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Accessing Residential Customer Satisfaction for Large Electric Utilities

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Abstract

Electric utilities, like other service organizations, rely on customer surveys to assess the quality of their services and customer relations. With responses to an in-depth survey of 2,216 residential customers, complementary data from geo-coded public sources, aggregate assessments of performance by J.D. Power & Associates from their independent surveys, historical records of individual customer usage and bill payments, streams of published media content and records of actual service delivery, we examine how measures of customer satisfaction are interrelated and how they relate to account activity, customer characteristics, and actual service delivery. We test our inferences against published J.D. Power ratings for 16 large Midwestern utilities in the same peer group. We find that ratings on different service dimensions are highly correlated and related to the customers' total expenditures for electric service. Customer ratings for quality and reliability of service reflect their sentiments about frequency of outages, duration of outages and the communications that customers receive while power is being restored. Relationships with the actual reliability of service delivered to customers' residences are much weaker. Experiments with automated text mining show some promise for augmenting statistical analysis with information from streams of published media content and social media.

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Introduction

Organizations frequently use customer surveys to assess the quality of their services and customer relations, but deriving effective managerial strategies from survey results can be quite challenging. Survey results depend on respondents' expectations and groups of customers may have different frames of reference. Carefully designed survey instruments can help to provide a consistent frame of reference for survey respondents but customers in different market segments (demographic or geographic) may still demonstrate systematic bias in their ratings of service on various dimensions. In this paper, we investigate possible sources of such bias and discuss how to mitigate them. We address the following questions:

1. How does overall satisfaction with corporate performance of electric utilities relate to ratings on individual dimensions?
2. To what extent are ratings of performance on one dimension related to ratings on other dimensions?
3. How do customer ratings of the quality and reliability of residential electric service relate to the actual levels of service that they receive?
4. How strongly correlated are actual levels of service and perceived levels of service?
5. How might electric utilities obtain objective measures of performance that align better with customers' perceptions?

Challenges in Interpreting Customer Ratings

Decades ago, Parasuraman et al. (1991) composed a survey instrument (SERVQUAL) for extracting measures of service quality from a series of questions that describe satisfaction with tangible and intangible aspects of service delivery on a Likert scale. Peterson and Wilson (1992), however, describe consumer satisfaction as a "complex and elusive phenomenon". Considering factors that can bias customer responses and the possible impact of consumers' attitudes and moods as they make subjective assessments, they assert that "… to the extent that observed satisfaction ratings are determined in part by measurement artifacts or the personal

characteristics of the surveyed customers, this suggests that caution must be employed when interpreting them [customer satisfaction ratings] or using them in decision making." Babakus and Boller (1992) cautioned against the use of generic surveys across industries. Morgan et al. (2005) conducted interviews and focus groups with business managers directly involved in designing or administering customer-satisfaction programs, and found that many failed to realize hoped-for benefits. The interviewees attribute this to lack of integration of data from different sources, low level of analytical sophistication within the firm, not linking consumer-satisfaction data to other variables and metrics that could guide strategies, and inadequate dissemination of timely customer-satisfaction information.

Delivery of services from an electric utility occurs constantly (24 hours per day). Apart from paying their monthly bills, most customers interact with the utility infrequently – usually to report or inquire about rare power outages, deal with a billing issue, or to participate in a program for efficient use of energy. This combination of continuous service and very intermittent contact complicates the collection and interpretation of information about customers' satisfaction with a utility's services. Sullivan et al. (1996) found, regarding power quality and reliability, that residential customers "differ dramatically in their expectations for the utility's performance along these dimensions" and that "most residential customers cannot distinguish high reliability service from low reliability service." Sharma (2010), found that satisfaction ratings of electricity customers in India (where there is much greater variance in quality and reliability of power than in the U.S.) were influenced by the utilities' pricing practices and the customers' experience in dealing with the company. In a similar vein but different realm, Van Riel et al. (2012) saw waiting times at the checkout significantly affect customers' ratings of overall store image of grocery stores.

Garg et al. (2014) conceive of customer experience in service industries (banks, in their case) as involving an emotional connection between the customer and the organization. They hypothesize that the nature of the experience is completely internal to a customer and dependent on the nature of interaction in moments of contact. In a few moments, experience with a call-center representative or technician, might therefore alter a customer's general perception about the overall quality and value of the actual product (electrical service, in our case). Formbrun and Shanley (1997) suggest that consumers build a picture of a company's reputation based on "available information about the firm's activities, which could come both directly from the firms themselves and indirectly through the media." Jin and Yeo (2011) found that "consumers who are exposed to positive news stories about an organization are more likely to favor that organization."

Research Approach

We focus our analysis on six key dimensions of electric-utility performance assessed by J.D. Power & Associates in their annual benchmarking surveys. These performance metrics, which are used widely in the industry, assess:

1. Power quality and reliability (which contributes 27% to the overall J.D. Power rating)
2. Price (which contributes 22% to the overall rating)
3. Billing and payment (which contributes 19% to the overall rating)
4. Corporate citizenship (which contributes 13% to the overall rating)
5. Communications (which contributes 13% to the overall rating)
6. Customer service (which contributes 6% to the overall rating).

Measures of overall customer satisfaction with the utility's services and details about the customers' assessments for these six dimensions are obtained from an in-depth survey that is administered quarterly by an independent research firm to a stratified random sample of the utility's customers. In a 25-minute telephone interview, customers rate aspects of the utility's

performance and their experience in dealing with the utility. They also provide additional information about their household characteristics to help place their responses in context. Topics include electricity usage, satisfaction with services received, nature of contacts with the company, knowledge of and participation in energy-saving programs, use of the company's call center and website, billing and payment options, electrical outages, sources of information about the company's use of social media, etc. Data for this study were obtained from the surveys conducted in 2012 and 2013.

Questions used to generate customer scores (on a Likert scale) for overall performance and for each of the six performance dimensions are provided in Appendix A. For some dimensions of performance, the survey contained a single question that provided a direct measure. For others, we created a factor from several related questions by using the simple average of the contributing scores. Scores for our major measures of corporate performance are thus:

- **Overall Satisfaction** from the response to a single question
- **Reliability and quality** from the response to a single question
- **Reasonable rates** from the response to a single question
- **Billing and Payment** as the average score from responses to four questions
- **Corporate image** as the average score from responses to fourteen questions
- **Communications effectiveness** from the response to a single question
- **Customer service** as the average score from responses to seven questions.

The correlation between the average scores for the six measures and the corresponding JD. Power ratings was .91 -- suggesting that the customer survey yields very similar information about the company's relative performance on the dimensions used to produce the J.D. Power rating.

When drawing inferences from customer-survey data and developing programs for customer relations management (CRM), an electric utility confronts several questions:

1. What are the main drivers of customer satisfaction?

2. To what extent does variation in customers' perceptions on one dimension of performance relate to variation in other dimensions?
3. How does a customer's recall of power outages align with actual outages experienced at the service address?
4. To what extent do actual service-delivery statistics, objective customer data from customer records, transactional data, and other publicly available household data explain variation in customers' ratings?
5. How much additional information is provided in data from commercial services which segment customers for consumer marketing?

To address these questions, we augment the survey data with: (a) account-activity data from the electric utility's records, (b) information about service interruptions in the previous year derived from the last step-down transformer, and (c) publicly available consumer data from LexisNexis Risk Solutions and Axciom, Inc. We first investigate how customers' ratings on the six dimensions of performance are related to one another and to the customers' overall assessment of satisfaction with the utility's service. Then, with a series of hierarchical regressions, we examine systematic relationships between these individual measures of satisfaction and:

- Responses to individual questions on the detailed consumer survey about power reliability, outage experience, household demographics, communications with the company engagement in energy-savings programs sponsored by the utility, service geography, etc.
- Actual frequency and duration of power outages, as revealed by historical data for the last step-down transformer serving the household (provided from network statistics archived by the utility)
- Historical bill payments for electrical service on the customer's account (from customer account records archived by the utility)
- Whether the customer had received aid in making payments from some program in the prior year (from customer account records maintained by the utility)
- Whether the company had taken a collection action on the account in the prior year (provides from customer account records maintained by the utility)
- Household and neighborhood characteristics as revealed by public data provided by LexisNexis Risk Solutions using address matching (where possible) and demographic data summarized at the Zip-code level
- Household and neighborhood characteristics as revealed by public data provided by Acxiom Corp using address matching (where possible) and demographic data summarized at the Zip-code level
- Geographical location (using Postal Zip code) of the customer's residence.

Research Findings

We begin with observations of the degree of correlation between each of the seven performance metrics (Table 1). Overall satisfaction is most highly correlated (.70) with the average scores for corporate-citizenship measures and with the average of scores for customer service (.68).

Table 1 – Simple Correlations for Model M1 Variables

	SAT	CC	CS	RP	BP	CE	RR
Overall Satisfaction (SAT)	1						
Corporate Citizenship (CC)	.70	1					
Customer Service (CS)	.68	.78	1				
Reliable Power (RP)	.62	.60	.65	1			
Billing Processes (BP)	.57	.59	.67	.56	1		
Communications Effectiveness (CE)	.51	.62	.59	.45	.47	1	
Reasonable Rates (RR)	.48	.59	.51	.41	.43	.39	1

Overall satisfaction is also highly correlated with the scores respondents gave for the utility's being a reliable source of power, having good billing processes, communicating effectively and offering reasonable rates. There is a high degree of correlation among the subjective scores for the different dimensions of performance (with all statistically significant at the .001 level). This may be attributable to a "halo" effect where perceived performance on one dimension spills over to impression about another dimension. This phenomenon would also occur if respondents to the survey deliberately try to make their responses on the individual performance dimensions agree with their overall assessments of satisfaction.

In Table 2 we indicate again how each of the measures is correlated with overall satisfaction. We also provide the magnitude of the coefficient for a simple linear regression between overall satisfaction and the other performance metric, the magnitude of the multiple regression

coefficient when each of the factors is used as in the model, and additionally, the level at which the factor appears in a regression tree constructed using CHAID (chi-square automatic interaction detector). We used backward elimination to produce a "parsimonious" regression model in which each of the explanatory variables is statistically significant at the .05 level. The resulting regression model for overall satisfaction is:

Overall Satisfaction = .16 + .30 * (corporate citizenship) + .23 * (customer service) + .25 * (reliable power) + .08 * (billing processes) + .16 * (reasonable rates) + unexplained variation.

This model explains 59% of the variation in overall satisfaction (as opposed to 49% explained by variation in the average scores for the corporate-citizenship elements and 25% explained by variation in the score for reasonableness of rates).

Table 2: Drivers of Overall Satisfaction[1]

Performance Dimension	Min-Max	Corr. With SAT	Mean Value	Std. Dev.	Level in Cluster Tree	Simple Regression Coeff.	Multiple Regression Coeff
Overall Satisfaction (SAT)	0-10	1	7.78	2.10	Top	n.a.	n.a.
Corporate Citizenship (CC)	0-10	.70	7.55	2.19	1	.67	.30
Customer Service (CS)	0-10	.68	8.02	1.90	2p	.75	.23
Reliable Power (RP)	0-10	.62	8.56	1.78	2p	.74	.25
Billing Processes (BP)	0-10	.57	8.54	1.84	3p	.65	.08
Communications Effectiveness (CE)	0-10	.51	6.41	2.76	2p	.38	abs
Reasonable Rates (RR)	1-5	.48	3.27	1.13	abs	.91	.39

[1] Levels of statistical significance are denoted with * =.05, **=.01, ***=,001. A suffix of "p" for level in the cluster tree indicates that the variable appears in some branches but not others at that level. The multiple regression model contains only variables that were marginally significant at the .05 level.

Reasonableness of rates was measured on a 5-point scale; so we consider a single point increase in that variable to be roughly equivalent to a 2-point increase in the other measures of satisfaction. Collectively, the correlations , the coefficients of the simple and multiple regression models, and the hierarchy in clustering trees, suggest that reliable power, reasonable rates, customer service and corporate citizenship are the primary determinants of customer satisfaction. Billing processes and corporate communications appear to be secondary (or supporting) determinants. We should mention, however, that a substantial percentage (38%) of survey respondents declined to offer an assessment on the reasonableness of rates while only 3 of the 2,216 respondents failed to offer an assessment of overall satisfaction. – a matter for further consideration in itself. Many customers seemed to lack a reference point for reasonableness of rates.

The magnitudes of correlation coefficients and regression parameters cannot themselves indicate the impact of incremental efforts to improve performance on a particular dimension, but these statistics do affirm that sentiments of customers on each of the major dimensions of performance are important to consider when assessing customer service overall. They also suggest that improving performance on one dimension can affect sentiments about performance on other dimensions.

Power quality and reliability

Power quality and reliability is logically the dimension of performance that receives the heaviest emphasis in the J.D. Power ratings. We first investigate the relationships among various measures of reliability and how they relate to the customer's overall assessment on this dimension. We then examine the overall rating in light of the customer's expressed sentiments about the electric utility's effectiveness in minimizing frequency of outages,

minimizing length of outages, and accurately predicting restoration times when outages occur; the customer's recall of the number of outages in the last three months; actual outage data derived from readings at the last step-down transformer serving the household; and the customer's subjective assessment of the quality of the company's infrastructure for electrical distribution. Metrics we used for aspects of reliability are thus:

- Customer's subjective judgment of how well the company minimizes the number of outages
- Customer's subjective judgment of how well the company minimizes length of outages
- Customer's subjective judgment of how well the company provides accurate restoration time estimates
- Number of short outages (under 5 minutes) in the last three months that the customer remembers having occurred
- Number of long outages (over 5 minutes) in the last three months that the customer remembers having occurred
- Actual number of short outages (under 5 minutes) in the previous 30, 90, 180 and 365 days (shortoutages30, shortoutages90, shortoutages180, shortoutages365) as indicated by deliveries to the last step-down transformer to the residence
- Actual number of long outages (over 5 minutes) in the previous 30, 90, 180 and 365 days (longoutages30, longoutages90, longoutages180, longoutages365) as indicated by deliveries to the last step-down transformer to the residence
- Total minutes without electricity in the previous 30, 90, 180 and 365 days (totminutesout30, totminutesout90, totminutesout180, totminutesout365) as indicated by deliveries to the last step-down transformer to the residence
- Customer's subjective assessment of the quality of the company's infrastructure.

Table 3 contains correlation statistics for measures of power quality and reliability. Most highly correlated with the overall assessment of power service and reliability were the respondents' subjective assessments of the extent to which they felt that the company minimizes the number of outages (r=.70), minimizes the lengths of outages (r=.70), and gives accurate estimates of when power will be restored (r=.58). Correlations with the customer's recall of the number of short-term and long-term outages in the last 90 days were much lower (both -.21) and correlations with the actual number of short-term and long-term outages in the previous 90 days as determined from transformer data were lower still (-.06 and -.10 respectively). Notable is the very strong relationship between the respondents' overall assessment of reliability and their

feelings about whether the company manages to minimize the number and length of outages and provides accurate estimates of when power will be restored. Correlations with **recollections of the number** of short and long outages (objective assessments) are considerably lower. Correlations with **verifiable objective measures** of service delivery (outage experience at the individuals' residences) are lower still.

A clustering tree (not shown) for assessment of reliable service which considers the measures of consumer sentiment along with customers' recall of numbers of the number of outages and the statistics of actual outages from the company's service records has three levels. The discriminator at the first level is the sentiment about the company's effectiveness in minimizing the number of outages, with average reliability score 9.7 for 653 customers (31%) who scored the company at 10 in that regard and average reliability score of 6.1 for 261 customers (12.5%) who scored the company at or below 5 with regard to minimizing the number of outages. Among those who rated the company low on minimizing length of outages, the power quality and reliability were rated lower still (4.9) if they had experienced a collection action in the previous year.

When objective measures only were used in constructing the clustering tree, ratings depended on the customer's recollection of the number of short and long outages (as opposed to the actual number), whether the respondent had been subject to a collection action in the previous year, and the total amount of their payments for electricity in the previous six months. The average ratings for clusters determined by these variables ranged between 7.1 and 9.0. When we restricted the clustering further to objective measures of service delivery that are verifiable, the number of outages with duration exceeding five minutes in the previous 180 days appeared at the first level tempered by whether the respondent had benefited from a financial

assistance program to cover part of their electric bills in the previous year. The number of short outages in the previous 90 days was a further qualifier for customers who experienced no more than one long outage in the previous 180 days. So also was the amount paid for electricity in the previous 30 days. Over all, the Cluster Trees for power quality and reliability suggest that the major concern is frequency of outages followed by length of outages but the assessments are affected by financial distress and amounts of recent electricity bills. Statistics for regression models used to explore these relationships are presented in Table 4.

Table 3 – Simple Correlations of Reliability Measures
(with number of pairs of contributing observations in parentheses)

	RP	MNO	MLO	ART	SO	LO	ALO 90	ALO 180	ALO 30	TMO 90
Reliable Power (RP)	1									
Minimizes Number of Outages (MNO)	.70***	1								
Minimizes Length of Outages (MLO)	.70***	.80***	1							
Accurate Restoration Times (ART)	.58***	.69***	.70***	1						
Short Outages Recalled (SO)	-.21***	-.22***	-.20***	-.16***	1					
Long Outages Recalled(LO)	-.21***	-.23***	-.19***	-.15***	.39***	1				
Actual Long Outages 90 (ALO90)	-.12**	-.11***	-.06***	-.05***	.13***	.25***	1			
Actual Long Outages 180 (ASO180)	-.11***	-.10***	-.05*	-.03	.09***	.26***	.11***	1		
Actual Long Outages 30 (ALO30)	-.10***	-.09***	-.05*	-.03	.09***	.21***	.58***	.41***	1	
Total Minutes Outage 90 (TMO90)	-.10***	-.11***	-.07**	-.04	.12***	.25***	.62***	.46***	.46***	1

Table 4 - Regressions of Overall Reliability Assessments against Metrics for Reliability

Performance Dimension	Min-Max	Corr. With RP	Mean Value	Std. Dev.	Level in Cluster Tree	Simple Regression Coeff.	Multiple Regression Coeff
Reliable Power (RP)	0-10	1	8.56	1.79	Top		
Minimizes Number of Outages (MNO)	0-10	.70***	8.10	2.09	1	0.59	0.29
Minimizes Length of Outages (MLO)	0-10	.70***	8.06	2.05	2	0.61	0.31
Accurate Restoration Times (ART)	0-10	.58***	7.57	2.46	abs	0.43	0.06
Short Outages Recalled (SO)	0-60	-.21***	1.30	3.20	2p	-0.12	-.023
Long Outages Recalled(LO)	0-15	-.21***	0.40	0.95	abs	abs	abs
Actual Long Outages 90 (ALO90)	0-4	-.12***	0.24	0.56	abs	-0.37	-0.15
Actual Long Outages 180 (ASO180)	0-8	-.11***	0.46	0.82	abs	.26***	.abs
Actual Long Outages 30 (ALO30)	0-3	-.10***	0.07	0.29	abs	.21***	abs
Total Minutes Outage 90 (TMO90)	0-2339	-.10***	36.1	137.5	abs	.25***	abs
Actual Long Outages 365 (ALO365)	0-11	-.09***	1.05	1.37	abs	-0.1	-0.053

In equation format, we express the relationships of reliability measures to the customers' overall reliability assessment as follows:

Overall reliability rating = 3.30 -.023 * short outages recalled in the last three months + 0.29 * judges company minimizes number of outages + 0.31* judges company minimizes length of outages +.065 * judges company provides accurate restoration time estimates -0.15 * actual number of long outages in previous 90 days - .053 * actual number of long outages in the previous year + unexplained variation.

This model explains 57% of the variability in the overall reliability rating and most of the explanatory power comes from the corresponding opinions of company behavior and recollection of short outages rather than the frequency and duration of actual outages.

When we restrict attention to the set of reliability metrics that are objective in nature (reported by the customer or verifiable from corporate customer-service data), the model for reliability has the following structure:

Overall reliability rating = 8.81 - .082 * short outages recalled in last three months

- .248 * long outages recalled in the past 90 days
- .21 * long outages recalled in the past 90 days + unexplained variation.

This model explains just 7% of the variation in quality rating.

Further dropping customer recollections of outages from the candidate list and relying strictly on corporate data for actual service delivery results in:

Overall reliability rating = 8.70 - .077 * short outages in the last 90 days (shortoutages90)
- .29 * long outages in the last 30 days (longoutages30)
- .26 * long outages in the last 90 days (longoutages90) + unexplained variation.

This model explains just 2% of the variation in the overall reliability rating.

Allowing consideration of other benchmarking elements assessed in follow-up questions about reliability, the result was the following regression equation (which explained 64% of variation in customers' overall assessments and had all terms statistically significant at the .05 level):

Overall reliability rating = 2.14 + .14 * extent to which the company is seen as minimizing the number of outages + .18 * extent to which the company is seen as minimizing length of outages + .22 * extent to which the company is seen as preventing spikes
+ . 17 * extent to which the company effectively restores power
+ .06 * extent to which the company helps with safe usage + unexplained variation.

The key drivers here are minimizing outages, avoiding spikes, reducing length of outages and restoring power quickly when it goes out.

Together the cluster trees, correlation coefficients, and regression models for power quality and reliability suggest that the major concern is frequency of outages followed by length of outages but the assessments are affected by financial distress and amounts of recent electricity bills. Further, the ratings for power quality and reliability are better if customers feel they receive good information about the restoration of power when outages occur. It was rather surprising that relationships between respondents' assessments of power quality and reliability

and measures of actual service delivery from the company's records are so weak. These data suggest that (1) customers may have different standards of good service, (2) they may not be aware when outages occur and how long they last (3) they do not recall the frequency and duration of outages very accurately, (4) customers may be recalling outages in their general residential neighborhood rather than for their own residence, or (5) customers may experience unreported outages due to deficiencies in the household circuitry which they erroneously attribute to the electric utility.

In sum, we find that consumers' assessments of reliability are explained quite well by their own sentiments about the company's customer service on various dimensions but they are not explained nearly as well by actual outage statistics derived from the transformers that step down the voltage for delivery to the customers' residences. Accepting the transformer data as providing accurate information, we found that respondents' recollections overestimated the number of short and long power outages that they experienced in the previous 90 days (by 90% and 70% respectively). Average numbers of outages recalled by respondents were, however, positively correlated with the average number of actual outages for respondents in their ZIP codes.

Price (Reasonable Rates)

The next dimension of corporate performance is tied to whether customers see their monthly electric bills as reasonable in magnitude. We examine customers' assessments on this dimension in light of the amounts that they actually paid for electricity and available demographic and socio-economic data. We expect that customers' assessments of price and value might be affected by the amount they pay for electricity and tempered by the characteristics of the household. The surrogates for household characteristics employed in our preliminary analysis are family income, whether the customer received assistance from a low-

income support program in the previous year to pay his or her electric bill, whether the company had initiated a collection action for the account in the previous year, and estimates of the market value of neighboring properties. With additional address-matching of the LexisNexis data and Axciom data, we also include estimates of market value and housing characteristics (e.g., square footage) for the individual property.

To explain customers' assessments of the reasonableness of their electricity rates, we thus considered:

- total amounts paid on their electric bills in the previous 30, 90, 180 and 365 days (elecpayments30, elecpayments90, elecpayments180, elecpayments365)
- total payments in the previous 90 days relative to household income given in the survey
- total bill relative to median neighborhood housing value
- whether the customer received assistance from a rate-relief program based on financial need in the previous year
- whether required a collection action was required for overdue payments in the previous year
- education level (education-level indicators)
- whether the respondent owned or rented his or her residence
- respondent's ethnicity (ethnicity indicators)
- respondent's family income (indicators for income groups)
- respondent's age (age-group indicators)}.

We mention again that a substantial number of respondents (38%) did not have an opinion on the reasonableness of electricity rates. The Cluster Tree therefore applies to the 1,370 of 2,216 respondents who gave an assessment of the rates. The total amount paid on the electric bill in the previous 30 days emerges as the primary discriminator – with 274 respondents (20%) whose payments exceeded $163 giving an average score of 3.17 (of 5) for the reasonableness of rates, and 234 respondents (17%) with payments under $64.70 giving an average score of 4.00 (of 5) for reasonableness of rates. At the next level, systematic differences are attributable to outage experience and collection actions, depending on the size of bill payments. Particularly notable are 77 respondents (5.6%) who paid over $163 and who were subject to a collection action. They gave an average score of 2.68 for reasonableness of rates. Rather surprising was the lack

of general discrimination that could be derived from demographic and socio-economic characteristics as revealed in the survey or neighborhood characteristics.

The corresponding correlation matrix and regression models provide additional perspective of what seems to be driving assessments of the reasonableness of electricity rates. Table 5 reveals that lower ratings were generally associated with higher electricity bills, whether the respondent had been party to a collection action or received assistance in the previous year, and whether the bill represented a higher percentage of family income. Also, individuals in the lowest and highest age groups tended to give higher ratings on this dimension. The resulting regression model for reasonableness of electricity rates is:

Reasonableness of Electricity Rates = 3.9 -.0008*(Total Electricity Payments 90) - .32*(Received Assistance) - .50*(Collection Action) + .94*(Age 18 to 24) + .16*(Age 55 to 64) + .29*(Age 65 and plus) -.14*(Surveyed 2013) + unexplained variation.

The survey results for 2013, after adjusting for the other factors, were .14 points lower, on average than in 2012, though no rate increase had occurred in 2013. The factors included in this statistical model explained just 11% of the variation in ratings given to the reasonableness of electricity rates.

The value of services is generally conceived to be a consolidated assessment of price and quality relative to expectations (Zeithaml, 1988). The relative importance of power reliability versus electricity rates in determining the assessment of value received by the customer was examined by regressing the respondents' ratings of **overall value** of electrical services against the their subjective assessments for the reliability of electricity delivery and the reasonableness of rates. The correlation coefficients are presented in Table 6. The related regression model, which explained 41% of the variation in value assessments, is:

Value of electrical service = 1.46 + .14*(Power reliability) + .40*(Reasonableness of Electricity Rates) + unexplained variation.

It is particularly notable that customers' assessments of the reasonableness of electricity rates (and therefore value of services delivered) are affected by the magnitude of their bills. Utilities tend to think of the reasonableness of rates in terms of cost per kWh. Customers, in contrast, appear to assess the rates in terms of the size of their bills which, of course, depends on electricity usage – not just on rates. This begs the question of whether utilities that serve customers in areas with lower needs for electricity may be perceived to have more reasonable rates (and accordingly higher ratings of overall satisfaction) even though the costs per kWh are higher.

Table 3 – Statistically Significant Correlations for Reasonableness of Electricity Rates

Variable	RRR	CA	TEP30	TEP90	TEP365	TEP180	RA	A1824	A65+	BHI
Reasonableness of Electricity Rates (RR)	1									
Collection Action (CA)	-.15***	1								
Total Electricity Payments 30 (TEP30)	-.14***	.07***	1							
Total Electricity Payments 90 (TEP90)	-.14***	.04	.72***	1						
Total Electricity Payments 365 (TEP365)	-.13***	.03	.61***	.76***	1					
Total Electricity Payments 180 (TEP180)	-.13***	.03	.68***	.91***	.91***	1				
Received Assistance (RA)	-.12***	.26***	.10***	.11***	.06**	.08***	1			
Age 18 to 24 (A1824)	.10***	.06**	-.07***	-.10***	-.08***	-.10***	-.04	1		
Age 65 and Plus (A65+)	.10***	-.10***	-.08***	-.10***	-.10***	-.09***	-.06***	-.10***	1	
Bill to Household Income (BHI)	-.10**	.21***	.22**	.31***	.16***	.25***	.29***	.02	.07*	1

Table 4 – Simple Correlations for Value of Services Received

	EV	REP	RP	S13
Electricity Value (EV)	1			
Reasonableness of Electricity Rates (REP)	.59***	1		
Reliable Power (RP)	.47***	.41***	1	
Surveyed in 2013 (S13)	-.03	-.06*	.003	1

Billing and Payment Processes

We investigated how the factor score for billing and payment processes was related to:

- whether the survey respondent received rate-relief of some kind in the previous year
- whether the respondent was subject to an The company collection action in the previous year
- the respondent's education level (with indicators for five educational groupings)
- indicator of whether the respondent was an homeowner or renter
- respondent's ethnicity (with indicators)
- family income (midpoints)
- respondent's age (age-group indicators).

A cluster tree shows lower average ratings for billing and payment (7.3 versus 8.6) from 110 customers who had received payment assistance in the previous year than the 2,106 who had not received payment assistance. Among those with no payment assistance, higher ratings were given by youngest (18-24) and oldest (65+) customers, white customers, and those without electricity outages in the previous 90 days. Variables that had absolute correlation coefficients greater than .1 with the factor score for billing and payment processes are summarized in Table 5.

Table 5 – Correlations Pertaining to Satisfaction with Bill Payment Options and Prices

	ABP	RA	CA	A65+
Average Bill Payment (ABP)	1			
Received Assistance (RA)	-.15***	1		
Collection Action (CA)	-.14***	.26***	1	
Age 65 and Plus (A65+)	.11***	-.06***	-.10***	1

A regression model (M4) for the average of ratings for measures pertaining to billing practices explains only 6% of the variation in assessments of the bill-paying practices. It has the following form:

Average of ratings for survey items re bill payment processes = 8.34
– 1.2*(Received Assistance) - .58*(Collection Action) + .36*(No Post-secondary Education) + .28*(Post Graduate) + .62*(Age 18 to 24) + .34*(Age 55 to 64) + .44*(Age 65 and Plus) + unexplained variation.

Most strongly related to customers' assessments of billing and payment options are apparent financial distress of the respondent as revealed in having received help from energy-assistance programs and being subject to collection actions in the previous year. Credit for relief is apparently not accruing to the electric utility. Ironically, customers for whom special help was given to cover their bills tended to give lower ratings for billing and payment processes. Open-ended comments in the survey to explain the ratings for billing and payment tended to dwell on billed amounts rather than billing and payment processes.

Corporate citizenship

A cluster tree was created for the average of scores of items on the questionnaire pertaining to corporate image or citizenship (the company's being seen as trustworthy, responsive, knowledgeable, customer-focused, hardworking, and community-minded). The primary discriminator for corporate citizenship was the extent to which the utility was perceived to help customers be more efficient in their use of electrical energy. Some further discrimination occurred in some groups according to whether that they felt they received good value from their electrical service overall and whether their payments for electrical service were extremely low.

A second cluster tree was created that used a single question about corporate citizenship as the target variable instead. Again, the primary factor explaining the rating for corporate citizenship is the extent to which the utility is seen as helping the customer with energy-efficiency initiatives.

These relationships are reinforced by correlations (Tables 6A, 6B) and regression results for the average ratings of company attributes related to corporate citizenship. We tested the assessment of corporate image = f{average of ratings for energy efficiency initiatives, value of electrical service delivered , whether received assistance of some kind in the previous year, whether required a collection action in the previous year , education level, owns or rents home, ethnicity, family income , respondent's age group}. The resulting parsimonious model (with all terms significant at the .05 level) was:

Average of scores for indicators of corporate citizenship =
1.63 +.50 * (Av rating for EE programs)
+.70 * (Value of Electrical Service Delivered) - .57 * (Received Assistance)
-.42 * (Surveyed 2013) + unexplained variation.

This model explained 62% of variation in the scores for corporate citizenship.

Table 6A – Correlates with Average of Company Attributes for Corporate Citizenship

Variable	CZ	EE	VAL	65+	NOPSED	2013
Corporate Citizenship (CZ)	1					
Energy Efficiency Pgms (EE)	.72***	1				
Value of Service (VAL)	-.58***	.50***	1			
Age 65+ (65+)	.14***	.14***	.13***	1		
No Educ PS (NOPSED)	.11***	.14***	.06*	.76***	1	
Surveyed 2013 (2013)	-.10***	-.03*	.-.03	-.02	.01	1

Next we use the regression to investigate the extent to which these assessments are related to demographic characteristics of the respondents To fit this more restrictive regression model, we

tested the assessment of corporate image = f{whether received assistance of some kind in the previous year, whether required a collection action in the previous year, education level, owns or rents home, ethnicity, family income, respondent's age group}. The resulting parsimonious model (with all terms significant at the .05 level) was:

Average of company assessments for corporate citizenship = 7.86 -1.15*(Received Assistance) - .69*(Collection Action) + .35*(No Post-secondary Education) - .000005*(Family Income) + .34*(Age 55 to 64) + .51*(Age 65 and Plus) - .40*(Surveyed 2013) + unexplained variation.

It explained just 6% of the variation in the surrogate rating for corporate citizenship.

Table 6B – Demographic Attributes Related to Assessment of Corporate Citizenship

	CZ	65+	NE	CA
Corporate Citizenship (CZ)	1			
Age 65 and Plus (A65+)	.14***	1		
No P.S. Education (NE)	.11***	.16***	1	
Collection Action (CA)	-.10***	-.10***	.15***	1
Surveyed 2013 (S13)	-.10***	-.02	.01	.02

A major factor related to the assessment for corporate citizenship is thus the extent to which the respondent sees the utility as doing a good job in helping the customer implement energy-efficiency measures (which presumably lead to savings in their bills for electricity). These sentiments are not strongly related to demographic characteristics of the respondents.

Communications

A cluster tree for effectiveness of communications shows that this assessment, like corporate citizenship, is highly related to the respondents' assessments of the utility's programs to help consumers use energy efficiently. At the next level, the rating is related to the extent to which the respondent sees the utility as well managed. Setting aside the rating for management, the

secondary considerations are the total number of minutes without electricity in the previous year and the more generous assessment of customers over 55 years of age. In our regression analysis, we first examine correlates with awareness of the utility's communications (Table 7) and then the assessments of communications effectiveness (Table 8).

We fit awareness of communications = f {whether respondent received assistance of some kind in the previous year, whether respondent received a collection action in the previous year, education level, owns or rents, ethnicity, family income, respondent's age group}. The resulting parsimonious model, which explains just 3% of variation in communications awareness is:

Awareness of Communications=1.70 + .07*(No Post Secondary Education) - .08*(Post Graduate) - .000004*(Family Income) + 2.30E-11*(Family Income Square) - .07*(Age 55 to 64) + unexplained variation

Fitting communications effectiveness = f {whether respondent received assistance of some kind in the previous year, whether respondent receives a collection action in the previous year, education level, owns or rents, ethnicity, family income, respondent's age group, short outages recalled in the last three months, long outages recalled in the last three months}, we obtained the parsimonious model:

Assessment of Communications Effectiveness = 6.25 - .44*(No Postsecondary Education) + .85*(Black Ethnicity) – 6.56E-11*(Family Income Squared) + .46*(Age 55 to 64) + .89* (Age 65 and Plus) -.10*(Number of Short Outages) + unexplained variation.

It explained 9% of the variation in communications effectiveness..

Table 7 – Correlates with Awareness of Communications

	AC	NE	FI	PG	FIS
Awareness of Communications (AC)	1				
No P.S. Education (NE)	.12***	1			
Family Income (FI)	-.12***	-.30***	1		
Post Graduate (PG)	-.11***	-.28***	.23	1	
Family Income Square (FIS)	-.10***	-.27***	.97***	.23***	1

Table 8 - Correlates with Advertising-Effectiveness Rating

	ACE	NE	FI	FIS	A65+	SO	BE	CD
Assessment of Communications Effectiveness (ACE)	1							
No P.S. Education (NE)	.19***	1						
Family Income (FI)	-.18***	-.30***	1					
Family Income Square (FIS)	-.17***	-.27***	.97***	1				
Age 65 and Plus (A65+)	.16***	.16***	-.18***	-.17***	1			
Short Outages (SO)	-.15***	-.04*	.03	.03	-.005	1		
Black Ethnicity (BE)	.11***	.02	-.18***	-.17***	-.06**	-.04*	1	
College Degree (CD)	-.10***	-.35***	.19***	.18***	-.16***	.003	-.05*	1

Customer service

We built a cluster tree for customer service considering contact information, customer demographics and objective corporate data about outages, bill payments, etc. A cluster tree for level of customer service again shows the positive effects of customers' feelings about the support they receive for energy-efficiency measures and their sense of receiving good value in their electrical service. Frequent contacts (presumably to deal with problems) are associated with lower customer service ratings – as are frequent outages and higher bills.

To see further how this may relate to customer characteristics and their interaction with the utility, we fit customer service = f {whether respondent received assistance of some kind in the previous year, whether respondent received a collection action in the previous year, education level, owns or rents, ethnicity, family income, respondent's age group indicators, short outages recalled last three months, long outages recalled last three months , and indicators of web usage}. Major correlates appear in Table 8.

The resulting parsimonious model, which explains 9% of variation in ratings for customer service was:

Assessment of Customer Service = 8.16 - 1.04*(Received Assistance) .
-.49 * (Collection Action) + .32*(No Postsecondary Education) - .20*(College Degree) +.24*(Age 55 to 64) + .46*(Age 65 and Plus) - .05*(Short Outages) - .23*(Long Outages) + unexplained variation.

Greatest (and negative) effects on ratings of customer service were attributable to whether the respondent needed payment assistance for his or her electrical bill and whether the person had received a collection action from the utility in the previous year. Older customers were more positive in their assessments than younger customers were. The suppressive effects of outages, though present, were not large.

Table 9 – Correlates with Customer-Service Rating

	ACS	WS	LO	AFI	SO	A65+	RA	CA
Assessment of Customer Service (ACS)	1							
Website Satisfaction (WS)	.52***	1						
Long Outages (LO)	-.17***	-.12***	1					
Able to Find Information (AFI)	-.17***	-.43***	-.0002	1				
Short Outages (SO)	-.16***	-.2***	.39***	.17**	1			
Age 65 and Plus (A65+)	.14***	.10	-.04	-.09	-.005	1		
Received Assistance (RA)	-.12***	-.14*	.04*	.07	.02	-.06***	1	
Collection Action (CA)	-.12***	-.21***	.05*	.1	-.007	-.10***	.26	1

Geographical Distribution of Customer Ratings

In the previous analysis, we did not consider the characteristics of the physical environment that may affect customer service and customer ratings. Characteristics of neighborhoods, housing stock, and concentrations of residents (and survey respondents) vary dramatically among ZIP codes served by the company. To search for systematic patterns of service quality and customer sentiment throughout the service territory, we therefore produced a set of “heat maps” which plot

summary statistics by ZIP code and color-code them in quintiles from worse (red) to better (green) to allow a visual scan for geographic relationships. Maps were produced to show geographical distributions of the following statistics for ZIP codes with five or more survey responses:

- Overall satisfaction with The company's service for electricity
- Average score for reliability
- Average amount of electricity payments in the previous 90 days
- Average ratings for customer service
- Average number of short outages (<5 minutes) experienced in previous 90 days (as determined from the last step-down transformer for the service address)
- Average number of short outages recalled by the customer in previous 90 days
- Average number of short outages recalled (but capped at the 99th percentile to eliminate infeasible values)
- Average number of long (5+ minutes) outages experienced in previous 90 days (as determined from the last step-down transformer for the service address)
- Average number of long outages recalled by the customer in previous 90 days
- Average number of long outages recalled (but capped at the 99th percentile to eliminate infeasible values)
- Average score for bill-payment processes
- Average payments for electricity made in the previous 90 days
- Average rating for corporate image (citizenship)
- Average rating for awareness of customer communications
- Average rating for effectiveness of corporate communications
- Average rating for effectiveness in minimizing outages
- Average rating for minimizing the duration (length) of outages when they occur
- Average of actual restoration times for outages that occurred (as determined from records for the last step-down transformer)
- Percentage of respondents who received payment assistance in the previous year
- Percentage of respondents who received a collection action from The company in the previous year
- Average family income
- Average ratio of electricity-bill payments to family income in the previous 90 days
- Average bill payment in the previous 90 days relative to market value of housing in the Zip code
- Minutes of power outage experienced in the previous 90 days
- Average rating for overall value of electrical service
- Proportion of respondents who rented their homes.

Comparing the maps, we observed lower average ratings in urban ZIP codes and some inner suburbs. Incomes and housing values tend to be lower in those areas as well. In some areas out-

state, we saw low ratings for satisfaction that were related to high electricity bills relative to family income and housing values. There were also pockets where outages seen to be concentrated and noticeable differences between reported and actual outages in a few areas. The maps suggest that ZIP codes may offer a useful grouping for summarizing quality of electrical service, developing programs to educate customers about the comparative rates, and promoting programs that help customers to conserve electricity.

Satisfaction as Related to Household Characteristics in Public Databases

In marketing of consumer products, "Big Data" from various sources are often used to shape marketing programs and improve consumer response rates. We investigated the extent to which customer satisfaction is related to consumer data provided from LexisNexis and Axciom. We felt that market values of homes and square footage of homes would be important variables determining electricity usage and perception of value. LexisNexis provided the former; Axciom provided the latter. We were able to match names and addresses for about half the survey responses; so this analysis necessarily treated half the cases as having missing values for square footage or market value. Surprisingly, hoousehold were less significant predictors of satisfaction that the data on outages and bills obtained from the company's own customer records. This is not to say that housing characteristics are irrelevant for targeting energy-efficient programs and other forms of outreach. Their relevance, however, needs to be tested by comparing consumer response to specific programs.

Triangulation with J.D. Power Survey Results

Prominent in our findings is the negative correlation between the magnitude of customers' bills and their ratings for reasonableness of rates (despite rates being the same for all residential customers). Does this relationship bear out in cross-sectional comparisons among utilities? To

investigate this, we used published statistics for 2013 from the utilities' filings with regulatory agencies to determine the average rates and average size of residential bills. We merged those data with reported ratings from J.D. Power & Associates on "price" for the 16 utilities in the company's peer group (large Midwestern electric utilities). The correlation between total residential revenue per residential KWh consumed (considering total blended generation and delivery charges) and J.D. Power rating for price was -.31 (with p-value=.12). The correlation between cost per kWH (i.e. average the residential rate) and J.D. Power rating for price was -.08 (with p-value=.39). These results are consistent with our observations from the multivariate micro analysis of survey results. In other words, when asked about rates, customers seem to be commenting more on the size of their bills rather than electricity rates per se.

The other major finding from our study was the weakness in relationship between objective measures of service delivery from company metered data to the customer's residence and the customer's ratings for power reliability when surveyed – but hints at relationships between broader outage statistics for their neighborhoods and ratings for power reliability. For inter-company comparisons in this regard, we merged reported overall indices for system outage frequencies and duration (SAIFI and SAIDI respectively) for peer utilities (where available) with their overall J.D. Power ratings and found (ironically) positive correlations for the relationships between frequency of system outages but (as expected) negative correlations between durations of outage and reliability. The data, however, were sparse for these statistics. Because as reporting requirements are not uniform among states, our data were representative of the entire service areas for several utilities.

Media Coverage

To get a sense of whether local media coverage may be affecting customers' attitudes toward their electric utilities, we subscribed to Google Alerts for the company (and a pair of its peers

with higher J.D. Power satisfaction scores for a three-month period) in the course of our investigations. Published articles that referred to the company in this periods contained a higher proportion of stories with a negative tone (as judged from the investigators' perusal) than did the streamed articles from the other utilities. The negative commentary for the company pertained primarily to environmental impact connected to coal-fired plants. Positive stories about energy-efficiency programs, renewable energy and their economic impact were more prevalent for the other utilities.

We also applied automated text mining to the articles in search of prevalent key words and themes. There were observable differences in key words and in articles regarding the different companies. Articles about the company more frequently mentioned "power outages," "freezing rain" and other negative events, while articles for the other utilities more frequently mentioned "wind energy", "renewable power", "renewable fuels" and "customer satisfaction." Further exploration needs to be done to definitively determine the sentiment in these articles as either positive or negative, but early associations of words with utilities highlights interesting, and nonuniform, media coverage across the utilities. A few frequency phrase plots are provided below for illustrative purposes.

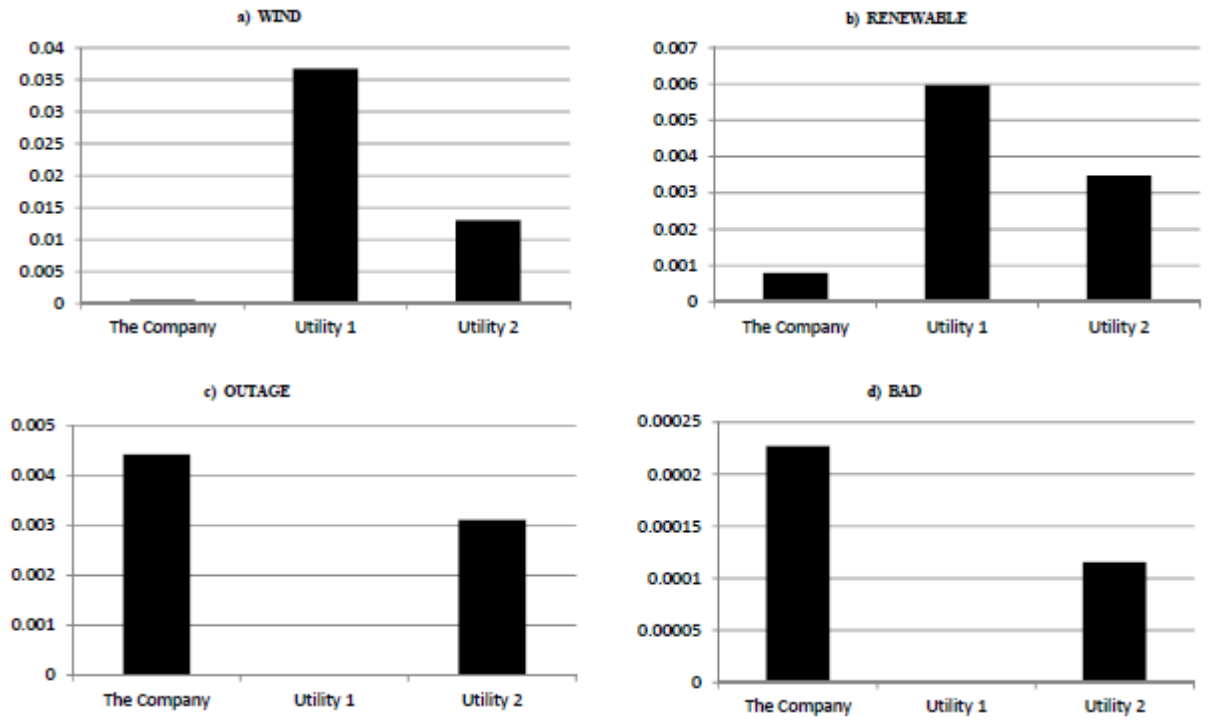

Figure 1 –Frequency of Words in Media Alerts for Three Utilities

In addition, a thematic analysis on top keywords used in the media articles, illustrated with a dendrogram, is provided below. The algorithm divides the keywords into nine primary themes (color-coded for easy visual reference), and as can be seen, The company's name is more frequently primarily with the negative theme of power outages. We emphasize again that the annual SAIFI and SAIDI statistics are comparable for the different utilities. What differed was the recent publicity (or possible recent experience of customers) for the three utilities.

The results here are preliminary as they are based on a small sample set of articles at a particular point in time (December 2014), but they present intriguing results about the company's perception in the media, and perhaps by its customers, that may be contributing to some of the negative customer satisfaction results on the J.D. Power & Associates surveys.

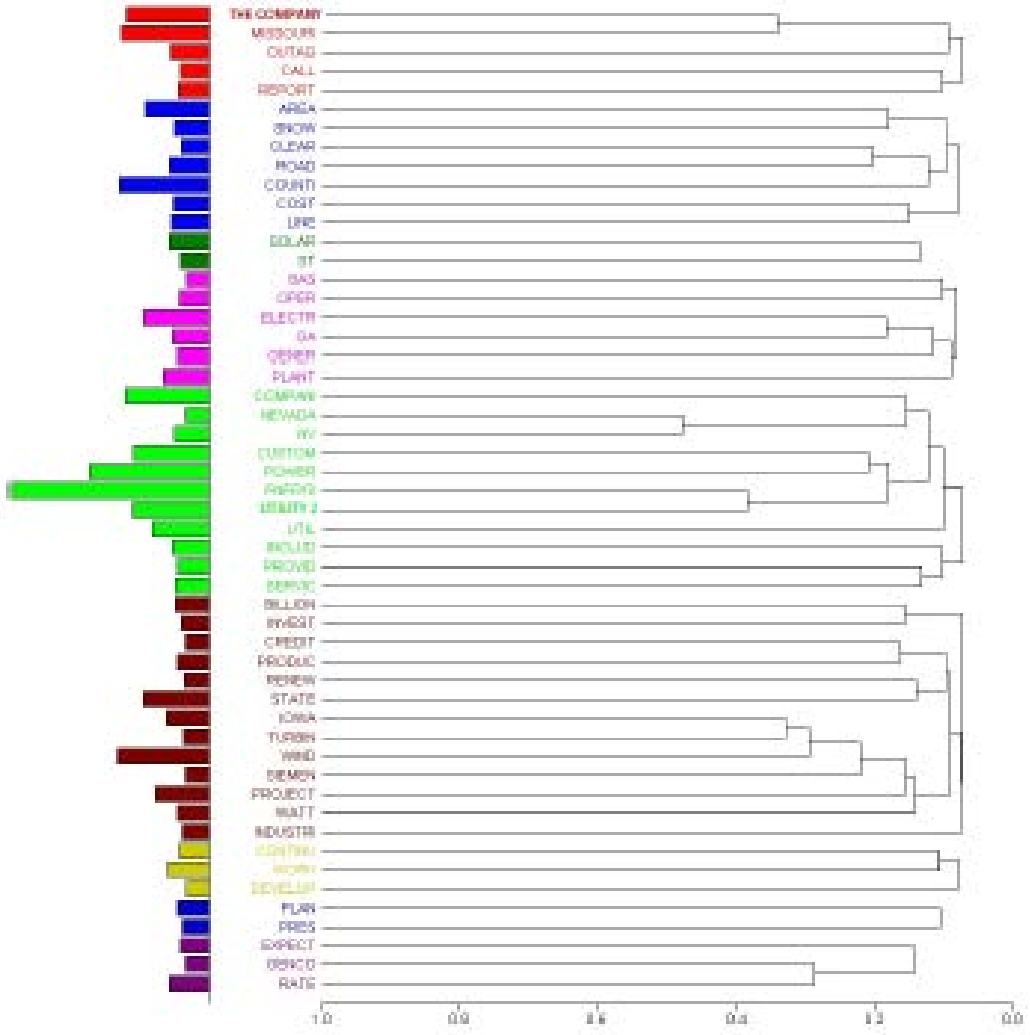

Figure 2 - Clustering of Words and Themes from Media Alerts

Discussion and Conclusion

Several major conclusions emerge from this study about the interpretation and use of survey data for customer satisfaction. First, we would emphasize that utilities should focus their attention on the rating scores rather than upon rankings based on the rating scores. Significant differences in ranking can occur with insignificant differences in ratings. Scores on each performance dimension covered by J.D. Power & Associates are correlated with overall satisfaction (a good thing). Respondents to surveys, however, may consciously express

sentiments on individual dimensions in a way that justifies their overall feeling of satisfaction. Changing a customer's impressions on one dimension is therefore likely to have some carry-over effects to assessments on other dimensions.

Ratings assigned by residential customers (especially for price and value but also for other dimensions of performance) appear to be affected by the total costs incurred for electricity rather than rates per kWh. Customers with high average bills (not surprisingly) give lower ratings for the reasonableness of rates. This relationship was also evident when rates and average ratings were examined across utilities. Utilities that serve a territory with high consumption (requiring more air conditioning in the summer, for example, or electric heating in the winter) face a challenge in matching consumer ratings of utilities where the consumers require less electricity. For utilities in high-consumption markets, special effort is required to educate consumers about how much their bill is determined by relative rates versus the amount of electricity used. A fair comparison of ratings may require some adjustment for average residential electricity usage in the market.

Scores given for power quality and reliability of power reflect respondents' subjective assessments of the company's effectiveness in minimizing outages, duration of outage and communications during outages. They are not so strongly correlated with actual outages in their personal residential service. Further research is required to determine if reliability statistics for the neighborhood track better with customers' perceptions of power quality and reliability. Regardless, effective communications around outages and good predictions of restoration times, can help improve customer ratings of reliability and customer service.

Ratings in surveys are affected by consumers' direct experience in dealing with the company and by their impressions of how the company works to serve their interests. Higher ratings for

corporate citizenship and effective communications are related with higher ratings on energy-efficiency programs. Customers claim to appreciate information and initiatives that help them understand and reduce their energy usage. Experiments with selective messages and offers to customer segments (e.g., for energy efficiency, alternative power, or energy conservation) are required to determine if modern consumer marketing can simultaneously improve financial performance and consumer satisfaction in electric utilities.

Since ratings reflect customers' perceptions of service (perhaps even more than objective measures of services delivered), electric utilities need to be aware of how information and personal interactions with the company are forming those impressions. Further research is required to determine how sentiments expressed in traditional media, internet blogs and social media relate to customer satisfaction and how corporate communications through such channels shape consumers' impressions.

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Appendix A – Surrogates for Overall Scores in J.D. Power Rating Categories

Overall Satisfaction
Now, thinking about your overall experience with <company name>as your electric utility, how satisfied would you say you are with <company name>on a zero to ten scale where zero means extremely dissatisfied and ten means extremely satisfied?

Reasonable Rates (Price)
In general, would you describe <company name>'s electric rates as very reasonable, somewhat reasonable, neither reasonable nor unreasonable, somewhat unreasonable, or very unreasonable?

Power Quality & Reliability
Next, I would like to ask you about <company name>'s basic electric service to your home. On a zero to ten scale, where a zero means you are extremely dissatisfied and a ten means you are extremely satisfied, how would you rate <company name>on providing reliable electric service?

Billing & Payment
Take average of scores for BP1-BP4
BP1: *Using a zero to ten scale, where zero means <company name> does an extremely poor job and ten means extremely good job, how would you rate <company name>on providing accurate bills?*
BP2: *How would you rate <company name>on having bills that are easy to understand?*
BP3: *How would you rate <company name>on providing a bill that clearly explains the charges?*
BP4: *Using a zero to ten scale, where zero means extremely dissatisfied and ten means extremely satisfied, how would you rate the overall format and content of your <company name>bill?*

Corporate Citizenship
Take average of scores for CC1-CC7
CC1: *Now, I'm going to read a list of characteristics and ask you to tell me how well each one describes <company name>. As I mention each one, I'd like you to use a scale from zero to ten, where zero means does not at all describe and ten means describes extremely well.*
CC2: *Trustworthy*
CC3: *Hardworking*
CC4 *Responsive*
CC5: *Knowledgeable*
CC6: *Customer-focused*
CC7: *Community-minded*

Communications

Using a scale of zero to ten, where zero means very ineffective and a ten means very effective, overall, how would you rate the effectiveness of <company name>'s communications?

Customer Service

Take average of scores for CS1-CS7

CS1: Thinking about all of your experiences with <*company name*>, in general, using a zero to ten scale, where zero means extremely poor job and ten means extremely good job, how would you rate <*company name*>on doing things right the first time?

CS2: Being easy to reach?

CS3: Following through on doing what we said we would do?

CS4: Being easy to do business with?

CS5: Showing concern and caring about its customers?

CS6: Having courteous employees?

CS7: Having knowledgeable employees?