Does Dynamic Pricing Make Sense for Mass Market Customers?

The added incentive to modify electric use under hourly versus monthly market-based pricing is small for most mass market customers in Upstate New York. If the ultimate policy goal of demand-response programs is to reduce peak load, then promoting conservation measures under monthly market-based pricing holds more promise.

Catherine McDonough and Robert Kraus

Catherine McDonough *is Manager of Dynamic Pricing Programs at National Grid. She is a financial economist with over 25 years' experience who has spent the last eight years developing strategic plans and managing electric pricing initiatives for National Grid in New York. Prior to joining National Grid, Dr. McDonough was Vice President and Senior Economist with Merrill Lynch Capital Markets in New York. She holds an M.A. and Ph.D. in Financial Economics from New York University and a B.A. in Economics from the University of Massachusetts at Amherst. She can be reached at catherine.mcdonough@us.ngrid.com.*

Robert Kraus *is a Senior Electric Pricing Analyst with National Grid. He has spent the last five years applying segmentation and simulation principles to National Grid's customer data to model the financial impact of alternative company strategies on customer classes. He holds an M.B.A in Operations Management from Syracuse University and a B.S. in Nuclear Engineering from the Georgia Institute of Technology.*

The authors gratefully acknowledge the helpful comments of James Bonner, William Deehan, Ahmad Faruqui, Bart Franey, Charles Goldman, Arthur Hamlin, Jonathan Holstein, Douglas Lutzy, Glenn Meyers, James Stapleton, and Thomas Turo. They are also grateful for the impact analysis on wholesale prices provided by Bernie Neenan and Jeremey Anderson of Utilipoint International Inc. The views expressed here are not necessarily those held by National Grid.

Most electricity customers see electricity rates that are based on average electricity costs that bear little relation to the true production costs of electricity that vary over time. Demand response is a tariff or program established to motivate changes in electricity use by the end-use customer in response to changes in the price of electricity over time. Price-based demand response such as RTP, CPP and TOU tariffs give customers time-varying rates that reflect the value and cost of electricity in different time periods. Armed with this information, customers tend to use less electricity at times when electricity prices are high.[1]

But what interval of time should be used to bill mass market customers for commodity? Will mass market customers adapt their usage sufficiently in response to hourly prices to justify the cost of installing interval meters and educating customers? How much incremental savings can consumers expect from market rates that vary hourly as opposed to monthly? Is the additional incentive contained in hourly prices sufficient, or even

  doi:/10.1016/j.tej.2007.07.005

necessary, to induce demand response?

The results from several pilot programs suggest that mass market electric customers are favorably disposed toward dynamic pricing and will modify their electricity use in response to it. Pilot results from a study in California suggest that a critical peak price—five times a normal peak hour price—can induce a 13 percent drop in peak-period electricity use on critical days.[2] A study conducted to evaluate the potential for residential RTP in Illinois indicates that mass market customers reduce load by as much as 4.7 percent in response to a doubling of hourly prices[3] and that even this level of response can generate benefits to participants and other customers.[4]

But these programs have been offered to customers in states with warm climates and complicated inverted block rate structures (Florida, California) or in states where the otherwise applicable flat price default service rate contains a substantial risk premium (Illinois). It is not clear whether dynamic pricing would be nearly as attractive to mass market customers in states with colder climates and, therefore, lower discretionary summer peak loads, and simpler market-based default rates that vary monthly and contain no risk premium. This is especially true if the cost of the interval metering (net of operational savings) required to support hourly pricing is relatively high.[5] Customer receptivity is particularly important in such states as New York, where a time-based rate cannot be mandated for residential customers.

This study uses a bottom-up analysis of customer load shapes to compare the financial incentives available to mass market customers from conserving energy under National Grid's existing monthly market-based default service in New York,[6] to the incentive that hourly market-based rates would create for those customers. We do not estimate the elasticity of demand. Instead, we simply estimate the additional commodity bill savings from conserving electricity under hourly pricing versus the existing monthly market-based default rate. We also establish an upper limit to the additional bill savings mass market customers might achieve under an hourly rate by shifting time-discretionary activities to lower-priced hours of the day. We additionally consider the potential feedback effects of conservation and load shifting on peak load, wholesale energy, and capacity prices in order to compare the demand response potential of the two commodity billing methods. Finally, we evaluate the incremental benefit of hourly market-based pricing for mass market customers relative to the incremental cost to support this rate, and discuss its policy implications.

Such conservation measures as the use of compact fluorescent bulbs inherently save more kWh during peak hours.

We focus on two low-cost conservation measures that hourly pricing would seem to strongly encourage: the use of compact florescent bulbs (CFLs), and raising thermostats on central air conditioners (ACs). Lighting accounts for 16 percent of annual household electricity use in New York State, and much of this use occurs during the high-priced hours of the winter months. So the recent improvement in quality and reduction in price of compact fluorescent bulbs (which use only 25 percent of the amount of electricity used by incandescent bulbs) creates the opportunity for substantial savings at low cost[7]—especially under hourly pricing.[8] About 18 percent of New York households own central air conditioners, and these units account for only about 2 percent of annual household electricity use. But ACs run mainly during the high-priced hours of summer days, so the financial incentive to raise thermostats on these units by 5 degrees would seem to be much higher under hourly pricing than under the current commodity billing method.

 1040-6190/$–see front matter doi:/10.1016/j.tej.2007.07.005

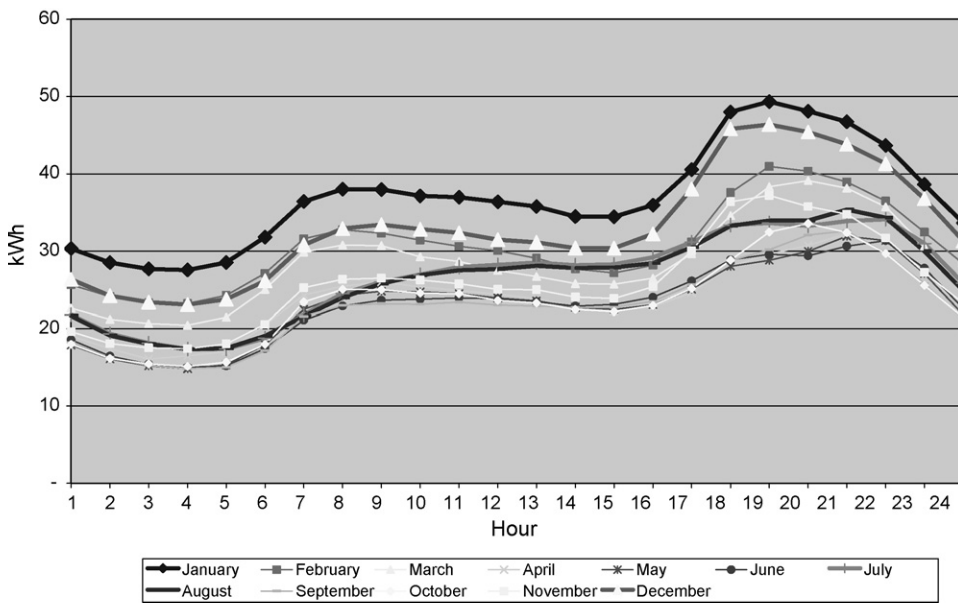

Figure 1: Average Hourly Usage of Mass Market Customer by Month, 2004

I. Current Commodity Billing Method

Under National Grid's existing default service, mass market customers are billed for commodity based on their kilowatt hour usage and a weighted average price indexed to the hourly NYISO[9] day-ahead location-based marginal price (DALBMP) over a monthly billing period.[10] The weights used to calculate this price are based on the average estimated hourly use for the entire residential class as derived from 333 sample customers. As shown in **Figure 1**, the average hourly use of National Grid's New York residential customers peaked in January 2004 at 7:00 P.M. This is the typical pattern for National Grid's mass market customers in New York, where peak usage for households is driven by winter lighting load.

The hourly prices used to generate the weighted average default price vary considerably throughout the day and across the year. As shown in **Figure 2**, hourly prices generally double between the pre-dawn hours and 6:00 P.M. before dropping back in the late evening hours. Most of the run-up in hourly prices during the day is due to the increase in the hourly DALBMPs, but part of the increase reflects a kW adder in effect from noon to 8 P.M. to collect the costs associated with National Grid's capacity requirement.[11,12]

II. Data, Assumptions, and Analysis

The increase in hourly prices throughout the day shown in Figure 2 suggests that customers may be able to save a significant amount of money under hourly commodity billing. With this method, customers would be billed for commodity based on their actual electric use each hour, as recorded by an interval meter, and the hourly market-based price. To evaluate the savings potential, we performed a series of comparative static exercises using the 2004 load-shapes for the 333 mass-market customers chosen to reflect the hourly usage patterns of the residential class.[13] As shown in **Table 1**, fewer sample meters are used to model the behavior of customers who use the smallest amount of electricity. The reason for this is that the usage patterns of such customers are less diverse than those of larger customers, but each sample customer maps to a significant cohort of residential customers.

As a first step, we simply analyze the impact of hourly pricing on customer commodity bills, assuming that customers do not shift or shed load in response to hourly prices. This essentially demonstrates the

  doi:/10.1016/j.tej.2007.07.005

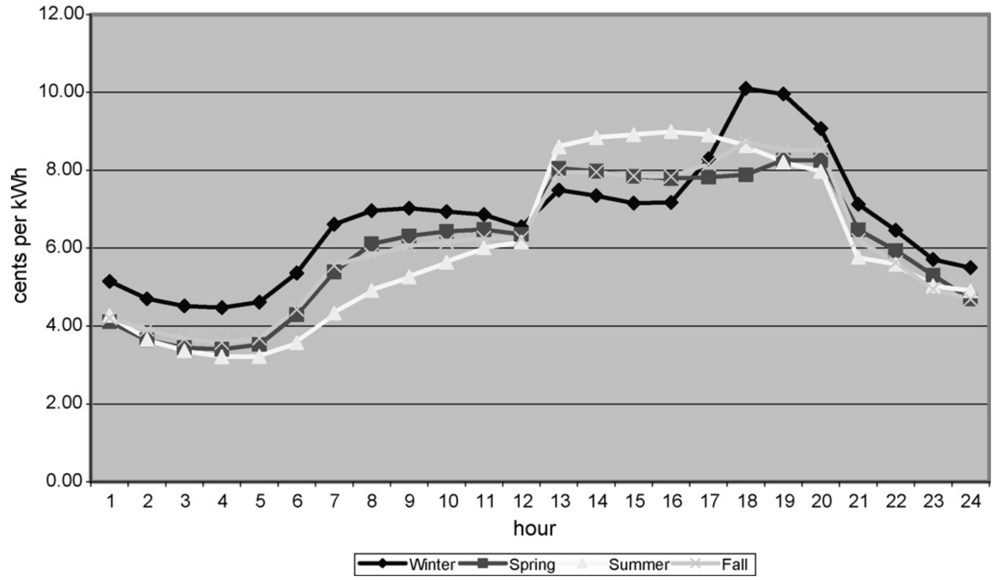

Figure 2: Average Hourly Week-Day Residential Commodity Prices

impact of unbundling the cross-subsidy embedded in the class-load weighted average default price. Customers who currently use a greater-than-average share of electricity in the early morning or late evening are natural beneficiaries of hourly pricing, while the initial impact of hourly pricing for customers who use a less-than-average proportion of electricity during those lower-priced hours will be unfavorable. This creates an incentive for customers to use less electricity when hourly prices are high by either conserving or shifting activities to lower-priced hours. But how much extra savings can customers reasonably expect to gain from these actions under hourly pricing?

A. Modeling the potential savings from shifting load

We model the potential for mass market customers to shift load in response to hourly prices by first identifying electric end-use activities that New York households could shift to lower-priced hours of the day without a major compromise in lifestyle (''time-discretionary activities''). Absent the actual energy use patterns of our sample customers, we use the results from the Energy Information Administration's New York Electricity Household Report for 2001 (''EIA Report'')[14], summarized in **Table 2**, to identify electric end uses that meet this criterion. The activities include dishwashing, clothes washing/drying, and pool pump operation—activities that account for about 19 percent of the annual electricity use for an average National Grid household that consumes 8,000 kWh per year. Because the ownership rate for much of this equipment is well under 100 percent, these end uses

Table 1: Mapping of Sample Meters to Mass Market Customers

Size Stratum	Maximum Annual (kWh)	#Accounts (millions)	kWh (millions)	# Sample Meters	# Accounts Per Sample Meter
A	B	C	D	E	[C/E]*1,000,000
1	5,378	0.551	1,748	46	11,968
2	7,820	0.302	1,982	69	4,381
3	10,436	0.234	2,113	47	4,976
4	14,258	0.185	2,239	65	2,852
5	644,310	0.129	2,473	106	1,217
Total		1.401	10,555	333	

Table 2: New York Household Electricity End Use, 2001

	A Millions of Households	B Percent of Households	C kW Per Household	D Total kWh Billions	E Percent of Total kWh
Heating ventilation cooling				8	19
Air conditioning					7
Central	1.3	18%			2
Individual room		3%	48		5
Kitchen appliances				13.6	32
Dishwasher	2.8	39%	409	1.1	2
Water heating	0.9	13%	2292	2.1	5
Lighting	7.1	100%	940	6.7	15
Home electronics				5.4	13
Laundry appliances				2.5	5
Clothes dryer	2.2	31%	865		4
Clothes washer	4.5	63%	120		1
Other equipment				1.3	3
Pool pump	0.3	4%		0.5	1
Other end uses				2.8	6
Total	7.1	100%	5974	42.3	100

account for only 10 percent of the total kWh consumed by New York households overall. We assume that all other household activities that consume electricity, such as home electronics, refrigeration and cooking appliances, lighting, heating, air conditioning, and water heating, cannot be shifted to off-peak hours without a major shift/compromise in lifestyle, and are therefore not likely to be shifted to lower-price periods even under hourly pricing.[15]

Based on appliance ownership rates, we selected a subset of sample customers who own all or some time-discretionary equipment and who therefore have the technological ability to shift load. We use the appliance ownership rates contained in the EIA Report and in a study funded by the New York State Energy Research and Development Authority (''NYSERDA Report'') [16] to identify the proportion of households in each stratum who own dishwashers, clothes washers, dryers, and pools. Lastly, we assume that the households presumed to own these appliances can observe the day-ahead hourly prices posted on the company Web site and shift the daily operation of this equipment to late evening hours. To model this shift, we reduce the daily kilowatt hours associated with dishwashing, clothes washing, and drying in each household's existing peak period[17] and add the same number of kilowatt hours to the 9-to-12 P.M. period. For pool pumps, we reduce the kilowatt hours associated with running the pool pump during the 9 A.M. to 9 P.M. period and increase the kilowatt hours during the 9 P.M. to 9 A.M. period by a commensurate amount. We assume that any customer whose peak already occurs off-peak, and who would therefore not save money from shifting load, does not shift load even though they are technically able to do so.

B. Modeling the potential savings from compact fluorescent lighting

We model the potential savings from the widespread use of compact fluorescent bulbs in several steps. First, we estimate that lighting accounts for 14 to 19 percent of total annual kWh usage for our sample customers based on the proportions generated in

  doi:/10.1016/j.tej.2007.07.005

the EIA and the NYSERDA Reports. We further assume, based on a study performed by the Bonneville Power Administration (BPA), that 26 percent of lighting load for each sample customer occurs in the summer months, and the remaining 74 percent in the winter.[18] We then estimate the daily lighting load for each sample customer by distributing the total estimated lighting load for the appropriate season (winter, fall, spring, or summer) to each day, based on the proportion of total seasonal load that occurs on that day. Next, we identify the existing lighting load in each hour of the day using the BPA's hourly load shapes for lighting, and reduce each sample customer's estimated hourly lighting load by 75 percent each hour. As a final step, we evaluate the dollar savings for each sample customer under the current commodity billing method versus hourly pricing.

C. Modeling the potential savings from adjusting AC thermostats

We use a similar method to evaluate the savings from turning up the thermostats on central air conditioning units by 5 degrees. First, we identify households that are likely to own such units based on the proportion of their load that occurs during the months of June, July, and August (''summer share'') and the estimated proportion of households in New York State that own such units as reported by EIA and NYSERDA. For these households we allocate the total estimated annual kWh used by central AC units according to EIA and NYSERDA across the summer days for each sample customer, based on the proportion of the customer's total summer load that occurred on that day. Next, we use the BPA's average hourly AC load shape to identify the proportion of daily AC load that occurs each hour, then reduce that amount by 12 percent. As a final step, we translate these kWh savings into dollars under both commodity billing methods.

III. Description of Results

A. Potential impact on customer bills

The initial impact of hourly pricing, in the absence of conservation or shifting load, would be modest for most households in Upstate New York. As shown in **Table 3**, column B, unbundling the cross-subsidy embedded in the current default price would reduce the annual commodity bills of 660,000 households (47 percent) that currently use a smaller-than-average proportion of electricity during low price hours by up to 5 percent, and the commodity bills of a similar number of households would increase by the same amount. Only 82,000 (6 percent) of households would experience an initial commodity bill impact of more than 5 percent, and the impact on the overall electric bills for these households would be half as great, since commodity charges account for only half the total bill for mass market customers.

In the absence of feedback effects on wholesale prices, the potential savings from mass market customers shifting load to off-peak periods also seems modest. As shown in **Table 4**, households that own a dishwasher, washer, and dryer, and that currently use the equipment during highest-price hours, can save up to $39 a year by using it after 9 P.M. But for most households the savings would be closer to $19 a year, either because they don't own all the appliances, or they don't currently use the equipment every day or at the time when hourly prices are highest. Households that own swimming pools can save another $30 to $35 per year if they operate the pumps for these pools overnight instead of during the day, but only about 4 percent of households in National Grid's service territory own pools. Households that own large well-insulated electric hot water heaters could save an additional $73 to $85 per year by operating the units only during the low-cost night-time hours. But it is not clear what fraction of the 13 percent of New York households that use electric hot water heaters have units that are large and well-enough insulated to reap these savings without compromising their quality of life.

Table 3: Impact on Commodity Bills under Hourly Pricing

	Percent Impact	No Shifting		Shifting Alone		Total	
		A Households	B Percent	C Households	D Percent	E Households	F Percent
Unfavorable	5 to 7	38,955	2.8	0	0.0	4,381	0.3
Unfavorable	2.5 to 4.9	187,425	13.4	0	0.0	62,198	4.4
Unfavorable	1 to 2.49	349,735	25.0	0	0.0	119,738	8.5
No Change	< 1	191,126	13.6	499,946	35.7	348,408	24.9
Favorable	1 to 2.49	382,055	27.3	451,458	32.2	300,983	21.5
Favorable	2.5 to 4.9	206,576	14.7	250,032	17.8	393,010	28.1
Favorable	5 to 7	36,456	2.6	145,674	10.4	101,030	7.2
Favorable	7 to 12	8,762	0.6	53,980	3.9	71,341	5.1
	Total	1,401,089	100.0	1,401,089	100.0	1,401,089	100.0

For many households, the savings from shifting load simply helps mute the impact of removing the cross-subsidy that occurs with the move to hourly pricing. This happens because households that use a greater-than-average proportion of electricity on-peak and who, therefore, pay more in the absence of the cross-subsidy under hourly pricing, also have more potential to save by shifting use to off-peak periods. When we include the loss in cross-subsidy, the average annual $19 savings from shifting load to low-price hours would be closer to $14 per year. As shown in Table 3, column F, more than 60 percent of households have the potential to reduce their commodity bill under hourly pricing when we consider the impact from shifting load along with the loss or gain from unbundling the cross subsidy. But only 14,000 (1 percent) of households have the potential to save more than 10 percent on their commodity bill, which equates to only about 5 percent of the overall electric bill. Moreover, the total impact of hourly pricing would still be unfavorable for 13 percent of households, and negligible for another 2 percent of households, even if they shifted all time-discretionary electric use to off-peak periods.

The potential savings from shifting time-discretionary activities to lower-priced hours of the day under hourly pricing also seems modest compared to the prospective savings to be gained from the low-cost conservation measures we examine. As shown in column B of **Tables 5 and 6**, even without the favorable feedback effect on wholesale prices, almost 95 percent of mass market customers have the potential to shave 12 to 16 percent from their commodity bills by replacing incandescent with compact fluorescent bulbs. The 18 percent of households who own central air conditioning systems could save another 2 to 3 percent by turning up the thermostats on these units by 5 degrees.[19]

Notably, the potential bill savings from these conservation

Table 4: Potential Annual Savings with Hourly Pricing[a]

	Maximum	Average
Load shifting actions		
Dish washing	$11.47	$6.08
Clothes washing	3.41	1.98
Clothes washing/drying	27.55	12.39
Pool pump (PP)	34.83	30.49
All shifting actions	73.85	48.96
Shifting actions ex PP	39.02	18.47
Load shedding activities		
Compact fluorescent bulbs	$911.02	$70.52
Raise central AC thermostat	$106.21	$21.26

[a] **Note:** Does not include associated feedback effect on market prices.

 1040-6190/$–see front matter doi:/10.1016/j.tej.2007.07.005

Table 5: Percent Commodity Bill Savings from Replacing Incandescent with Compact Fluorescent Bulbs

Stratum	A Current Method (%)	B Hourly Pricing (%)	C # HH	D % HH
1	11.0	11.7	550,531	100
2	12.2	13.0	302,289	100
3	12.9	13.8	233,872	100
4	13.7	14.6	185,380	100
5	14.4	15.5	129,002	100
Total			1,401,089	

Table 6: Percent Commodity Bill Savings from Raising Thermostat on Central AC

Stratum	A Current Method (%)	B Hourly Pricing (%)	C # HH	D % HH
1	1.6	2.0	38,500	7
2	2.0	2.4	42,320	14
3	2.6	3.1	53,791	23
4	3.2	3.2	68,591	37
5	2.3	2.8	50,311	39
Total			253,512	18

measures are only slightly higher under hourly pricing than they would be under the existing default rate. The average household could save $66 annually using compact fluorescent bulbs under the existing default rate compared to $71 under hourly pricing—only about $5 more per year. Similarly, the average household that owns a central air conditioner could save $18 annually by turning up the thermostat 5 degrees under the existing default rate versus $21 under hourly pricing—only $3 more per year. As can be seen from Tables 5 and 6, the incremental savings from the conservation measures under hourly pricing versus the current default rate is minor compared to overall household commodity bills.

B. Potential impact on peak demand, energy and capacity prices

Interestingly, the potential impact of the conservation measures on summer peak demand and energy use far exceeds the potential impact from shifting time-discretionary activities to off-peak hours. National Grid's summer peak demand would have been 38 MW lower in 2004 if all customers were subject to hourly pricing and shifted all time-discretionary activities to low-price hours (to the extent that they could save any money doing so.) In contrast, the use of compact fluorescent bulbs and the raising AC thermostats would have cut 133 MW and 85 MW from the summer peak, respectively (**Table 7**).

Moreover, the widespread use of compact fluorescent bulbs could save 1.4 billion kWh of electricity each year, while raising AC thermostats could add another 73 million kWh in savings. Of course, shifting time-discretionary activities to lower-price hours would not save any kilowatt hours, but these actions could reduce energy use during high-priced hours by 184 million kWh and so help dampen the wholesale price of electric commodity and capacity.

Even so, the low-cost conservation measures seem to have much greater potential to dampen commodity and capacity prices than the load shifting action that hourly pricing might induce. As shown in **Figures 3a and 3b**, the use of compact fluorescent bulbs has the potential to reduce energy prices by six to

Table 7: Potential Impact on Peak Demand (MW)

	Summer		Winter	
	A Weekday	B Weekend	C Weekday	D Weekend
Shifting Time discretionary activities	38.45	18.48	38.14	18.17
Compact fluorescent bulbs	133.49	135.65	189.61	202.52
Adjusting AC thermostats	85.35	84.74		

Table 8: Potential Impact on Capacity Prices 2004 ($ kW/month)

	January–April	May–October	November–December
Original	$1.17	$1.68	$0.60
Shift	$1.10	$1.62	$0.53
CFL	$0.94	$1.46	$0.37
AC	$1.12	$1.54	$0.45
CFL + AC	$0.79	$1.31	$0.22
Shift CFL + AC	$0.72	$1.24	$0.15
Change from original			
Shift	($0.07)	($0.06)	($0.07)
CFL	($0.23)	($0.22)	($0.23)
AC	($0.05)	($0.14)	($0.15)
CFL + AC	($0.38)	($0.37)	($0.38)
Shift, CFL + AC	($0.45)	($0.44)	($0.45)

seven times more than the maximum possible impact from customers shifting load to off-peak hours under an hourly pricing program, and energy prices would not reverse course during evening hours.[20] The sharp reduction in summer peak load from the conservation measures would also have six times the impact on capacity prices compared with the impact of shifting load (**Table 8**).

IV. Discussion and Conclusion

National Grid's monthly market-based default service for mass market customers in New York creates a substantial incentive to conserve electricity, especially during the winter months when prices are generally highest. Our analysis shows that even under the existing default service households can save 11 to 14 percent on their commodity bills by replacing incandescent with compact fluorescent bulbs. Households that own central air conditioners could save another 2 to 3 percent by turning up the thermostat on these units by 5 degrees. These conservation measures naturally save more kilowatt hours during peak hours of the day, and therefore have the potential to generate a significant reduction in peak commodity and capacity prices—at very little cost. This type of natural demand response potential would seem to be embedded in most conservation measures.

The main potential drawback with the existing default service is that—unlike hourly commodity pricing—it creates no added incentive to reduce load during the higher-price hours of the day or on the higher-price days of the billing period. This is potentially significant since 10 percent of National Grid's annual peak demand occurs in just 1 percent of the annual number of hours. But our analysis shows that the incremental incentive to conserve under hourly pricing is, in fact, quite modest for National Grid customers in Upstate New York. So it is natural to wonder whether hourly pricing would induce any more conservation than what the existing monthly market-based default rate already calls forth.

To be sure, hourly market-based pricing also creates a financial incentive to shift load to lower-priced hours of the day and lower-priced days of the month. However, according to our estimates, the average household in National Grid's New York service territory that doesn't own a pool or new large-capacity water electric heater would save only about $14 a year from shifting all time-discretionary electricity use to lower-priced hours. In response to a recent poll of households performed by EEI, 70 percent of customers said they would shift load for a 5 percent bill savings.[21] Our analysis shows that only 1 percent (14,000 households) in National Grid's New York service territory would save 5 percent or more even if they shifted all time-discretionary use to late evening hours or overnight.

Our estimate of the incremental savings available to customers under hourly versus monthly market-based rates is not the bill savings projected for households that participate in the Real Time Pricing program now underway in Chicago. Under this program 213,000 participants are expected to realize annual savings of $92, but 83% of these savings come

 1040-6190/$–see front matter doi:/10.1016/j.tej.2007.07.005

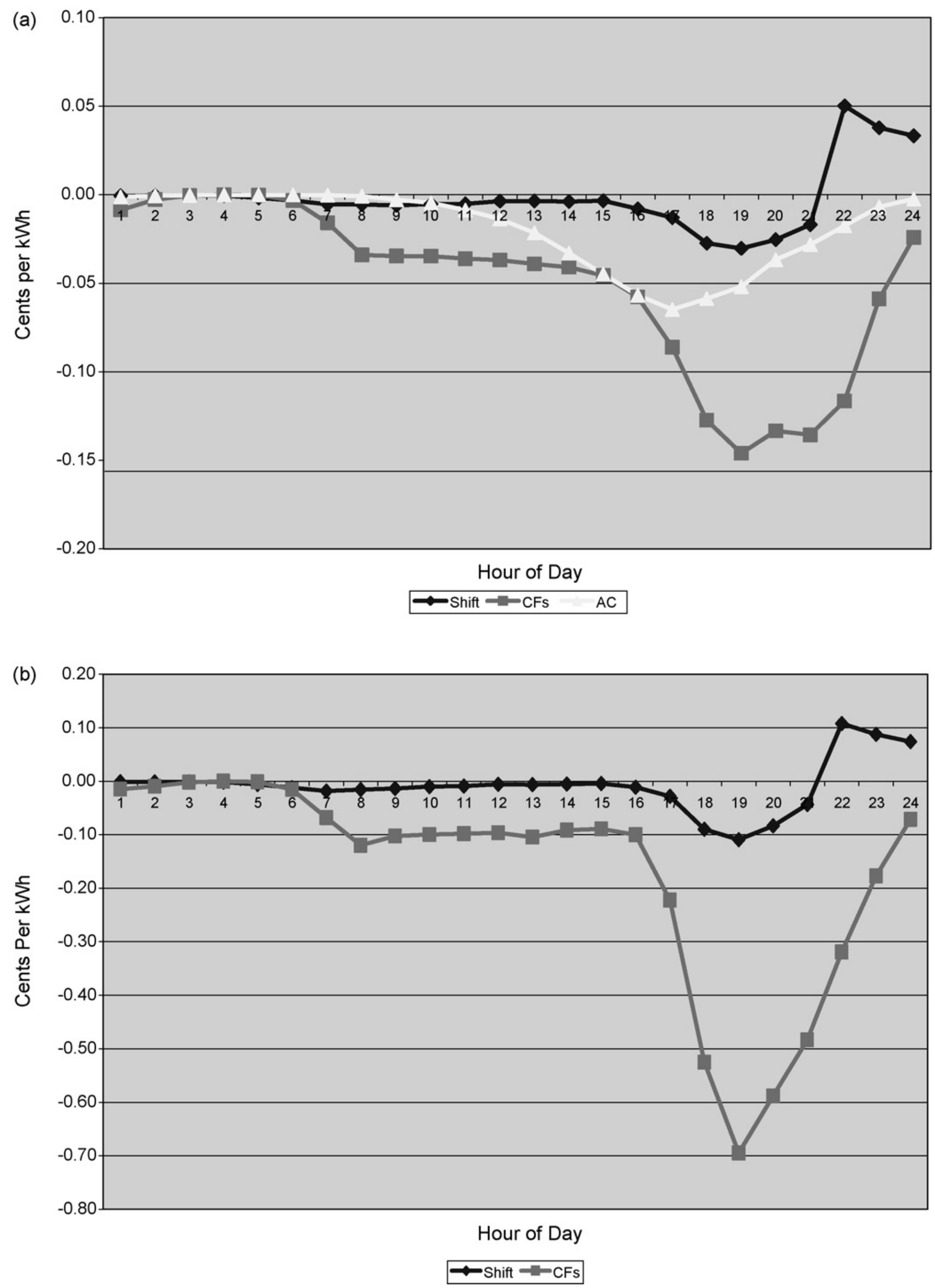

Figure 3: (a) Potential Impact on Hourly Prices in Summer Months. (b) Potential Impact on Hourly Prices in Winter Months

from avoiding the utility's hedge premium embedded in the otherwise applicable default service price[22]—something that National Grid's mass market New York customers are not subject to under the current monthly market-based default rate. The estimated annual savings from customer actions in the Illinois program are just $16 per participant. Most of this savings is expected to result from conservation, since program participants said that they respond to high hourly prices by reducing discretionary usage, not by shifting electricity use to other times.[23]

Hourly pricing may generate additional benefits for participants and non-participants in the form of lower commodity and/or capacity prices, but only if a significant number of households are subject to the rate and conserve more than otherwise during high-priced periods. Since time-based rates cannot be mandated for mass market customers under New York State Public Service Law, customers must volunteer. The key question is this: are the prospective savings from hourly pricing large enough to induce customers to volunteer for the rate?

For National Grid, the total incremental savings per household from conserving and shifting load under hourly commodity pricing, versus the existing rate, would need to be at least $39 per year to cover the incremental customer charge required to pay for the advanced metering infrastructure (AMI) necessary to support this rate.[24] This metering charge would be considerably higher under a voluntary program that requires meters to be installed one household at a time. And this incremental cost does not cover the added expense of educating customers. With incremental metering costs at this level, it seems unrealistic to expect a high number of volunteers given the low level of incremental savings for National Grid Customers in New York.

Hourly pricing may be more attractive to mass market customers in places where the otherwise applicable default rate contains a substantial risk premium. But since it does not require interval metering, monthly market-based commodity service would seem a more economical way to enable mass market customers to avoid hedge premiums unless the incremental cost of installing interval metering (net of operational savings) is also much lower in these locations.

Dynamic pricing for mass market customers makes more

sense in places where the hourly cost of electricity is higher and more volatile during peak periods and/or the proportion of households with large amounts of time-discretionary load, such as pools, is high. This is especially true if the cost of AMI (net of operational savings) is much lower. The availability of such a rate would also support the development of technologies like plug-in hybrid automobiles which could raise household demand for off-peak electricity but reduce overall household energy use by cutting gasoline consumption.

Still, if the ultimate policy goal of demand response programs is to reduce peak load and ameliorate wholesale price spikes and capacity prices, then promoting conservation under National Grid's existing monthly market-based default service holds much promise. Conservation measures such as the use of compact fluorescent bulbs and raising thermostats on central ACs inherently save more kilowatt hours during the peak hours of the day when customers use these devices most, and therefore have the potential to significantly reduce peak commodity and capacity prices—at very little incremental cost. Other types of conservation measures would have similar built-in demand response potential.■

Endnotes:

1. Department of Energy, Benefits of Demand Response in Electricity Markets and Recommendations for Achieving Them, Report to U.S. Congress Pursuant to Section 1252 of EPA of 2005, Feb. 2006. at V.

2. Ahmad Faruqui and Stephen George, *Quantifying Customer Response to Dynamic Pricing*, ELEC. J., May 2005, at 55.

3. Summit Blue Consulting, *Evaluation of the 2005 Energy-Smart Pricing Plan*, Final Report, Aug. 1, 2006, at ES-4.

4. Direct Testimony of Bernard Neenan on behalf of the Citizens Utility Board and the City of Chicago, ICC Docket 06-0617, Oct. 30, 2006.

5. Utilities that have already reduced meter-reading costs by installing a drive-by automatic meter reading (AMR) system have much lower prospective operational savings from installing an automated meter infrastructure (AMI) system so that a larger proportion of incremental metering costs would be borne directly by customers.

6. National Grid delivers electricity to 1.4 million mass market customers

  doi:/10.1016/j.tej.2007.07.005

across a service territory that extends from Buffalo to Albany in Upstate New York. These customers have been able to take commodity service from energy service companies (ESCos) since 2001, but most have opted to take commodity service from National Grid.

7. A compact fluorescent bulb (CFL) now costs about $2 versus $0.25 for an incandescent bulb that throws a comparable amount of light, but the CFL lasts seven to 10 years longer. According to an estimate from Phillips, CFLs currently account for only 6 percent of the bulbs in American households. (See John Fialka and Kathryn Kranhold, *Lighting Rule Would Darken Incandescent Bulbs*, Wall Street J., May 5, 2007).

8. The cogeneration heat advantage of incandescent bulbs during the winter months and any incremental disposal costs associated with CFLs should be considered in a comprehensive analysis of this conservation measure. (See *Squeezing BTUs from Light Bulbs*, Pub. Util. Fortnightly, Aug. 2006). This is beyond the scope of our study, which simply attempts to highlight the incremental financial incentive for conservation contained in hourly prices, and the demand response potential of conservation measures in general.

9. The New York Independent Systems Operator (NYISO) manages the operation of the wholesale electricity markets in New York State.

10. Residential customer bills show delivery charges separate from commodity charges. Most residential customers are also subject to a monthly adjustment on the delivery portion of their bill designed to ensure that National Grid collects the stranded costs associated with its legacy supply contracts.

11. The capacity adder is based on the coincident peak demand of the residential class on the day of the NYISO system peak in the previous year and the monthly price of capacity generated from a six-month capacity strip auction held twice a year. Residential summer load peaked at about 2,000 MW in 2003 and accounted for over one-third of National Grid's peak demand on the day of the NYISO system peak. In 2004, the capacity adder for residential customers was 0.8 to 1.5 cents/kWh in the winter months (January to April, November, and December) and 2.2 to 2.3 cents/kWh from May to October. Hourly prices also include a small markup each hour to collect the cost of ancillary services and to reflect losses.

12. The standard deviation around these hourly price levels is generally around 0.6 to1.2 cents in spring, fall, and summer but closer to 1.4 cents during winter. The hourly pattern of prices is similar in all six NYISO load zones relevant to National Grid's New York service territory but prices in the Capital Region (ISO Load Zone 4) are generally about half a cent higher on average than in the other load zones.

13. We use the sample load shapes and hourly prices for 2004 because this was the most recent year for which load data was readily available and because the pattern of hourly prices and hourly usage was fairly typical for that year. The load data for 2006 was not yet available when we began this study, and the pattern of prices in 2005 was sharply distorted by the impact of Hurricane Katrina.

14. The results from the 2005 EIA survey were not yet available when we began this study.

15. The subset of households that own newer large-capacity high insulation hot water heaters are clearly an exception to this rule. We consider the additional savings available to these households separately in Section III.

16. *Energy Efficiency and Renewable Energy Resource Development Potential in New York State*, Final Report, Aug. 2003.

17. We consider each household's peak period to be the daily hour of peak usage during the shoulder months and the hour just preceding and following this hour. For most household's this peak occurs at 7 P.M.—the same time that hourly prices peak—but the peak for some household's is at 7 A.M. We move load from the customer's peak period to better simulate the time when customers are home and therefore able to shift usage. On those days, when the time-discretionary load is greater than the actual load, we assume the customer is not home and is therefore unable to shift. We use the electricity use per appliance as reported by EIA and NYSERDA to determine the amount of load shifted for each type of appliance.

18. Bonneville Power Administration's End-Use Load and Conservation Assessment Program/Regional End-Use Monitoring Program.

19. This does not include the delivery charge savings. Since a large portion of delivery costs are collected volumetrically, under the current rate design households would realize total savings of 18 percent to 26 percent relative to existing commodity bills, and the savings from raising thermostats on central ACs could be as high as 6 percent of commodity bills.

20. The feedback effects on wholesale commodity prices were estimated by Bernie Neenan and Jeremy Anderson of Utilipoint using models of the wholesale electric market that have been used extensively to evaluate demand response programs in New York.

21. Energy Electric Institute (EEI), National Public Opinion Monitor, Q4 2006 results.

22. Direct Testimony of Bernie Neenan on Behalf of Citizens Utility Board and the City of Chicago, ICC Docket No 06-0617, Oct. 2006, at 21.

23. *Id.*

24. National Grid estimates that the up-front cost to install an AMI in its Upstate New York service territory would be $260 per metering point, since most of the operational savings associated with AMI have already been captured with a drive-by AMR system. The incremental metering costs associated with the AMI would need to be collected from customers in the form of an incremental customer charge. If we assume a 10-year recovery life, and an 8.41 percent cost of capital, the incremental customer charge would be about $3.21 per month or $39 per year.