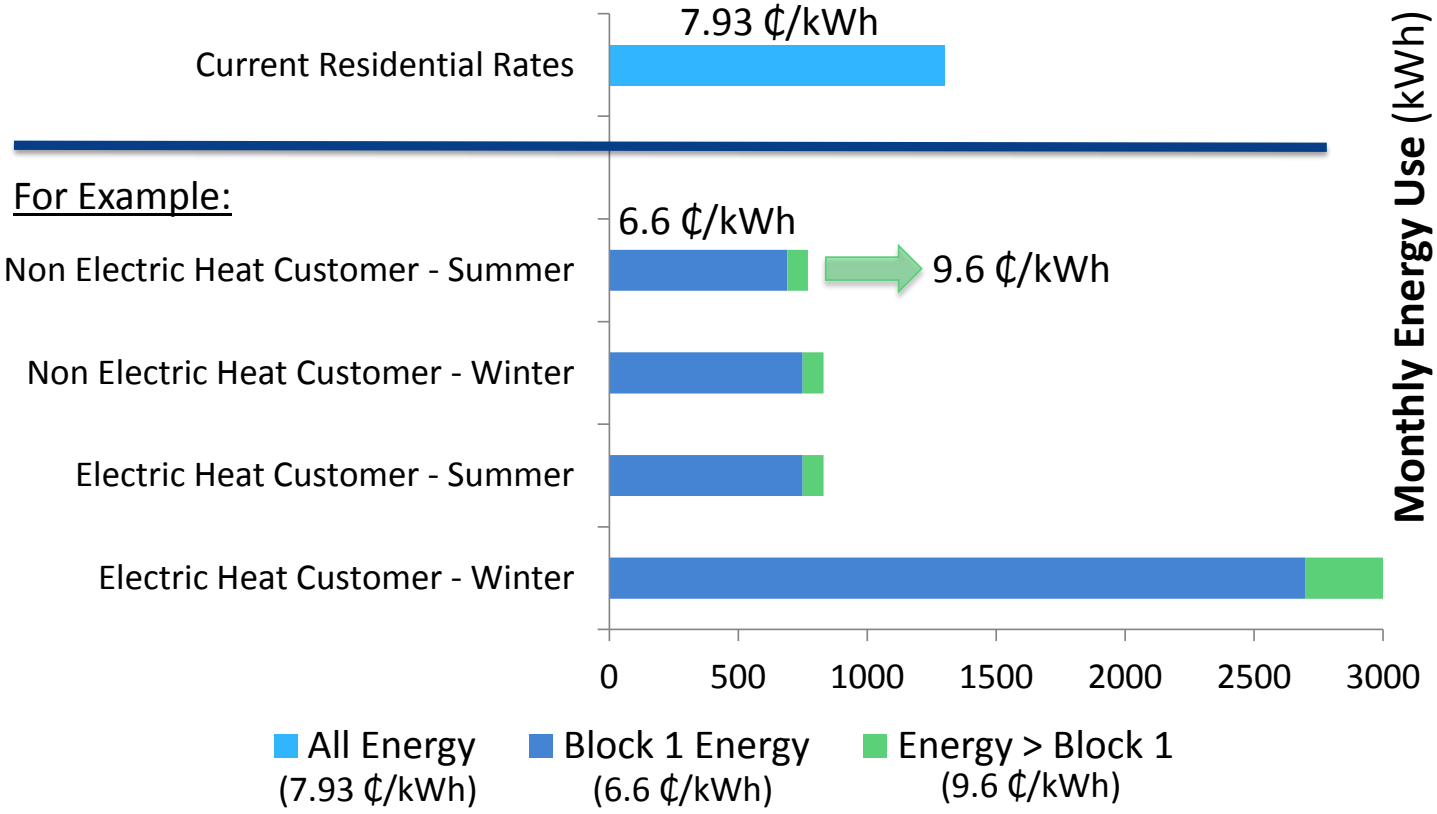
Conservation Rates – Inclining Block Rate Structure



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Planning & Design Considerations – Inclining Block Rates

- Price structure
  - Annual / Seasonal
  - Scale of Differential - 2¢, 3¢, or 4¢ per kWh
- Block 1 Thresholds
  - Where do we set the threshold?
    - % of Median monthly energy use; equal blocks?
- Price Elasticity
  - Range 0.10 – 0.25
  - Allocation of impacts between Rate and DSM Programming
- Timing of Introduction

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Additional Considerations

- Distribution of bill impacts on customer sectors:
  - Electric Space Heat & non-Electric Space Heat Customers
  - LICO-125 customers
- Effect of planned rate increases.
- Impact of weather variation (cold winter/warm winter)
  - On customer bills
  - On Corporation's revenue

Example 1:

- Objective to be Revenue Neutral for the Residential Class overall after anticipated price response.
  - Assume Price elasticity of 0.15.
- Different block thresholds for electric space heated (ESH) customers and all other customers.
  - Set block 1 thresholds at the same % of median monthly energy use (e.g. 90% for Electric Space Heat customers and 90% for Other customers)
- Annual rates for each block (same in winter & summer) with set rate differential of 3¢ per kWh.

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Example 1

Block 1 Thresholds – *Same %*

- Setting Block 1 threshold at same % of median usage (*e.g.*, 90%) for both Electric Space Heat and Other customers creates bill impact differentials

Space Heat Type	Season	Block 1 Threshold -- % of Median Monthly Bill	
		90%	90%
Other	Winter	735	
	Summer	634	
Electric Space Heat	Winter		2,734
	Summer		1,066

- Model "solves" for the Block 1 and Block 2 rates.

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Example 1

Block 1 Threshold: 90% for Other & Electric Space Heat

Space Heat Types	Averge Annual Bill (Before Conservation Rates)	Block Rate Structure (¢/kWh)			Energy Savings from Price Response		Annual Bill Changes ($)		% Bill Changes	
		Rate Gap	Block 1 Rate	Block 2 Rate	Total GWh	% Change	**Before** Price Response	**After** Price Response	**Before** Price Response	**After** Price Response
Other	$905	3¢	6.61¢	9.61¢	-93	-2.5%	$45	$19	4.8%	2.0%
Electric Space Heat	$1,992				-70	-2.4%	$1	-$54	0.1%	-2.8%
Total	$1,184				-163	-2.4%	$34	$0	2.8%	0.0%

Bill impacts *before* price response

Revenue Neutral but Bill Impacts differ by Space Heat Type

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Example 1

Annual Bill Impacts *by Income Status*

Space Heat Type	Income Category	Average Annual Bill (Before Conservation Rate)	After Price Response		% of Category
			Average Bill Change	% Bill Change	
Other	Less than $40,000	$739	$13	1.7%	23.2%
	$40,000 to $75,000	$863	$9	1.0%	33.6%
	More than $75,000	$1,083	$33	3.0%	43.2%
	Average	**$905**	**$19**	**2.0%**	**100%**
Electric Space Heat	Less than $40,000	$1,806	-$65	-3.7%	22.9%
	$40,000 to $75,000	$1,907	-$69	-3.7%	38.8%
	More than $75,000	$223	-$28	-1.3%	38.2%
	Average	**$1,992**	**-$54**	**-2.8%**	**100%**
Total		$1,184	$0	0.0%	100%

- ***Block 1 = 90%/90%***
- ***ϵ = -0.15***
- ***3 ¢ /kWh Rate Differential***

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Example 1

Annual Bill Impacts ***by LICO125 Status***

Space Heat Type	Low Income Status	Average Annual Bill (Before Conservation Rate)	After Price Response		% of Category
			Average Bill Change	% Bill Change	
Other	LICO125	$800	$19	2.3%	26.8%
	Non-LICO125	$952	$19	1.9%	73.2%
	Average	**$905**	**$19**	**2.0%**	**100%**
Electric Space Heat	LICO125	$1,908	-$62	-3.3%	27.4%
	Non-LICO125	$2,026	-$51	-2.5%	72.6%
	Average	**$1,992**	**-$54**	**-2.8%**	**100%**
Total		$1,184	$0	0.0%	100%

- ***Block 1 = 90%/90%***
- ***ϵ = -0.15***
- ***3 ¢ /kWh Rate Differential***

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Example 1

Annual Bill Impacts and Average Monthly Usage
Best and Worst Case Outcomes

Low Income Status	Space Heating Type	Best/Worst Case	Current Rate Structure		With Conservation Rate Structure			
					Annual Bill Changes ($)		% Bill Changes	
			Monthly kWh	Annual Bill (Before Conservation Rate)	Before Price Response	After Price Response	Before Price Response	After Price Response
All Customers	Other	Best	599	$636	-$65	-$73	-10.7%	-12.3%
		Worst	8,418	$7,619	$1,944	$1,626	22.7%	19.3%
	Electric Space Heat	Best	1,628	$1,578	-$156	-$184	-10.4%	-12.4%
		Worst	6,956	$6,364	$1,127	$867	16.3%	12.8%
LICO125	Other	Best	591	$632	-$65	-$73	-10.8%	-12.2%
		Worst	3,900	$3,615	$830	$678	20.7%	17.2%
	Electric Space Heat	Best	1,645	$1,595	-$152	-$180	-10.0%	-12.0%
		Worst	5,045	$4,573	$742	$549	15.0%	11.3%

- ***Block 1 = 90%/90%***
- ***ϵ = -0.15***
- ***3 ¢ /kWh Rate Differential***

For discussion purposes only.

Example 1:

- Revenue Neutral within the customer categories and for Residential Class overall after anticipated price response.
  - Assume Price elasticity of 0.15.
- Different block thresholds for electric space heated customers and all other customers.
  - Set block 1 thresholds at a % of median monthly energy use to achieve revenue neutrality within customer category (e.g. 90% for "other" customers and 66% for Electric Space Heat customers)
- Annual rates for each block (same in winter & summer) with set rate differential of 3¢ per kWh.

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Example 2

Block 1 Thresholds – Different %

- Set the Block 1 thresholds to achieve comparable average bill impacts:

Space Heat Type	Season	Block 1 Threshold -- % of Median Monthly Bill	
		90%	66%
Other	Winter	735	
	Summer	634	
Electric Space Heat	Winter		2,005
	Summer		782

- Set the Block 1 threshold for 90% of Median and model "solves" for the Electric Space Heat Block 1 threshold and solves for the Block 1 and Block 2 rates.

For discussion purposes only.

Example 2

Block 1 Threshold: 90% for Other & 66% for Electric Space Heat

Space Heat Types	Averge Annual Bill (Before Conservation Rates)	Block Rate Structure (¢/kWh)			Energy Savings from Price Response		Annual Bill Changes ($)		% Bill Changes	
		Rate Gap	Block 1 Rate	Block 2 Rate	Total GWh	% Change	**Before** Price Response	**After** Price Response	**Before** Price Response	**After** Price Response
Other	$905	3¢	6.41¢	9.41¢	-80	-2.1%	$22	$0	2.4%	0.0%
Electric Space Heat	$1,992				-79	-2.6%	$61	-$1	3.0%	0.0%
Total	$1,184				-159	-2.4%	$32	$0	2.7%	0.0%

Bill impacts *before* price response

Revenue Neutral; Same average bill impacts

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Example 2

Annual Bill Impacts and Average Monthly Usage
Best and Worst Case Outcomes

Low Income Status	Space Heating Type	Best/Worst Case	Current Rate Structure		With Conservation Rate Structure			
					Annual Bill Changes ($)		% Bill Changes	
			Monthly kWh	Annual Bill (Before Conservation Rate)	Before Price Response	After Price Response	Before Price Response	After Price Response
All Customers	Other	Best	599	$636	-$79	-$86	-13.3%	-14.6%
		Worst	8,418	$7,619	$1,738	$1,458	20.6%	17.5%
	Electric Space Heat	Best	1,628	$1,578	-$140	-$147	-14.0%	-14.7%
		Worst	6,956	$6,364	$1,130	$902	16.3%	13.3%
LICO125	Other	Best	591	$632	-$79	-$86	-13.4%	-14.6%
		Worst	3,900	$3,615	$733	$599	18.5%	15.3%
	Electric Space Heat	Best	1,645	$1,595	-$140	-$147	-14.0%	-14.7%
		Worst	5,045	$4,573	$767	$596	15.5%	12.3%

- ***Block 1 = 90%/66%***
- ***ϵ = -0.15***
- ***3 ¢ /kWh Rate Differential***

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Example Comparison

- Overall energy use reductions range from 100 GWh for 2-cent price differential to 200 GWh for a 4-cent differential.
- Reduced Block 1 Threshold for Electric Space Heat customers (66% of median, from 90%) balances bill changes between Electric Space Heat and Other Heat customers.
- Low-usage customers experience bill *reductions*; higher-usage customers have bill *increases.*
- Lower Income customers and LICO125 customers with electric space heat, on average, benefit; however LICO125 customers with Other Heating, on average, do not benefit.
- Customer-level bill changes range from ~15% bill savings (very low energy consumers) to ~17% bill increases (very high energy consumers)

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Weather-Sensitivity

Example 2
Bill Impacts with Varying Weather
by Fiscal year and LICO Status

Space Heat Type	Low Income Status	% Bill Change				
		2011 (Mild)	2012 (Norm)	2013 (Cold)	2014 (Norm)	Average
Other	LICO125	-0.6%	0.3%	0.8%	0.4%	0.2%
	Non-LICO125	-0.7%	0.0%	0.4%	-0.2%	-0.1%
	Average	**-0.7%**	**0.1%**	**0.5%**	**0.0%**	**0.0%**
Electric Space Heat	LICO125	-2.6%	-0.6%	0.6%	-0.9%	-0.9%
	Non-LICO125	-1.3%	0.4%	1.4%	0.2%	0.2%
	Average	**-1.6%**	**0.1%**	**1.2%**	**-0.1%**	**-0.1%**
Total		-1.1%	0.1%	0.8%	-0.1%	-0.1%

Results by year show fiscal 2012 & 2014 similar to average.
Mild year (2011/2012) produces modest bill reductions relative to average.
Cold year (2013/2014) produces modest bill increases relative to average.

- ***B1 = 90%/65%***
- ***ϵ = -0.15***
- ***3 ¢ /kWh Rate Differential***

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Circling Back to Planning & Design Considerations…

Circling Back:

Your thoughts on Planning & Design Considerations?

- Price Elasticity
- Block 1 Thresholds
  - Revenue Neutrality
  - What level?
    - % of Median monthly energy use; equal blocks?
- Price structure
  - Annual / seasonal
  - Scale of Differential
- Timing of Introduction

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Thank you.

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EXPLORING CONSERVATION RATES

Residential Conservation Rates Sub-Group

January 12, 2017

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Energy Conservation Rates

- Component of Current Power Smart Plan
- Initiative identified under Manitoba's Climate Change and Green Economy Action Plan under previous Government
  - New Plan expected under new Government
- Interest by Manitoba Public Utilities Board

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Purpose of Sub-Group

- Provide a forum for input/feedback in the development of possible Residential Conservation Rates.
- Balance achieving conservation objectives with meeting rate design objectives of simplicity and fairness while recovering required revenues with the Residential Rate Class.

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Your thoughts on Planning & Design Considerations?

- Price Elasticity
- Block 1 Thresholds
  - Revenue Neutrality
  - What level?
    - % of Median monthly energy use; equal blocks?
- Price structure
  - Annual / seasonal
  - Scale of Differential
- Timing of Introduction

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Price Elasticity

- Range 0.10 – 0.25
  - Does Elasticity differ among market sectors?

Table 1. Summary of own-price elasticities in AEO2014 Residential and Commercial Demand Modules

	Short Run			Long Run
	Year 1	Year 2	Year 3	Year 25
Residential				
Electricity	-0.12	-0.21	-0.24	-0.40
Natural Gas	-0.08	-0.14	-0.17	-0.28
Distillate Fuel	-0.08	-0.14	-0.17	-0.20
Commercial				
Electricity	-0.12	-0.20	-0.25	-0.82
Natural Gas	-0.14	-0.24	-0.29	-0.45
Distillate Fuel	-0.14	-0.24	-0.29	-0.42

U.S. Energy Information Administration – Price Elasticities for Energy Use in Buildings of the United States, October 2014

Table E.4. Step 2 Price Elasticity by Customer Characteristics

Customer Segment	Step 2 Elasticity Low Estimate	Step 2 Elasticity High Estimate
Region		
Lower Mainland	-0.11	-0.13
North	-0.12	-0.15
Southern Interior	-0.08	-0.12
Vancouver Island	-0.15	-0.15
Dwelling Type		
Single Family Dwelling	-0.08	-0.14
Row/Townhouse	-0.06	-0.07
Apartment	-0.03	-0.04
Mobile Home	-0.10	-0.10
Other	-0.05	0.09
Space Heating		
Electric	-0.10	-0.14
Non-Electric	-0.08	-0.09
Consumption		
1350 kWh - 2400 kWh	-0.13	-0.01
2400 kWh and above	-0.16	-0.18

Evaluation of the Residential Inclining Block Rate F2009-F2012, BC Hydro, June 2014

- Allocation of impacts between Rate and DSM Programming

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Block 1 Thresholds

- Other jurisdictions:
  - Ranges of 300 kWh to 1000 kWh depending upon area, season, and heating type.
- Examples explored so far:

Space Heat Type	Season	Block 1 Thresholds -- % of Median Monthly Bill	
		Example 1	Example 2
		90%	90% Other/ 66% Electric
Other Fuel	Winter	735	735
	Summer	634	634
Electric Space Heat	Winter	2,734	2,005
	Summer	1,066	782

  - Based on all housing types: single detached, multi attached, apartments.

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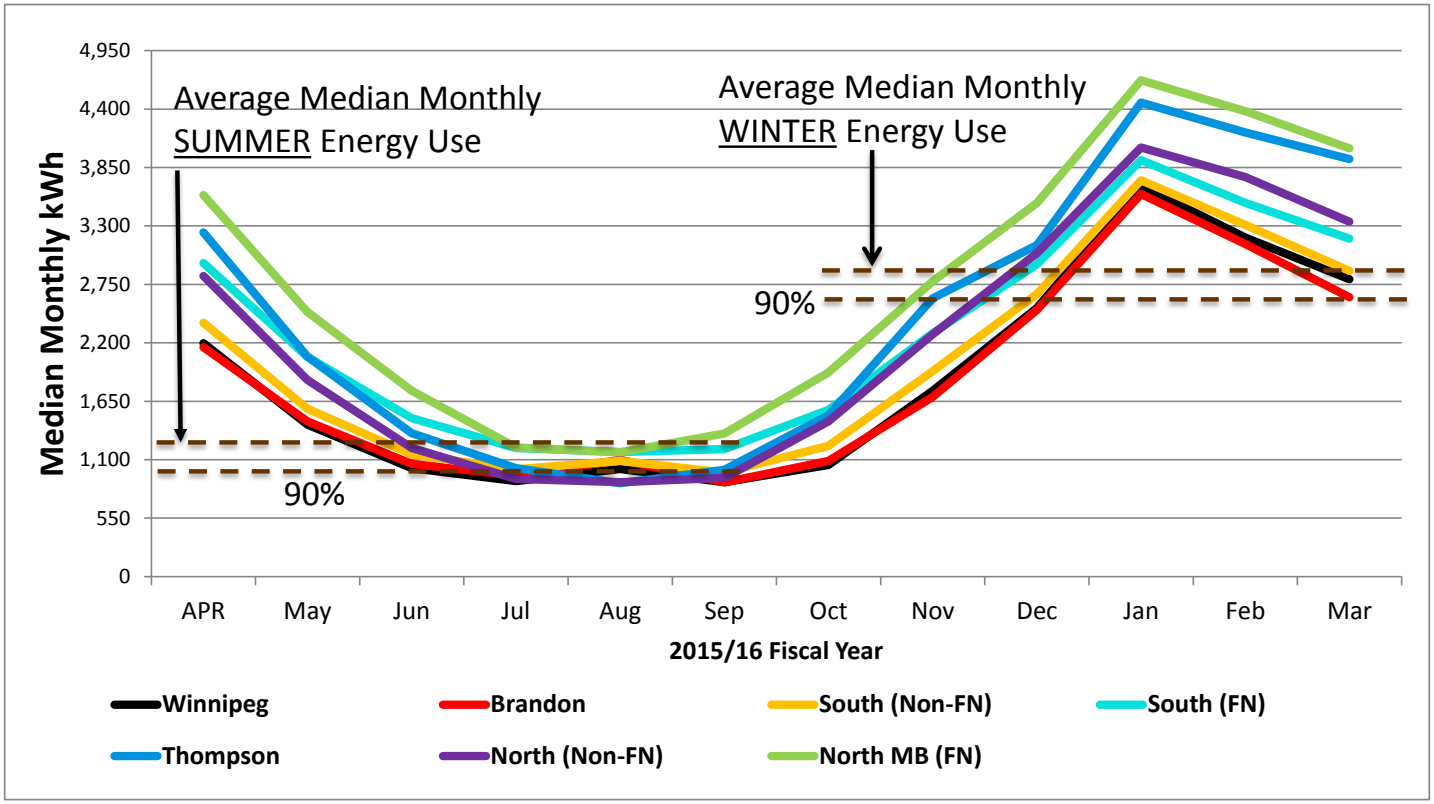
Median Monthly Billed kWh for Electrically Heated Single Detached Homes



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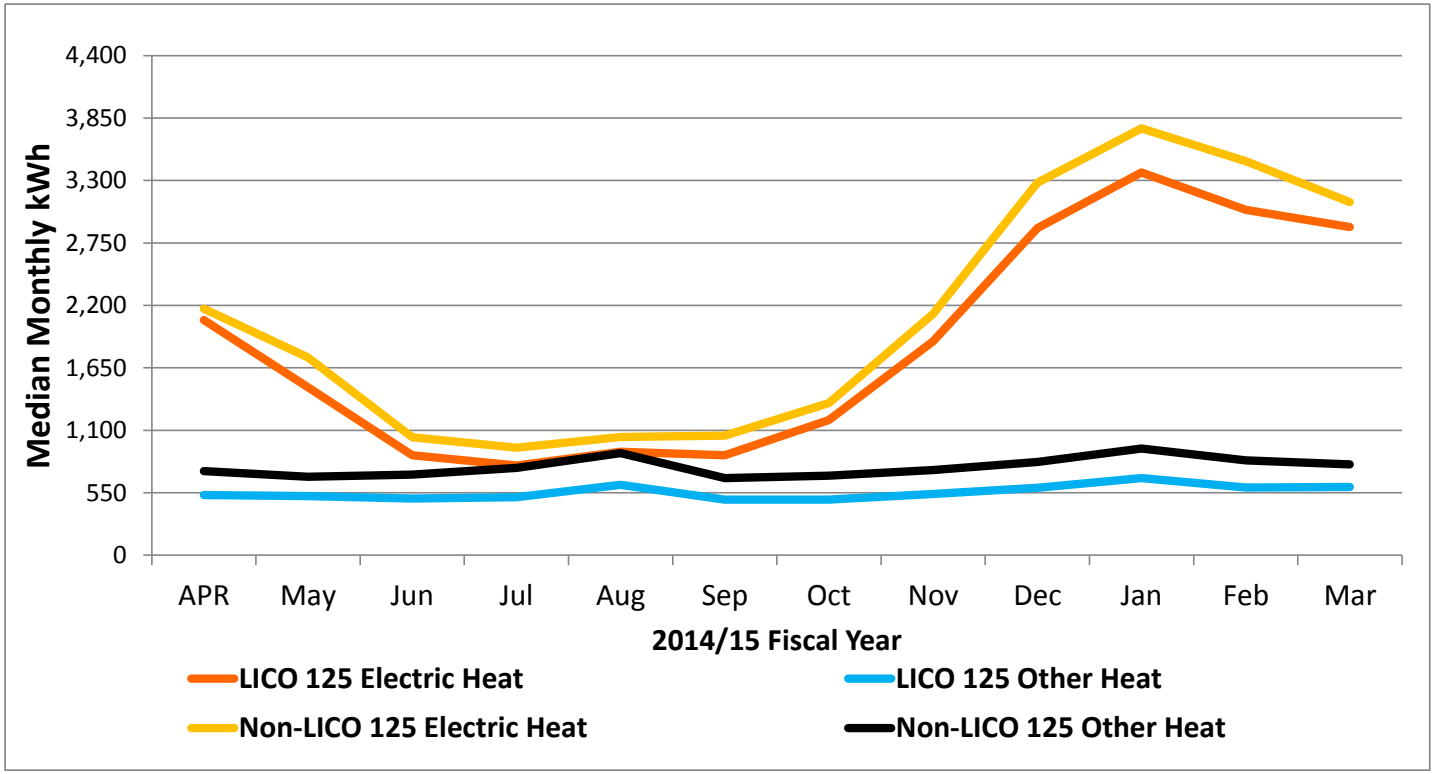
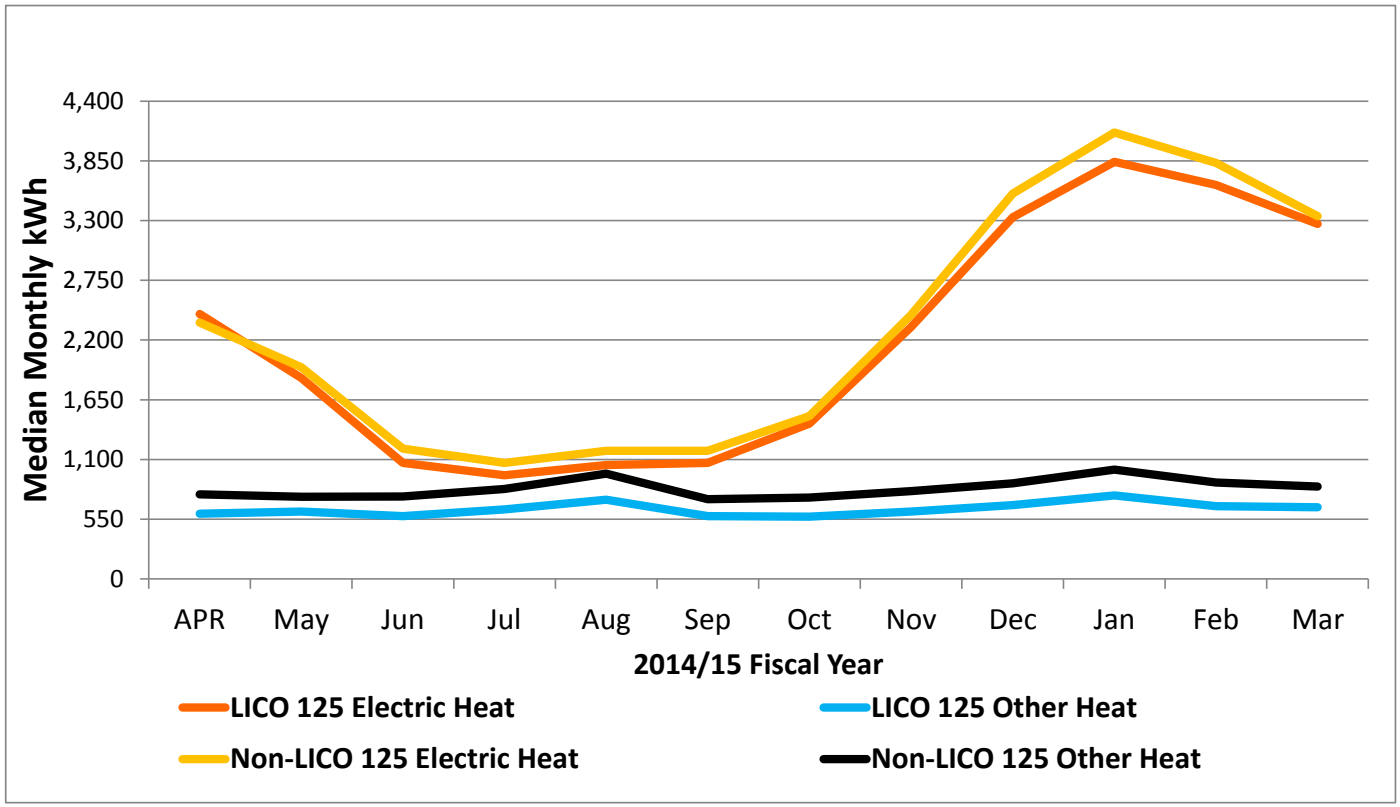
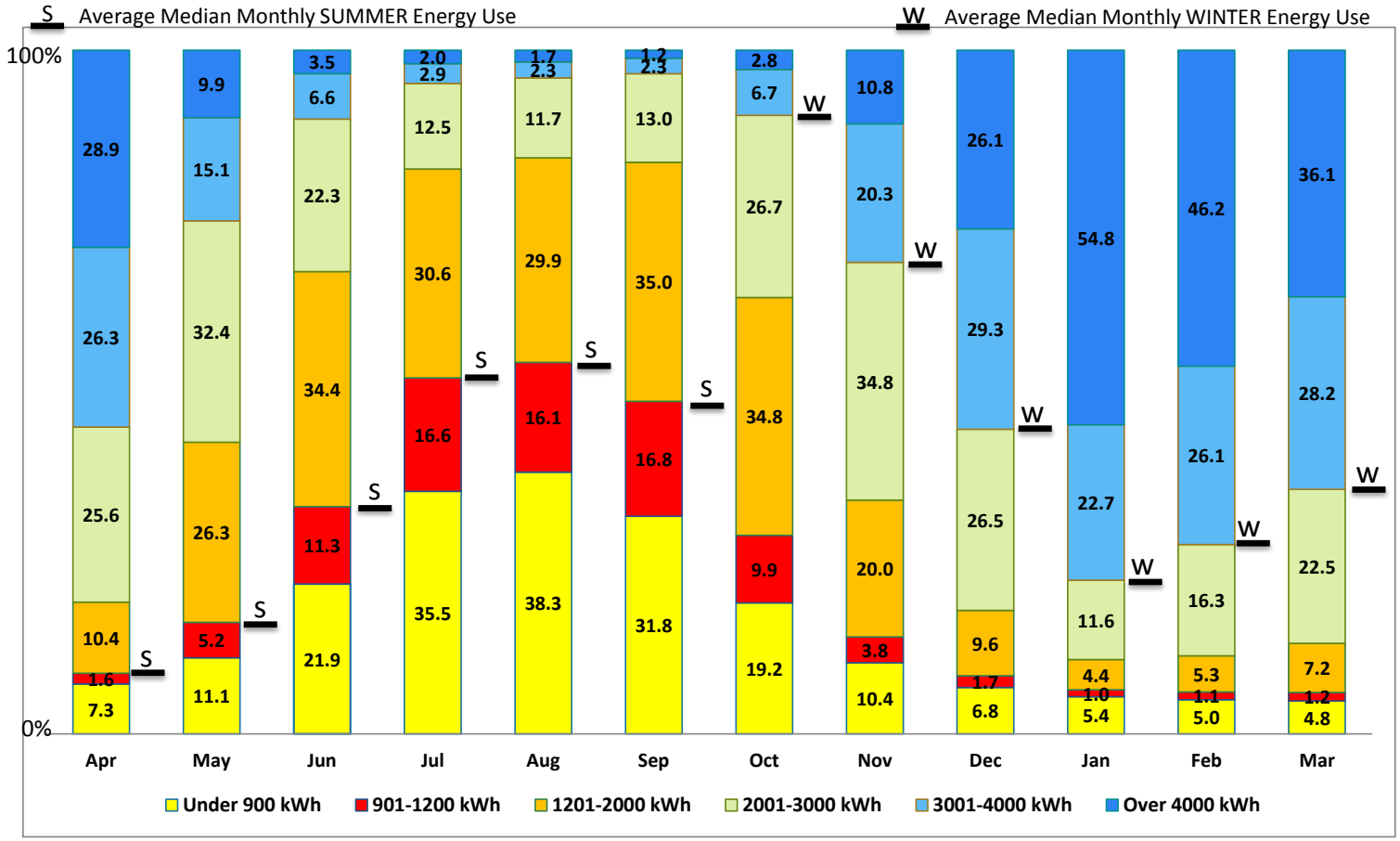
Median Monthly Billed kWh for All Residential Dwelling Types



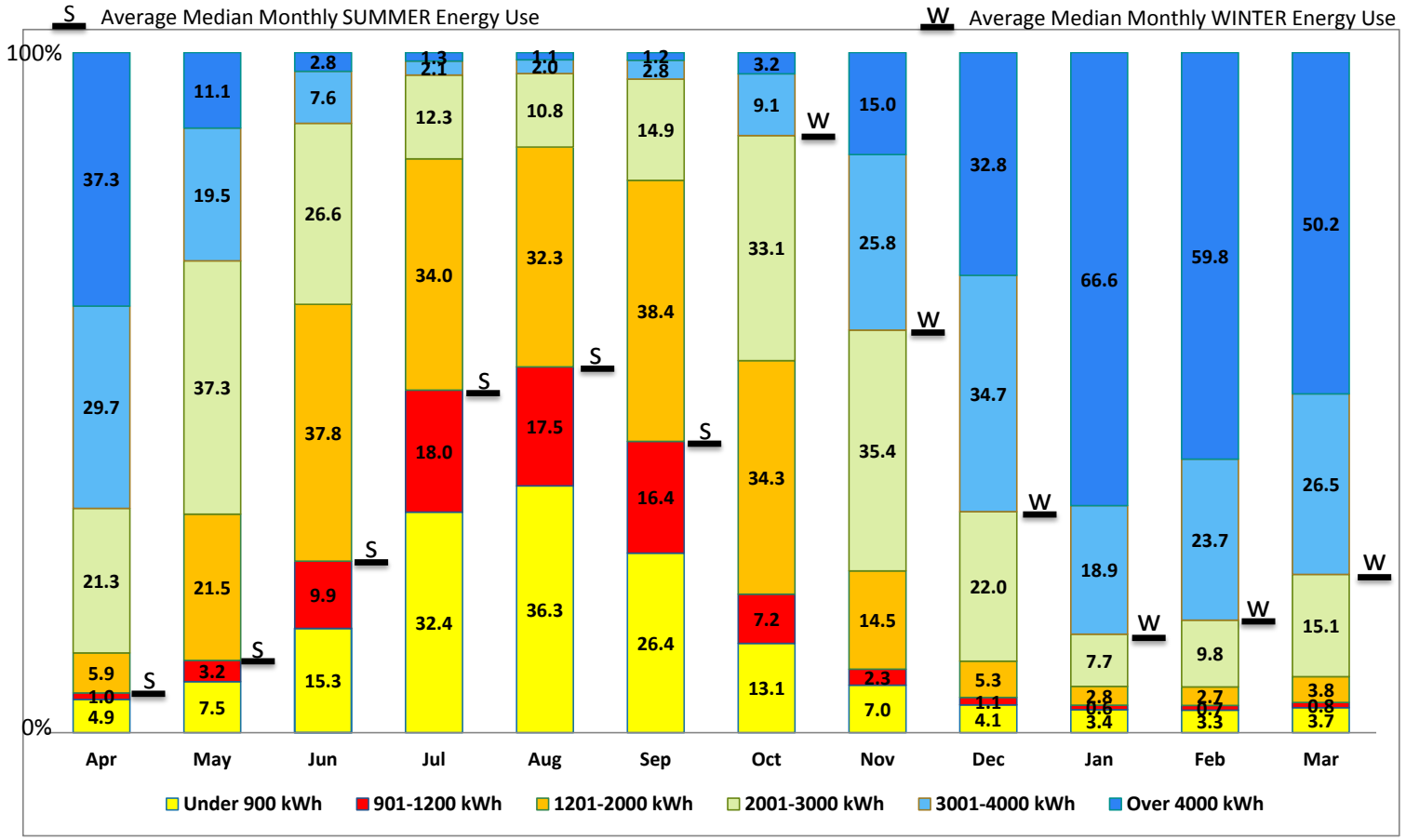
Median Monthly Billed kWh for Single Detached Dwellings



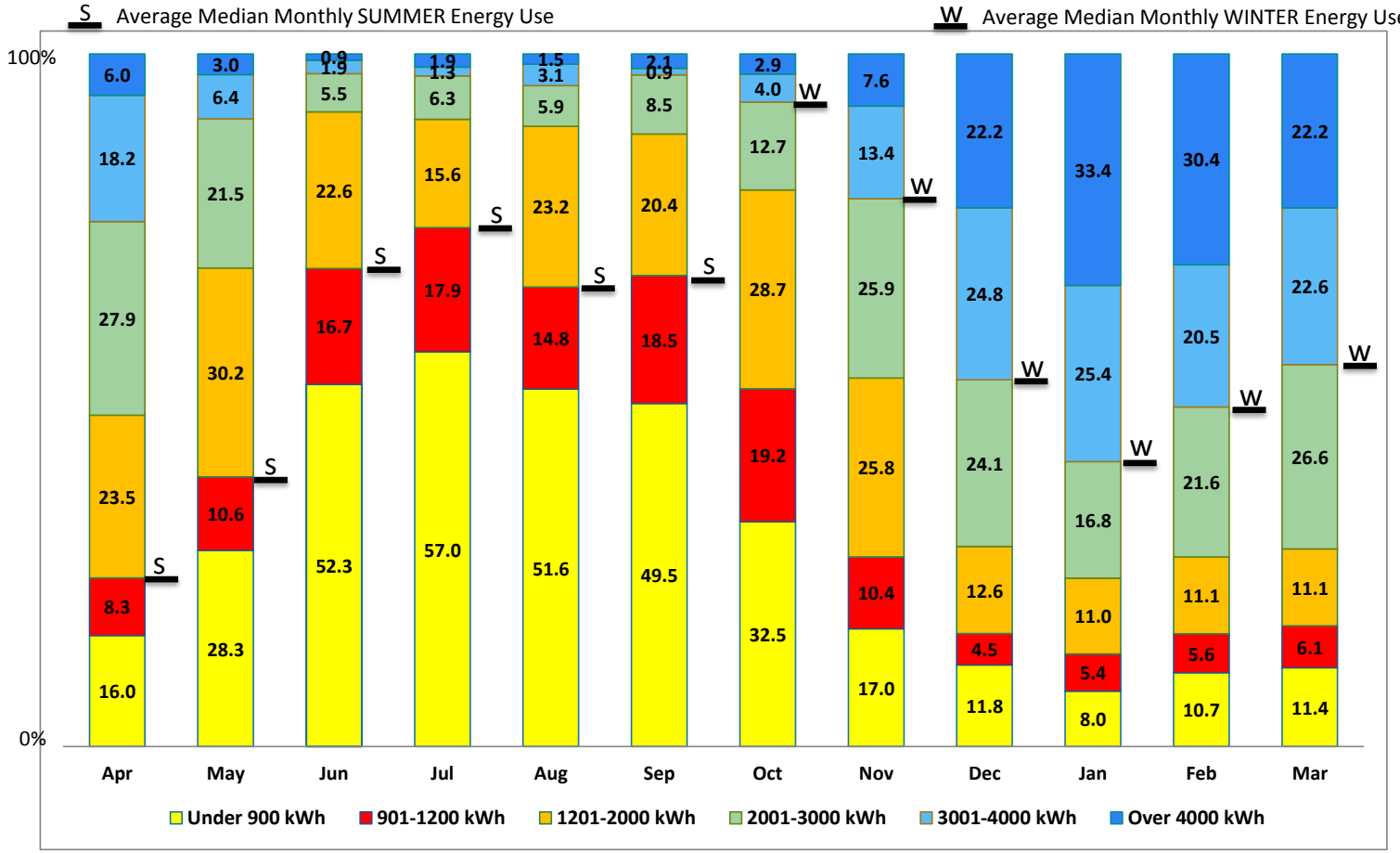
% Distribution of Monthly Billed kWh for Electric Heat Single Detached Homes
All First Nations Communities



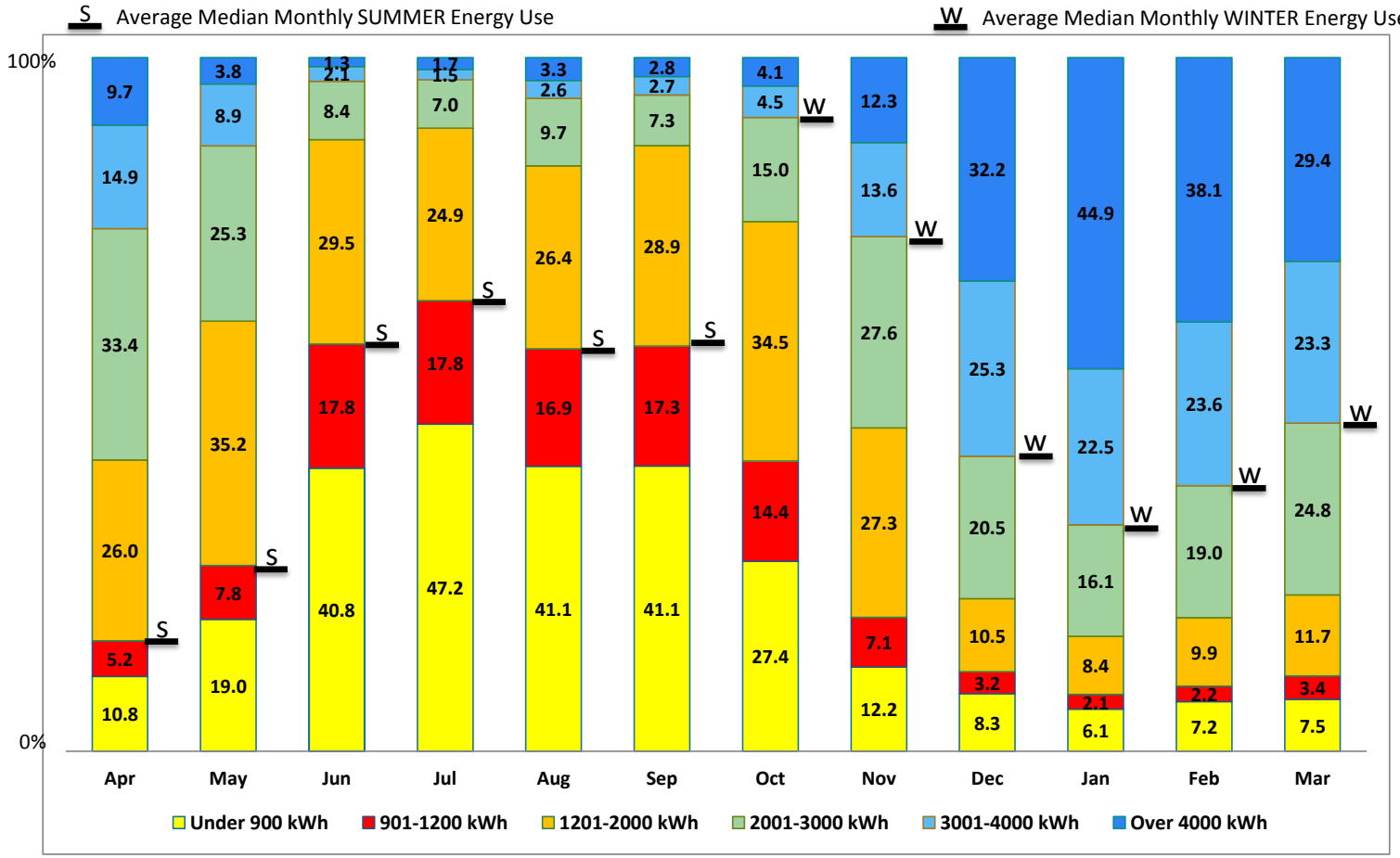
% Distribution of Monthly Billed kWh for Electric Heat Single Detached Homes
Manitoba Keewatinowi Okimakanak (MKO) Communities



% Distribution of 2014/15 Billed kWh Ranges by Month for All Dwelling Types
LICO 125 Electric Space Heat



% Distribution of 2014/15 Billed kWh Ranges by Month for All Dwelling Types
Non-LICO 125 Electric Space Heat



Price Structure

- Annual / Seasonal
- Scale of Differential
  - Analysis to date based on differentials of 2¢, 3¢, or 4¢ per kWh
  - Set differential based on %?

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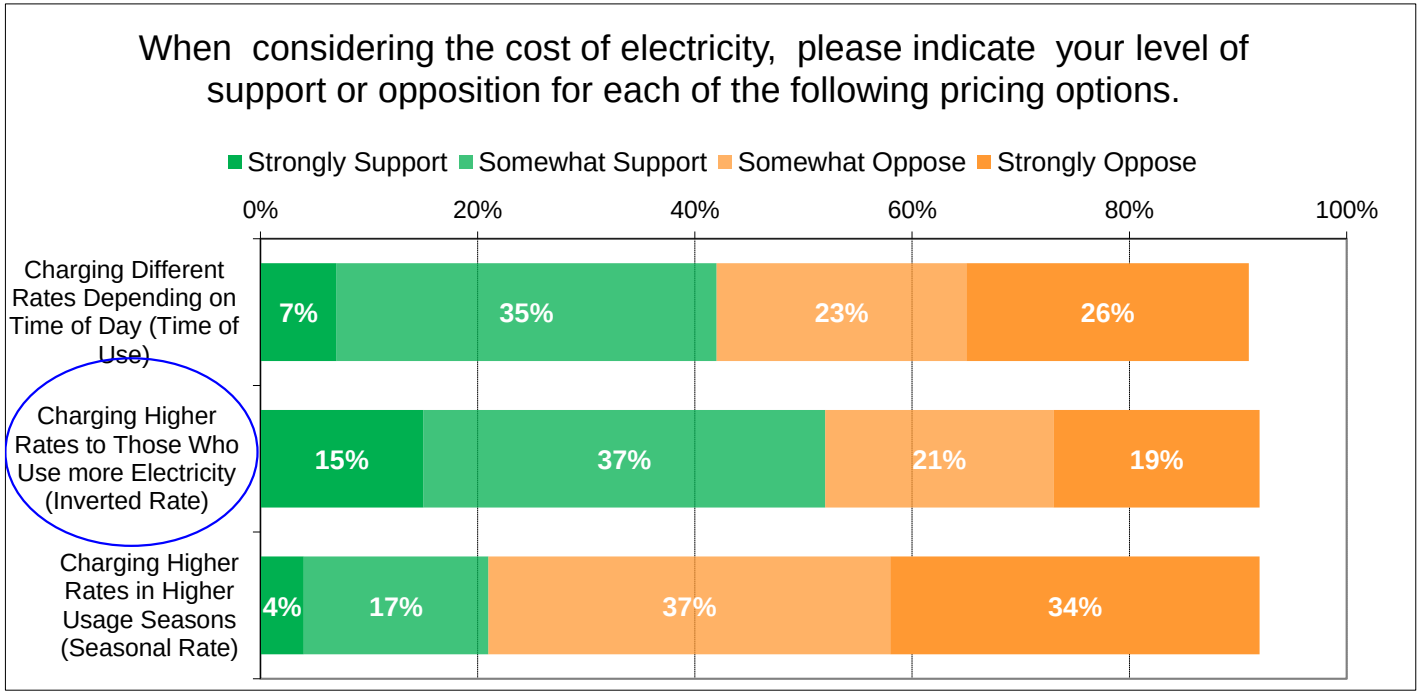
Market Acceptance & Timing

- Compounding effect with planned rate increases.
- Timing of need for new resources
- What do customers think of an inclining block rate structure?
  - Some general perspectives available
  - Additional information required

Customer Perceptions of Various Rate Structures (2013)



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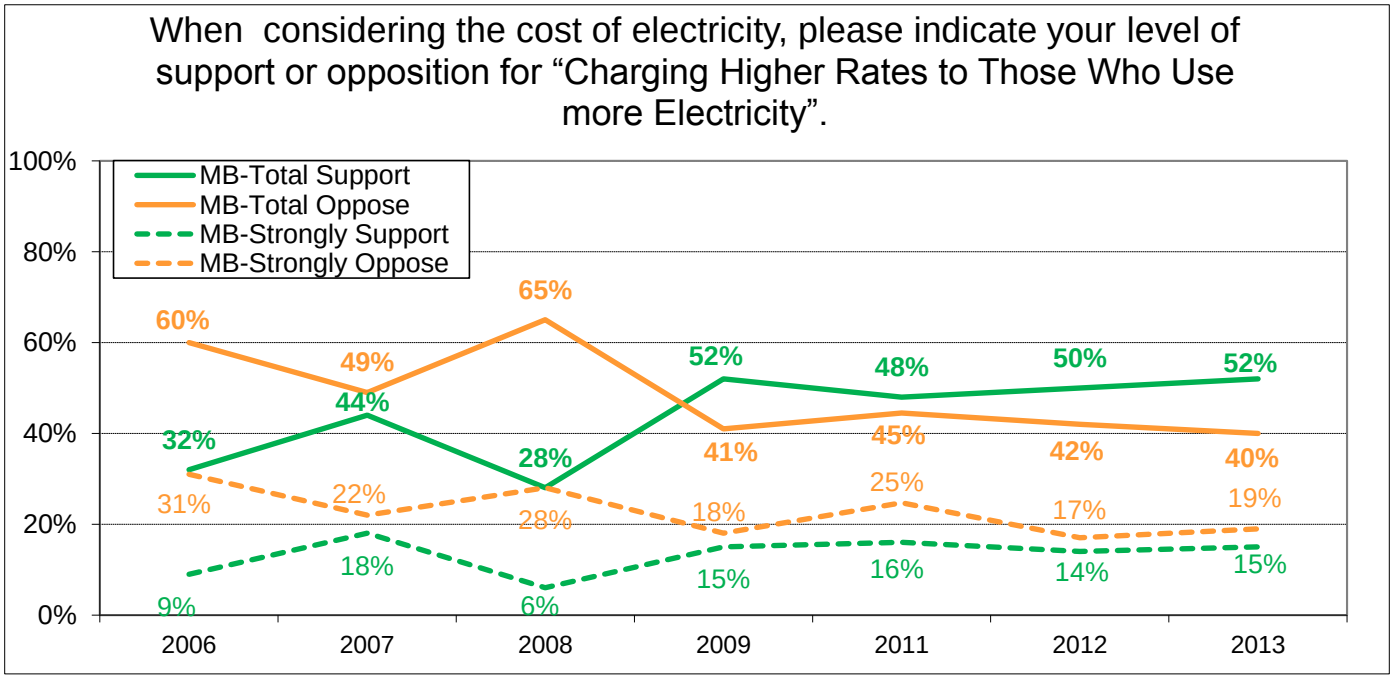
Customer Perceptions of Inverted Rate Structures



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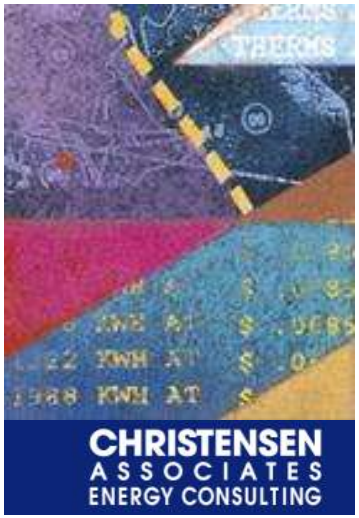
Next Steps

- Additional Customer Research
  - Quarterly Customer Satisfaction Tracking Study
  - Next Residential Energy Use Survey
  - Other opportunities…
- Additional Energy/Bill Analyses
- Additional Block/Price Structure Analyses



Initial Assessment: MH's Conservation Rate Initiative

Dave Armstrong
Steve Braithwait
Robert Camfield
Christensen Associates Energy Consulting

March, 2016

Approach

- Data: MH sample of residential billing data
  - ≈ 285,000 records over four years
  - no data errors found
- Analysis Framework
  - Most recent 12 months covering 4743 customers
  - Classic model of electricity demand - $D=f(P) = \alpha \cdot P^{\epsilon}$
  - Assumes consumers respond to prices of the marginal block, in isolation
- Conservation rate scenarios
  - Two-block tariff structure
    - alternative block boundaries set at 600, 750, 900, 1100kWh/month
  - Price response parameters (elasticity of demand wrt own price)
    - parameter set = -0.10, -0.15, -0.25
  - Customer charge held unchanged

Baseline Conditions, Definitions of Scenarios

2015 Baseline: Status Quo Pricing

Total Revenue (000)	$545,956
Total GWh	6,778.5
Average Price/kWh	$0.0805

Alternative Rate Block Scenarios	**1**	**2**	**3**	**4**
Block 1 length (kWh)	600	750	900	1100
GWh in Block 1	2,730.2	3,223.5	3,642.9	4,105.1
% of Total	40%	48%	54%	61%
GWh in Block 2	4,048.3	3,555.0	3,135.6	2,673.5
% of Total	0.60	0.52	0.46	0.39
Customer Charge Revenue ($ 000)	$38,867	$38,867	$38,867	$38,867
Block 1 kWh Revenue ($ 000)	$163,811	$193,410	$218,575	$246,305
Customer + Block 1 Revenue ($ 000)	$202,678	$232,276	$257,441	$285,171
Block 2 kWh Revenue ($ 000)	$343,278	$313,679	$288,514	$260,784
Customer, Blocks 1&2 Revenue ($ 000)	$545,956	$545,956	$545,956	$545,956

Block 1 Price	**$0.0600**	**$0.0600**	**$0.0600**	**$0.0600**
Revenue Neutral Block 2 Price	**$0.0848**	**$0.0882**	**$0.0920**	**$0.0975**
Block 2 Price: % Change from Flat Rate	**10.0%**	**14.0%**	**18.2%**	**24.0%**

Analysis Results
(price response = -0.10)

Impacts Demand Response to Conservation Rates **Price Elasticity: -0.10**

Block 1 length (kWh)	600	750	900	1100
% Customers with Increasing Usage	24.9%	32.7%	39.6%	47.1%
% Customers with Decreasing Usage	75.0%	67.3%	60.4%	52.9%
Increase in GWh	7.23	11.66	16.74	23.73
Decrease in GWh	-70.98	-86.01	-98.83	-112.46
Net Change in Total GWh	-63.74	-74.35	-82.10	-88.73
% of Total	-0.94%	-1.10%	-1.21%	-1.31%

Block 1 Price	$0.0600	$0.0600	$0.0600	$0.0600
Revenue Neutral Block 2 Price	$0.0848	$0.0882	$0.0920	$0.0975
Block 2 Price: % Change from Flat Rate	10.0%	14.0%	18.2%	24.0%

Analysis Results…2
(price response = -0.18)

Impacts Demand Response to Conservation Rates **Price Elasticity: -0.18**

Block 1 length (kWh)	600	750	900	1100
% Customers with Increasing Usage	25.0%	32.8%	39.7%	47.3%
% Customers with Decreasing Usage	74.9%	67.1%	60.2%	52.7%
Increase in GWh	13.19	21.27	30.53	43.28
Decrease in GWh	-127.00	-153.60	-176.13	-199.83
Net Change in Total GWh	-113.81	-132.33	-145.60	-156.56
% of Total	-1.68%	-1.95%	-2.15%	-2.31%

Block 1 Price	$0.0600	$0.0600	$0.0600	$0.0600
Revenue Neutral Block 2 Price	$0.0848	$0.0882	$0.0920	$0.0975
Block 2 Price: % Change from Flat Rate	10.0%	14.0%	18.2%	24.0%

Analysis Results…3
(price response = -0.25)

Impacts Demand Response to Conservation Rates			**Price Elasticity:**	**-0.25**
Block 1 length (kWh)	600	750	900	1100
% Customers with Increasing Usage	25.1%	32.8%	39.9%	47.5%
% Customers with Decreasing Usage	74.8%	67.1%	60.0%	52.4%
Increase in GWh	18.52	29.89	42.89	60.81
Decrease in GWh	-175.46	-211.86	-242.49	-274.43
Net Change in Total GWh	-156.94	-181.97	-199.60	-213.62
% of Total	-2.32%	-2.68%	-2.94%	-3.15%

Block 1 Price	$0.0600	$0.0600	$0.0600	$0.0600
Revenue Neutral Block 2 Price	$0.0848	$0.0882	$0.0920	$0.0975
Block 2 Price: % Change from Flat Rate	10.0%	14.0%	18.2%	24.0%

Analysis Summary

Impacts Demand Response to Conservation Rates			**Price Elasticity:**	**-0.10**
Block 1 length (kWh)	600	750	900	1100
% Customers with Increasing Usage	24.9%	32.7%	39.6%	47.1%
% Customers with Decreasing Usage	75.0%	67.3%	60.4%	52.9%
Increase in GWh	7.23	11.66	16.74	23.73
Decrease in GWh	-70.98	-86.01	-98.83	-112.46
Net Change in Total GWh	-63.74	-74.35	-82.10	-88.73
% of Total	-0.94%	-1.10%	-1.21%	-1.31%

Impacts Demand Response to Conservation Rates			**Price Elasticity:**	**-0.18**
Block 1 length (kWh)	600	750	900	1100
% Customers with Increasing Usage	25.0%	32.8%	39.7%	47.3%
% Customers with Decreasing Usage	74.9%	67.1%	60.2%	52.7%
Increase in GWh	13.19	21.27	30.53	43.28
Decrease in GWh	-127.00	-153.60	-176.13	-199.83
Net Change in Total GWh	-113.81	-132.33	-145.60	-156.56
% of Total	-1.68%	-1.95%	-2.15%	-2.31%

Impacts Demand Response to Conservation Rates			**Price Elasticity:**	**-0.25**
Block 1 length (kWh)	600	750	900	1100
% Customers with Increasing Usage	25.1%	32.8%	39.9%	47.5%
% Customers with Decreasing Usage	74.8%	67.1%	60.0%	52.4%
Increase in GWh	18.52	29.89	42.89	60.81
Decrease in GWh	-175.46	-211.86	-242.49	-274.43
Net Change in Total GWh	-156.94	-181.97	-199.60	-213.62
% of Total	-2.32%	-2.68%	-2.94%	-3.15%

ROUND TWO ANALYSIS RESULTS

MANITOBA HYDRO CONSERVATION RATE STUDY

prepared by
CHRISTENSEN ASSOCIATES ENERGY CONSULTING

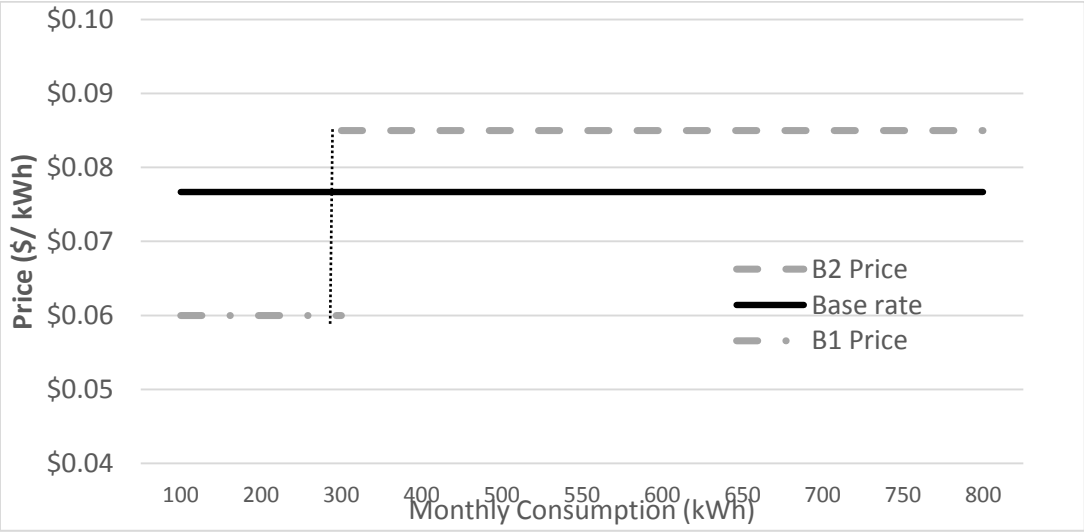
March 23, 2016

INTRODUCTION

The Conservation Rates Study is a collaborative study between Manitoba Hydro (MH) and Christensen Associates Energy Consulting, focused on alternative conservative rate designs. Manitoba Hydro has committed to aggressively pursuing demand side management (DSM) opportunities, which encourage customers to reduce usage through energy efficiency investments. MH has twenty years of successfully fielding *Power Smart* programs, current versions of which are detailed in *The 2014-17 Power Smart Plan – 15 Year Supplemental Report.* Included in the plan are *Conservation Rates*, rates designed to provide incentives for customers to reduce consumption. Initial high-level projections estimate 342 GWh of annual energy savings coupled with a decrease of 41MW in peak loads, by Plan Year 2028/29.

The analysis in the study to date has assessed two-block conservation rate alternatives. More precisely, two-block conservation rates are two-tier inclining block rate (IBR) structures, with second-tier prices that exceed the level of the current flat energy rate. IBR designs, as illustrated in Figure 1, establish an initial "block" of monthly energy usage, within which energy consumption is billed at a rate below a comparable flat rate. Consumption beyond the first block is billed at a higher rate, providing consumers with an incentive to reduce high levels of consumption.

Figure 1: Base Rate and Inclining Block Rate



DESIGNING INCLINING BLOCK RATES

Designing IBR structures involves setting a price for the initial block, and calculating the price for the second block such that revenues to MH remain the same as under the current flat rate. Two such

"revenue neutrality" conditions may be applied. One involves revenue neutrality at customers' *base level* of consumption. An issue with this approach is that MH may under-recover allowed revenues if customers reduce consumption from the base level. An alternative condition involves adjusting the second block price to account for anticipated reductions in consumption, thus maintaining revenue neutrality at *forecast* levels of consumption. Forecasting the impact of the changing prices requires a *demand model* and assumptions about consumers' *price elasticity* of demand.

As a matter of accuracy, designing and analyzing the impact of an IBR structure for MH requires data on monthly usage for a representative sample of its customers. Fortunately, MH maintains a detailed database of customer characteristics and historical monthly consumption and bills in its *Customer Information Data Base (CIDB)*. CIDB integrates key data dimensions including billing data, household characteristics, building characteristics, and end-use technologies (*e.g.*, type of space heating system), along with appropriate scaling factors for expanding the consumption data to the population level.

ROUND TWO ANALYSIS: *WITH AND WITHOUT SPACE HEATING*

METHODOLOGY

Customers with and without electric space heating (ESH) have markedly different patterns of monthly and seasonal electricity consumption, as expected. ESH customers' average monthly consumption is greater than that of non-ESH customers in both summer (May through October) and winter (January – April, November – December), though the difference is much more pronounced in winter. These seasonal average values are shown in Table 1.

Table 1: Average Monthly Consumption by Season and Space Heat Type (kWh)

Season	Non-ESH	ESH
Summer	398	552
Winter	614	1,559

In consideration of these differences in usage patterns, *round two* evaluates separate IBR structures for the two customer types and two seasons. The primary factor differentiating the designs is the length of the initial block and the resulting second block price. For the resulting four categories (*i.e.*, season and space heating type), a number of alternative scenarios were examined. One constant factor common to all designs was an assumption that the initial block price was set to $0.06 per kWh, which represents a 24 percent reduction from the current flat energy rate of $0.0767.[1]

Factors that varied across scenarios were the following:

- First block length – Summer (ranged from 300 to 600 kWh for both customer types)
- First block length – Winter (ranged from 300 to 600 kWh for non-ESH, and 900 to 1300 for ESH)
- Price elasticity (three alternative values of -0.10, -0.15, and -0.20)

[1] The assumption of a $0.06 price for the initial block is largely arbitrary. A somewhat higher price would imply lower prices for the second block at the block lengths described below.

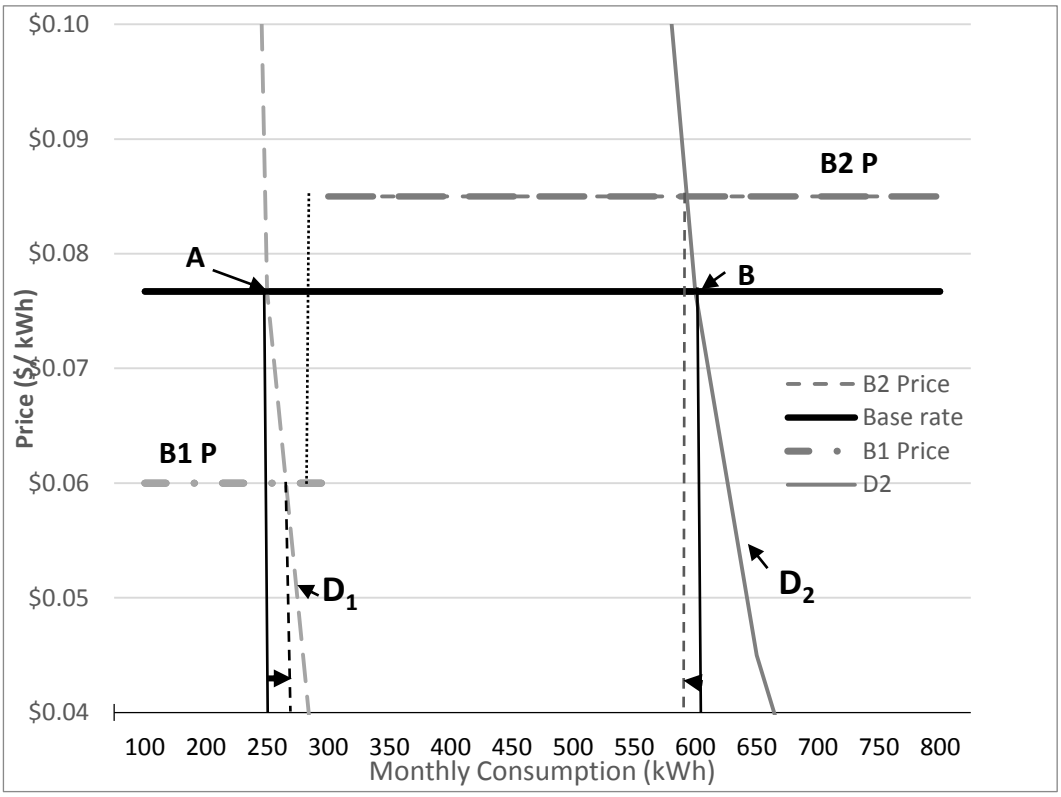
Consistent with the round 1 analysis reported earlier, the demand model for the analysis simulates consumers' demands for electricity using an exponential (or log-linear) relationship between price and quantity, with a constant price elasticity, as follows:

$$K_S = K_0 * [P_S / P_0]^{Elast}$$

The variables K_0 and K_S represent the base (0) and simulated (S) values of monthly consumption, and P_0 and P_S represent the base (0) and simulated (S) values of the relevant price (B1P or B2P). For round two, the price response parameter, *Elast*, alternatively assumes the above values (-0.10, -0.20, -0.30). In the initial analysis (round one), we assumed that customers respond to the relevant marginal price for their usage level. That is, customers whose monthly usage is less than the first block boundary respond to the reduced first block price (B1P), while customers whose monthly usage exceeds the first block boundary respond to the increased second block price (B2P), *without consideration of the block one price*.

Figure 2 illustrates how the demand model operates in the context of a transition from a flat energy price to a two-tier IBR structure. The two demand curves D_1 and D_2, representing relatively small and relatively large customers respectively, cross the base rate (the solid dark horizontal line) at points *A* and *B*. At this price, the small customer uses 250 kWh per month, while the large customer uses 600 kWh. In a two-tier IBR, the first block price (*B1 P*) is set below the base price, and the second block price (*B2 P*) is above the base price. At these prices, the downward sloping demand curves implied by their underlying price elasticities indicate that the small customers will increase usage, while the large customers will reduce usage. Those changes in usage are calculated and accumulated for all of the customers in the sample.

Figure 2: Demand Model Simulation



PRELIMINARY FINDINGS, ROUND TWO

Table 2 summaries the results of a limited number of scenarios that may be described as relatively conservative in terms of assumptions.[2] The two groups of three rows show results for the Non-ESH and ESH categories. Results for the summer and winter seasons are shown in several pairs of columns. The second column indicates that all scenarios in the table are based on a price elasticity assumption of -0.1. The next two columns show the assumed lengths of the first block in summer and winter respectively.

The primary effect of the first block assumption is twofold: 1) it determines the number of customers and amount of consumption that is influenced by the price reduction for that block (the shorter the block, the smaller amount of consumption exposed to a price reduction), and 2) it affects the magnitude of the price increase for consumption beyond the first block. Essentially, the longer the first block, the smaller is the amount of consumption available beyond the first block, which necessarily raises the second block price – at least under revenue neutrality.

The next two columns show the second block prices in summer and winter that are required to achieve revenue neutrality after accounting for customers' price response. These are followed by two columns showing the corresponding percentage increases implied by those prices. As indicated above, as the length of the first block increases, the amount of change in the second block price increases as well. In

[2] Results for additional scenarios are available in an appendix.

the first Non-ESH row, approximately a third of total consumption is included in the first block, and second block price increases are 10 percent or less. As the first block is lengthened to include 40 to 50 percent of total consumption, the second block price increases become larger. The third row in each group of rows represents a case of relatively long first blocks, and thus higher second block price increases.

The last pair of columns show the net percentage changes in total consumption in summer and winter. For the relatively low second block price increase in the first row, these are approximately 1 percent reductions. The last column shows the implied level of reduction in annual GWh. The primary differences in the scenarios for ESH are that the first block lengths are generally greater than for non-ESH. The second block price increases and percentage reductions in seasonal energy consumption are similar to those for Non-ESH.

The last three rows in the table simply sum the Non-ESH and ESH reductions in annual consumption by row, showing overall changes, which range from nearly 70 GWh to 100 GWh.

Table 2: Selected Conservation Rate Scenario Results

SH Type	Elast.	Blk 1 S	Blk 1 W	B2P-S ($/kWh)	B2P-W ($/kWh)	% Chg B2P-S	% Chg B2P-W	B1 % of Base MWh-S	B1 % of Base MWh-W	% Chg kWh S	% Chg kWh W	Chg in Total GWh
Non-ESH	-0.1	300	400	$0.0847	$0.0829	9.9%	7.8%	34%	33%	-1.1%	-0.9%	-37
		300	500	$0.0847	$0.0860	9.9%	11.4%	34%	40%	-1.1%	-1.2%	-42
		500	600	$0.0964	$0.0894	22.9%	15.3%	53%	46%	-1.9%	-1.3%	-58
ESH	-0.1	400	1100	$0.0829	$0.0831	7.7%	7.9%	30%	33%	-0.9%	-1.0%	-30
		500	1300	$0.0859	$0.0856	11.2%	11.0%	37%	39%	-1.2%	-1.3%	-38
		600	1300	$0.0895	$0.0856	15.4%	11.0%	44%	39%	-1.5%	-1.3%	-41
Tot-LoP												-67
Tot-ModP												-80
Tot-HiP												-99

PROPOSED NEXT STEPS

Our immediate plans are to conduct a follow up analysis, building on the round two results presented above. The first, we will examine the range of bill impacts implied by the above scenarios across customers in the two lowest income categories used in MH's residential customer survey. Second, we will explore an alternative analysis of demand, where consumer electricity demand is driven by average price measures. This alternative approach assumes that, while consumers make rational choices with respect to electricity consumption, the choices are only boundedly rational: customers are assumed to have less certain knowledge about consumption levels and the relevant block price – i.e., the marginal block price. That is, we will assume that they respond to a *weighted average* of the two prices, where the weights depend on the fraction of their average monthly consumption in each block, by season.

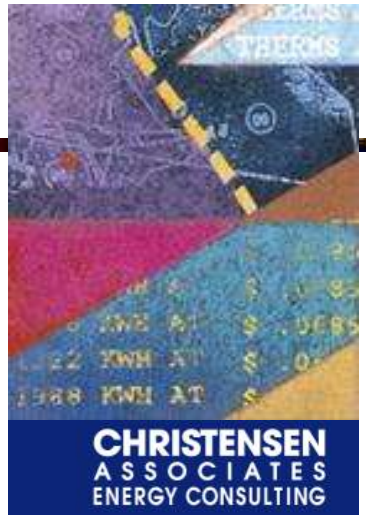
APPENDIX

Table A1: Alternative Conservation Rate Scenarios – *NonESH* (First block price = $0.06/kWh)

Elast.	Blk 1 S	Blk 1 W	% Chg B2P-S	% Chg B2P-W	B1 % of Base MWh-S	B1 % of Base MWh-W	% Chg kWh S	% Chg kWh W	Chg in Total GWh
	300								
		300	9.9%	4.6%	34%	25%	-1.1%	-0.7%	-31
		400	9.9%	7.8%	34%	33%	-1.1%	-0.9%	-37
		500	9.9%	11.4%	34%	40%	-1.1%	-1.2%	-42
		600	9.9%	15.3%	34%	46%	-1.1%	-1.3%	-46
	400								
		300	15.8%	4.6%	44%	25%	-1.5%	-0.7%	-38
-0.1		400	15.8%	7.8%	44%	33%	-1.5%	-0.9%	-43
		500	15.8%	11.4%	44%	40%	-1.5%	-1.2%	-48
		600	15.8%	15.3%	44%	46%	-1.5%	-1.3%	-52
	500								
		300	22.9%	4.6%	53%	25%	-1.9%	-0.7%	-44
		400	22.9%	7.8%	53%	33%	-1.9%	-0.9%	-50
		500	22.9%	11.4%	53%	40%	-1.9%	-1.2%	-55
		600	22.9%	15.3%	53%	46%	-1.9%	-1.3%	-58
	300								
		300	10.9%	5.1%	34%	25%	-1.7%	-1.1%	-51
		400	10.9%	8.7%	34%	33%	-1.7%	-1.5%	-60
		500	10.9%	12.7%	34%	40%	-1.7%	-1.9%	-69
		600	10.9%	17.1%	34%	46%	-1.7%	-2.2%	-76
	400								
		300	17.6%	5.1%	44%	25%	-2.5%	-1.1%	-62
-0.15		400	17.6%	8.7%	44%	33%	-2.5%	-1.5%	-71
		500	17.6%	12.7%	44%	40%	-2.5%	-1.9%	-80
		600	17.6%	17.1%	44%	46%	-2.5%	-2.2%	-86
	500								
		300	25.9%	5.1%	53%	25%	-3.2%	-1.1%	-74
		400	25.9%	8.7%	53%	33%	-3.2%	-1.5%	-83
		500	25.9%	12.7%	53%	40%	-3.2%	-1.9%	-91
		600	25.9%	17.1%	53%	46%	-3.2%	-2.2%	-98
	300								
		300	12.2%	5.8%	34%	25%	-2.6%	-1.6%	-75
		400	12.2%	9.8%	34%	33%	-2.6%	-2.2%	-88
		500	12.2%	14.3%	34%	40%	-2.6%	-2.9%	-101
		600	12.2%	19.3%	34%	46%	-2.6%	-3.4%	-112
	400								
		300	19.9%	5.8%	44%	25%	-3.7%	-1.6%	-92
-0.2		400	19.9%	9.8%	44%	33%	-3.7%	-2.2%	-105
		500	19.9%	14.3%	44%	40%	-3.7%	-2.9%	-118
		600	19.9%	19.3%	44%	46%	-3.7%	-3.4%	-129
	500								
		300	30.0%	5.8%	53%	25%	-5.0%	-1.6%	-111
		400	30.0%	9.8%	53%	33%	-5.0%	-2.2%	-124
		500	30.0%	14.3%	53%	40%	-5.0%	-2.9%	-138
		600	30.0%	19.3%	53%	46%	-5.0%	-3.4%	-148

Table A2: Alternative Conservation Rate Scenarios –*ESH* (First block price = $0.06/kWh)

Elast.	Blk 1 S	Blk 1 W	% Chg B2P-S	% Chg B2P-W	B1 % of Base MWh-S	B1 % of Base MWh-W	% Chg kWh S	% Chg kWh W	Chg in Total GWh
-0.1	400	900	7.7%	5.3%	30%	27%	-0.9%	-0.8%	-25
		1000	7.7%	6.6%	30%	30%	-0.9%	-0.9%	-27
		1100	7.7%	7.9%	30%	33%	-0.9%	-1.0%	-30
		1200	7.7%	9.4%	30%	36%	-0.9%	-1.2%	-33
		1300	7.7%	11.0%	30%	39%	-0.9%	-1.3%	-36
	500	900	11.2%	5.3%	37%	27%	-1.2%	-0.8%	-27
		1000	11.2%	6.6%	37%	30%	-1.2%	-0.9%	-30
		1100	11.2%	7.9%	37%	33%	-1.2%	-1.0%	-32
		1200	11.2%	9.4%	37%	36%	-1.2%	-1.2%	-35
		1300	11.2%	11.0%	37%	39%	-1.2%	-1.3%	-38
	600	900	15.4%	5.3%	44%	27%	-1.5%	-0.8%	-30
		1000	15.4%	6.6%	44%	30%	-1.5%	-0.9%	-32
		1100	15.4%	7.9%	44%	33%	-1.5%	-1.0%	-35
		1200	15.4%	9.4%	44%	36%	-1.5%	-1.2%	-38
		1300	15.4%	11.0%	44%	39%	-1.5%	-1.3%	-41
-0.15	400	900	8.5%	6.0%	30%	27%	-1.5%	-1.3%	-40
		1000	8.5%	7.4%	30%	30%	-1.5%	-1.5%	-45
		1100	8.5%	8.9%	30%	33%	-1.5%	-1.7%	-49
		1200	8.5%	10.6%	30%	36%	-1.5%	-1.9%	-54
		1300	8.5%	12.4%	30%	39%	-1.5%	-2.2%	-59
	500	900	12.5%	6.0%	37%	27%	-2.0%	-1.3%	-45
		1000	12.5%	7.4%	37%	30%	-2.0%	-1.5%	-49
		1100	12.5%	8.9%	37%	33%	-2.0%	-1.7%	-53
		1200	12.5%	10.6%	37%	36%	-2.0%	-1.9%	-58
		1300	12.5%	12.4%	37%	39%	-2.0%	-2.2%	-63
	600	900	17.3%	6.0%	44%	27%	-2.6%	-1.3%	-49
		1000	17.3%	7.4%	44%	30%	-2.6%	-1.5%	-53
		1100	17.3%	8.9%	44%	33%	-2.6%	-1.7%	-58
		1200	17.3%	10.6%	44%	36%	-2.6%	-1.9%	-62
		1300	17.3%	12.4%	44%	39%	-2.6%	-2.2%	-67
-0.2	400	900	9.6%	6.8%	30%	27%	-2.2%	-1.9%	-59
		1000	9.6%	8.4%	30%	30%	-2.2%	-2.2%	-65
		1100	9.6%	10.2%	30%	33%	-2.2%	-2.5%	-72
		1200	9.6%	12.1%	30%	36%	-2.2%	-2.8%	-79
		1300	9.6%	14.2%	30%	39%	-2.2%	-3.2%	-87
	500	900	14.1%	6.8%	37%	27%	-3.0%	-1.9%	-65
		1000	14.1%	8.4%	37%	30%	-3.0%	-2.2%	-72
		1100	14.1%	10.2%	37%	33%	-3.0%	-2.5%	-78
		1200	14.1%	12.1%	37%	36%	-3.0%	-2.8%	-85
		1300	14.1%	14.2%	37%	39%	-3.0%	-3.2%	-93
	600	900	19.7%	6.8%	44%	27%	-3.9%	-1.9%	-72
		1000	19.7%	8.4%	44%	30%	-3.9%	-2.2%	-79
		1100	19.7%	10.2%	44%	33%	-3.9%	-2.5%	-85
		1200	19.7%	12.1%	44%	36%	-3.9%	-2.8%	-93
		1300	19.7%	14.2%	44%	39%	-3.9%	-3.2%	-100



Update and Summary: MH Conservation Rate Study

Steve Braithwait
Robert Camfield
Dave Armstrong
Christensen Associates Energy Consulting

June 30, 2016

Topics

- Project Objectives
- Approach to Analysis
- Data
- Analysis Results
- Summary

Objectives, Process

- Determine proposed *Conservation Rates* for consideration by MH, stakeholders, and the PUB
- Analytics
  - *Decision support*: analytical framework/model to assess rate scenarios
    - MWh sales, prices, revenues
    - bill impacts
  - *MH residential survey data*:
    - highly detailed profiles of consumers; sample ≈ 4,700 customers
    - exceptionally high data quality
    - 48 months of billing data (285,000 records); '15 billing data used in study
    - sample weights to scale to residential class level

Approach to Analysis

- Framework: *demand simulation*
  - Model applied to monthly data of individual customers in sample
  - Simulate change in electricity usage, in response to price changes

    %ΔUsage determined by %ΔPrices, *given price elasticity (ϵ)*

    Example:

    Percentage: *%Δ Prices = +15%, ϵ = −0.15; %Δ Usage ≈ −2.25%*

    Levels (kWh): *$500*(8.05¢/7.00¢)^{-0.15} = 489.63$; Δ Usage = 10.37*
  - Sensitivity to prices (elasticity) not known, exactly
    - plausible range: -0.10 to -0.25; -0.15 underlies results shown
    - assume consumers respond to a weighted average of block 1 (B1P) and block 2 prices (*B2P*)

Model Run:

- Prices initialized
- Intermediate solutions (MWh, prices, revenues) obtained
- Converged solution reached: usage, prices that preserve revenues

  i.e., revenue neutrality constraint

Electricity Demand Model:

$D_{New} = D_{Base} x (P_{New}/P_{Base})^{\epsilon}$

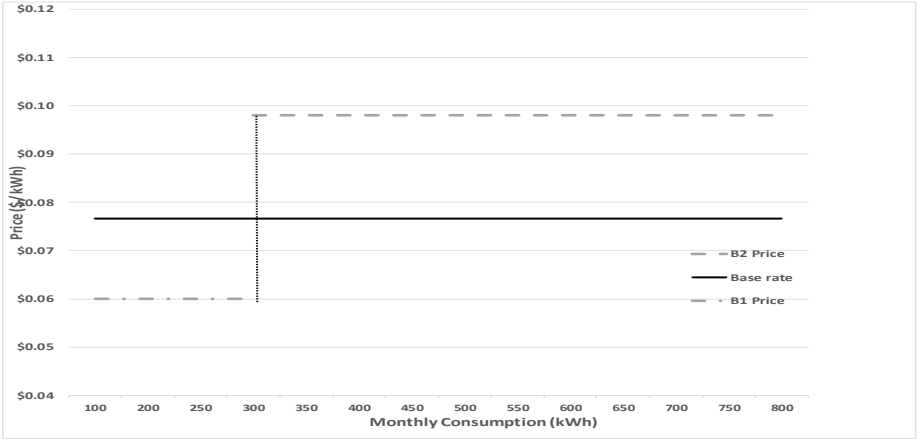
$\epsilon = \%\Delta D/\%\Delta P$

Structure of Conservation Rates

- Conservation rate scenarios
  - Two-block *inverted* structure, for residential class
    - rising tail block (B2) price, compared to current tariff (baseline)
    - lower first block (B1) price, also with reference to baseline

    Block 1 thresholds differentiated by Season and Space heat type

    Block prices differ by season (seasonal revenue neutrality)
  - Customer charge unchanged



Structure of Conservation Rates…2

- Scenarios investigated so far
  1. Differentiated B1 thresholds, holding B1P constant (6 cents)
  2. ESH and Non-ESH market segments
     - differentiated block prices, by season and market segment
     - revenue neutrality within season and market segment
  3. Customer-specific two-part tariff* (customer-specific B1 thresholds)

  4. Reported herein: *Constant price differences from baseline*
     - example…*B1P=1.5 cents below; B2P=1.5 cents above current flat rate*

** In the parlance of economics, a variant of 3rd degree price discrimination*

Price Elasticity Estimates

- *ϵ = %Δ in usage / %Δ in prices*
- Summary of elasticity estimates in literature:
  - Short-run: -0.05 to -0.40
  - Long-run: -0.30 to -1.20
  - Dynamic pricing: -0.05 to -0.20
  - Inclining block rate, California: -0.09
- Three alternative elasticity values used in analysis, so far
  - -0.10, -0.15, -0.20
  - Results reported herein based on elasticity of -0.15

Profile: Residential Markets Served by MH

	Customer Category	Heating	Residential Sample Count	Share (%)			Class Totals Count	Season	GWh	$ Million	Monthly Bill ($)
LICO Consumers	Non-LICO		2,506	53%			237,889	Summer	1,184	99.2	$ 73
								Winter	1,569	127.2	$ 92
		ESH in Place	931	20%			84,367	Summer	619	50.2	$ 105
								Winter	1,570	120.7	$ 248
	LICO		955	20%			104,773	Summer	386	33.2	$ 58
					Total, LICO Group			Winter	624	50.7	$ 86
		ESH in Place	343	7%	1,298	27%	33,755	Summer	230	18.7	$ 97
								Winter	595	45.8	$ 234
SENIORS >55	Non-Senior		1,240	26%			126,413	Summer	589	49.4	$ 70
								Winter	772	62.8	$ 87
		ESH in Place	467	10%			43,707	Summer	338	27.3	$ 112
								Winter	823	63.3	$ 252
	Senior Over 55		2,221	47%			216,250	Summer	982	83.0	$ 67
					Total, >55 Group			Winter	1,420	115.1	$ 92
		ESH in Place	807	17%	3,028	64%	74,416	Summer	510	41.6	$ 98
								Winter	1,342	103.3	$ 240
SENIORS >65	Non-Senior		2,137	45%			211,368	Summer	1,005	84.4	$ 70
								Winter	1,338	108.6	$ 89
		ESH in Place	799	17%			74,216	Summer	567	45.8	$ 109
								Winter	1,418	109.0	$ 255
	Senior Over 65		1,324	28%			131,295	Summer	566	48.1	$ 64
					Total, >65 Group			Winter	854	69.2	$ 92
		ESH in Place	475	10%	1,799	38%	43,906	Summer	282	23.1	$ 92
								Winter	747	57.6	$ 226

Block 1 Thresholds

- Setting B1 threshold at same % of median usage (*e.g.*, 90%) for both Non-ESH and ESH creates bill impact differentials
- Adjusted ESH thresholds to achieve comparable average bill impacts:

SH Type	Season	B1 Threshold -- % of Median	
		90%	64%
NonESH	Winter	763	
	Summer	660	
ESH	Winter		1,960
	Summer		777

By Block Price Differentials

Analysis Results

B1 threshold = 90% of median usage; 64% for ESH; ϵ = -0.15

SH Type	Block Prices ($/kWh)					Change in Usage		% Bill Changes	
	Diff'l: (B2P - B1P)	B1		B2		% Change	Total GWh	Rel. to Base Use	Rel. to Sim Use
		Summer	Winter	Summer	Winter				
Non-ESH	$ 0.02	0.0687	0.0669	0.0887	0.0869	-1.5%	-55	1.6%	0.0%
	$ 0.03	0.0655	0.0631	0.0955	0.0931	-2.2%	-80	2.4%	0.0%
	$ 0.04	0.0623	0.0594	0.1023	0.0994	-2.8%	-103	3.4%	0.1%
ESH	$ 0.02	0.0687	0.0669	0.0887	0.0869	-1.8%	-54	1.9%	0.0%
	$ 0.03	0.0655	0.0631	0.0955	0.0931	-2.6%	-78	3.0%	0.0%
	$ 0.04	0.0623	0.0594	0.1023	0.0994	-3.4%	-101	4.1%	-0.1%
Total	$ 0.02					-1.6%	-109	1.7%	0.0%
	$ 0.03					-2.4%	-158	2.7%	0.0%
	$ 0.04					-3.1%	-204	3.7%	0.0%

% Customers w/*Increased* Usage, Lower Prices:

Non-ESH: 28%

ESH: 8%

Bill impacts *before* price response

Affirm revenue neutrality

B1 = 90/64%
ϵ = -0.15

Bill Impacts…1
by Residence Type

Heating Status	Own/ Rent	Residence Type	Average Base Bill ($)	Average Bill Change ($)	% Bill Change	% of Class
Non-ESH	Own	Single	1,023	4.79	0.5%	81.5%
		Multi Attached	721	-26.32	-3.6%	5.8%
		AptCondo	470	-29.98	-6.4%	1.8%
		Mobile	1,254	78.49	6.3%	0.5%
		Other	828	37.85	4.6%	0.5%
		Average	**971**	**0.93**	**0.1%**	**90.1%**
	Rent	Single	1,276	79.66	6.2%	3.4%
		Multi Attached	750	-5.48	-0.7%	2.5%
		AptCondo	363	-20.22	-5.6%	3.9%
		Mobile	0	0.00	0.0%	0.0%
		Average	**569**	**-2.91**	**-0.5%**	**9.9%**
ESH	Own	Single	2,167	17.60	0.8%	80.6%
		Multi Attached	1,450	-86.38	-6.0%	3.2%
		AptCondo	722	-68.89	-9.5%	1.0%
		Mobile	1,788	-56.64	-3.2%	8.4%
		Other	1,710	-10.61	-0.6%	1.4%
		Average	**2,041**	**1.78**	**0.1%**	**94.6%**
	Rent	Single	1,917	5.36	0.3%	3.6%
		Multi Attached	1,233	-89.91	-7.3%	0.8%
		AptCondo	494	-49.09	-9.9%	0.4%
		Mobile	1,783	-83.25	-4.7%	0.6%
		Average	**1,415**	**-32.96**	**-2.3%**	**5.4%**

B1 = 90/64%
ϵ = -0.15

Bill Impacts…2
by Income Status

by Income Group

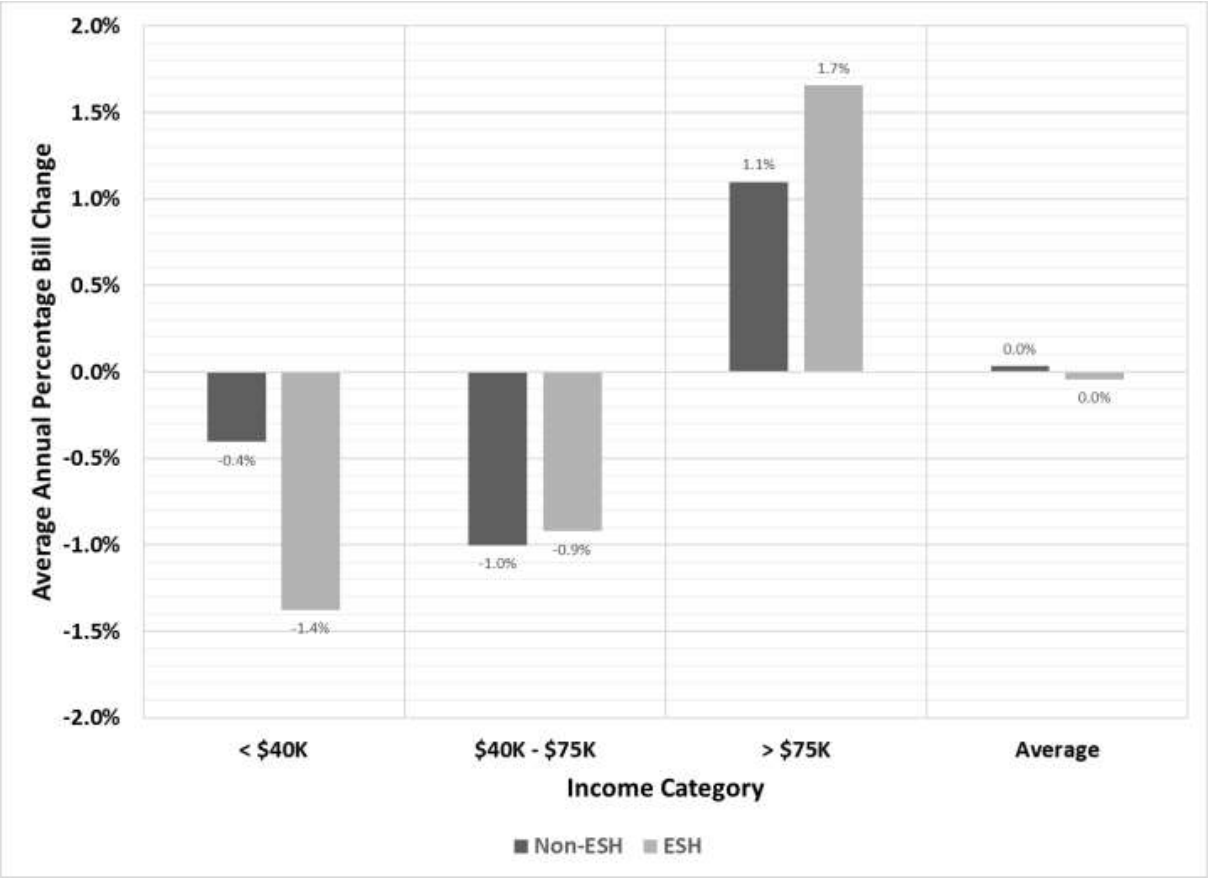
Heating Status	Income	Average Base Bill ($)	Average Bill Change ($)	% Bill Change	% of Class
Non ESH	< $40K	739	-2.99	-0.4%	23%
	$40K - $75K	863	-8.65	-1.0%	34%
	> $75K	1,083	11.90	1.1%	43%
	Average	**905**	**0.31**	**0.0%**	**100%**
ESH	< $40K	1,806	-24.86	-1.4%	23%
	$40K - $75K	1,907	-17.59	-0.9%	39%
	> $75K	2,233	36.96	1.7%	38%
	Average	**1,992**	**-0.90**	**0.0%**	**100%**

LICO Status

Heating Status	LICO Status	Average Base Bill ($)	Average Bill Change ($)	% Bill Change	% of Class
Non ESH	Non LICO	952	-0.41	0.0%	73%
	LICO	800	1.94	0.2%	27%
	Average	**905**	**0.31**	**0.0%**	**100%**
ESH	Non LICO	2,026	4.67	0.2%	73%
	LICO	1,908	-14.76	-0.8%	27%
	Average	**1,992**	**-0.90**	**0.0%**	**100%**

B1 = 90/64%
ϵ = -0.15

Bill Impacts by Income Category



B1 = 90/64%
ϵ = -0.15

Bill Impacts…3
by Senior Status

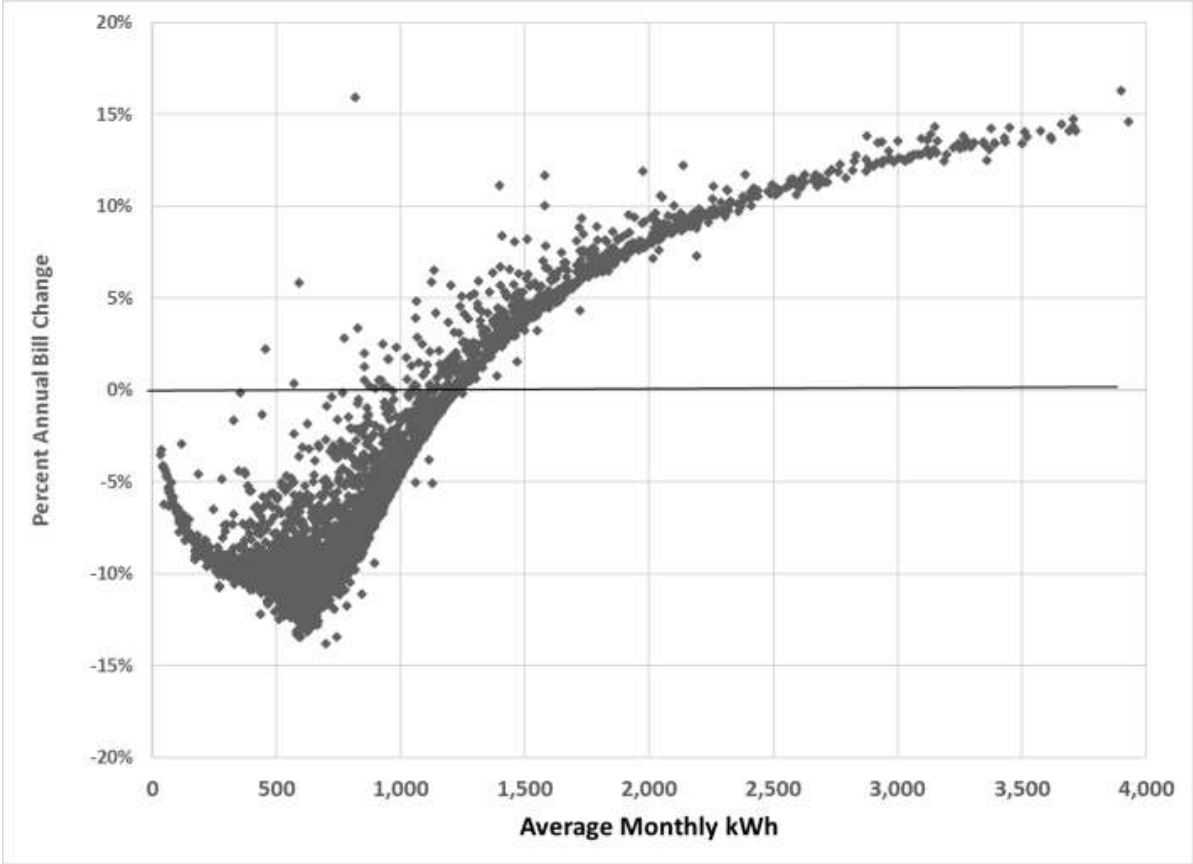
55 and over

Heating Status	Senior (>55)	Average Base Bill ($)	Average Bill Change ($)	% Bill Change	% of Class
Non ESH	Non Senior	888	0.80	0.1%	36%
	Senior	916	0.02	0.0%	64%
	Average	**905**	**0.31**	**0.0%**	**100%**
ESH	Non Senior	2,073	10.80	0.5%	39%
	Senior	1,945	-7.76	-0.4%	61%
	Average	**1,992**	**-0.90**	**0.0%**	**100%**

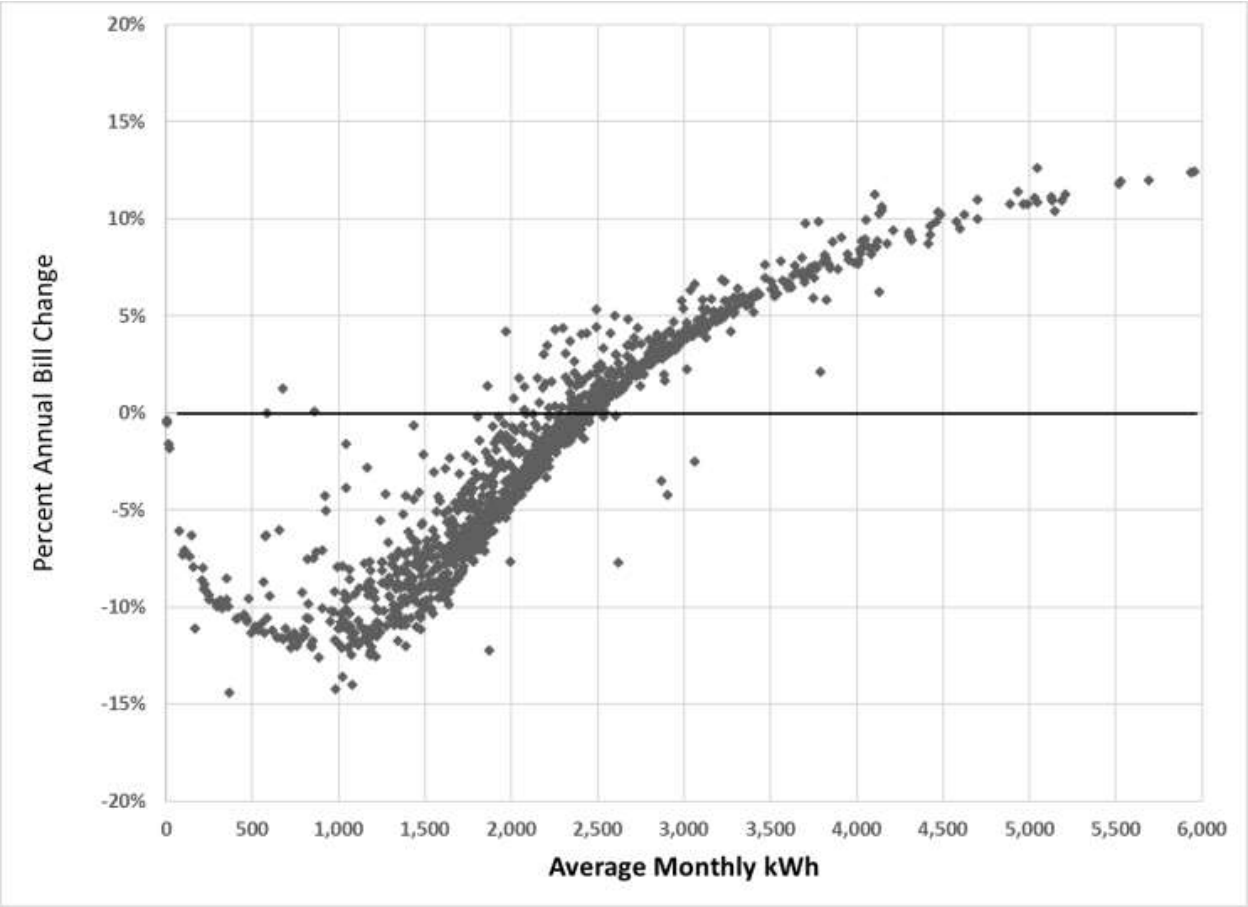
65 and over

Heating Status	Senior (>65)	Average Base Bill ($)	Average Bill Change ($)	% Bill Change	% of Class
Non ESH	Non Senior	913	-0.16	0.0%	62%
	Senior	893	1.06	0.1%	38%
	Average	**905**	**0.31**	**0.0%**	**100%**
ESH	Non Senior	2,083	10.21	0.5%	66%
	Senior	1,839	-19.70	-1.1%	34%
	Average	**1,992**	**-0.90**	**0.0%**	**100%**

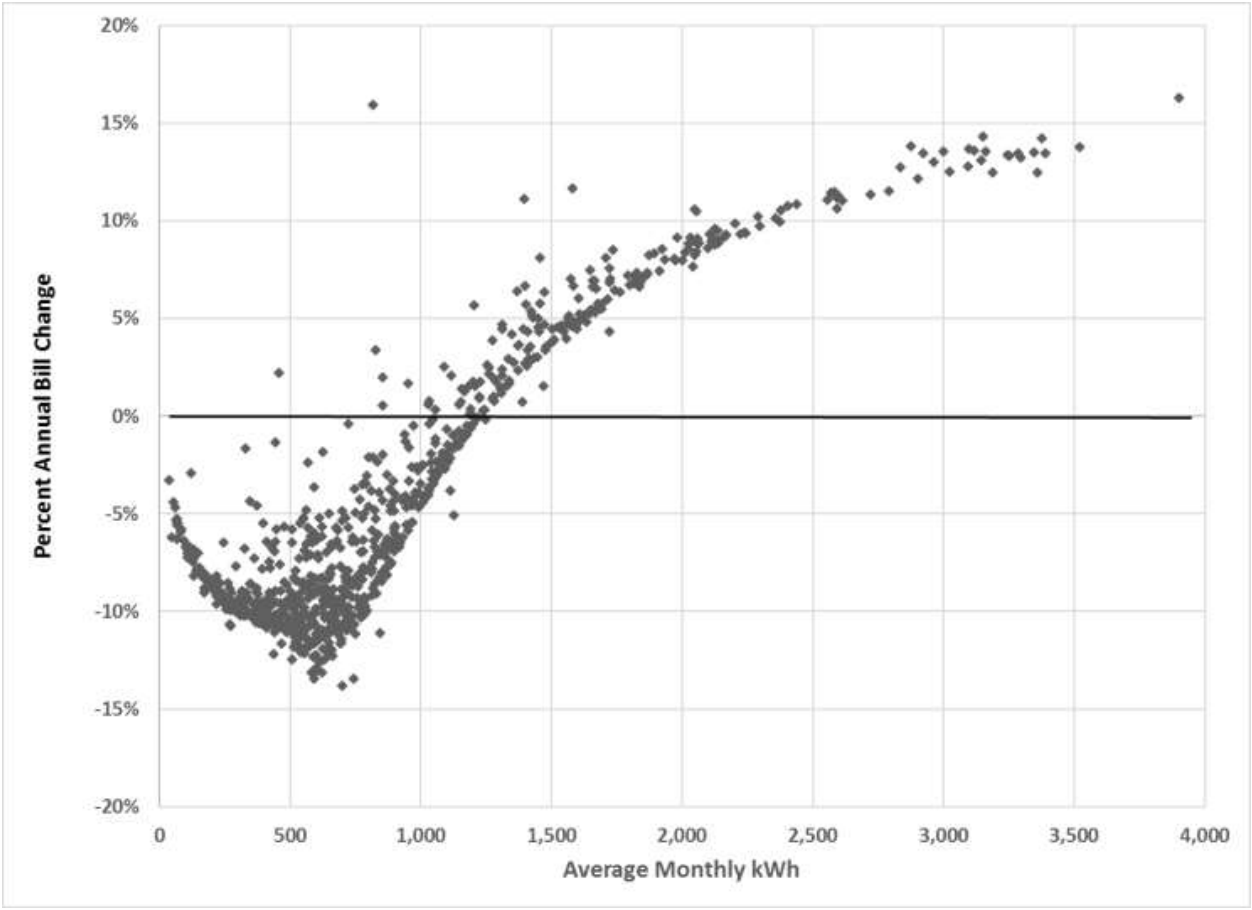
Bill Impacts and Average Monthly Usage
(Non-ESH Consumers)



Bill Impacts and Average Monthly Usage
(ESH Consumers)



Bill Impacts and Average Monthly Usage
(Non-ESH LICO Consumers)

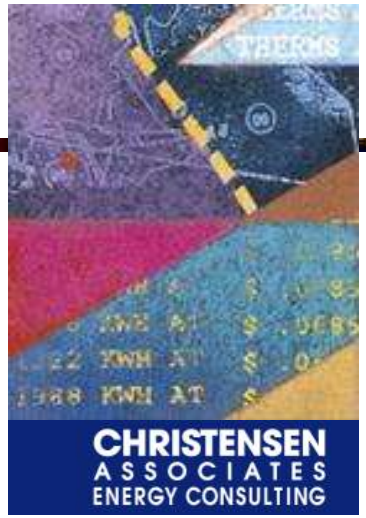


Summary

- Overall usage reductions range from approximately 100 GWh for 2-cent price differential to 200 GWh for a 4-cent differential
- Reduced B1 threshold for ESH customers (64% of median, from 90%) to balance bill changes between ESH and Non-ESH
- Low-usage/low-income customers experience bill *reductions*; higher-usage customers have bill *increases* (1 to 2 percent, on average)
- Customer-level bill changes range from 15% bill savings to 15% bill increases (for very high energy consumers)

Outstanding Policy Issues

- Explore further analytics:
  - Stepwise variation in monthly service charges
    - can likely obtain increases in resource efficiency (conservation)
- Elasticities: Do we have a sufficient analytical foundation?
  - If not, what action/research should be taken?



MH Conservation Rate Study: *Multi-year / Weather Analysis Update*

Steve Braithwait
Robert Camfield
Dave Armstrong
Christensen Associates Energy Consulting

July 25, 2016

Topics

- Objectives of Multi-year Analysis
- Approach to Analysis
- Analysis Results
  - Review of 2015-only
  - Multi-year results
- Summary

Objectives of Multi-year Analysis

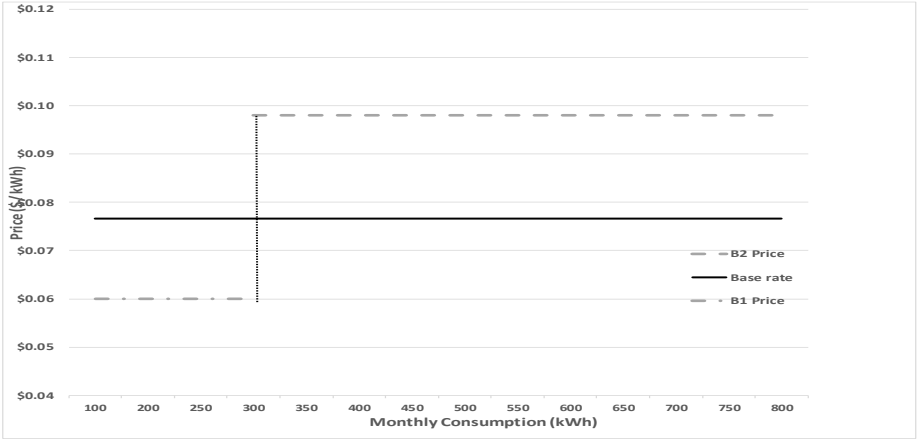
- Previous analysis used data for 2015 calendar year – concern about representativeness
- Updated analysis – designs conservation rates using combined usage and price data for four fiscal years: '11/'12 to '14/'15 (April – March)
- Bill impacts by income group and LICO status examined for all four years
  - '11/'12 – winter *warmer* than normal
  - '12/'13 – winter approximately normal
  - '13/'14 – winter *colder* than normal
  - '14/'15 – winter approximately normal

Structure of Conservation Rates

- Conservation rate scenarios
  - Two-block *inverted* structure, for residential class
    - rising tail block (B2) price, compared to current tariff (baseline)
    - lower first block (B1) price, also with reference to baseline

    Block 1 thresholds differentiated by Season and Space heat type

    Block prices differ by season (**annual** revenue neutrality)
  - Customer charge unchanged



Structure of Conservation Rates…2

- Scenarios investigated to date (**1 - 4 use calendar 2015 data**):
  1. Differentiated B1 thresholds, holding B1P constant (6 cents)
  2. ESH and Non-ESH market segments
     - differentiated block prices, by season and market segment
     - revenue neutrality within season and market segment
  3. Customer-specific two-part tariff (customer-specific B1 thresholds)
  4. Constant price differences between B1P and B2P
     - Ex: *B1P=1.5 cents below; B2P=1.5 cents above current flat rate*
  5. **Reported herein:** Multi-year analysis (‘11/’12 – ’14/’15)
     - Examine “cold” and “warm” year differences

Review Results for 2015 Analysis:

- B1 thresholds at 90% of median for both space heat types
- B1 thresholds:
  - 90% for Non-ESH
  - 64% for ESH

Block 1 Thresholds (2015 only)

- Setting B1 threshold at same % of median usage (*e.g.*, 90%) for both Non-ESH and ESH creates bill impact differentials
- Adjusted ESH thresholds by season to achieve comparable average bill impacts:

SH Type	Season	B1 Threshold -- % of Median	
		90%	64%
NonESH	Winter	763	
	Summer	660	
ESH	Winter		1,960
	Summer		777

By Block Price Differentials

Overall Analysis Results (2015)

B1 threshold = 90% of median usage; 64% for ESH; ϵ = -0.15

SH Type	Block Prices ($/kWh)					Change in Usage		% Bill Changes	
	Diff'l: (B2P - B1P)	B1		B2		% Change	Total GWh	Rel. to Base Use	Rel. to Sim Use
		Summer	Winter	Summer	Winter				
Non-ESH	$ 0.02	0.0687	0.0669	0.0887	0.0869	-1.5%	-55	1.6%	0.0%
	$ 0.03	0.0655	0.0631	0.0955	0.0931	-2.2%	-80	2.4%	0.0%
	$ 0.04	0.0623	0.0594	0.1023	0.0994	-2.8%	-103	3.4%	0.1%
ESH	$ 0.02	0.0687	0.0669	0.0887	0.0869	-1.8%	-54	1.9%	0.0%
	$ 0.03	0.0655	0.0631	0.0955	0.0931	-2.6%	-78	3.0%	0.0%
	$ 0.04	0.0623	0.0594	0.1023	0.0994	-3.4%	-101	4.1%	-0.1%
Total	$ 0.02					-1.6%	-109	1.7%	0.0%
	$ 0.03					-2.4%	-158	2.7%	0.0%
	$ 0.04					-3.1%	-204	3.7%	0.0%

<u>% Customers w/*Increased* Usage, Lower Prices</u>:

Non-ESH: 28%

ESH: 8%

Bill impacts *before* price response

Affirm revenue neutrality

By Block Price Differentials

Overall Analysis Results (2015)

B1 threshold = 90% of median usage; ϵ = -0.15

SH Type	Block Prices ($/kWh)					Change in Usage		Reference to Baseline Bills	
	Diff'l: (B2P - B1P)	B1		B2				Impact *Before* Demand Respone to Rate Changes	Impact *After* Demand Respone to Rate Changes
		Summer	Winter	Summer	Winter	% Change	Total GWh		
Non-ESH	$ 0.02	0.0697	0.0685	0.0897	0.0885	-1.7%	-65	3.2%	1.4%
	$ 0.03	0.0671	0.0656	0.0971	0.0956	-2.5%	-93	4.9%	2.1%
	$ 0.04	0.0644	0.0627	0.1044	0.1027	-3.3%	-120	6.6%	2.8%
ESH	$ 0.02	0.0697	0.0685	0.0897	0.0885	-1.6%	-48	-0.1%	-1.9%
	$ 0.03	0.0671	0.0656	0.0971	0.0956	-2.3%	-70	-0.1%	-2.9%
	$ 0.04	0.0644	0.0627	0.1044	0.1027	-3.0%	-90	0.0%	-3.8%
Total	$ 0.02	0.0697	0.0685	0.0897	0.0885	-1.7%	-113	1.8%	0.0%
	$ 0.03	0.0671	0.0656	0.0971	0.0956	-2.4%	-163	2.8%	0.0%
	$ 0.04	0.0644	0.0627	0.1044	0.1027	-3.2%	-210	3.8%	0.0%

% Customers w/*Increased* Usage, Lower Prices:

Non-ESH: 23%

ESH: 20%

Bill impacts *before* price response

Affirm revenue neutrality; but Bill impacts differ

Results – Multi-year Analysis

Block 1 Thresholds (Multi-year)

- Adjusted ESH thresholds by season to achieve comparable average bill impacts. Values for multi-year analysis:

SH Type	Season	B1 Threshold -- % of Median	
		90%	64%
Non-ESH	Winter	774	
	Summer	650	
ESH	Winter		2,104
	Summer		811

By Block Price Differentials

Overall Analysis Results (Multi-year)

B1 threshold = 90% of median usage; 64% for ESH; ϵ = -0.15

SH Type	Block Prices ($/kWh)					Change in Usage		Reference to Baseline Bills	
	Diff'l: (B2P - B1P)	B1		B2				Impact *Before* Demand Respone to Rate Changes	Impact *After* Demand Respone to Rate Changes
		Summer	Winter	Summer	Winter	Total GWh	% Change		
Non-ESH	$ 0.02	0.0701	0.0690	0.0901	0.0890	-53	-1.5%	1.5%	0.0%
	$ 0.03	0.0668	0.0652	0.0968	0.0952	-77	-2.1%	2.4%	0.0%
	$ 0.04	0.0636	0.0615	0.1036	0.1015	-99	-2.7%	3.2%	0.0%
ESH	$ 0.02	0.0701	0.0690	0.0901	0.0890	-52	-1.8%	1.9%	0.0%
	$ 0.03	0.0668	0.0652	0.0968	0.0952	-75	-2.6%	3.0%	0.0%
	$ 0.04	0.0636	0.0615	0.1036	0.1015	-97	-3.3%	4.1%	0.0%
Total	$ 0.02	0.0701	0.0690	0.0901	0.0890	-104	-1.6%	1.7%	0.0%
	$ 0.03	0.0668	0.0652	0.0968	0.0952	-152	-2.3%	2.6%	0.0%
	$ 0.04	0.0636	0.0615	0.1036	0.1015	-196	-3.0%	3.6%	0.0%

<u>% Customers w/*Increased* Usage, Lower Prices</u>:

Non-ESH: 26%

ESH: 8%

Bill impacts *before* price response

Affirm revenue neutrality

B1 = 90/64%
ϵ = -0.15

Bill Impacts…2
by Fiscal year and Income Status

Results by year show fiscal 2012 & 2014 similar to average.
Mild year (2011/2012) produces modest bill reductions relative to average.
Cold year (2013/2014) produces modest bill increases relative to average.

Heating Status	Income	% Bill Change				
		2011 (Mild)	2012 (Norm)	2013 (Cold)	2014 (Norm)	Average
Non ESH	< $40K	-1.2%	-0.2%	0.2%	-0.2%	-0.4%
	$40K - $75K	-1.5%	-0.7%	-0.3%	-1.1%	-0.9%
	> $75K	0.3%	0.9%	1.3%	0.8%	0.8%
	Average	**-0.7%**	**0.1%**	**0.5%**	**-0.1%**	**0.0%**
ESH	< $40K	-3.2%	-1.3%	-0.2%	-1.5%	-1.6%
	$40K - $75K	-2.5%	-0.6%	0.4%	-0.8%	-0.9%
	> $75K	0.4%	1.9%	2.8%	1.5%	1.6%
	Average	**-1.5%**	**0.2%**	**1.2%**	**-0.1%**	**-0.1%**

B1 = 90/64%
ϵ = -0.15

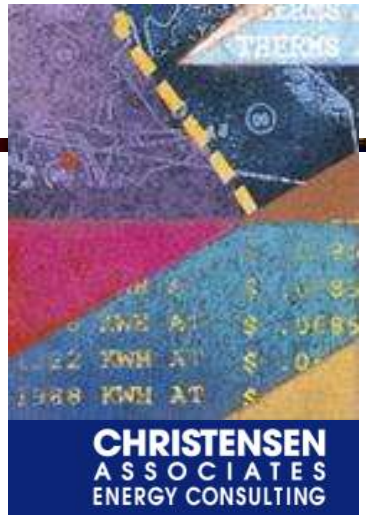
Bill Impacts…3
by Fiscal year and LICO Status

Results by year show fiscal 2012 & 2014 similar to average.
Mild year (2011/2012) produces modest bill reductions relative to average.
Cold year (2013/2014) produces modest bill increases relative to average.

Heating Status	LICO Status	% Bill Change				
		2011 (Mild)	2012 (Norm)	2013 (Cold)	2014 (Norm)	Average
Non ESH	Non LICO	-0.7%	0.0%	0.4%	-0.2%	-0.1%
	LICO	-0.7%	0.3%	0.7%	0.3%	0.2%
	Average	**-0.7%**	**0.1%**	**0.5%**	**-0.1%**	**0.0%**
ESH	Non LICO	-1.2%	0.4%	1.4%	0.2%	0.2%
	LICO	-2.5%	-0.6%	0.5%	-0.9%	-0.9%
	Average	**-1.5%**	**0.2%**	**1.2%**	**-0.1%**	**-0.1%**

Summary of Multi-year Analysis

- Overall usage reductions still range from approximately 100 GWh for 2-cent price differential to 200 GWh for a 4-cent differential
- Overall % bill impacts (after price response, – 0.15 elasticity)
  - 0.7% to 1.5% bill reductions in mild winter (‘11/’12)
  - 0.5% to 1.2% bill increases in cold winter (‘13/’14)
  - Compare to revenue neutral (0% bill change) for average year



Manitoba Hydro Conservation Rate Study

Steve Braithwait
Robert Camfield
Dave Armstrong
Christensen Associates Energy Consulting

September 16, 2016

Topics

- Projected energy impacts – Block 1 thresholds for non-ESH and ESH as % of median usage
  - Same thresholds (90/90)
  - Adjusted for equal average bill impacts (90/66 for ESH)
  - With 3.95% rate increase
- Distributions of bill impacts
  - ESH & non-ESH
  - LICO customers
  - Northern customers
- Weather sensitivity – 4 years (‘11/’12 – ’14/’15)

Block 1 Thresholds –
Same for Non-ESH and ESH

- Setting B1 threshold at same % of median usage (*e.g.*, 90%) for both Non-ESH and ESH creates bill impact differentials

SH Type	Season	B1 Threshold -- % of Median 90%	90%
Non-ESH	Winter	735	
	Summer	634	
ESH	Winter		2,734
	Summer		1,066

Overall Analysis Results (2015)

B1 threshold (% of median usage): 90% non-ESH, 90% ESH

SH Type	Block Prices ($/kWh)			Change in Usage		Average Base Bill ($)	Bill Changes ($)		% Bill Changes	
	P Diff: (B2P - B1P)	B1	B2	Total GWh	% Change		Before Price Response	After Price Response	Before Price Response	After Price Response
Non-ESH	$ 0.02	0.0689	0.0889	(64)	-1.7%	905	29	12	3.1%	1.4%
	$ 0.03	0.0661	0.0961	(93)	-2.5%	905	45	19	4.8%	2.0%
	$ 0.04	0.0633	0.1033	(120)	-3.2%	905	61	25	6.5%	2.7%
ESH	$ 0.02	0.0689	0.0889	(49)	-1.6%	1,992	0	(36)	0.0%	-1.8%
	$ 0.03	0.0661	0.0961	(70)	-2.4%	1,992	1	(54)	0.1%	-2.8%
	$ 0.04	0.0633	0.1033	(91)	-3.1%	1,992	4	(72)	0.2%	-3.7%
Total	$ 0.02	0.0689	0.0889	(113)	-1.7%	1,184	22	(0)	1.8%	0.0%
	$ 0.03	0.0661	0.0961	(163)	-2.4%	1,184	34	(0)	2.8%	0.0%
	$ 0.04	0.0633	0.1033	(210)	-3.2%	1,184	46	(0)	3.8%	0.0%

Bill impacts *before* price response

Affirm revenue neutrality; but Ave. bill impacts differ by SH Type

Bill Impacts
by Income Status

B1 = 90/90%
ϵ = -0.15
3-cent P Diff

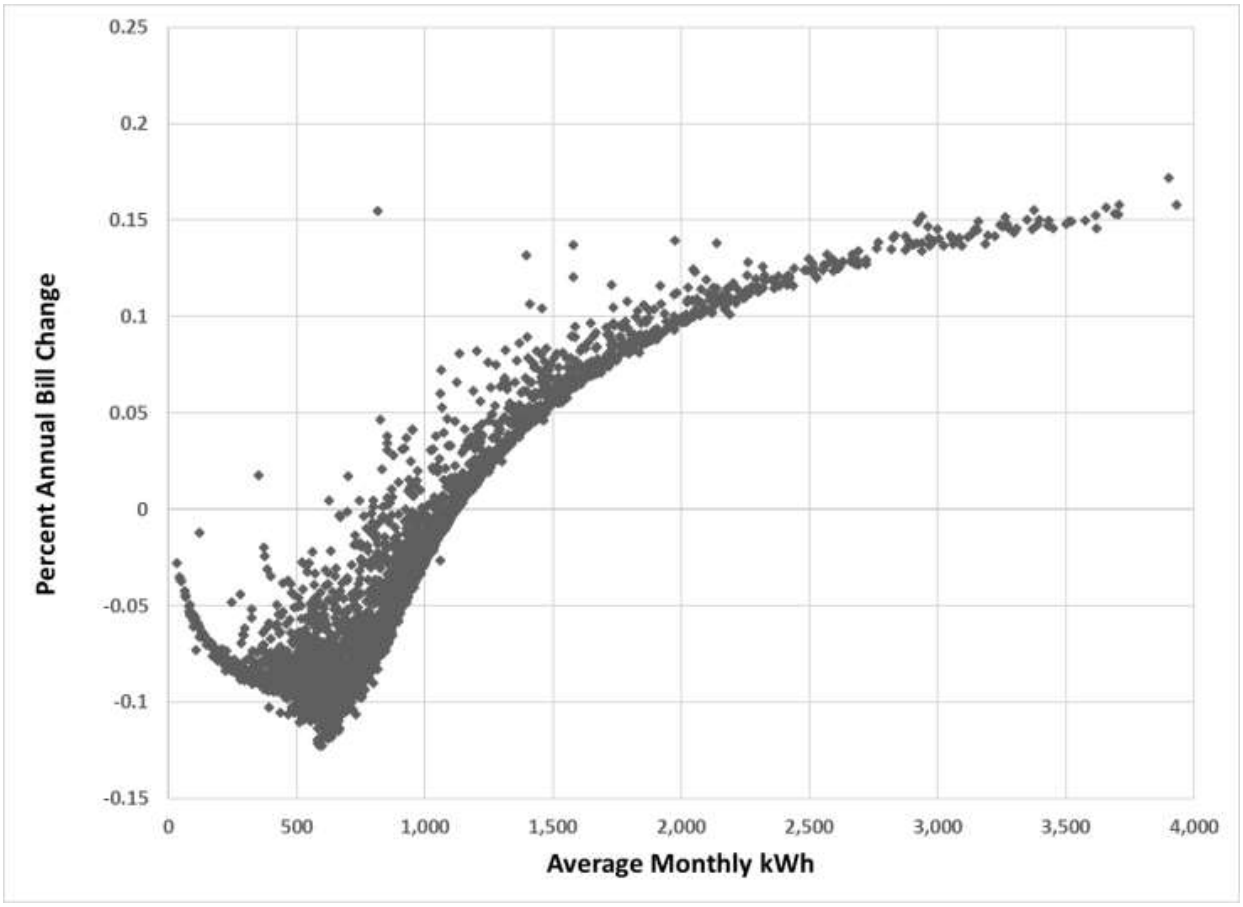
by Income Group

SH Type	Income	Average Base Bill	Average Bill Change	% Bill Change	% of Class
Non-ESH	< $40K	$ 739	$ 13	1.7%	23.2%
	$40K - $75K	$ 863	$ 9	1.0%	33.6%
	> $75K	$ 1,083	$ 33	3.0%	43.2%
	Average	**$ 905**	**$ 19**	**2.0%**	**100%**
ESH	< $40K	$ 1,806	$ (65)	-3.7%	22.9%
	$40K - $75K	$ 1,907	$ (69)	-3.7%	38.8%
	> $75K	$ 2,233	$ (28)	-1.3%	38.2%
	Average	**$ 1,992**	**$ (54)**	**-2.8%**	**100%**
Total		**$ 1,184**	**$ (0)**	**0.0%**	**100%**

LICO Status

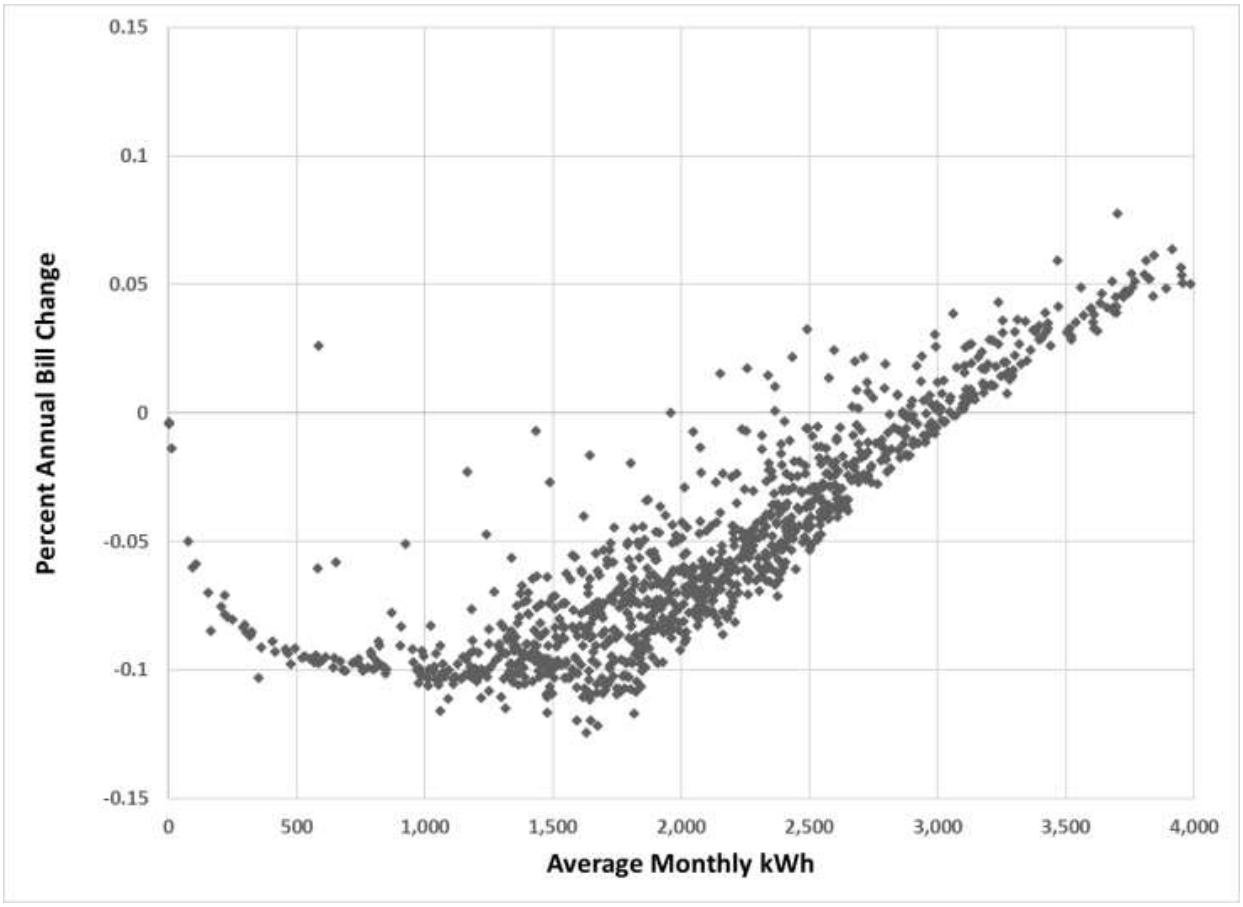
SH Type	LICO Status	Average Base Bill	Average Bill Change	% Bill Change	% of Class
Non-ESH	Non LICO	$ 952	$ 19	1.9%	73.2%
	LICO	$ 800	$ 19	2.3%	26.8%
	Average	**$ 905**	**$ 19**	**2.0%**	**100%**
ESH	Non LICO	$ 2,026	$ (51)	-2.5%	72.6%
	LICO	$ 1,908	$ (62)	-3.3%	27.4%
	Average	**$ 1,992**	**$ (54)**	**-2.8%**	**100%**
Total		**$ 1,184**	**$ (0)**	**0.0%**	**100%**

Bill Impacts and Average Monthly Usage
(Non-ESH Consumers)



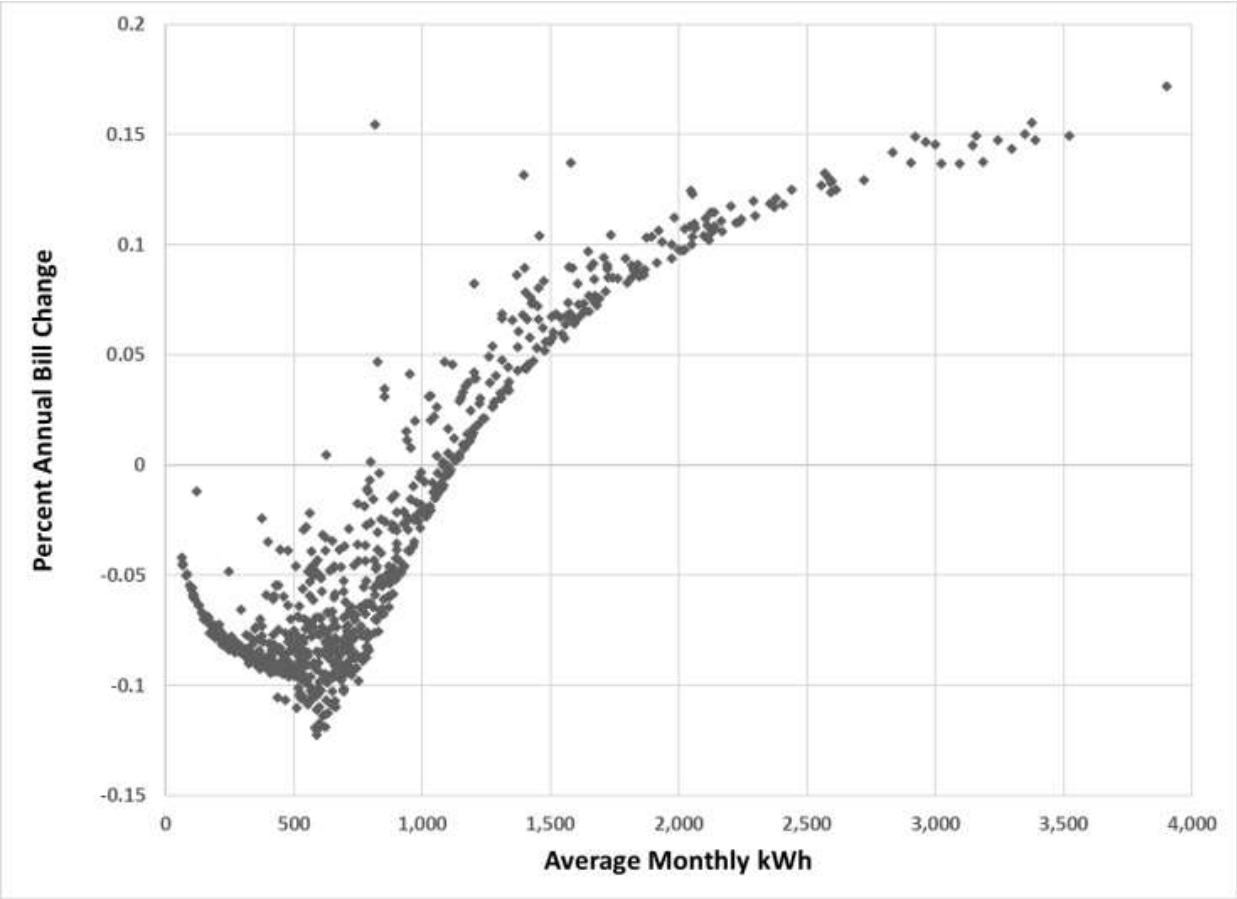
B1 = 90/90%
ϵ = -0.15
3-cent P Diff

Bill Impacts and Average Monthly Usage
(ESH Consumers)



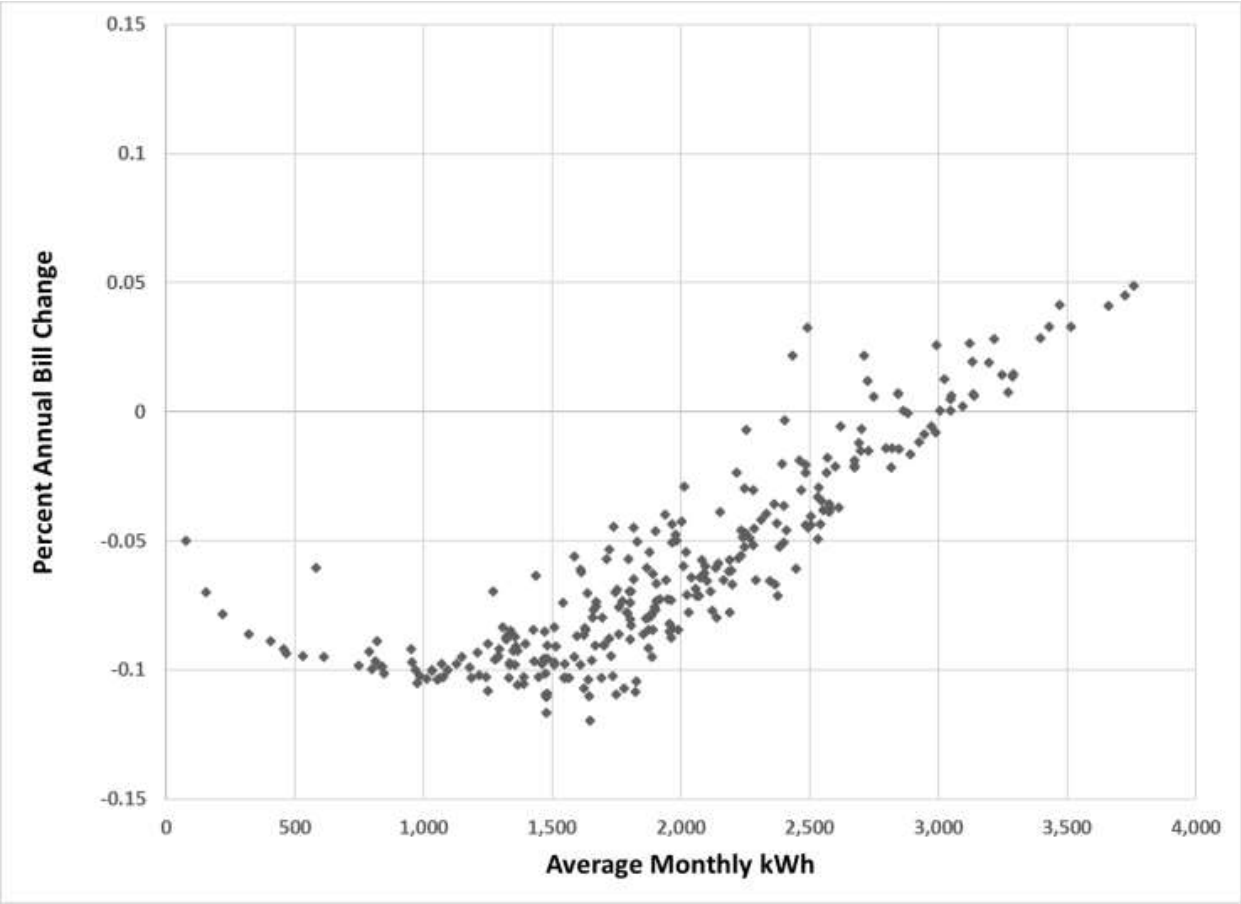
B1 = 90/90%
ϵ = -0.15
3-cent P Diff

Bill Impacts and Average Monthly Usage
(Non-ESH LICO Consumers)



B1 = 90/90%
ϵ = -0.15
3-cent P Diff

Bill Impacts and Average Monthly Usage
(ESH LICO Consumers)



B1 = 90/90%
ϵ = -0.15
3-cent P Diff

Bill Impacts and Average Monthly Usage
Best and Worst Case Outcomes

B1 = 90/90%
ϵ = -0.15
3-cent P Diff

					Bill Changes		% Bill Changes	
LICO Status	SH Type	Case	Monthly kWh	Base Bill	Before Price Response	After Price Response	Before Price Response	After Price Response
Any	Non-ESH	Best	599	$ 636	$ (65)	$ (73)	-10.7%	-12.3%
		Worst	8,418	$ 7,619	$ 1,944	$ 1,626	22.7%	19.3%
	ESH	Best	1,628	$ 1,578	$ (156)	$ (184)	-10.4%	-12.4%
		Worst	6,956	$ 6,364	$ 1,127	$ 867	16.3%	12.8%
LICO	Non-ESH	Best	591	$ 632	$ (65)	$ (73)	-10.8%	-12.2%
		Worst	3,900	$ 3,615	$ 830	$ 678	20.7%	17.2%
	ESH	Best	1,645	$ 1,595	$ (152)	$ (180)	-10.0%	-12.0%
		Worst	5,045	$ 4,573	$ 742	$ 549	15.0%	11.3%

Differentiated Block 1 Thresholds

- Setting B1 threshold at same % of median usage (*e.g.*, 90%) for both Non-ESH and ESH creates bill impact differentials
- Selects ESH thresholds to achieve comparable average bill impacts:

SH Type	Season	B1 Threshold -- % of Median 90%	66%
Non-ESH	Winter	735	
	Summer	634	
ESH	Winter		2,005
	Summer		782

Overall Analysis Results (2015)

B1 threshold (% of median usage): 90% non-ESH, 66% ESH

SH Type	Block Prices ($/kWh)			Change in Usage		Average Base Bill ($)	Bill Changes ($)		% Bill Changes	
	P Diff: (B2P - B1P)	B1	B2	Total GWh	% Change		Before Price Response	After Price Response	Before Price Response	After Price Response
	$ 0.02	0.0676	0.0876	(55)	-1.5%	905	14	(0)	1.5%	0.0%
Non-ESH	$ 0.03	0.0641	0.0941	(80)	-2.1%	905	22	0	2.4%	0.0%
	$ 0.04	0.0606	0.1006	(103)	-2.8%	905	31	1	3.4%	0.1%
	$ 0.02	0.0676	0.0876	(54)	-1.8%	1,992	40	0	2.0%	0.0%
ESH	$ 0.03	0.0641	0.0941	(79)	-2.6%	1,992	61	(1)	3.0%	0.0%
	$ 0.04	0.0606	0.1006	(102)	-3.4%	1,992	83	(1)	4.1%	-0.1%
	$ 0.02	0.0676	0.0876	(109)	-1.6%	1,184	21	(0)	1.7%	0.0%
Total	$ 0.03	0.0641	0.0941	(159)	-2.4%	1,184	32	(0)	2.7%	0.0%
	$ 0.04	0.0606	0.1006	(205)	-3.1%	1,184	45	(0)	3.7%	0.0%

Bill impacts *before* price response

Affirm revenue neutrality; same aveage bill impacts

Bill Impacts
by Income Status

B1 = 90/66%
ϵ = -0.15
3-cent P Diff

by Income Group

SH Type	Income	Average Base Bill	Average Bill Change	% Bill Change	% of Class
Non-ESH	< $40K	$ 739	$ (2)	-0.3%	23.2%
	$40K - $75K	$ 863	$ (9)	-1.0%	33.6%
	> $75K	$ 1,083	$ 11	1.0%	43.2%
	Average	**$ 905**	**$ 0**	**0.0%**	**100%**
ESH	< $40K	$ 1,806	$ (24)	-1.3%	22.9%
	$40K - $75K	$ 1,907	$ (17)	-0.9%	38.8%
	> $75K	$ 2,233	$ 37	1.6%	38.2%
	Average	**$ 1,992**	**$ (1)**	**0.0%**	**100%**
Total		**$ 1,184**	**$ (0)**	**0.0%**	**100%**

LICO Status

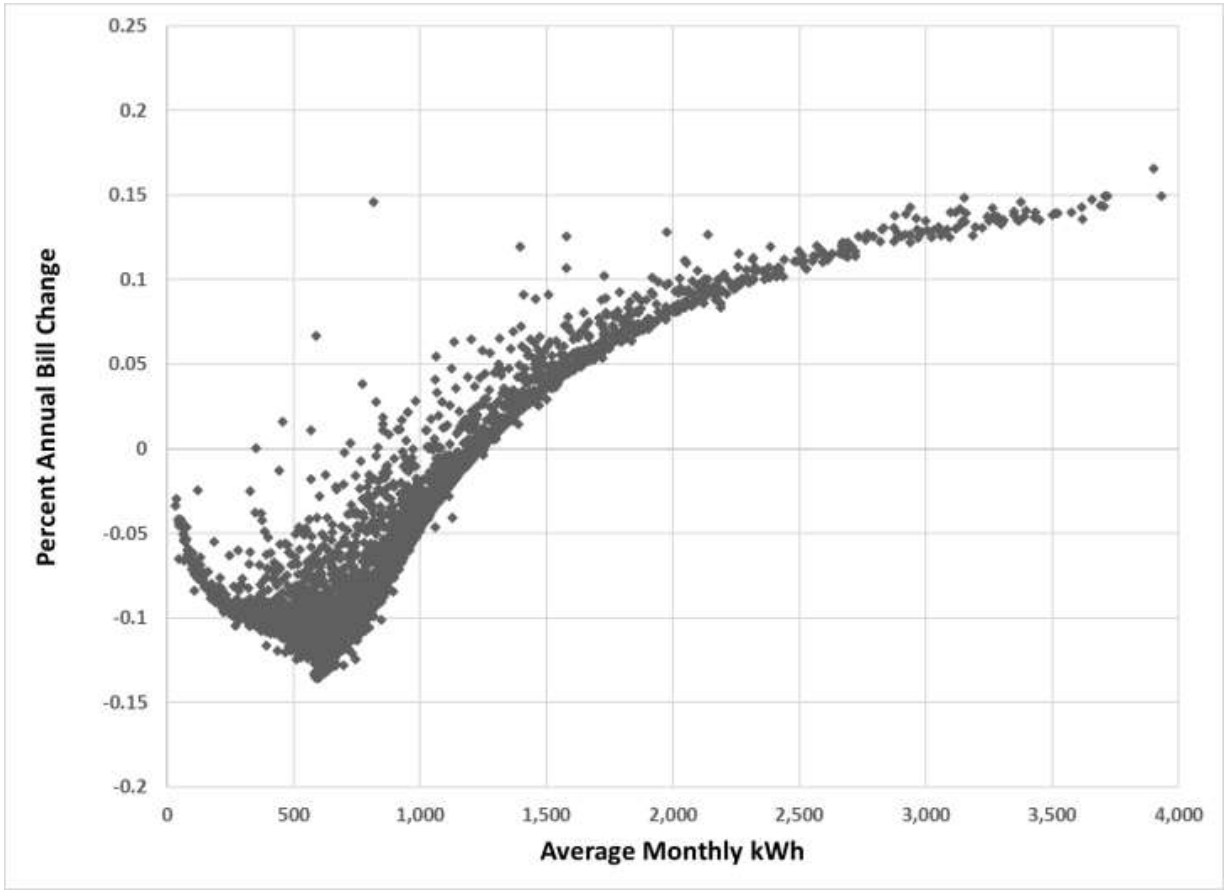
SH Type	LICO Status	Average Base Bill	Average Bill Change	% Bill Change	% of Class
Non-ESH	Non LICO	$ 952	$ (1)	-0.1%	73.2%
	LICO	$ 800	$ 2	0.3%	26.8%
	Average	**$ 905**	**$ 0**	**0.0%**	**100%**
ESH	Non LICO	$ 2,026	$ 5	0.2%	72.6%
	LICO	$ 1,908	$ (14)	-0.7%	27.4%
	Average	**$ 1,992**	**$ (1)**	**0.0%**	**100%**
Total		**$ 1,184**	**$ (0)**	**0.0%**	**100%**

Overall Analysis Results (2015) *w/ 3.95% Rate Increase*
B1 threshold (% of median usage): 90% non-ESH, 66% ESH

3.95% Rate increase

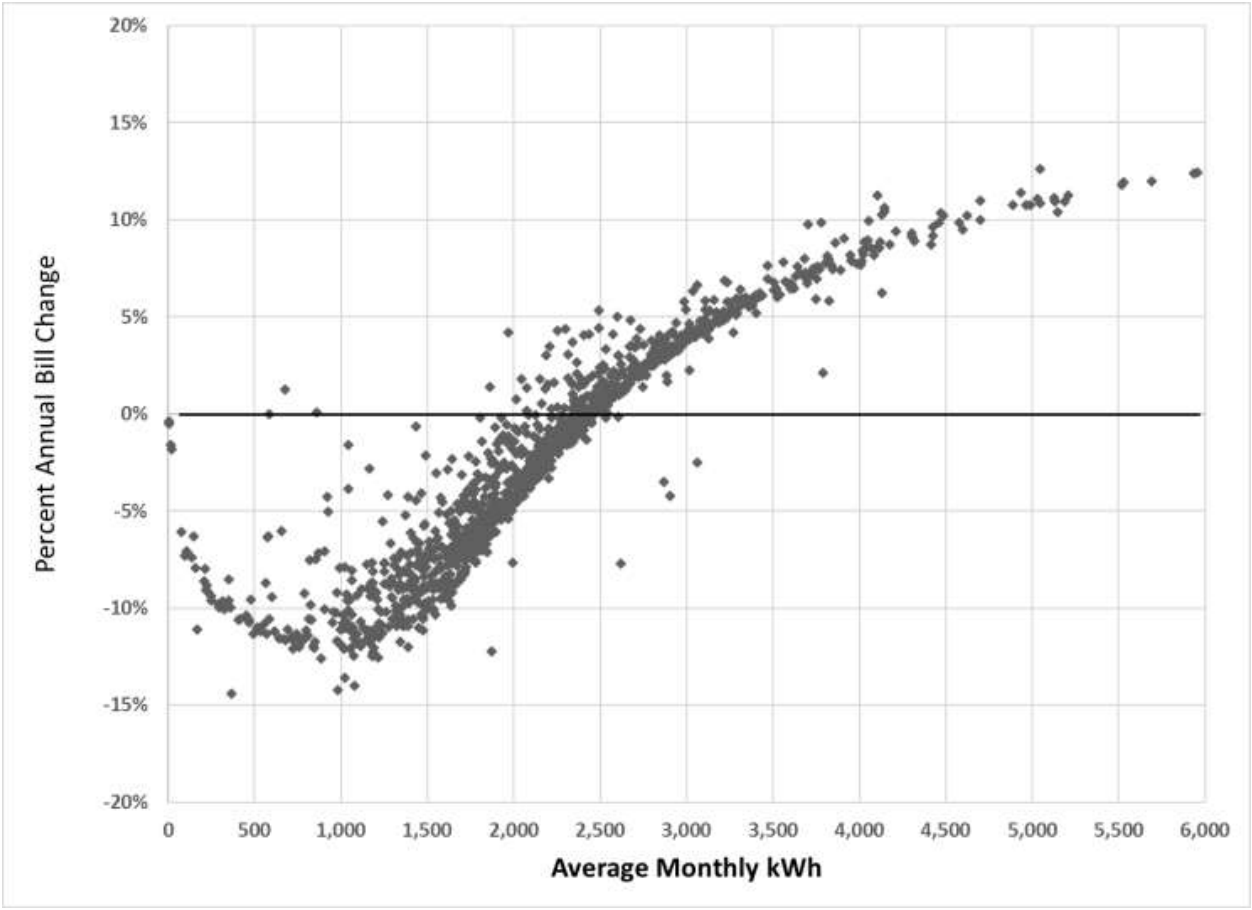
SH Type	Block Prices ($/kWh)			Change in Usage		Average Base Bill ($)	Bill Changes ($)		% Bill Changes	
	P Diff: (B2P - B1P)	B1	B2	Total GWh	% Change		Before Price Response	After Price Response	Before Price Response	After Price Response
	$ 0.02	0.0701	0.0909	(76)	-2.0%	905	46	26	4.9%	2.8%
Non-ESH	$ 0.03	0.0664	0.0976	(100)	-2.7%	905	53	25	5.7%	2.7%
	$ 0.04	0.0627	0.1043	(123)	-3.3%	905	62	24	6.6%	2.7%
	$ 0.02	0.0701	0.0909	(72)	-2.4%	1,992	121	66	5.9%	3.3%
ESH	$ 0.03	0.0664	0.0976	(96)	-3.2%	1,992	145	67	7.0%	3.3%
	$ 0.04	0.0627	0.1043	(119)	-4.0%	1,992	170	67	8.2%	3.3%
	$ 0.02	0.0701	0.0909	(147)	-2.2%	1,184	65	36	5.3%	3.0%
Total	$ 0.03	0.0664	0.0976	(196)	-2.9%	1,184	77	36	6.3%	3.0%
	$ 0.04	0.0627	0.1043	(242)	-3.6%	1,184	89	35	7.3%	2.9%

Bill Impacts and Average Monthly Usage
(Non-ESH Consumers)



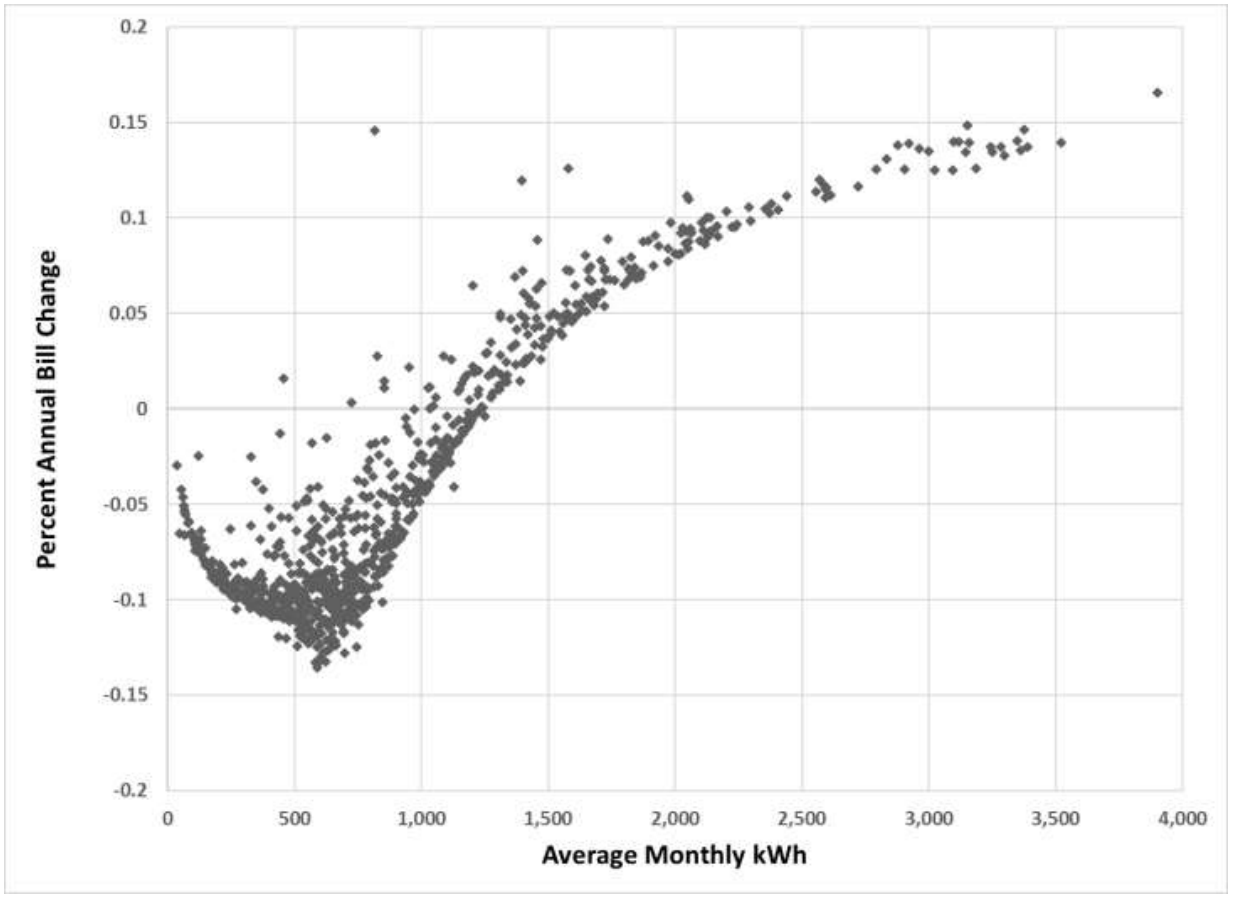
B1 = 90/66%
ϵ = -0.15
3-cent P Diff

Bill Impacts and Average Monthly Usage
(ESH Consumers)



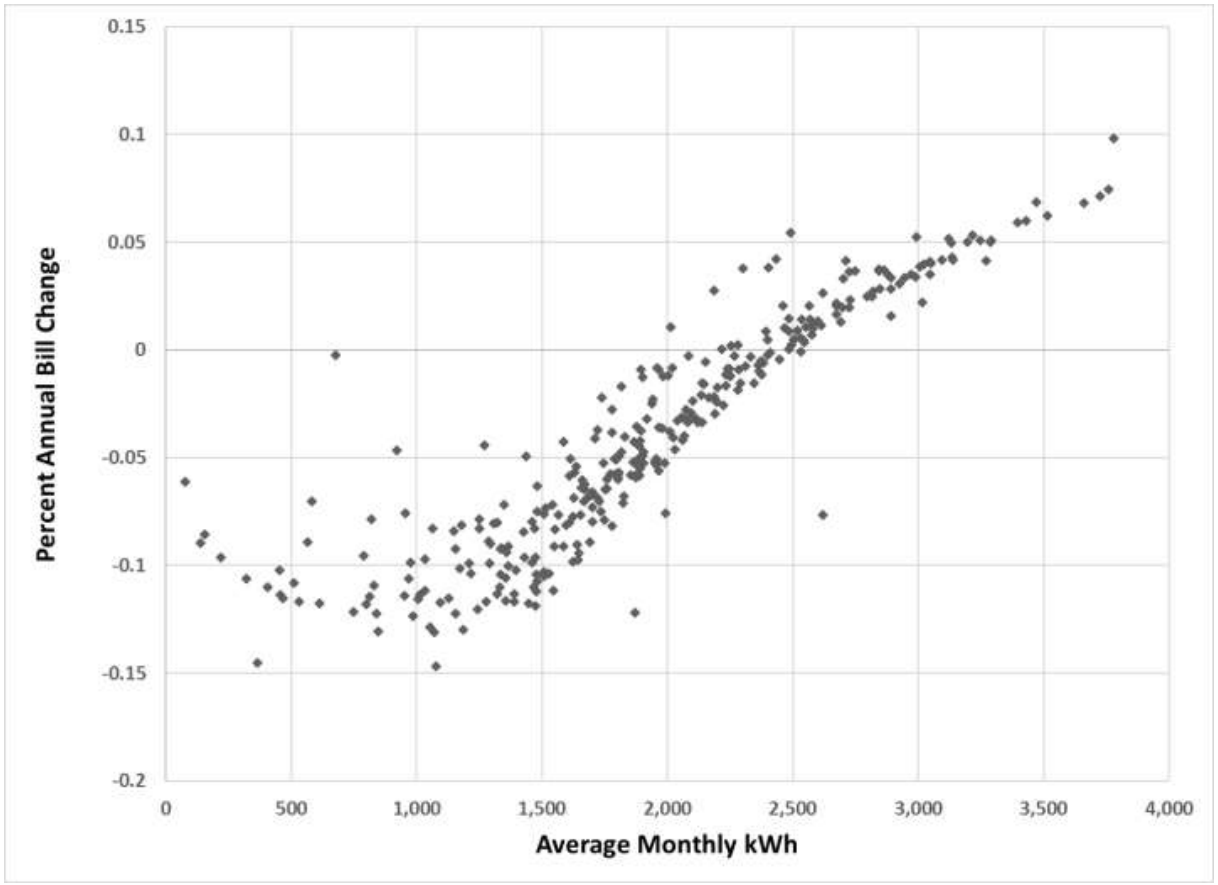
B1 = 90/66%
ϵ = -0.15
3-cent P Diff

Bill Impacts and Average Monthly Usage
(Non-ESH LICO Consumers)



B1 = 90/66%
ϵ = -0.15
3-cent P Diff

Bill Impacts and Average Monthly Usage
(ESH LICO Consumers)



B1 = 90/66%
ϵ = -0.15
3-cent P Diff

Bill Impacts and Average Monthly Usage
Best and Worst Case Outcomes

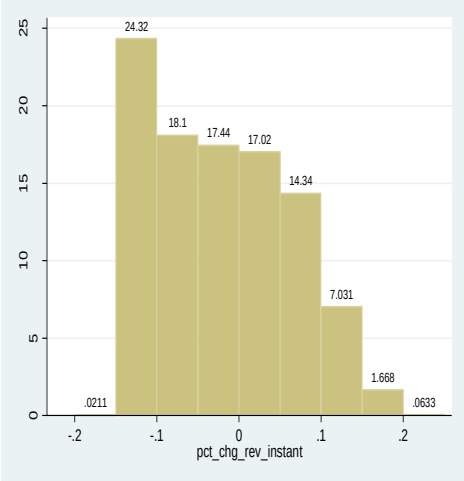
B1 = 90/66%
ϵ = -0.15
3-cent P Diff

					Bill Changes		% Bill Changes	
LICO Status	SH Type	Case	Monthly kWh	Base Bill	Before Price Response	After Price Response	Before Price Response	After Price Response
Any	Non-ESH	Best	599	$ 636	$ (79)	$ (86)	-13.3%	-14.6%
		Worst	8,418	$ 7,619	$ 1,738	$ 1,458	20.6%	17.5%
	ESH	Best	1,078	$ 1,076	$ (140)	$ (147)	-14.0%	-14.7%
		Worst	6,956	$ 6,364	$ 1,130	$ 902	16.3%	13.3%
LICO	Non-ESH	Best	591	$ 632	$ (79)	$ (86)	-13.4%	-14.6%
		Worst	3,900	$ 3,615	$ 733	$ 599	18.5%	15.3%
	ESH	Best	1,078	$ 1,076	$ (140)	$ (147)	-14.0%	-14.7%
		Worst	5,045	$ 4,573	$ 767	$ 596	15.5%	12.3%

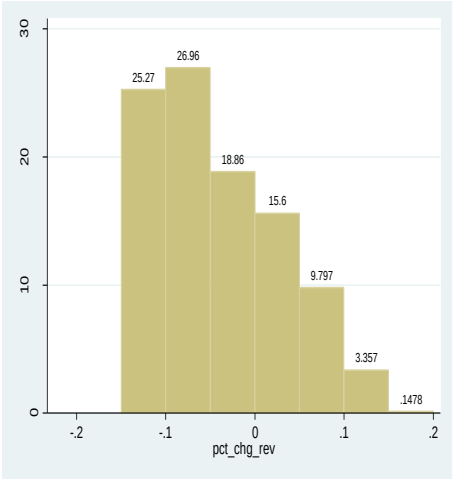
B1 = 90/66%
ϵ = -0.15
3-cent P Diff

Bill Impacts Distribution

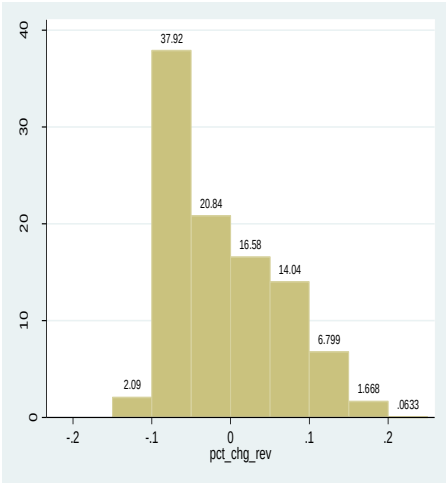
Before Load Response



After Load Response



After Load Response and 3.95%



Summary

- Overall usage reductions range from approximately 100 GWh for 2-cent price differential to 200 GWh for a 4-cent differential
- Reduced B1 threshold for ESH customers (66% of median, from 90%) to balance bill changes between ESH and Non-ESH
- Low-usage/low-income customers experience bill *reductions*; higher-usage customers have bill *increases* (1% to 2%, on average)
- Customer-level bill changes range from 15% bill savings to 15% bill increases (for very high energy consumers)

Results – *Weather-Sensitivity Analysis*

Differentiated Block 1 Thresholds

SH Type	Season	B1 Threshold -- % of Median 90%	65%
Non-ESH	Winter	774	
	Summer	650	
ESH	Winter		2,137
	Summer		824

Bill Impacts
by Fiscal year and Income Status

B1 = 90/65%
ϵ = -0.15
3-cent P Diff

Results by year show fiscal 2012 & 2014 similar to average.
Mild year (2011/2012) produces modest bill reductions relative to average.
Cold year (2013/2014) produces modest bill increases relative to average.

SH Type	Income	% Bill Change				
		2011 (Mild)	2012 (Norm)	2013 (Cold)	2014 (Norm)	Average
Non ESH	< $40K	-1.2%	-0.1%	0.3%	-0.1%	-0.3%
	$40K - $75K	-1.5%	-0.7%	-0.3%	-1.0%	-0.9%
	> $75K	0.2%	0.9%	1.3%	0.8%	0.8%
	Average	**-0.7%**	**0.1%**	**0.5%**	**0.0%**	**0.0%**
ESH	< $40K	-3.3%	-1.3%	-0.1%	-1.5%	-1.6%
	$40K - $75K	-2.5%	-0.7%	0.4%	-0.9%	-0.9%
	> $75K	0.3%	1.8%	2.8%	1.5%	1.6%
	Average	**-1.6%**	**0.1%**	**1.2%**	**-0.1%**	**-0.1%**
		-1.1%	**0.1%**	**0.8%**	**-0.1%**	**-0.1%**

Bill Impacts
by Fiscal year and LICO Status

B1 = 90/65%
ϵ = -0.15
3-cent P Diff

Results by year show fiscal 2012 & 2014 similar to average.
Mild year (2011/2012) produces modest bill reductions relative to average.
Cold year (2013/2014) produces modest bill increases relative to average.

SH Type	LICO Status	% Bill Change				
		2011 (Mild)	2012 (Norm)	2013 (Cold)	2014 (Norm)	Average
Non ESH	Non LICO	-0.7%	0.0%	0.4%	-0.2%	-0.1%
	LICO	-0.6%	0.3%	0.8%	0.4%	0.2%
	Average	**-0.7%**	**0.1%**	**0.5%**	**0.0%**	**0.0%**
ESH	Non LICO	-1.3%	0.4%	1.4%	0.2%	0.2%
	LICO	-2.6%	-0.6%	0.6%	-0.9%	-0.9%
	Average	**-1.6%**	**0.1%**	**1.2%**	**-0.1%**	**-0.1%**
		-1.1%	**0.1%**	**0.8%**	**-0.1%**	**-0.1%**

Summary of Weather Sensitivity Analysis

- Overall usage reductions still range from approximately 100 GWh for 2-cent price differential to 200 GWh for a 4-cent differential
- Overall % bill impacts (after price response, – 0.15 elasticity)
  - 0.7% to 1.6% bill reductions in mild winter (‘11/’12)
  - 0.5% to 1.2% bill increases in cold winter (‘13/’14)
  - Compare to revenue neutral (0% bill change) for average year

Information on electricity price elasticities of low-income customers

For Manitoba Hydro

Steven Braithwait

December 29, 2016

This memorandum summarizes the findings of a brief search of the literature on the price responsiveness of different types of residential electricity customers, particularly those classified as low-income. The search yielded several recent papers, including one relating directly to Canadian customers. Some of the studies involve measures of customers' *overall* price responsiveness, or elasticity. Others involve recent interest in how consumers respond to various types of *time-varying pricing* plans, such as critical peak pricing (CPP).

The overall pattern of findings across the studies that report results by income level is somewhat mixed. Several report that low-income customers are somewhat *more* price responsive than the average customer, with responsiveness declining by income level. One study of CPP price response (Cappers, et. al.) reports no apparent statistically significant differences in responsiveness among "vulnerable" sub-populations. Another (Christensen Associates) reports that customers who qualify for a low-income rate discount at a California utility (PG&E) are *less* responsive than non-qualifying customers. Likely contributors to the differences in findings have to do with differences in data used (*e.g.*, monthly or annual consumption, or usage by hourly time period), level of aggregation (*e.g.*, customer-level or aggregate), assumptions regarding the nature of customers' price perception (*e.g.*, marginal price, average price, or entire rate structure), and method of estimation.

The intuition behind findings that price elasticities decline by income level is that electricity expenditures account for relatively higher portions of low-income customers' budgets, thus making them more sensitive to price increases. Potentially counteracting this effect is the tendency of low-income customers to possess fewer major energy-using devices and to live in smaller dwellings than do higher-income customers. As a result, they may have less energy consumption to reduce (some of the studies report higher price elasticities for customers with major energy using devices such as electric space heating and water heating). In addition, high-income customers facing price increases may be more likely to replace appliances with higher efficiency units that reduce their consumption.

A key issue in estimating price elasticities has to do with the nature of the price change(s) relative to which customers' changes in consumption are measured. For example, for a given utility, electricity prices tend to not vary greatly over time or across customers. Exceptions include rates such as CPP, where the peak price on an event day differs substantially from that on a normal day (*e.g.,* $0.90 per kWh compared to $0.10 per kWh), and inclining block rates, where the average or marginal price of high-use customers may be substantially higher than that of low-use customers. Some studies attempt to create greater price variation by using aggregate data or household survey data across states or regions. Espey and Espey study the effect of various factors in estimating short-run and long-run price elasticities. However, they do not report differences by income level.

Table 1 provides a synthesis and summary of relevant results for several of the papers and reports listed in the references. The three studies that explicitly estimate price elasticities by income category report quite similar findings, with elasticities for low-income customers ranging from -0.34 to -0.5, and elasticities for high-income customers ranging from -0.25 to -0.29.

Table 1. Data and price elasticity findings relative to low-income customers

Author(s)	Country	Pricing	Data	Elasticity finding	Elast. by Income Level		
					Low	Average	High
You, et. al.	S. Korea	Inclin. block	Agg. Annual & 2011 household-level survey	Declining by income	-0.34	-0.3	-0.28
Guertin, et. al.	Canada	Average	HH survey (SHEU); Statistics Canada; Elect. Power Stats.	Declining by income (esp. space heating)	-0.43	-0.35	-0.25
Pineau	Canada		Prices for BC, Sask. Manitoba, Quebec	Elast. applied to estimate impact of removing price subsidies by province; no low-income distinction			
Reiss & White	U.S. (CA)	Inclin. block	Sample of utility households	Declining by income (higher w/ space heating)	-0.49	-0.39	-0.29
Schulte & Heindl	Germany	Average	German HH survey data	Elast. Varied by HH type (lowest for single, higher for couple & children); Elast. Increases by level of usage (-0.23 to -0.72 for couple); not distinguished by income			
Cappers, et. al.	U.S.	Crit. Pk. Pricing	HH data from 2 CPP experiments -- SMUD (CA) and Green Mtn. (VT)	Price response of Low inc customers no diff. than other customers; dist. of bill impacts also similar			
Christensen Assoc	U.S.	CPP	HH data for enrollees in PG&E's voluntary CPP rate (CA)	Estimated % reduction in peak kW during events. % reduction for Low-inc customers (6%) was 1/3 of that for non-low inc. (17%). Across cust. by usage level, % of stat. sig. responders by low-use cust. (17%) was half of high-use cust. (33%).			

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