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The Detroit Edison Company		Exhibit No.:	A-21
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Pacific Economics Group LLC - Service Quality Report

SERVICE QUALITY REGULATION FOR DETROIT EDISON:

A CRITICAL ASSESSMENT

Pacific Economics Group, LLC

Economic and Litigation Consulting

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1. Introduction and Executive Summary

1.1 Introduction

Service quality is an increasingly important issue in utility regulation. In addressing this topic for all regulated industries, a report by North American regulators stated that "attention to service quality will be of greater importance as competitive markets proliferate and financial regulation diminishes."[1] Service quality issues have become especially prominent in the electric power industry, partly because advanced industrial economies like the United States are more dependent than ever on reliable power supplies. Increasing digitalization and the 'e–economy' are leading both to greater demands for power and for more reliable power supplies. The location of new demands is also more difficult to predict than in the past *(e.g.* suburban areas, in addition to central business districts and industrial parks). At the same time, forces such as mergers, industry restructuring, and increased competition are putting pressures on power delivery systems. These trends have led to a greater volume of power transactions and flows, more desire to operate systems closer to their capacity limits, and increased emphasis on cost–cutting.

Some observers have questioned whether traditional regulation is best suited to this new environment. One early statement of this view comes from a Power Outage Study Team (POST) commissioned by the US Department of Energy (DOE) to investigate several prominent power outages in the US in 1999. In addressing the relationship between regulation and appropriate reliability, DOE POST wrote:

> '(I)s the existing regulatory policy package adequate in light of the new demands on electricity delivery companies? Additional regulatory measures and increased incentives, including performance-based standards, may be required to assure that the necessary actions are taken to provide the proper level of reliability.'[2]

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[1] The National Regulatory Research Institute, (1995), *Missions, Strategies, and Implementation Steps for State Public Utility Commissions in the Year 2000: Proceedings of the NARUC/NRRI Commissioners Summit*, Columbus, Ohio, p. 4.

[2] US Department of Energy Power Outage Study Team, (2000), *Interim Report of the U.S. Department of Energy's Power Outage Study Team: Findings From the Summer of 1999*, p. 2.

Policymakers at both the State and Federal levels have responded to these concerns in a number of ways. For example, the Federal Energy Regulator Commission (FERC) has recently developed a generic policy regarding innovative and incentive-based ratemaking. This proceeding was initiated by the Energy Policy Act of 2005 (Epact2005), which compelled FERC to establish rules regarding incentive-based rates for electricity transmission. The ultimate objective of FERC's rulemaking was to benefit consumers by enhancing reliability and, by reducing transmission congestion and bottlenecks, reducing the cost of delivered power to end-users. It was recognized that the goals of enhanced reliability and reduced congestion could only be achieved through increased investment in the transmission sector. In response to the Epact 2005 mandate, FERC issued Order 679, which outlines policies related to specific incentives that are designed to encourage transmission investment and promote power reliability.[3] [4]

Most States have also implemented policies that are designed to ensure that electric utilities provide appropriate service quality. The vast majority of States require companies to provide information on service quality metrics and monitor utilities' performance on the selected indicators. Several state commissions have established service quality targets that they expect utilities under their jurisdiction to attain. A significant number of service quality incentive (SQI) mechanisms have also been approved, which penalize (and sometimes reward) utilities based on how their measured service quality performance compares to established benchmarks. Most of State regulators' attention has focused on maintaining the reliability of power supplies, but

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[3] The Energy Policy Act took effect on August 8, 2005 and required FERC rules to be established within one year. In November 2005, FERC issued a Notice of Proposed Rulemaking and invited comments from interested parties. FERC's proposed policies were presented on July 20, 2006 in Order 679 ("Promoting Transmission Investment through Pricing Reform"). In response to comments on Order 679, FERC agreed to re-hear a limited number of issues. Its Final Rule and Order on Rehearing, Order 679-A, was issued on December 22, 2006.

[4] It should also be noted that Order 679 "does not grant outright any incentives to any public utility but rather identifies specific incentives that the Commission will allow when justified…" (116 FERC, Docket No. RM06-4-000, Order 679, p.1). FERC evaluates each proposed incentive ratemaking treatment on a case-by-case basis, in which Companies must establish a "nexus between the incentive being sought and the investment being made." In the Order on rehearing, FERC broadened the "nexus" requirement so that not only is each particular requested incentive to be justified, but the entire set of requested incentives is also to be justified as a package.

policies have also addressed other aspects of service quality that are delivered to end-users, such as the responsiveness of telephone centers and the accuracy of customer billing.

One State that has investigated service quality issues in some detail is Michigan. The Michigan Public Service Commission (MPSC) established statewide service quality standards in the wake of a November 1999 report by MPSC Staff that investigated the reliability of Detroit Edison's (DTE's) distribution system and storm response capability. The Staff report contained eight recommendations, including the development of reliability performance targets that would be submitted to the Commission for approval. The MPSC noted that while the Staff's recommendations were specific to Detroit Edison, many of them were applicable to all electric utilities in Michigan, particularly the recommendation regarding reliability performance targets.[5] The MPSC therefore began a proceeding to review the regulation of reliability for all of Michigan's electric utility customers. Shortly after this proceeding was initiated, legislation (Public Act 141 of 2000) was adopted in Michigan that required the MPSC to adopt generally applicable service quality standards for the State's regulated utilities. These standards went beyond reliability to include factors such as telephone service, billing, and public and employee safety. Furthermore, Act 141 said that "(i)n setting service quality and reliability standards, the commission shall consider safety, costs, local geography and weather, applicable codes, national electric industry practices, sound engineering judgment, and experience."[6]

The Commission's service quality examination culminated in a July 2001 Order that established ten specific performance standards. Michigan electric utilities were required to report their measured performance on each metric and whether they were in compliance with the associated standard. If a utility failed to comply with a standard, its report was to include a discussion of the root cause of the unacceptable performance and corrective actions that had been undertaken to remedy the service quality problems. The

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[5] Michigan Public Service Commission, "In the Matter, on the Commission's own motion, of the investigation into methods to improve the reliability of electric service in Michigan," Case No. U-12270, January 3, 2000.

[6] MCL 460.10p(5): MSA 22.13 (10p)(5).

Commission also mandated credits that were to be paid to customers if certain reliability standards were violated. Annual reports were also to include a summary of any such credits that had been provided. The specific standards established in the July 2001 Order were the following:

1. Electric utilities should restore service to at least 90% of interrupted customers within 36 hours or less.
2. During catastrophic events, electric utilities should restore service to at least 90% of interrupted customers within 60 hours or less.
3. Under normal conditions, electric utilities should restore service to at least 90% of interrupted customers within 8 hours or less.
4. No more than 5% of utility circuits should experience 5 or more outages in a 12 month period.
5. In Metropolitan Statistical Areas (MSAs), at least 90% of downed wires in police and fire situations should be guarded by utility personnel within 4 hours.
6. The average speed of answer for customer calls to utility phone centers should not exceed 90 seconds.
7. A utility's call blockage factor (*i.e.* the percentage of calls to the phone center not answered by company personnel) should not exceed 5%.[7]
8. A utility should respond to at least 90% of customer complaints within three business days.[8]
9. A utility should read 85% of customer meters each billing period.
10. At least 90% of new service installations should be completed within 15 days.

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[7] A call where a customer hangs up before the call is answered by utility personnel is also often referred to as an "abandoned call." Many utilities therefore use the term "abandoned call rate," which is synonymous with the call blockage factor.

[8] A utility response was defined as a company apprising a customer within three business days of (1) the nature of the problem and (2) what the utility intends to do to solve the problem, but not necessarily a complete resolution of the complaint.

At a later date, the MPSC added a standard that 90% of wires (in police and fire situations) down in non-metropolitan areas (non MSAs) should be relieved within six hours. A total of 11 standards therefore currently apply in Michigan. Three of these standards involve credits to customers, although in each case the standard that leads to customer compensation differs from the one mentioned above that establishes "unacceptable" service. Customer credits will be issued if customer service is not restored within 16 hours under normal conditions or under 120 hours during catastrophic conditions, defined to be those that lead to at least 10% of customers on the system being interrupted. Credits will also be issued when there are eight or more interruptions on a circuit in a twelve month period. The credits in each case will be either $25 or the monthly customer charge on the affected customer's tariff, whichever is greater.

It should be noted that, in its review of service quality regulation, the MPSC chose not to establish standards for system-wide reliability performance metrics. Such measures include the system average interruption frequency index (SAIFI), the system average interruption duration index (SAIDI), and the customer average interruption duration index (CAIDI). These reliability metrics are used widely in the electric power industry and measure, respectively, the number of interruptions, number of minutes without power, and average duration of an interruption when it occurs that is experienced annually by an average customer on the system. The Staff had originally proposed standards for SAIFI and SAIDI but these recommendations were abandoned, primarily because the MPSC learned that Michigan utilities differ significantly in how they define and measure these indicators. The MPSC wanted to monitor performance indicators for which a single standard could reasonably be implemented throughout the entire State, and this was not feasible for system-wide reliability metrics since they were not measured comparably across the State's regulated utilities.

DTE has generally satisfied the MPSC standards since they were implemented, but some other issues regarding the Company's service quality have arisen during that time.[9] One was an increase in complaints for frequent outages or low voltage in 2005.

[9] DTE has achieved every service quality standard in each year from 2002 through 2006 with the exception of restoring power to at least 90% of customers under normal conditions, which it fell short of in

Because summer temperatures in 2005 were significantly higher than the year before, the MPSC said this increase was not necessarily a cause for concern, but it did direct DTE to file a report reviewing its outage experience and actions that it had taken to address any potential problems.

DTE's service quality also eventually became an issue when, in March 2006, the MPSC directed DTE to show cause why its electric rates should not be reduced. The Company agreed to a settlement of this case with the MPSC Staff and other interested parties which was ultimately accepted by the Commission. One issue addressed in the Settlement was a "Performance Excellence Process" (PEP) that DTE is currently undertaking to achieve top quartile cost and service quality performance. To achieve top quartile cost performance, PEP will reduce some operating expenses, which in turn contributes to a lower cost of service and facilitates lower prices for customers. Some parties expressed a concern that these efforts could reduce the resources needed to deliver high quality service to customers and could therefore lead to degradations in quality. The settlement agreement therefore required DTE

> "…to initiate an independent study performed by an outside consultant to monitor any impact of the PEP on service quality. The study will be submitted by the Company in the 2007 rate case and will address the following[10]:
>
> - Disclosure of which indicators are currently established to measure customer service quality
> - Providing recommendations for a formal process of monitoring a possible expanded set of indicators
> - Present a proposal for inter-company service quality benchmarking"[11]

Pacific Economics Group LLC (PEG) was chosen by DTE, in cooperation with MPSC Staff and other interested parties, to prepare this study. PEG has advised a

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2002 through 2005 but attained in 2006. The gap between DTE's measured performance and the standard generally declined over the 2002-2005 period.

[10] The settlement agreement also required DTE to file a general rate case in 2007.

[11] Michigan Public Service Commission, "In the Matter, on the Commission's own motion, ordering the Detroit Edison Company to show cause why its retail rates for the sale and distribution of electric energy should not be decreased," Case No. U-14838, August 31, 2006.

number of electric utilities and regulators throughout the world on service quality regulation issues. PEG is also one of North America's leading consultants on benchmarking utility performance for regulatory applications. This report presents our findings on: 1) the suitability of the indicators currently used to measure service quality for DTE and other electric utilities in Michigan; 2) the suitability of Michigan's current service quality regulatory process, especially for DTE as it begins the cost cutting initiatives in PEP; 3) the issues that would need to be addressed to undertake rigorous, inter-company comparisons of service quality performance, and a framework for undertaking such comparisons if there was interest in doing so.

These specific issues are corollaries to the more fundamental concern of how utility regulation should be structured so that it delivers appropriate levels of service quality to customers. Clearly, any analysis of whether service quality is "appropriate" must consider what indicators are chosen to measure quality and the process used to evaluate a given utility's measured quality. But, especially in light of the current PEP initiatives, evaluating whether DTE's quality levels are appropriate also raises the following two questions:

1. Is DTE's current service quality adequate given the business conditions in its service territory and the costs it incurs to deliver quality?
2. Is DTE providing the levels of service quality that its customers expect and demand?

These questions are related but distinct. The first focuses entirely on the *company's* performance in delivering high quality service. This is equivalent to examining the "supply side" of service quality provision, or how efficiently DTE is in delivering (*i.e.* supplying) quality to its customers. The second question focuses on *customers'* service quality expectations. This is the "demand side" of the marketplace, which depends on customers' preferences and willingness to pay for quality.

Both the supply and demand side are relevant for determining whether customers are receiving "value for the money" regarding their quality of power distribution service. On the supply side, whether customers are receiving value for the money depends on the service quality "outputs" that the utility is delivering to its customers and how those outputs compare to what would be expected given the underlying technology for power distribution services. This issue is often analyzed through comparative benchmarking studies, which evaluate how a given company's cost or quality compares with those of other firms in the industry. Appropriate benchmarking is complicated by the fact that many business conditions that can affect measured service quality (such as weather and population densities) differ widely among US utilities and are largely beyond managerial control. Any rigorous, comparative assessment of utilities' underlying performance in supplying service quality to their customers must therefore control for the impact of these business conditions.

On the demand side, whether customers are receiving value for the money depends on their price-quality tradeoffs. These tradeoffs exist because customers prefer products that are both high-quality and low-price but these objectives usually conflict. Compared with lower-quality alternatives, higher-quality goods and services can typically only be produced using either more or more highly valued resources. The costs of these resources tend to raise price, with the consequence that in most markets there is a tradeoff between the quality of available products and the prices that customers pay. Consumers can choose from among the available products and select the option that best matches their price-quality preferences. While consumer choice is (with rare exceptions) not possible for regulated power distribution service, the same underlying price-quality tradeoffs will exist among any utility's customers. All else equal, consumers will always prefer "more" to "less" quality, but if higher utility quality can only be achieved through higher prices, then some customers are likely to prefer the lower price and lower quality distribution service.

This report was explicitly directed to consider performance benchmarking. It is therefore reasonable for our analysis to emphasize "supply side" issues when evaluating whether the current regulatory indicators and framework are likely to deliver service quality "value for the money." Nevertheless, we believe it is important for regulators and other interested parties not to lose sight of consumers' demand for quality when evaluating regulatory policy. By their very nature, the PEP initiatives raise the issue of price-quality tradeoffs and how regulators should balance the twin goals of encouraging low prices while simultaneously delivering adequate service quality. Regulation in

Michigan is likely to be more effective if it takes account of, and is informed by, both utilities' effectiveness in delivering quality to customers and customers' underlying demand for quality.

1.2 Executive Summary

The results of this report can be briefly summarized. There are many dimensions of the service quality provided by utilities to retail customers. With only a few exceptions, most of these service quality metrics must be collected directly within the utility itself. Most utilities have historically collected and monitored these data primarily for internal management rather than external regulatory purposes. Accordingly, until recently, there have been few attempts to standardize the definition and measurement of service quality indicators across utilities. It is therefore common for the measurement of service quality indicators, especially reliability indicators, to differ across utilities.

The measured quality of utility service can also vary because of external business conditions that are beyond managerial control. Utilities have an obligation to provide service to customers in assigned territories. Power delivery requires direct connection and delivery into the homes and businesses of end users. The conditions of a utility's service territory and customer base can therefore affect the cost and measured quality of service for power delivery networks. These business condition variables often differ substantially among companies. In addition to varying across distributors, some of these business conditions (particularly weather) are quite volatile and unpredictable over time. As a result, external business conditions lead both to systematic differences in measured quality across companies and year-to-year fluctuations in some quality indicators.

A utility's measured service quality is not determined entirely by external conditions but also depends on the efficacy of what may be termed the distributor's service quality effort. In evaluating work practices and investments that can enhance quality, it is rational from both a shareholder and customer perspective to balance cost and quality considerations. It is generally not cost effective to have the same quality levels in service territories with markedly different business conditions. The appropriate balancing of cost and external business considerations implies that utilities' measured quality often *should* vary across companies. Differences in measured quality across utilities are therefore not necessarily evidence of either good or bad service quality performance. Robust inferences on the effectiveness of a utility's service quality effort are only possible if benchmarking comparisons control for differences in business conditions across utilities. In addition, it should be recognized that distribution systems are rationally designed to deliver fluctuating quality levels. A short-term decline in service quality performance is not necessarily cause for concern.

The analysis of service quality economics in competitive markets provides an important guide for evaluating how best to regulate the quality of regulated services. Supply and demand conditions are distinct aspects of any marketplace. For most goods and services, the market forces of customer choice and competition among firms induce companies to make supply decisions that reflect consumer demands for product quality, including the willingness to pay for quality. These same forces are not operative for power delivery and related services which, even in a market where retail competition has been introduced for power supply services, will overwhelmingly be provided by regulated utilities that have a monopoly over power distribution in designated service territories. In principle, regulation will be more effective if it replicates the market-like incentives that move the quality of utility services towards optimal levels that reflect customer demands and willingness to pay. However, service quality approaches that tend to promote optimal quality are much more information-intensive than other, simpler regulatory approaches.

Three broad approaches can be taken towards service quality regulation. Under service quality monitoring, utilities are required to report their performance on defined indicators to regulators, and perhaps other parties, at defined intervals. A service quality target regime is one where companies are expected to achieve established, targeted levels of performance on a series of identified performance indicators. This approach requires setting one or more benchmarks for each of the indicators and providing information on how the Company's current performance compares with those benchmarks. If utilities fail to achieve a given benchmark, they may be compelled to present action plans on how they plan to boost performance to the benchmark level. Service quality incentives (SQIs) are regulatory mechanisms that automatically penalize, and sometimes reward, companies depending on how their measured service quality performance compares with established performance benchmarks. The main idea behind SQI plans is to establish rules that create inherent incentives for utilities to meet desired regulatory objectives. A well–designed SQI plan will create incentives for the utility to operate in an efficient and effective manner for the benefit of customers, so there is less need for continuous and detailed regulatory scrutiny of utility operations.

Service quality benchmarking can be used to establish benchmarks in either a quality targets or SQI regime. In general, benchmarking involves comparing one or more utility performance measures to external performance standards. "External" performance standards can be defined as measures that are outside of the utility itself and beyond its control. These external standards are sometimes computed using data from firms that are viewed as "peers" of the utility. When this is the case, benchmarking involves comparing the utility's performance on a selected indicator directly to the measured performance of a peer utility, or the average performance of a peer group, on that same indicator.

In regulatory applications, benchmarking is more often undertaken using various benchmarking techniques. The three most widely used benchmarking techniques are indexing, econometric modeling, and data envelope analysis (DEA). All of these techniques attempt to control for the impact of external business conditions on a utility's quality (or cost) performance. In service quality applications, econometric methods are likely to be the only practical technique for benchmarking a utility's comparative service quality performance. A service quality econometric model would relate sample data on measured quality attributes to external business condition variables that are beyond company control.

A survey of US service quality regulation shows that the service quality indicators established in Michigan are unique in several respects. No other State has placed as much emphasis on establishing service standards that apply to the reliability experience of individual and relatively small groups of customers (*e.g.* customers on a circuit) without also considering more system-wide reliability measures. The regulatory process in Michigan is also somewhat unique. The State has adopted a penalty regime, although the penalties are based on customer-specific rather than system-wide measures. While there are some precedents for this, most penalty plans have applied more widely and have been more balanced across all aspects of service quality.

Service quality benchmarking has been very rare in regulation. This issue has been considered most often for reliability comparisons but has not, to our knowledge, been accepted by any US jurisdiction that has examined the issue. One clear challenge in service quality benchmarking is obtaining data that are uniformly defined and measured across companies. This task is complicated by the fact that there are no requirements to report these data according to standardized formats and definitions in different States. This is especially true for reliability data.

The first requirement for this report is to examine the indicators that are currently used to measure customer service quality in Michigan and to propose a possible expanded list of indicators that are appropriate for DTE given its PEP program. We recommend that SAIFI and SAIDI be added to the list of monitored indicators. In both cases, we recommend that the measured indicators exclude outage events that lead to interruptions for at least 10% of customers on the system, as is currently the case in Michigan. Compared to the current regime, we believe that adding SAIFI to the list of indicators will give DTE more incentives to help outages from occurring in the first place. We also believe that adding SAIDI to the list of indicators will give DTE more balanced incentives to reduce the durations of outages experienced by all customers on the system. Both indicators represent important service attributes that are not currently reflected in the service quality regime.

We also recommend that the percent of customer bills that are adjusted be added as an indicator. We believe that billing indicators are generally preferred to metering indicators since the former reflects the quality of something that customers experience directly – the bill – rather than an aspect of utility operations necessary to produce a bill. Billing indicators are therefore more akin to service quality "outputs" delivered to customers rather than the service quality "inputs" that firms utilize to provide service. Adding a billing indicator could therefore make Michigan's regulatory framework more directly focused on customer welfare. The percent of customer bills that the utility must adjust because of billing errors reflects the "bottom line" service quality concern of billing accuracy, which incorporates errors that can occur at the meter reading (including an estimated rather than an actual meter read) and bill preparation level. We do not recommend modifications to any of the other indicators.

The second requirement for this project was to provide recommendations for a formal process of monitoring a possible expanded set of indicators. To accommodate the three new indicators and advance the goal of establishing a more balanced service quality approach, we recommend the following modifications of the regulatory process for DTE:

- Benchmarks for each of the new indicators should be set at the 10 year average value on the respective service quality indicator.
- Because SAIFI and SAIDI can fluctuate considerably from year to year due to factors beyond DTE's control, both of these indicators should be measured as the two-year average value of the respective metrics.
- Deadbands equal to one standard deviation of SAIFI and SAIDI performance should be established around the benchmarks.
- In light of the PEP initiatives, parties should consider extending the scope of potential penalties. Making all of DTE's service quality indicators (other than the downed wire indicators) subject to penalties will eliminate the current asymmetry in the penalty regime, where reliability performance can be subject to penalties but non-reliability performance cannot. Extending the scope for penalties therefore creates more balanced incentives for DTE to maintain service for both reliability and non-reliability quality indicators.
- The recommended penalty amount for each indicator will be based on US service quality precedents, scaled so that they are proportionate to DTE operations. This approach is feasible for all but the downed wire indicators, for which we are not aware of any relevant precedents. We therefore propose to exclude these indicators from the extended penalty regime.
- Allowing rewards for service quality performance is generally good public policy, and it is often appropriate to have balanced penalty-reward mechanisms in service quality regulation. We therefore recommend that DTE present a proposal to turn the penalty-only regime into a balanced penalty-reward approach at the earliest possible date.
- It is critical that everyone have confidence in the data that are used in service quality regulation. All interested parties should therefore convene a technical

conference and series of follow up discussions to educate Staff about how the various service quality data are collected and to establish protocols for ensuring that the data provided to the MPSC are accurate.

- As part of the technical conference related to data issues, we recommend that parties examine the costs and potential benefits to DTE and its customers of collecting MAIFI and enhanced telephone responsiveness metrics.

The third requirement for this project was to present a proposal for inter-company service quality benchmarking. If there is interest in pursuing service quality benchmarking in Michigan, we would propose the following process and approach:

- More data exists throughout the industry on reliability than other service quality metrics; service quality benchmarking should therefore begin by exploring service reliability benchmarking, with the results of this project providing a foundation for benchmarking other service quality attributes.
- SAIFI and SAIDI data for individual utilities would be gathered from publicly available sources; data would also be collected on business condition variables that can affect measured SAIFI and SAIDI, and these data would be mapped to specific electric utilities.
- Using this publicly available data, econometric models that relate SAIFI and SAIDI to various business condition variables beyond management control would be estimated. The econometric research would develop estimates of the quantitative impact of each of the external "quality drivers" on average SAIFI and SAIDI performance.
- The "reliability driver" models can then be used to develop preliminary benchmarking evaluations of different utilities' reliability performance. This can be done by inserting values for the external business conditions into the estimated reliability driver econometric models. The results will be econometric benchmark predictions for SAIFI and SAIDI. Each company's actual SAIFI and SAIDI performance can then be compared to the predictions.

However, these results must be interpreted with caution; in particular, this approach will not yield robust inferences on a utility's SAIFI and SAIDI performance whenever a utility measures SAIFI and SAIDI in a way that differs from the way these indicators are measured, on average, by the firms in the sample that is used to estimate the econometric models.

- To develop more robust inferences on reliability performance, the MPSC should commence a process to standardize SAIFI and SAIDI measures across the State's utilities. This process would begin at the same time the econometric research outlined above commences. The resulting data can then be applied in the econometric, reliability driver models and used to develop more robust benchmarking inferences.

The plan for this report is the following. Chapter Two briefly describes the power distribution business, the important service quality attributes that distributors provide to customers, and the type of service quality information that distributors often collect. Chapter Three provides a conceptual framework for analyzing service quality issues. This framework considers both the "supply side" and the "demand side" of electric utility service quality. Chapter Four discusses various options for service quality regulation. Chapter Five provides an introduction to, and preliminary assessment of, service quality benchmarking. Chapter Six surveys current service quality regulation practices in the US. Chapter Seven then evaluates service quality regulation for Detroit Edison. This evaluation includes an assessment of the service quality indicators currently used to measure DTE's service quality, the process for monitoring service quality regulation in the State, and the feasibility and desirability of service quality benchmarking. Chapter Seven also includes recommendations for amending DTE's service quality regulation going forward and some possible directions for further research and/or action by Detroit Edison, the Michigan Public Service Commission or other interested parties.

2. The Electric Utility Business and Service Quality

2.1 Power Distribution and Service Quality

The main function of utility distribution companies (UDCs) is to receive power in bulk from points on high-voltage transmission grids and distribute it to consumers in assigned territories. Delivery involves reducing the voltage of bulk power supplies to the levels used in end-use electrical equipment. Delivery is achieved via conductors that are usually held above ground but pass underground in some areas through conduits. Important UDC facilities include conductors, line transformers, station equipment, poles and conduits, computer systems and software, transportation equipment, storage areas, and office buildings. UDCs commonly construct, operate, and maintain such facilities but may outsource certain functions.

Continuous use of electric power is essential to the functioning of modern homes and businesses. Power storage, self-generation and self-delivery from the grid are generally not cost competitive with power delivered by UDCs. End users therefore want power delivered to their premises and must be physically connected to the distribution system. To satisfy consumer demands, UDCs construct and maintain power delivery networks that establish physical contact with almost every business and household in their service territory.

The essential nature of power demand also makes interruptions in power delivery costly to customers. UDCs are therefore expected to design and operate distribution networks to assure reliable deliveries. One important design requirement is that the capacity of the delivery system must be able to accommodate the peak demands in the territory. UDCs must also endeavor to connect customers rapidly to the network. End use electrical equipment is also designed to operate within a narrow range of voltage levels. Thus in addition to providing power supplies that are as continuous and uninterrupted as possible, UDCs must attempt to conform to technical standards affecting the quality of power deliveries (*e.g.* regarding voltage, waveform, and harmonics).

Even well-built delivery systems are subject to disruption from accidents and weather conditions. When disruptions occur, UDCs are expected to restore service promptly. UDCs can maintain service quality in a number of ways. Important facilities that promote continuous and high quality power supplies are protective devices such as fuses and circuit breakers, switchgear, automatic reclosers, voltage regulators, capacitors, and cable insulation. Supervisory control and data acquisition (SCADA) and distribution automation systems also permit more centralized monitoring and control of power distribution systems, thereby reducing the extent and duration of interruptions experienced by customers in the event of equipment failure.

In addition to these capital assets, the quality of delivery services depends on a UDC's operation and maintenance (O&M) activities. Vegetation management and tree trimming can reduce the likelihood of contact between foreign objects and power lines that lead to interruptions. More frequent washing of insulators can reduce contamination and enhance reliability. Wood pole wraps and other pole maintenance also promote system integrity. When outages do occur, the size and deployment of restoration crews affects the duration of interruptions that customers experience.

UDCs also provide various services to retail customers that are related to, and typically bundled with, local power delivery. These include metering, customer billing and collection, and information services. Facilities that are important in the provision of these services include meters and related equipment, communications equipment (including telephone centers), and computer systems and software. Providing these retailing services also involves O&M expenses such as the labor costs for meter reading, customer billing, telephone center and related personnel.

2.2 Service Quality Measures

Consistent with the wide range of services provided, there are many dimensions of the service quality provided by UDCs to retail customers. The specific quality indicators that utilities measure vary somewhat from company to company, but there are nevertheless broad similarities among the types of performance indicators that are used to measure and monitor service quality for electric utilities. We have found it useful to group service quality indicators into seven broad categories.[12]

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[12] Any classification will be somewhat arbitrary and, in some cases, indicators that have been developed and used for service quality regulation for some UDCs do not fit into any of these categories.

Reliability indicators measure the continuity of the basic power delivery service. Electric utilities are expected to provide a continuous power supply at all times, so interruptions in power supply constitute a diminution in service quality. Reliability is often measured by the frequency and duration of power interruptions. Reliability is most often measured at the level of the entire system, although it can also be measured for subsets of the network such as for operating areas or specific circuits. The most typical measures used in utility regulation are:

- the System Average Interruption Frequency Index (SAIFI), or the number of sustained interruptions that is experienced annually by an average customer on the system
- the System Average Interruption Duration Index (SAIDI), or the number of minutes of sustained power interruptions that are experienced annually by an average customer on the system
- the Customer Average Interruption Duration Index (CAIDI), or the average duration of a sustained interruption experienced annually by a customer on the system[13]
- the Momentary Average Interruption Frequency Index (MAIFI), or the number of momentary interruptions that is experienced annually by an average customer on the system

The definition of "sustained" and "momentary" outages differs among utilities, but in most cases a sustained outage is either one that lasts at least one minute or (as in Michigan) five minutes; a momentary outage is any loss of power experienced by a customer that is not "sustained." There are also analogues of each of the reliability measures above for subsets of the network. An example might be a "circuit SAIFI," which measures the number of annual outages experienced by an average customer on a

[13] SAIDI is equal to the product of SAIFI and CAIDI, so if any two of these indicators are measured the third can be computed.

specific circuit. Reliability indicators can also focus on thresholds for restoring power to customers.

In Michigan, there are essentially four reliability indicators used in the current service standards. These are: 1) electric utilities should restore service to at least 90% of interrupted customers within 36 hours or less; 2) during catastrophic events, electric utilities should restore service to at least 90% of interrupted customers within 60 hours or less; 3) under normal conditions, electric utilities should restore service to at least 90% of interrupted customers within 8 hours or less; and 4) no more than 5% of utility circuits should experience 5 or more outages in a 12 month period.

Public safety indicators reflect possible health and safety problems if utility products are not delivered properly. In utility regulation, public safety indicators are much more common for gas than electric utilities. An example is the time it takes for utility personnel to respond to calls about gas odors.

While public safety indicators are relatively rare for electric utilities, two such indicators are used in Michigan's service standards: 1) in Metropolitan Statistical Areas (MSAs), at least 90% of downed wires in police and fire situations should be guarded by utility personnel within 4 hours; and 2) in non-MSAs, at least 90% of downed wires in police and fire situations should be guarded by utility personnel within 6 hours.

Employee safety indicators measure the safety of the working conditions for the utility labor force. Although the welfare of utility employees is not an attribute of the quality of service delivered to customers *per se*, maintaining employee safety is especially important to some stakeholders such as unions. Accordingly, a number of regulatory plans include employee safety indicators. Employee safety is usually measured as the total injury and illness rate among workers (the OSHA total incidence rate) or the lost time accident rate. There are no employee safety indicators in Michigan's current service quality standards.

Telephone services pertain to the quality of service provided by the company's phone center. Since most customers communicate complaints or their concerns with utility service by telephone, the quality of phone contacts is an important component of overall service and is often linked to other indicators (eg the response time for emergency visits can depend in part on how rapidly calls are answered and relayed to field personnel). One example of a telephone service indicator is the average time it takes to answer customer calls. Another is the percentage of calls (*e.g.* 80%) that are expected to be answered within a defined interval (*e.g.* 30 seconds).

There are two telephone indicators in Michigan's service standards: 1) the average speed of answer for customer calls to utility phone centers should not exceed 90 seconds; and 1) a utility's call blockage factor (*i.e.* the percentage of calls to the phone center not answered by company personnel) should not exceed 5%.

Metering and billing indicators reflect the quality with which the utility measures and bills for a customer's power consumption. Quality in this area will be enhanced by timely and accurate meter–reading and bill preparation. Examples of metering and billing indicators include the percentage of meters that are read each billing period and the percentage of prepared bills that must be adjusted because of errors. There is one metering indicator used in Michigan: the utility should read 85% of customer meters each billing period.

Customer satisfaction is a category that reflects how content customers generally are with their utilities. The most common such indicator is a survey of customer satisfaction. Such surveys can be based directly on the quality of service provided by utility personnel to customers in either a face-to-face or telephone interaction (sometimes called a "transactional survey") or surveys can be more general and based on random samples of customers. Customer satisfaction can also be measured negatively, through customer complaints to either the utility or Commission. There is one customer satisfaction indicator used in Michigan: a utility should respond to at least 90% of customer complaints within three business days.

Non–emergency on–site services pertain to non–safety or non-reliability related services that require visits to customer premises, such as a visit to repair a broken meter. On–site visits to restore power supplies may fall into this category if the supply problems are customer–specific rather than network–related. An example of a non–emergency on–site indicator is the percentage of non–emergency calls that the company responds to within 24 hours. There is one non-emergency on-site service indicator in Michigan: at least 90% of new service installations should be completed within 15 days.

With only a few exceptions, most of these service quality metrics must be collected directly within the utility itself. Most service quality indicators are linked directly to aspects of utility service that only the UDC is in a position to measure. Historically, most utilities have collected and monitored these data primarily for internal management rather than external regulatory purposes. Accordingly, until recently, there have been few attempts to standardize the definition and measurement of designated service quality indicators across utilities. It is therefore common for measured service quality indicators to differ across utilities.

This is probably most true for reliability indicators. There is considerable variation in how reliability measures such as SAIFI and SAIDI are defined and calculated across utilities. Sources of difference include:

- *Which interruption events are excluded from the metrics* Utilities can differ in which outages are included or excluded from SAIFI and SAIDI statistics. For example, some companies exclude planned outages while others do not. Some electric utilities are still vertically-integrated, and their reliability measures will include generation, transmission and distribution outages, while others (such as DTE) are stand-alone distributors and their outages reflect only outages at the distribution level. While vertically-integrated reliability measures can be separated into those resulting from the generation, transmission and distribution systems (and most are usually distribution-related), a failure to do so will lead to inherently misleading comparisons among some utilities' reliability measures.

  The largest source of discrepancies in outage exclusions across utilities concerns major event days, or what in Michigan are termed catastrophic conditions. Nearly all utilities exclude these events from recorded reliability statistics because major events and storms are atypical and idiosyncratic, so including them can lead to a distorted perception of the utility's underlying reliability performance. However, utilities have adopted different definitions of what qualifies as "major" or "catastrophic" events. DTE had historically defined a catastrophic event as one that leads to 110,000 customers on the system being interrupted; this is a less demanding standard than the 10% standard adopted for Michigan's service quality standards, and less demanding standards for excluding events tend to improve a company's measured reliability performance. Some utilities in other States have also used the same 10% standard used in Michigan, while others have defined a major event as one leading to 10% of customers in an individual operating area, not the entire system, as being excluded. In 2002-2003, there was an effort by the Institute for Electrical and Electronic Engineers ("IEEE") to standardize the definition of major event days across utilities. This culminated in IEEE Standard 1366, which is sometimes referred to as the "Beta Method." While this standard has been promulgated worldwide, relatively few US electric utilities have apparently adopted it as a basis for their officially reported reliability statistics. Accordingly, the creation of IEEE 1366 has not in practical terms eliminated the impact of differences in major day event exclusions on utilities' reliability data.[14]

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[14] The main steps for identifying an major event day under Standard 1366 are the following:

- A major event day is a day in which daily SAIDI exceeds a threshold value $T_{MED.}$
- In calculating daily SAIDI, interruption durations that extend into subsequent days are assigned to the day on which the interruption begins. This technique ties the customer-minutes of interruption to the instigating events.
- The major event day identification threshold value T_{MED} is calculated at the end of each reporting period for use during the next reporting period. For utilities that have six years of reliability data, the first five are used to determine T_{MED} and that threshold is applied during the sixth year.
- The methodology for calculating T_{MED} is as follows:
  - Values of daily SAIDI for a number of sequential years, ending on the last day of the last complete reporting period, are collected.
  - If any day in the data set has a value of zero for SAIDI, those SAIDI data are excluded from the analysis.
  - The natural logarithm of each daily SAIDI value in the data set is calculated.
  - The average of the logarithms, α , of the data set is calculated.
  - The standard deviation of the logarithms, β , of the data set is calculated.
  - The major event day threshold, T_{MED}, is calculated by using the equation (this value should in theory give an average of 2.3 major event days per year)

- *Step restoration* When utilities restore power after widespread outages, restoration typically proceeds in "steps," where some phases of a circuit are restored before others. Companies vary in the extent to which they track customer minutes of interruption in response to partial restoration of circuits. This can affect both the "start" and "stop" times of a given interruption and the total minutes of the recorded outage.

- *Degree of automation* Companies differ in the extent to which they rely on manual or automated systems (such as outage management systems, or OMSs) to record reliability data. It is quite common for companies' measured frequency and duration of outages to rise substantially after they move to more automated recording systems. This implies that manual systems for measuring interruption data tend to miss or undercount the frequency and duration of outages.

For these and related reasons, there is typically substantial variation in how companies measure and record reliability indicators. In principle, reliability measurement can be standardized among electric utilities in a State, but doing so is likely to take considerable effort. It would also lead to inconsistency between the past and standardized reliability measures for many utilities. The definition and measurement of most other data collected by utilities, such as telephone center response rates, meter reading, and billing accuracy, can be standardized more easily. This has apparently been done successfully in Michigan, and other States like Massachusetts have undertaken similar efforts.

However, it should be recognized that the utility itself will remain responsible for measuring the service quality metrics and providing them to regulators. If financial

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$$T_{MED} = e^{\alpha + 2.5\beta}$$

- Any day with daily SAIDI greater than the threshold value T_{MED} is designated a major event day, and data for this day is removed from SAIFI and SAIDI performance to provide a "normalized" measure of performance.

penalties or rewards are attached to service quality performance, a utility may have incentives to manipulate its measured and reported quality. There are at least two recent cases where this type of data manipulation has been alleged. One is for Southern California Edison, where it is claimed that the company has manipulated the scores on its customer satisfaction surveys (*e.g.* by cherry picking the customer telephone numbers forwarded to the third party administering the survey, in order to eliminate unsatisfied customers) and on its employee accident data. This case is ongoing and has not been resolved. A second instance is for Xcel Energy in Minnesota, where an investigation by the firm *Fraud*wise highlighted a number of suspect practices that may have improved the company's reported reliability statistics. This case was resolved between the utility and interested parties without the company admitting guilt. It should be noted that there is no proof of wrongdoing in either of these cases. Nevertheless, it is important for all parties in the regulatory process to have confidence in the underlying data that are used for service quality regulation and, if necessary, to establish controls and auditing requirements to ensure that this is the case.

2.3 Business Conditions and Measured Service Quality

The measured quality of UDC service can also vary because of external business conditions that are beyond managerial control. UDCs have an obligation to provide service to customers in assigned territories. Power delivery also requires direct connection and delivery into the homes and businesses of end users. The conditions of a utility's service territory and customer base can therefore affect the cost and measured quality of service for the delivery networks that UDCs construct and maintain. These business condition variables can also vary considerably among companies. The list of relevant business conditions that can impact different aspects of service quality includes:

- weather (*e.g.* winds, storms, lightning, extreme heat and cold)
- vegetation (contact with power lines)
- the amount of undergrounding mandated by local authorities (reducing the contact of power lines with foreign objects but typically increasing the duration of interruptions that do occur)

- the degree of ruralization in the territory (typically increasing the exposure of feeders to the elements and lengthening response times when faults occur)
- the difficulty of the terrain served
- the mix of residential, commercial, and industrial customers (*e.g.* industrial and large commercial customers value power reliability more than smaller customers and are often willing to pay more for it; a greater share of such customers may therefore be correlated with better reliability indices)
- the incidence of poverty (potentially correlated with credit problems and the incidence of calls to the telephone center)
- the heterogeneity of languages spoken (perhaps affecting call response times)
- the rate of growth in the number of customers (*e.g.* affecting the demand for new installations and utility's response time)
- the tendency of customers to relocate (*e.g.* affecting the demand for new installations and utility's response time)
- regulatory changes such as a restructuring of the industry to promote competition.
- in the short run, it should also be noted that the age of the utility's network can also affect its reliability performance, although in the longer term this variable is subject to managerial control

In addition to varying across distributors, some of these business conditions are quite volatile and unpredictable over time. This is particularly true for weather. This implies that business conditions can lead not only to systematic differences in measured quality across companies, but year-to-year fluctuations in some quality indicators.

Of course, a UDC's measured service quality is not determined entirely by external conditions but also depends on the efficacy of what may be termed the distributor's service quality effort. This effort will include work practices, worker training, and capital investment that impact measured quality. Relevant work practices include the size and training of call center staffing and power line maintenance procedures such as tree trimming. Relevant capital investments include the size and sophistication of OMS and call center communications equipment and software.

In evaluating work practices and investments that can enhance quality, it is rational from both a shareholder and customer perspective to balance considerations of cost and quality. It is generally not cost effective to have the same quality levels in service territories with markedly different business conditions. For example, most will agree that it would be cost prohibitive for UDCs serving highly rural territories to have the same SAIFI as an urban distributor.[15]

The appropriate balancing of cost and external business considerations implies that UDCs' measured quality often *should* vary across companies. Differences in measured quality across UDCs are therefore not necessarily evidence of either good or bad service quality performance. Robust inferences on the effectiveness of a utility's service quality effort are only possible if benchmarking comparisons control for differences in business conditions across utilities. In addition, it should be recognized that distribution systems are rationally designed to deliver fluctuating quality levels. A short-term decline in service quality performance is not necessarily cause for concern.   It is important to keep these points in mind when formulating regulatory policies for service quality.

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[15] Circuits in rural areas are longer and more exposed to a variety of factors that can lead to outages. Rural utilities can thereby maintain the quality levels of more urbanized utilities only by incurring extra costs, such as additional protective devices or maintenance. By the same token, the extensive underground systems of highly urbanized utilities are much less exposed to contact with foreign objects than overhead networks. UDCs in such areas may be forced to underground much of their systems to comply with local ordinances.

3. Service Quality Economics

To provide context for the discussions that follow, this chapter discusses service quality economics for power distribution services. We begin with a general analysis of service quality economics. We then consider the regulation of the quality of power distribution services more specifically.

As one author has stated, "when one investigates quality in economics, one is asking, in effect, what is it about a good or service that makes it more desirable?"[16] Economists make this open–ended question more manageable by conceiving of products as a (finite) bundle of attributes or characteristics.[17] Each characteristic is desirable in the sense that it satisfies consumer tastes and preferences. Since all characteristics are valuable to consumers, consumers generally prefer 'more' rather than less of each.

However, higher quality comes at a price. It is typically costly to add quality characteristics to a product or to provide 'more' of any given attribute. The amount and number of quality attributes that firms choose to bundle with their products is ultimately limited by consumers' willingness to pay. Economists therefore believe that each quality attribute carries an implicit price that, in turn, is reflected in the overall price of the product or service in the marketplace.[18]

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[16] Payson, S., (1994), *Quality Measurement in Economics: New Perspectives on the Evolution of Goods and Services*, Edward Elger, p.2.

[17] One of the earliest analyses adopting this perspective can be found in Lancaster (1966).

[18] The implicit prices for various quality attributes can be quantified through statistical methods and aggregated in so-called hedonic price indexes that summarize overall quality differences between products. One of the earliest economic analyses of this issue is contained in Rosen (1974). Clearly, quality attributes are rarely priced explicitly in the marketplace, but it does not follow that the estimation and use of hedonic prices is simply an academic exercise. One example where these economic concepts are applied is by the Bureau of Labor Statistics of the US Department of Labor, which computes hedonic prices indices and adjusts for changes in the quality of some products when it computes the U.S. Consumer Price Index (CPI). For example, CPI calculations control for quality changes in personal computers. The quality of PCs has been increasing at the same time that their prices have fallen. The real decline in PC prices is, therefore, even greater than reflected in their list prices, since consumers are getting more for their money. Alternatively, if a firm were to offer a new PC that had quality levels equal to those of a PC ten years ago, it would certainly fetch a lower price than the higher-quality new models that are available. Hedonic price indexes adjust PC prices so that they reflect the price declines associated with a PC of constant quality.

It is also important to recognise that preferences differ among customers. Consumers naturally have different tastes regarding the quality characteristics that they find desirable in a given product or service. Just as importantly, customers differ in their willingness to pay for quality (for absolute quality levels and in the relative valuation of different quality attributes). These differences stem from differences in income as well as heterogeneous tastes and preferences.

Firms in competitive markets have strong incentives to meet customers' demands for quality. Because consumer preferences are heterogeneous, firms are financially motivated to offer an array of products that cater to customers' different tastes and willingness to pay for quality. This can result in firms choosing to compete in different segments or 'niches' in the marketplace. A simple example is the distinction between 'high end" (*e.g.* Nieman Marcus) and 'low end' (*e.g.* WalMart) general retailers. The abundance of quality–differentiated products observed in most markets, therefore, reflects differences in product attributes that are bundled together to appeal to the multiplicity of consumer tastes, preferences and price–quality tradeoffs.

Firms' choices on quality levels, and the implicit prices they charge for quality, can have important financial consequences. Consumers choose among goods and services available in the market based on their price and quality. If customers believe that a product does not offer good quality for the money, they will purchase other products that offer more appropriate price–quality terms. Firms providing poor quality products (at a given price), therefore, suffer financially as sales are lost to competitors. By the same token, firms providing superior quality for the money are rewarded with additional sales and profits. Firms in competitive markets, therefore, have powerful incentives to provide appropriate quality levels on the products that customers demand.

These same forces are weaker for regulated monopoly services. Consumer choice is rarely possible for power distribution. Regulation, therefore, does and should play an important role in ensuring that utility customers receive appropriate service quality.

This discussion naturally raises the question of what constitutes 'appropriate' quality for a given price. From the customer's perspective, the quality of any given attribute will be appropriate as long as the (implicit) price at which it is offered is no greater than his willingness to pay. Consumers' marginal willingness to pay for a quality attribute typically declines as the amount of quality increases. That is, as they attain higher quality levels, consumers place less value on additional quality improvements. This implies, for example, that customers are prepared to pay less to go from very good service to excellent service than they would be to go from poor to mediocre service.

Firms are willing to supply a quality attribute as long as the (implicit) price received is at least equal to the marginal cost of providing that attribute. Firms typically face increasing marginal costs of improving quality. That is, as quality levels increase, firms often must incur greater incremental costs to increase quality still further.

Consumption and production decisions for each quality attribute lead to a type of equilibrium, pictured in Figure 1 below. Customers' demand for quality will be given by plotting the willingness to pay for additional increments of quality. Therefore, going from one quality level to the next along the demand curve reflects consumers' marginal willingness to pay for quality. The firm's supply curve is given by the marginal cost of providing quality. Moving along the supply curve from one quality level to the next reflects the marginal cost of providing additional quality.

Consumers continue to demand quality, and firms continue to supply it, until the point where the demand and supply curves intersect. At this point, the marginal willingness to pay for quality is just equal to the marginal cost to firms of supplying it. This yields the (implicit) equilibrium quality indicated.[19] These equilibrium quality levels and implicit prices are appropriate in that they reflect customers' preferences and willingness to pay for quality and firms' willingness to supply it. The market equilibrium depicted in this diagram is also optimal, since it maximises the difference between customers' total willingness to pay for the quality attribute and firms' total cost of producing quality.

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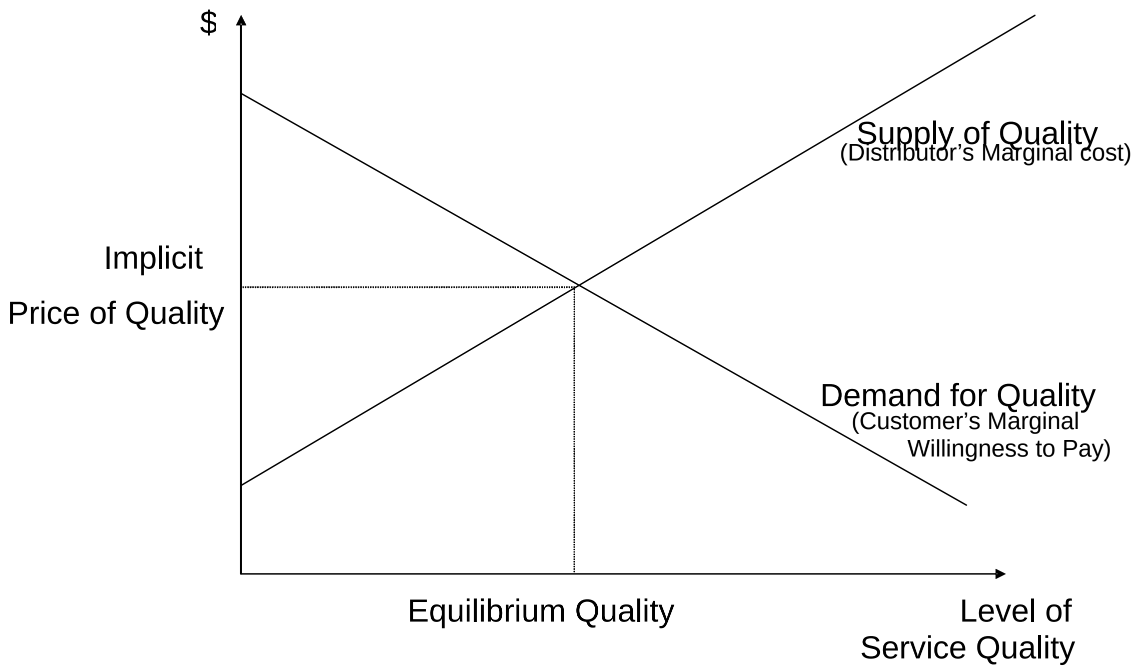
[19] Rosen (1974, p.34) describes this equilibrium more formally as follows:

> 'A class of differentiated products is completely described by a vector of objectively measured characteristics. Observed product prices and the specific amounts of characteristics associated with each good define a set of implicit or "hedonic" prices. A theory of hedonic prices is formulated as a problem in the economics of spatial equilibrium in which the entire set of implicit prices guides both consumer and producer locational decision in characteristics space.'

Figure 1**: The marginal benefits and costs of service quality**



This treatment is, of course, highly stylized. Actual quality choices and implicit prices are more complicated since quality attributes are not supplied in isolation but rather are bundled with the basic product or service in question. Firms' decisions regarding quality attribute bundling depend on customer preferences, among other things. Consumer tastes, company costs, and marketplace conditions (*e.g.* general competitive pressures) can also change over time, and these factors naturally affect firms' behavior and the financial consequences of quality decisions.[20] Nevertheless, this analysis demonstrates that firms in competitive markets are driven to provide quality levels that

[20] This discussion also abstracts from information available to consumers and producers and how this affects decisions, as well as the cost considerations of supplying multiple quality attributes jointly rather than in isolation.

reflect customer demands and their willingness to pay. Firms that meet these demands most successfully are rewarded, while companies that fail to provide appropriate quality levels suffer financial penalties.

This analysis of service quality economics in competitive markets provides an important guide for evaluating how best to regulate the quality of regulated services. The supply and demand characteristics are distinct aspects of any marketplace, although for most goods and services, the market forces of customer choice and competition among firms induce companies to make supply decisions that reflect consumer demands. These same forces are not operative for the power delivery and related services which, even in a market where retail competition has been introduced for power supply services, will overwhelmingly be provided by regulated utilities that have a monopoly over power distribution in designated service territories. In principle, however, regulation will be more effective if it replicates the market-like incentives that move the quality of UDC services towards optimal levels that reflect customer demands and willingness to pay.

It should also be recognized that the desirability of enhanced quality ultimately depends on customers' preferences for quality vis-à-vis cost. Customers do not inherently demand "more" service quality from UDCs. Indeed, some customers may even prefer lower UDC quality in exchange for lower costs and prices.[21]

The following chapter will consider alternative approaches to service quality regulation. It will be seen that service quality approaches that tend to promote optimal quality are much more information-intensive than other, simpler regulatory approaches. The most reasonable regulatory approach in Michigan depends on the objectives for service quality regulation in the State, as well as parties' willingness to undertake the research necessary to increase assurance that regulation is moving quality towards optimal levels.

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[21] A good competitive market example where this was apparently true was for airline travel. After airline deregulation in the US, many customers chose to consumer lower-price but lower-quality airline services compared with what prevailed under regulation.

4. Alternative Approaches for Service Quality Regulation

There are several broad approaches available for service quality regulation. Some regulatory approaches are more suited for attaining certain regulatory objectives than others. These approaches also differ in the amount and complexity of the information that is required for implementation. This chapter will briefly describe the main approaches that can be taken towards regulating service quality and some of the issues that need to be addressed to implement each of them.

4.1 Regulatory Objectives

Regulators try to achieve a number of different objectives through service quality regulation. This report will not address all of these specific objectives that are manifested in service quality regulations adopted in different jurisdictions. Rather, we discuss a few fundamental features that can be used distinguish the approaches that are broadly used to regulate service quality in the US electric utility industry.

One issue is whether policies are designed to maintain or improve quality levels. In many instances, regulators and other interested parties believe utilities' existing service quality is generally adequate. Regulatory policy in these jurisdictions is therefore designed to maintain the status quo. In other cases, however, service quality regulation is driven by a perception that quality levels have either been slipping or are otherwise inadequate. Service quality regulation in these jurisdictions will therefore place more emphasis on the need to improve the quality that utilities deliver to customers.

A second fundamental issue is whether policy should focus on "current" or "leading" measures of service quality performance. Current service quality measures are those that reflect the quality of service that is delivered to customers either contemporaneously or in the recent past (*e.g.* within the last year). A leading indicator is an activity variable that could be indicative of future service quality problems. Examples of leading indicators may be tree trimming expenses or asset inspection cycles; delayed or declining expenditures on either activity could lead to conditions that lead to power interruptions in the future. Most jurisdictions have focused on current service quality measures as the basis for policy, although some States have established targets for activities such as inspection and maintenance. These approaches are also not necessarily mutually exclusive.

A third issue is whether regulation relies on pre-established rules or regulatory discretion as the means of responding to service quality problems that do occur. Regulatory discretion utilizes regulatory judgment to evaluate and respond to service quality problems, essentially on a case by case basis. For example, regulators could ask utilities to develop “action plans” that address observed service quality concerns, which they would monitor until they were satisfied that the problems had been fixed. In contrast, a “rule based” approach establishes known and automatic consequences for a given level of service quality performance. An example would be financial penalties for service quality performance that falls below specific benchmarks. Regulators often rely on rule-based approaches as a way to “countervail” or offset service quality concerns that arise when companies have stronger incentives to cut costs, such as when mergers or performance based ratemaking (PBR) plans are approved. Rule-based service quality plans are often coupled with merger and PBR plans to ensure that these cost savings are not achieved at the expense of service quality.

Before turning to the alternative regulatory approaches, it is worth making a few observations on these objectives. One is that it is generally more challenging to structure regulation to encourage service quality improvements rather than simply to maintain quality. Drawing on the service quality conceptual framework presented in Chapter Three, service quality will be substandard if the firm is inefficient in supplying service quality to customers, the service quality delivered to customers does not reflect their preferences and willingness to pay, or both. The logical end point for “improving” service quality is to move it to the optimal level. At the optimum, the utility is efficiently supplying service quality to customers, and the amount of service quality provided just matches customers’ willingness to pay.

However, determining whether and when customers’ quality levels are optimal is informationally demanding. Assessing whether companies are supplying service quality efficiently, or what service quality should be expected for a utility given its costs and operating conditions, involves benchmarking analyses. Evaluating whether quality is consistent with customers' demands also involves research on valuing customers' willingness to pay for service quality improvements, or their willingness to accept service quality declines in exchange for lower prices. These types of analyses are complex and not necessary if the main objective is to maintain quality.

Regulators can avoid undertaking this research and simply set arbitrary "stretch" goals for improved service quality performance that they expect utilities to attain. However, this approach is potentially risky and may be unfairly demanding for utilities if their service quality performance is already good. Stretch goals that entail service quality improvements may also not be in customers' interests if the costs of achieving the service quality improvements are not at least met, and ideally exceeded, by customers' willingness to pay for the incremental service quality gains. For these reasons, if a primary objective for service quality regulation is to improve the quality of service delivered to customers, this goal should ideally be matched with the necessary benchmarking and/or customer demand research that is needed to support rigorous "stretch" goals for a utility's service quality performance.

Second, while the notion of using "leading" service quality indicators may have some surface appeal, in practical terms there are both limits and certain disadvantages to this approach. All else equal, regulators and other parties would like to establish a regulatory framework that addresses service quality problems before they occur rather than responding to them after the fact. Monitoring activity variables such as tree trimming expenses may be seen as a means for ensuring that quality problems do not arise in the first place. However, there is typically a significant and unpredictable lag between declines in such activity variables and potential service quality problems. Because parties cannot be certain how changes in such activity may impact future service quality, there are limits to relying on these variables as the basis for service quality regulation. Even more importantly, monitoring activity variables creates incentives for companies to maintain the associated spending on a continuous basis. Such incentives can be counterproductive and may prevent companies from adopting innovative strategies, such as "reliability centered maintenance" practices, which can lead to lower maintenance spending while not jeopardizing service quality. A focus on "leading" service quality indicators may therefore unintentionally create perverse incentives that run counter to the goal of supplying service quality efficiently.

On the issue of using rules and discretion, it should be recognized that there are some advantages in principle with a rule-based approach. One is that rules are more predictable than discretion, so a rule-based approach tends to promote regulatory stability. All else equal, a stable regulatory framework fosters efficient utility behavior that can ultimately benefit customers. Establishing a rule-based approach does require some initial start-up costs, but once it is in place can operate more or less automatically. Rule-based approaches can therefore be easier to monitor and less burdensome than regulation which places more emphasis on regulatory discretion to identify and remediate problems. A rule-based approach can also alleviate concerns that may arise because of other regulatory changes, such as mergers or PBR plans, that may lead to unintended service quality declines. A well-designed, rule-based service quality plan can minimize those concerns and allow regulatory oversight and discretion to be more focused and efficient.

4.2 Approaches to Service Quality Regulation

Three broad approaches can be taken towards service quality regulation. *Service quality monitoring* is where utilities are required to report their performance on defined indicators to regulators, and perhaps other parties, at defined intervals. Reporting can also include information on specific programs the company may be taking to maintain or enhance performance and spending on certain critical activities (*e.g.* tree trimming). Monitoring approaches are relatively unobtrusive. They can often satisfy regulators and other parties who simply want more information on a utility's current service quality performance and comfort that the company is acting to maintain performance and address whatever problems may exist.

Service quality targets is a regime where companies are expected to achieve established, targeted levels of performance on a series of identified performance indicators. This approach requires setting one or more benchmarks for each of the indicators and providing information on how the Company's current performance compares with those benchmarks. If utilities fail to achieve a given benchmark, they may be compelled to present action plans on how they plan to boost performance to the benchmark level. In some cases, regulators may also impose penalties if a company consistently fails to satisfy the benchmarks. Target approaches are usually designed to maintain rather than improve quality levels, but they are more demanding than monitoring regimes since companies are expected to attain concrete performance standards. Because it can involve reporting on forward-looking action plans in addition to historical information, this can also be more administratively burdensome than quality monitoring.

Service quality incentives (SQIs) are regulatory mechanisms that automatically penalize, and sometimes reward, companies depending on how their measured service quality performance compares with established performance benchmarks. SQIs are often included as a component of a broader PBR plan or as part of many merger agreements. In these cases, SQIs are often viewed a kind of "countervailing" incentive.

The main idea behind SQI plans, like all incentive regulation plans, is to establish rules that create inherent incentives for utilities to meet desired regulatory objectives. A well–designed SQI plan will create incentives for the utility to operate in an efficient and effective manner for the benefit of customers, so there is less need for continuous and detailed regulatory scrutiny of utility operations. An essential feature of incentive regulation is therefore the existence of well-defined rules that (1) provide clear guidance to the utility in structuring its operations to achieve the desired objectives, and (2) create a framework that allows for an objective evaluation of the distributor's performance, which is essential in minimizing administrative burdens for regulators and the distributor.

There are three basic elements in a SQI plan: 1) a series of indicators of the utility's quality of service, which are the aspects of a utility's service quality that are measured and monitored under the SQI plan; 2) associated performance benchmarks, or the standards against which measured quality is judged; plans also often include deadbands around those benchmarks, or a zone around the benchmarks within which utility performance is neither penalized nor rewarded; and 3) a penalty/reward mechanism, which translates a utility's quality performance into a change in utility rates or allowed returns via rewards or penalties. In general, measured performance that "exceeds" the benchmarks (or upper bands) signals superior quality and a possible reward. Performance below the benchmarks (or lower bands) indicates sub–standard quality and a possible penalty.

There are some common elements to all or some of the service quality approaches. In principle, service quality benchmarking can also be used in either a target or SQI approach, but in practice this is rare. We will discuss service quality benchmarking in the following chapter. Below we discuss some issues regarding the other components of the basic regulatory approaches.

4.3 Implementation Issues

4.3.1 Quality Indicators

One common element in all the service quality regulatory approach is quality indicators. To implement any service quality regulation method, objective, quantifiable and verifiable performance indicators are required. We believe the service quality indicators used in regulation should satisfy four, common sense criteria:

- they should be related to the aspects of service that customers value;
- they should focus on monopoly services;
- utilities should be able to affect the measured quality; and
- the indicators should be sensitive to "pockets" of service quality problems.

First, indicators should be linked to aspects of utility service that customers actually value. This may seem obvious, but a strict application of this criterion excludes indicators that have been included in some plans. For instance, the knowledge and courtesy of phone center employees may be a legitimate quality indicator, but the goal of establishing worker training programs to build these skills is not. Similarly, the reliability of service delivered to customers is an appropriate service quality indicator while tree trimming expenses generally is not. As discussed above, we believe that using activity variables like maintenance expenses as quality indicators has limited usefulness and may unintentionally create perverse incentives.

Notwithstanding these points, we have less concern with including utility “inputs” such as activity variables (*e.g.* tree trimming expenses) rather than the quality “outputs” delivered directly to customers (*e.g.* SAIFI and SAIDI) in quality monitoring approaches than in SQIs. The reason is that under SQIs, utilities can be penalized or rewarded depending on an indicator’s measured performance. Such penalties or rewards are usually levied as changes to customer rates. It is not appropriate to base changes in customer rates on changes in indicators that do not directly pertain to or reflect customer welfare.

Second, indicators should focus on the quality of the activities for which there are few if any alternative suppliers. This is consistent with the principle that regulation, including regulation of service quality, is less necessary in competitive markets. Market forces are likely to create acceptable quality levels when products are available from multiple providers.

Third, utilities should be able to influence measured quality through their own behavior. It is nonsensical to evaluate a company’s quality performance using indicators that are largely or entirely unrelated to management actions. As discussed in Chapter Two, the measured quality of power distribution service is potentially influenced by a number of external factors that are beyond managerial control. These factors vary substantially between distributors and some are quite volatile. If random or unforeseen incidents can affect important quality dimensions, the impact of these events should ideally be eliminated from the indicators.

Fourth, it is often sensible to have indicators that are measured on less than a system-wide basis. This is because system-wide measures may mask persistent service quality problems for “pockets” of customers. An example of such an indicator in Michigan is the circuit reliability performance standard.

Overall, the choices for quality indicators should balance the needs of comprehensiveness and simplicity. The selected indicators should not focus on some areas while ignoring other quality attributes that are important to customers, because performance may deteriorate in the non–targeted areas. Comprehensiveness can be achieved simply by adding indicators to a plan. However, regulatory costs also rise as the regulatory plan includes more indicators since more utility and regulator resources must be devoted to quality monitoring. One way to reduce these regulatory costs is to include broadly–based indicators, such as system-wide reliability measures.

4.3.2 Quality Benchmarks

Quality benchmarks are the standards against which measured quality is judged. Quality benchmarks are elements of both the target and SQI regimes. Whenever benchmarks are established, it is also common to have 'deadbands' around the benchmarks, or a zone within which utility performance is neither penalized nor rewarded. As with the quality indicators, some basic criteria can be used to evaluate the design of performance benchmarks and deadbands.

One important criterion is that benchmarks should be calculated on the same basis as the quality indicators. If the data used to measure quality are not comparable to those used to set the benchmark, the regulatory plan will not lead to an objective comparison of the company's measured quality relative to the benchmark. This is almost literally a case of 'comparing apples to oranges'. Discrepancies between measured and historical benchmark performance can arise if utilities change the measurement systems used to record reliability data, such as installing a new OMS.

Benchmarks and deadbands should also reflect external business conditions in a utility's service territory. Chapter Two discussed these business conditions in some detail. A failure to control for these business conditions in a regulatory benchmark can expose utilities to arbitrary and unfair performance evaluations. For example, consider a SQI plan where a utility is rewarded or penalized depending on how its measured quality compares to that of another utility. Assume that both companies measure every quality indicator in the same way. This plan would still lead to unreasonable penalties or rewards if one utility had a more demanding territory (*e.g.* more severe weather). Not controlling for the effect of business conditions in that service territory would tend to handicap the utility serving that territory and, over time, lead to penalties that did not reflect its real quality performance.[22]

Third, benchmarks should be as stable as possible during the regulatory plan. Stable benchmarks give utility managers more certainty over the resources they must devote to providing adequate service quality, as reflected in those benchmarks. It is harder for managers to hit a 'moving target', particularly if operational changes can only be implemented over longer periods. Stable benchmarks therefore promote more effective, longer–term service quality programs.

In some cases, however, a lack of data available at the outset of regulatory plan may make it more difficult to set benchmarks that are viewed as reliable over the term of a multi–year plan. This would be true if the information systems used to record quality data had changed recently or if there was little confidence that a short data series reflected typical external business conditions for the utility. If this is the case, benchmarks can be updated using data that becomes available during the term of the plan, but this should be done according to well–defined rules that are established at the outset of the plan. An example would be a benchmark equal to a ten year moving average of a company's historical performance on an indicator, until 10 years of historical data are available. Setting benchmarks according to such objective rules creates as much stability as is feasible given data constraints.

In practical terms, two main sources of information can be used to set benchmarks and deadbands in regulatory targets and SQI plans. The first option is peer performance. In principle, peer–based benchmarks may be attractive since they are commensurate with the operation and outcomes of competitive markets, where firms are penalized or rewarded for their price and quality performance relative to their competitors. In

[22] For example, suppose the company in the more demanding territory really had worse service quality performance than the other firm in a given year; this SQI plan would lead to penalties both for worse performance and because one firm had more demanding conditions that made it more difficult to provide the same level of service as the other firm. In principle, a firm in a more demanding territory could also have better service quality performance and yet still register worse measured quality performance because of the impact of its more demanding business conditions. Here, the company is penalized even though it is a superior performer. In both cases the company's penalties do not reflect its real quality performance unless adjustments are made to the SQI plan to reflect differences in the companies' service territories.

practice, however, industry–based benchmarks are challenging. One reason is that uniform data are not generally available for utility quality measures. Differences in measure definitions would make peer data difficult to compare and inappropriate as benchmarks. Even if measures are defined comparably across utilities, peer benchmarks should control for differences in utility business conditions that affect quality performance. Controlling for the impact of business conditions on expected service quality performance is complex and will be discussed further in the following chapter.

The alternative is the utility's own performance on an indicator. For example, benchmarks could be based on average performance on a given indicator over a recent period. Quality assessments would then depend on measured quality levels that differ either positively or negatively from recent historical experience.

The use of past utility performance to set benchmarks is appealing in many respects. Historical benchmarks reflect a company's own operating circumstances. Historical data will reflect the typical external factors faced by the company if the period used to set benchmarks is long enough to reflect the expected temporal variations in these factors. Longer periods are more likely to achieve this goal than shorter periods and are therefore preferred. As noted above, if only short time series are available at the outset of a (quality target or SQI) regulatory plan, benchmarks can be updated at the outset of future plans as more data become available. The rules for updating benchmarks should be spelled out clearly in advance to create the appropriate performance incentives and minimize administrative burdens.

A potential concern with using a company's past performance to set benchmarks will arise if the utility has historically registered substandard quality performance. If this is the case, the benchmark would reflect a level of inefficiency in service quality delivery. A more objective standard of service quality performance may then be appropriate and would benefit of customers. Evaluating whether a company's historical service quality performance is substandard again raises issues of performance benchmarking, which will be addressed in the next chapter.

4.3.3 Controlling for Volatility

Although historical averages of company performance will reflect typical external factors faced by a company, they will not control for shorter–term fluctuations in external factors around their norms. As noted, some business conditions that can affect measured quality are quite volatile from year to year. Weather is the salient example, and it can affect a host of service–quality measures (eg number and duration of outages, response times to service calls, the number of calls to the phone center and therefore response time, etc.).

One way to accommodate year–to–year fluctuations in external factors is by measuring indicators on a multi-year basis. For example, a regulatory plan could target a three-year moving average of SAIFI and SAIDI rather than the SAIFI and SAIDI values registered each year. Measuring indicators over multiple years will tend to smooth out the impact of random factors on indicator values and lead to a more reasonable measure of the company's underlying service quality performance.

Another way to accommodate year-to-year fluctuations in external factors is through deadbands. Suppose, by way of example, that the value of a quality indicator is known to fluctuate in a certain range due to external factors. The mean value of this indicator over a suitable historical period would reflect the typical long run external business conditions faced by the utility. Variation in the company's performance around this historical mean will accordingly reflect short run fluctuations in those business conditions. Deadbands should therefore reflect the observed variability in measured service quality performance. One straightforward measure of this year–to–year variability is the standard deviation of the quality indicator around its mean.

4.3.4 Penalties and Rewards

SQI plans include a mechanism to reward or penalize a utility for its service quality performance, while the other regulatory approaches do not. In some cases, however, regulators can levy penalties in target regimes for especially poor performance. The amount of these penalties is usually based on regulatory judgment, although it is sometimes constrained by law.

In SQIs, a penalty/reward mechanism links a quality assessment to a change in the utility's rates or allowed returns. A quality assessment relates quality as measured by the indicators to the quality benchmarks. In general, measured performance that "exceeds" the benchmarks signals superior quality and a possible reward. Performance below the benchmarks indicates sub–standard quality and a possible penalty.

One important design issue for a penalty/reward mechanism is whether the award mechanism will be symmetric (both rewards and penalties are possible) or asymmetric (penalty–only). Some parties believe that only asymmetric service quality plans are appropriate. Proponents of this view contend that, in PBR plans, service quality incentives are designed to prevent quality declines that may result from the incentives utilities have to reduce costs. Penalties are sufficient to deter such behavior and rewards are therefore unnecessary.

This argument has some merit if the goal of regulation is to maintain service quality levels. However, a strong case can be made that symmetric incentive plans are more appropriate, particularly if there is uncertainty about customers' service quality demands. Optimal regulation (discussed in Chapter Three) is not necessarily focused on keeping service quality performance from slipping, but rather will encourage service quality to be provided up to the point where consumers' marginal valuations of quality gains equals a utility's marginal costs. An optimal provision of service quality could entail service quality enhancements in at least some areas. Since just and reasonable prices and the quality of service are both important to customers, symmetric SQIs are more effective than asymmetric plans in creating incentives to improve performance in all areas valued by customers.

Symmetric plans are also more consistent with the behavior of unregulated markets than are asymmetric plans. Customers in competitive markets routinely pay higher prices for higher quality products, and a symmetric service quality incentive reflects this phenomena. However, competitive markets usually offer an array of goods with varying quality levels, and not all customers choose to consume high quality goods. This will not be the case for power distribution services. Even if it is possible to provide premium quality services to some customers, it is not practical to tailor quality levels to every individual retail customer on a distributor's network. Symmetric SQI plans could therefore lead to price increases on monopoly services. Because price-quality tradeoffs differ among customers, such price increases imply that at least some customers will be paying for quality improvements that they do not want.[23]

It should also be noted that, for some quality indicators, it is possible to make penalty payments directly to affected customers whenever quality falls below the associated benchmark. U.S. utilities sometimes refer to this as a system of "performance guarantees." Such customer-specific payments are also part of the service standards regime in Michigan, where customers will receive compensation from their utility if the company has not restored power within defined intervals or if a circuit has experienced seven or more outages in a year. Targeting compensation directly to customers that directly experience service quality degradations is generally desirable, since it establishes a nexus between penalties for poor service and those customers who actually experienced poor quality. But while such guarantees can be effective when problems are customer-specific, this method is more difficult to implement and less appropriate for system-wide quality measures such as SAIDI and SAIFI.

[23] However, it should be noted that, depending on the other features of the regulatory plan, symmetric service quality incentive plans may not lead to price increases even if the utility is rewarded under the plan. For example, if the regulatory plan also features an earnings sharing mechanism, the service quality reward can take effect as an increase in the allowed return at which earnings are shared, rather than a price increase.

5. Service Quality Benchmarking

Service quality benchmarking can in principle be used to establish benchmarks in either a quality targets or SQI regime. In general, benchmarking involves comparing one or more utility performance measures to external performance standards. “External” performance standards can be defined as measures that are outside of the utility itself and beyond its control. These external standards are sometimes computed using data from firms that are viewed as “peers” of the utility. When this is the case, benchmarking involves comparing the utility’s performance on a selected indicator directly to the measured performance of a peer utility, or the average performance of a peer group, on that same indicator.

In regulatory applications, benchmarking is more often undertaken using various benchmarking techniques. The three most widely used benchmarking techniques are indexing, econometric modeling, and data envelope analysis (DEA). These approaches are defined briefly below and addressed in further detail in subsequent sections. For service quality applications:

- Index-based benchmarks relate a comprehensive measure of utility output to either comprehensive or partial measures of utility input; measured quality can be treated as an output in the indexing calculation.
- Econometric benchmarks typically use statistical methods to estimate the quantitative impact of various “driver” variables on utility quality. Measures of the driver/business condition variables for any given utility can be inserted into the estimated econometric model to generate predictions for the expected service quality for the utility which can, in turn, be compared to the company’s actual quality.
- DEA uses linear programming techniques to “envelope” data on sample firms that relate inputs to outputs. The technique identifies a cost or production “frontier,” and a peer firm’s efficiency is measured by comparing its cost or production relative to the identified frontier. Quality can be included as an output in the analysis.

As discussed in Chapter Two, it is widely recognized that differences in the values of the quality indicators that companies achieve depend partly on differences in performance and partly on differences in external business conditions. An external business condition is a condition of the operating environment that a firm cannot control. The quality performance of a utility depends on the measured quality that it achieves *given the external business conditions it faces*. A benchmarking evaluation must therefore reflect external business conditions if they are to lead to accurate measurements of a company's underlying service quality performance.

Any regulatory benchmarking approach should, at a minimum, have the following desirable attributes:

- Benchmarking evaluations are improved by the use of standardized data reporting, which facilitates more accurate performance comparisons across companies
- Benchmarking approaches are superior when they control effectively for differences in external business conditions that can affect measured performance on the selected metric(s)
- In regulatory applications, it is preferable for benchmarking methods to compare utilities to the sample average performance than to what is known as the "frontier" performance level; frontier performance standards are more difficult to implement because of factors including non-standardized and volatile data
- Benchmarking results are enhanced when the benchmarking techniques take account of the inherent uncertainty involved in performance bench-marking; for example, statistical tests can be used to evaluate whether a particular firm's quality performance (*e.g.* the difference between its measured performance and benchmark performance) is significant in a statistical sense
- All else equal, a benchmarking program is preferred when it employs simple, low cost methods, although in practice there is often a tradeoff between simplicity and accuracy of benchmark comparisons

5.1 Index Based Benchmarking

An index is defined as "a ratio or other number derived from a series of observations and used as an indicator or measure (as of a condition, property, or phenomenon)."[24] Indexes can be designed to make trend or levels based comparisons. The consumer price index (CPI) is perhaps the most familiar example of an index designed to make trend comparisons. A levels comparison, in contrast, might involve calculations of the ratios of the values of performance indicators for a subject utility to the corresponding values of the indicators among a sample of other utilities.

A productivity index is the ratio of an output quantity index to an input quantity index. One aspect of utility output is the quality of service that it delivers to customers. Quality measures can therefore be aggregated with other output measures to develop a comprehensive measure of utility output. Productivity indices can be calculated for a particular utility and for a sample of other utilities. Productivity comparisons are then made by comparing each firm's productivity relative to the entire sample.

Productivity indexes do control for differences in two important sets of external business conditions that vary between utilities. One is the total amount of work the utility performs *i.e.* the outputs it supplies. A second is the prices it pays for inputs.

However, productivity comparisons do not control for all of the important "quality driver" variables that differ between utilities. Most notably, they do not control for differences in the variables such as differences in weather, vegetation, customer density, or line undergrounding. For this reason, while productivity indexes are sometimes used to benchmark utility cost, we are not aware of any studies that have used this methodology to benchmark service quality *per se*. We also do not believe that productivity indexes are sophisticated enough empirical tools, on their own, to be able to control for the complex set of business conditions that can affect measured quality performance. Thus, while productivity indexing can have real value in many utility regulatory applications, we do not believe it is suitable for service quality benchmarking.

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[24] *Webster's Third New International Dictionary of the English Language Unabridged*, Volume 2, p. 1148. (Chicago: G. and C. Merriam and Co. 1966).

5.2 Econometric Modeling

Relationships between the utilities' measured service quality and external business conditions can be estimated using econometric methods. In such an exercise, a functional relationship is posited between a particular quality measure and variables that represent external business conditions and which can influence the value of this measure. The parameters of the function reflect the impact of these business conditions on the quality indicator.

A branch of statistics called econometrics has developed procedures for estimating parameters of economic functions using historical data. For example, "quality driver" parameters can be estimated econometrically using historical data on the measured quality for a sample of utilities and the business conditions they face.[25] An economic function fitted with econometric parameter estimates may be called an econometric model. We can use such a model to predict the expected value of a company's measured quality given local values for the business condition variables. These predictions may be called econometric benchmarks. These benchmarks automatically control for all of the business conditions that are represented in the quality driver model.

This can perhaps be clarified with an example. Suppose we wish to develop a "reliability driver" model that relates a utility's system-wide interruption frequency to a number of business condition variables that are beyond its control. The researcher would begin by collecting the best available SAIFI data for a sample of US utilities. Next, the analyst would develop a model that relates utilities' measured SAIFI performance to a number of business condition variables that may affect a company's ability to provide reliable service to its customers at a given cost. On the demand side, the mix of customers served by a utility may influence reliability. Some customer groups incur very high costs when their power supplies are interrupted (*e.g.* large industrials and financial services companies). It is reasonable to assume that utilities or regulators in jurisdictions with a larger percentage of such customers will be more sensitive to reliability concerns,

[25] The sample used in model estimation can be a time series consisting of data over several years for a single firm, a cross section consisting of one observation for each of several firms, or a panel data set that pools time series data for several companies.

and this may be manifested in more stringent standards and better reliability performance.

On the supply side, many environmental and operating factors can affect a company's ability to provide reliable service at a given cost. Precipitation is likely to be correlated with several factors that can come into contact with power lines and create outages (*e.g.* trees, lightning, animals). Other weather factors can also affect reliability performance. For example, transformers may be more prone to overheating when utilities operate in warm weather. Heating degree days may be correlated with severe winter weather that increases interruptions. Strong winds can also lead to downed power lines and power outages. Line undergrounding is often undertaken because of local ordinances or other public policy mandates. Underground lines are less prone to contact and interruption, so undergrounding may be associated with a lower SAIFI. More ruralized territories also have longer and more exposed feeders and are therefore more prone to interruptions. SAIFI may therefore be inversely related to the number of customers per square mile of territory.

Based on this assessment of the main "reliability drivers," the analyst could specify an econometric benchmarking model to estimate that relates a utility's measured SAIFI performance to the following "quality driver" variables: 1) the percent of its lines that are underground; 2) the percent of kWh deliveries to industrial customers; 3) heating degree days in its territory; 4) cooling degree days in its territory; 5) annual precipitation in its territory; and 6) customers per square mile of territory. Data are available on each of these quality driver variables for many utilities, and these data can be compiled and mapped to individual utilities in the sample. The analyst would then postulate a functional form that relates SAIFI to the quality drivers and would run econometric regressions that estimate the parameters for each quality driver. These parameter estimates would reflect the quantitative impact that each of the quality driver variables has on the SAIFI performance for a sample average utility. After these parameters are estimated, the analyst would substitute the quality driver variables associated with a specific utility into the specified econometric function that is "fitted" with the parameter estimates. This step would generate a SAIFI prediction, or econometric SAIFI benchmark, for the utility that is tailored to the specific business condition variables in its territory. Because the estimated parameters reflect the quantitative impact of each variable on SAIFI for a sample average firm, the interpretation of this econometric benchmark is that it reflects the SAIFI performance that a sample average firm would be expected to have if it operated under the same business conditions as the utility in question. The utility's actual SAIFI performance can then be compared to this econometric benchmark.

A service quality prediction generated in the manner described above is our best single guess of the Company's measured quality given the business conditions it faces. This is an example of a *point* prediction. Such predictions are likely to differ from the true benchmark, which accurately embodies the desired standard and controls for the impact of external business conditions.

One potential source of inaccuracy is the ability of the explanatory variables to accurately measure business conditions. A second is the extent to which the model captures the form of the relationship between business conditions and quality. Still another is a failure of the model to include all relevant business conditions.

Statistical theory provides useful guidance regarding the extent of inaccuracy. One important result is that an econometric model can yield *biased* predictions of the true benchmark if relevant business condition variables are excluded from the model. A model used to benchmark the reliability of a rural power distributor might, for example, yield a benchmark value for SAIFI that is below its true value (and is thus excessively challenging) if it failed to include variables that properly represent the extensiveness of a distribution system and the magnitude of rural quality management challenges. It is therefore desirable to include in an econometric benchmarking model all business conditions which are believed to be relevant, for which data are available at reasonable cost, and which have plausible and statistically significant parameter estimates.

Econometric models can be used to generate confidence intervals around the benchmark prediction. Confidence intervals become wider as uncertainty about the true benchmark level increases. In general, it can be shown that confidence intervals increase as:

- the econometric model is less successful in explaining the measured variation in quality within the sample;

- the size of the sample is small;
- the number of quality drivers is large;
- the external business conditions of sampled companies become more homogeneous; and
- the external business conditions of the subject utility become more dissimilar to those of the typical firm in the sample.

These results suggest that econometric benchmarking will in general be more accurate to the extent that it is based on a large and diverse sample of good data. When the sample is small, it will be difficult to identify all of the relevant quality drivers and the appropriate functional form.[26] It should also be noted that the precision of an econometric benchmarking exercise is actually *enhanced* by using data from companies with diverse operating conditions. For example, we will obtain a better estimate of the impact of customer density on reliability if we include in the sample companies that have *high* customer density as well as data for companies that have low customer density.

Confidence intervals developed from econometric results permit us to test hypotheses regarding service quality performance. Suppose, for example, that in a benchmarking exercise we use a sample average quality standard and construct a 95% confidence interval around the econometric benchmark prediction for each sample utility. It is then possible to test the hypothesis that the company is an average quality performer. If the company's actual measured quality is lower than the benchmark generated by the model but nonetheless lies within the confidence interval (as in the figure below), this hypothesis cannot be rejected. In other words, the company is not a *significantly* inferior quality performer. Suppose, alternatively, that the company's quality is above the quality predicted by the model by enough to be outside the confidence interval. We may then conclude that it is a *significantly superior* quality performer.

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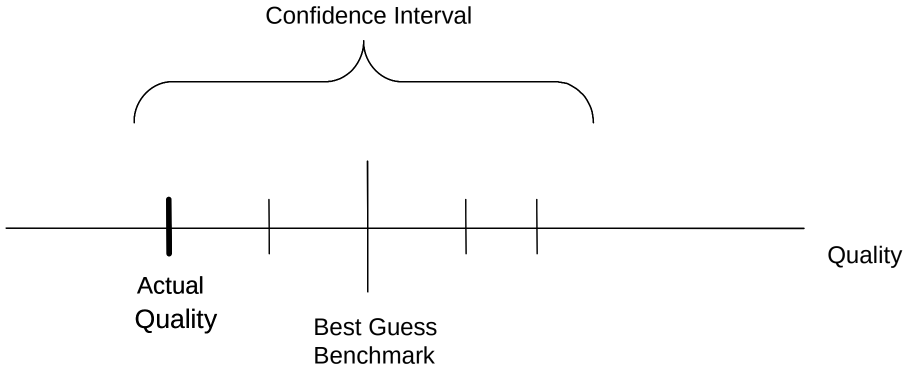
[26] It follows that it will generally be preferable to use panel data (*i.e.* a time series of observations for a cross section of firms) instead of a single cross section of data when these are available.

Figure Two



An important advantage of efficiency hypothesis tests is that they take into account the accuracy of the benchmarking exercise. As we have just discussed, there is uncertainty involved in the prediction of benchmarks. These uncertainties are reflected in the confidence interval that surrounds the point estimate (best single guess) of the benchmark value. The confidence interval will be greater as uncertainty increases about the true benchmark value. If uncertainty is great, our ability to draw conclusions about service quality performance is hampered.

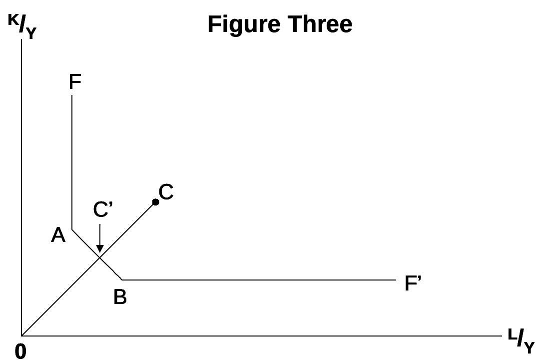
5.3 Data Envelope Analysis

DEA uses linear programming techniques to "envelope" data on sample firms that relate outputs to inputs. It is therefore essentially a technique for identifying what are known in economics as isoquant or isocost curves. Efficiency is measured as the distance from the best attainable curve. As in productivity analysis, quality measures can be used as outputs in the analysis.

In a basic input-oriented DEA model, the relative efficiency of a firm is determined by assigning weights to firm inputs and outputs such that the ratio of aggregated outputs to aggregated inputs is maximized. This linear programming problem is subject to the constraint that the efficiency score cannot exceed a value of one for a firm using the same set of weights. The result of this process will be an efficiency measure for each firm that takes a value between zero and 100%. A perfect efficiency score would be 100%. A more typical score might be 80%.

These scores are relative to "peers" identified through the analysis and which set the efficiency "frontier." The DEA efficiency score has the intuitive interpretation that, relative to the peers, it measures the amount by which a firm can radially contract all of its inputs while still producing the same level of output. This can perhaps be clarified through a visual example. In Figure Three, there are two inputs, capital (K) and labor (L). The X axis in this figure is labor per unit of output (L/Y) while the Y axis is capital per unit of output (K/Y).

Figure Three



In this example, the points A, B and C refer to specific firms that are identified as peers. It can be seen that firms A and B are using fewer capital and labor inputs per unit of output than firm C. The DEA technique would construct a piece-wise linear frontier through points A and B, which is identified by the line FABF'. This line is the production frontier. The efficiency of firm C is measured relative to this frontier, and the efficiency measure is equal to OC'/OC. Suppose this value turns out to be 0.6. This implies that firm C is 40% below the production frontier, and it can reach the frontier by reducing both its capital and labor inputs by 40%. Under input-oriented DEA, the firm's measured inefficiency is therefore equal to the entire difference between its position and the constructed efficiency frontier.

The basic input-oriented DEA model can be expanded in various ways. Technically, this occurs by modifying the linear programming problem to relax various assumptions. These more sophisticated DEA models can break down the sources of efficiency into various components. As one example, the model above assumes *constant* returns to scale in the relationship between inputs and outputs. This assumption can be relaxed to allow for *variable* returns to scale. Under variable returns to scale, returns to scale can differ at different levels of output. A firm of average size would typically realize greater scale economies than one of small size. A DEA model with variable returns to scale permits the efficiency measure described above to be decomposed into scale efficiency and "pure" technical efficiency.

Another enhancement possible in a DEA analysis is to incorporate data on input prices into the analysis. It is then possible to consider a company's *allocative* efficiency (its success in choosing the right input mix given current input prices) as well as its technical efficiency. The sum of allocative efficiency and operating efficiency is a more complete measure of operating efficiency than technical efficiency alone. DEA can also be modified to include second-stage regressions that regress DEA efficiency scores on other business condition variables. The results of these regressions can then be used to adjust the efficiency scores resulting from the DEA analysis.[27]

A complete analysis of the advantages and disadvantages of DEA as a benchmarking technique goes beyond the scope of this paper.[28] However, as a means of benchmarking service quality *per se*, we believe that DEA suffers from the same fundamental flaw as index-based techniques. Neither approach is flexible enough to capture all the external business condition variables that affect measured quality. We therefore do not believe that DEA is a suitable technique for benchmarking service quality performance.

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[27] The primary reason for undertaking such regressions rather than including all relevant business condition variables in the linear programming problem is that increasing the number of inputs in DEA analysis tends to reduce the number of peers that are identified for any firm. Having fewer peer firms can artificially inflate the efficiency measure. Indeed, in the limit, if enough inputs are introduced in the analysis, no firm may be identified as a peer for any other firm. The DEA measure therefore becomes one for all firms by default, which is usually an unrealistic result.

[28] An example of such a report that contains such an analysis is L. Kaufmann, "External Benchmarks, External Benchmarking and Electricity Distribution Network Regulation: A Critical Evaluation," prepared for the National Electricity Distribution Forum in Australia. A copy is available by request from the author.

5.4 Assessment

Performance benchmarking is a complex subject. Analysts face data and technical challenges in appropriately controlling for the impact of external business conditions on a utility's quality or cost performance, and adequately quantifying these business conditions is necessary for obtaining robust inferences in management's underlying quality or cost performance. This report has provided only a brief, non-technical analysis of the main benchmarking approaches. Nevertheless, our analysis reveals that econometric methods are likely to be the only practical technique that may be used to benchmark a utility's service quality performance. Any such econometric model would relate sample data on measured quality attributes to external business condition variables that are beyond company control. We will discuss the merits and some of the implementation details that are associated with econometric service quality benchmarking for DTE in Chapter Seven.

6. Survey of Service Quality Regulation

Before evaluating the performance indicators and regulatory process for DTE, it will be valuable to review service quality regulatory policies. With only a couple of limited exceptions, our review is limited to the United Sates. The US service quality regulatory experience is nevertheless vast, and the short time available for this report did not permit us to undertake a comprehensive survey of all service quality regulatory practices.[29] This chapter will instead focus on what we believe are the prevalence of the main service quality regulatory approaches at the State level throughout the country; precedents for the service quality indicators adopted in different jurisdictions, particularly those jurisdictions that have used indicators that are similar to those used in Michigan; and highlight some significant trends and States where there have been interesting service quality regulation approaches or developments.

6.1 Overview

PEG reviewed service quality regulation in all 50 States and the District of Columbia. This task was complicated by the fact that service quality regulation can be implemented through a number of different forums. Policies are sometimes determined through generic proceedings that establish service quality standards or regulatory approaches throughout a State. Most of these Statewide proceedings are initiated by regulators, but regulatory policy can also be determined or at least influenced by legislation. Some service quality regulation plans are approved as components of settlement agreements or Commission Orders that apply only on a company-specific rather than a Statewide basis. It should also be recognized that a sizeable number of service quality plans have been adopted as components of merger agreements.

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[29] It should also be noted that, because of time constraints, we have not been able to fact check all of the information presented in this chapter as carefully as PEG normally would. Fact checking is more difficult for service quality policies because there is no universally agreed vocabulary or definitions used to describe different regulatory practices. There may accordingly be some minor discrepancies between the information presented here and that developed and presented through other sources. However, we certainly believe that the broad thematic points in this chapter are accurate, and these are perhaps most relevant for informing service the quality recommendations presented for DTE in the following chapter.

The first issue we wished to address was the prevalence of the three basic approaches to regulation *i.e.* whether the State had adopted a service quality monitoring, quality targets, and penalty/reward (or incentive) approach. In some cases, States can use different approaches for different companies under their jurisdiction. For example, service quality incentive plans can be approved for a single company while monitoring is in place for other companies. Where this has been the case, we have chosen to classify a State as adopting a "penalty/reward" approach if it currently has an approved SQI for at least one electric utility.

The results of this review are reported in Table One. The first column in this table lists the States with service quality monitoring regimes. The second column presents States that use service quality targeting. The third column presents States that have implemented penalty or reward provisions, either Statewide or for individual companies. The final column lists States that have no formal approach towards service quality regulation, although in some of these States informal service quality monitoring has been implemented as part of regulatory approvals of merger agreements.

Table Two presents merger agreements that have included service quality provisions. In a sizeable number of cases, those service quality plans establish penalties for performance that falls short of established benchmarks. In most mergers, however, the regulatory plan is more akin to quality monitoring.

We find that penalty/reward approaches, where companies can be penalized or (less frequently) rewarded based on their service quality performance, have been approved in 20 States. One of these States is Michigan, which directly compensates customers when utilities fail to satisfy certain reliability standards. Only three States and the District of Columbia have implemented a service targets regime, with benchmarks that electric utilities are expected to achieve although they are not subject to penalties for failing to do so. Fourteen States use monitoring regimes, while thirteen do not have any explicit service quality regulatory policies.

One somewhat surprising result from this review is that relatively few States have simply adopted targets. In most instances, when regulation has gone beyond quality monitoring to set quality targets it has also specified financial consequences for utilities if

Table 1

Alternative Approaches to Service Quality Regulation

Monitoring	**Targets**	**Penalties**	**No Plans**
Alabama	D.C.	California	Alaska
Arkansas	Ohio	Colorado	Arizona
Connecticut	Oklahoma	Delaware	Georgia
Hawaii	Pennsylvania	Florida	Montana
Illinois		Idaho	Nebraska
Indiana		Louisiana	New Hampshire
Iowa		Maine	New Mexico
Kansas		Massachusetts	North Carolina
Kentucky		Michigan	South Carolina
Maryland		Minnesota	South Dakota
Missouri		Mississippi	Tennessee
Nevada		New Jersey	West Virginia
Virginia		New York	Wyoming
Wisconsin		North Dakota	
		Oregon	
		Rhode Island	
		Texas	
		Utah	
		Vermont	
		Washington	

Table 2

Electric Utility Mergers with Service Quality Provisions

Merging Companies		Year	Jurisdiction	Regulatory Approach
WPS Resources	Peoples Energy	2007	Wisconsin	Service quality monitoring
MidAmerican Energy Holdings	Pacificorp	2006	Wyoming, Washington, Utah, Oregon, Idaho, California	Service quality monitoring
Duke Energy	Cinergy	2005	South Carolina, North Carolina, Kentucky	Service quality monitoring
			Ohio	Service quality target
			Indiana	Penalty/Reward
PNM Resources	TNP Enterprises	2005	Texas	Penalty/Reward
Black Hills Corp.	Cheyenne Light, Fuel & Power	2004	Wyoming	Service quality monitoring
Ameren	Illinois Power	2004	Illinois	Service quality monitoring
Ameren	CILCORP	2003	Illinois	Service quality monitoring
PEPCO	Conectiv	2002	Maryland, District of Columbia	Service quality monitoring
			Delaware, New Jersey	Penalty/Reward
Emera	Bangor Hydro Electric	2001	Maine	Penalty/Reward
Northwestern Energy	Montana Power, LLC	2001	Montana	Service quality target
Utilicorp (Aquila)	St. Joseph Light & Power	2001	Missouri	Service quality monitoring
FirstEnergy	GPU	2001	Pennsylvania	Penalty/Reward
			New Jersey	Service quality target
Vectren Holding	Southern Indiana Gas & Electric, Indiana Gas	2001	Indiana	Service quality monitoring
Allegheny Power (Monongahela Power)	West Virginia Power	2000	West Virginia	Service quality monitoring
Scottish Power	Pacificorp	2000	Washinton, Utah, Idaho, Oregon	Penalty/Reward
ST Acquisition	Texas-New Mexico Power	2000	Texas	Penalty/Reward
Exelon	Unicom	2000	Pennsylvania	Service quality target
AEP	Central & Southwest Corporation	2000	Kentucky, Louisiana, Indiana, Michigan, Arkansas, Oklahoma	Service quality monitoring
			Texas	Penalty/Reward
Carolina Power & Light	Florida Power Corporation	2000	Florida	Penalty/Reward
			North Carolina	Service quality monitoring
Northern States Power	New Century Energies	2000	North Dakota, New Mexico	Service quality monitoring
			Minnesota, Texas	Penalty/Reward
			Colorado	Service quality monitoring
Powergen	LG&E Energy	2000	Kentucky	Service quality monitoring
Energy East	Central Maine Power	2000	Maine	Service quality monitoring
Sierra Pacific Resources	Nevada Power	1999	Nevada	Service quality monitoring
National Grid	New England Electric System	1999	New Hampshire	Service quality target
			Rhode Island	Penalty/Reward
Delmarva Power Co.	Atlantic Energy	1998	Delaware, New Jersey	Service quality monitoring
WPL Holdings	IES Industries	1998	Wisconsin, Iowa	Service quality monitoring
LG&E Energy	Kentucky Utilities	1998	Virginia	Service quality target
			Kentucky	Service quality monitoring
Consolidated Edison	Orange & Rockland Utilities	1998	New York	Penalty/Reward
			New Jersey, Pennsylvania	Service quality monitoring
Enron	Portland General Electric	1997	Oregon	Service quality target
Public Service Company of Colorado	Southwestern Public Service Company	1997	Colorado	Penalty/Reward
Puget Sound Power & Light	Washington Energy	1997	Washington	Penalty/Reward

they fail to satisfy those targets. In most cases these penalties are more general (*i.e.* tied to system-wide performance measures and levied as general tariff adjustments) rather than customer specific.

Tables Three through Nine summarize information on the different types of quality indicators used in service quality regulatory plans. Because of time constraints, the plans included in these tables do not represent a complete survey of service quality regulation for electric utilities in the US. Nevertheless, we believe these tables are representative of service quality regulation in the industry and include most major plans.

Table Three presents information on reliability indicators. We find the most common quality indicators that are reported are the system average interruption frequency index (SAIFI) and the system average interruption duration index (SAIDI). Nearly all plans that have reliability indicators have separate indicators for the frequency and duration of interruptions. The momentary average interruption frequency index (MAIFI) is only reported in only 11 States.

There are a significant number of plans that monitor reliability at the circuit level. Table Four shows that circuit reliability indicators are regulated in 27 States and the District of Columbia. Most of these plans monitor performance and either require explanations or action plans from companies as the consequence for failing to provide what is viewed as acceptable performance. Other than Michigan, only four of these States (Texas, Massachusetts, Utah and Washington) include penalties for circuit performance, and in at least two of these States the penalty provisions are less strict than in Michigan. Massachusetts will only levy penalties if circuits fall below the specified standards for three consecutive years, not annually as can be the case in Michigan. The penalty payment in Utah is also significantly below that in Michigan.

There are relatively few States that monitor, target or penalize service restoration. Table Five shows that restoration indicators are featured in only ten States. Five of these States (Michigan, Colorado, Idaho, Utah and Washington) have penalty provisions for failing to restore service in defined intervals while another (New Jersey) levies penalties for failing to *begin* service restoration promptly. Service restoration is a major part of the service standards regime in Michigan, accounting for three of the eleven specified

Table 3

System Reliability

Jurisdiction	Companies Involved	Indicators	Benchmarks	Consequences
Alabama	All utilities	SAIFI, SAIDI, CAIDI, MAIFI	NA	Service Quality Monitoring
California	All utilities	CAIDI	Unspecified	Service Quality Target
	San Diego Gas & Electric	SAIDI	69+/-3	Penalty/Reward
		SAIFI	0.68+/-.03	Penalty/Reward
		MAIFI	0.77+/-.03	Penalty/Reward
Colorado	Public Service Company of Colorado	SAIFI	Unspecified	Penalty/Reward
	Public Service Company of Colorado, Aquila	SAIDI	Unspecified	Penalty/Reward
Connecticut	All utilities	SAIDI, SAIFI, CAIDI	NA	Service Quality Monitoring
D.C.	Pepco	SAIFI, CAIDI, SAIFI	Unspecified	Service Quality Target
Delaware	Delmarva Power & Light	SAIDI	635 minutes/customer	Penalty/Reward
		SAIFI, CAIDI	NA	Service Quality Monitoring
Florida	All utilities	SAIFI, SAIDI, CAIDI	NA	Service Quality Monitoring
	Progress Energy	SAIDI	20% below 2000 SAIDI level by 2005	Penalty/Reward
Idaho	Scottish Power-Pacificorp	SAIDI, SAIFI, MAIFI	Performance during the merger year	Penalty/Reward
Illinois	All utilities	SAIFI, CAIDI	Unspecified	Service Quality Monitoring
Indiana	All utilities	SAIDI, SAIFI, CAIDI	NA	Service Quality Monitoring
	Duke Energy	SAIDI	175 Minutes	Service Quality Monitoring
		CAIDI	115 Minutes	Service Quality Monitoring
		SAIFI	1.65 Interruptions	Service Quality Monitoring
Iowa	All utilities	SAIDI, SAIFI, CAIDI, MAIFI	NA	Service Quality Monitoring

Table 3

Jurisdiction	Companies Involved	Indicators	Benchmarks	Consequences
Kansas	All utilities	SAIFI, CAIDI, SAIFI	NA	Service Quality Monitoring
Kentucky	Duke Energy	CAIDI, SAIFI, SAIDI	NA	Service Quality Monitoring
	AEP Kentucky	CAIDI, SAIFI	NA	Service Quality Monitoring
Louisiana	All utilities	SAIDI	3.58 (decreasing by 5% per year for 5 years)	Penalty/Reward
		SAIFI	2.84 (decreasing by 5% per year for 5 years)	
Maine	Central Maine Power	CAIDI	2.58	Penalty/Reward
		SAIFI	1.8	
	Bangor-Hydro Electric	CAIDI	2.13	Penalty/Reward
		SAIFI	1.43	
Maryland	All utilities	CAIDI, SAIFI, SAIDI	NA	Service Quality Monitoring
Massachusetts	All utilities	SAIDI, SAIFI	10 year average performance + 1 standard deviation	Penalty/Reward
Michigan	Indiana-Michigan	CAIDI, SAIFI	NA	Service Quality Monitoring
Minnesota	Xcel Energy	SAIFI	1.0 Interruptions	Penalty/Reward
		SAIDI	1.9 hours	
Missouri	Utilicorp (Aquila)	CAIDI, SAIFI, SAIDI	NA	Service Quality Monitoring
Nevada	All utilities	SAIDI, SAIFI, CAIDI, MAIFI	NA	Service Quality Monitoring
New Jersey	All utilities	SAIFI, CAIDI	Unspecified	Service Quality Monitoring
	Atlantic City Electric	MAIFI	NA	Service Quality Monitoring
New York	All utilities	SAIFI, CAIDI	Varies by company	Penalty/Reward
Ohio	All utilities	SAIDI, CAIDI, SAIFI	Unspecified	Penalty/Reward
		MAIFI	NA	Service Quality Monitoring
	Duke Energy	CAIDI, SAIDI, SAIFI, Average System Availability Index	2005 performance	Service Quality Target
Oklahoma	All utilities	SAIDI, SAIFI, and MAIFI (if applicable)	Unspecified	Service Quality Target
Oregon	Portland General Electric	SAIDI, SAIFI, MAIFI	3 year moving average targets vary by company	Penalty/Reward
	Scottish Power-Pacificorp	SAIDI, SAIFI	Performance during merger year	Penalty/Reward

Table 3

Jurisdiction	Companies Involved	Indicators	Benchmarks	Consequences
Pennsylvania	All utilities	SAIDI, SAIFI (CAIDI, MAIFI also reported but not targeted)	Varies by company	Service Quality Target
	Exelon	CAIDI, SAIFI	Exceed Commission requirements by 10% by 2005	Service Quality Target
		MAIFI, SAIDI	NA	Service Quality Monitoring
Rhode Island	National Grid	SAIFI-Coastal	Penalty over 1.43 Bonus under 0.99	Penalty/Reward
		SAIFI-Capital	Penalty over 1.27 Bonus under 0.83	Penalty/Reward
		SAIDI-Coastal	Penalty over 82.7 Bonus under 52.7	Penalty/Reward
		SAIDI-Capital	Penalty over 70.3 Bonus under 44.7	Penalty/Reward
Texas	All utilities	SAIFI, SAIDI	Exceed system-wide standards by more than 10%	Penalty/Reward
Utah	PacifiCorp	SAIDI SAIFI	217 minutes 2.2 interruptions	Penalty/Reward
Vermont	Central Vermont Public Service	SAIFI CAIDI	2.1 interruptions 2.6 hours	Penalty/Reward
	Green Mountain Power	SAIFI CAIDI	1.7 interruptions 2.2 hours	Penalty/Reward
Virginia	All utilities	SAIDI, SAIFI	NA	Service Quality Monitoring
Washington	Scottish Power-Pacificorp	SAIDI, SAIFI, MAIFI	Performance during the merger year	Penalty/Reward
	Puget Sound Energy	SAIDI	149.4 minutes/year (years 1-4) 116.2 minutes/year (year 5)	Penalty/Reward
		SAIFI	1.473 interruptions/year (years 1-4) 1.25 interruption/year (year 5)	
Wisconsin	All utilities	SAIDI, SAIFI, CAIDI	NA	Service Quality Monitoring

Table 4

States with Circuit Indicators

Jurisdiction	Circuits Reported	Consequences
Alabama	Worst 10	Plan for future action
California	Any with SAIFI above 12	Explanation
Colorado	Aquila reports 10 worst by SAIDI	Explanation
Connecticut	Worst 100	Explanation
Delaware	Worst 10	Plan for future action
DC	Worst 3% by CAIDI	Plan for future action
Florida	Worst 3% by SAIDI	Report actions undertaken
Idaho	Pacificorp reports worst 5 by CPI: Weighted avg, SAIDI, SAIFI.	Penalty up to $1/customer if average CPI of each worst circuit not 20% better in two years.
Illinois	Worst by SAIDI, SAIFI, CAIDI. Targets for SAIFI of 6 and CAIDI of 18 set.	Utility reports past and future action.
Kansas	Worst 10 by SAIDI, SAIFI	Plan for future action
Louisiana	Worst 5% by SAIDI and SAIFI	Report actions undertaken
Maryland	Worst 2%	Explanation
Massachusetts	Worst 5% by SAIDI or SAIFI. Compare averages of worst circuits to rest.	Penalty proportional to gap of averages up to 0.45% of company revenue.
Michigan	No more than 5% of circuits should have 5 outages/year.	Reporting of cause, explanation of past actions to correct.
	No circuits should have 8 or more outages/year.	Larger of $25/customer or customer charge.
Minnesota	Worst circuits	Plan for future action
Nevada	Worst 25 by CAIDI, SAIDI, SAIFI	Explanation

Table 4

States	Circuits Reported	Consequences
New Jersey	Worst 5 by SAIFI or CAIDI	Plan for future action
New York	Worst 5% by SAIFI or CAIDI	Plan for future action
Ohio	Worst 8% for all utilities	Explanation
	AEP reports SAIDI for all circuits.	SAIDI targets for each quartile of circuit.
Oklahoma	Worst by SAIDI, SAIFI	Report actions undertaken and plan for future action
Oregon	Worst 5	Plan for future action
Pennsylvania	Worst 5% by SAIFI, CAIDI	Explanation. Exelon required to improve worst circuits for next year.
Rhode Island	Worst 5% by SAIFI	Explanation
Texas	Worst 10% by SAIDI, SAIFI. Compare one year's "worst list" to next. Note if any are above 300% of sample average.	Penalty of $50/customer for outlier performance, and $20/customer if two consecutive years in worst group. Each violation's loss capped at $9.1M/year.
Utah	Pacificorp reports worst 5 by CPI: Weighted avg, SAIDI, SAIFI, MAIFI.	Penalty up to $1/customer if 3-year average CPI of each worst circuit not 20% better in two years.
Vermont	Worst 10	Plan for future action
Washington	Pacificorp reports worst 5 by CPI: Weighted avg, SAIDI, SAIFI, MAIFI.	Penalty up to $1/customer if 3-year average CPI of each worst circuit not 20% better in two years.
Wisconsin	Worst by SAIDI, SAIFI, CAIDI	Report actions undertaken and plan for future action

Table 5

States with Restoration Standards

States	Company	Standard	Consequences
Arkansas	Statewide	End repair on all circuits within 24 hrs.	Explanation
California	Statewide	System-wide CAIDI	Explanation
Colorado	Public Service of Colorado	End repair in 24 Hours.	Penalty per customer of $50, capped at $1M.
Delaware	Statewide	Begin repair within 2 Hours	Explanation
Idaho	Pacificorp	End repair on 80% of circuits within 3 hours, all within 24.	Penalty per customer of $1 paid directly to customers.
		End repair in 24 Hours	Penalty per customer of $50 + $25/each incremental 12-hour interval
Michigan	Statewide	End repair on 90% of circuits in 8 hours (normal), 60 (emergency), 36 (total)	Report cause of performance and past remedial actions.
		End repair in 16 hours, or 120 in case of emergency.	Penalty per customer of $25 or customer charge for each violation.
New Jersey	Statewide	Begin repair within 2 hours	Penalty of up to $25K/violation.
	PEPCO	End repair in 24 hours.	Penalty per customer of $50 per 24 hours.
Utah	Pacificorp	End repair on 80% of circuits within 3 hours, all within 24.	Penalty per customer of $1 paid directly to customers.
		End repair in 24 Hours	Penalty per customer of $50 + $25/each incremental 12-hour interval
Washington	Pacificorp	End repair on 80% of circuits within 3 hours, all within 24.	Penalty per customer of $1 paid directly to customers.
		End repair in 24 Hours	Penalty per customer of $50 + $25/each incremental 12-hour interval
Wyoming	Cheyenne L&P	End repair on all circuits within 24 hrs	Explanation

indicators. This appears to be unique among US States, with no other State establishing separate benchmarks for restoration under "normal" and "catastrophic" conditions. However, the actual restoration benchmarks that Michigan's utilities must satisfy appear less demanding than those in Colorado, Utah or Idaho. The penalty payments in Idaho are much lower than those that apply in Michigan, although the penalty payments are substantially greater in Utah.

There are also very few States that have public safety indicators for electric utilities, akin to the downed wire indicators in Michigan. As discussed in Chapter Two, public safety indicators are much more common for gas utilities (*e.g.* timeliness of response to gas odor calls) than for electric utilities. The only such State that includes such an indicator is in Oregon, where Pacificorp could have been fined for major safety violations. Because this is the only precedent we are aware of, we have not included a separate table for public safety indicators.

Table Six presents information on telephone service indicators. It can be seen that these indicators are also popular in service quality regulation. The Michigan service quality standards use average speed of answer and the call blockage rate (*i.e.* the abandoned call rate) as indicators. Other than Michigan, these indicators are used in only three and two other surveyed plans, respectively, that have penalties, although they are more common in monitoring plans. A more common measure of telephone service quality in penalty/reward plans is the percent of calls answered within established thresholds. In our survey, most of these plans use percent of calls answered within 30 seconds, although several use percent of calls answered within 20 seconds, one uses percent of calls within 60 seconds, and one uses percent of calls answered within 10 seconds as indicators.[30]

Table Seven presents information on meter and billing indicators. These indicators are relatively less prominent than for either telephone or reliability quality.   It can be seen that fourteen states (including Michigan) regulate these indicators. There are

[30] In some cases, the threshold for which telephone responsiveness is measured changes under the approved plan.

Table 6

Telephone Services

State	Company	Indicators	Benchmarks	Consequences
California	All utilities	Percent of calls receiving a busy signal during major outages	Level of busy signals on the day of outage	Monitoring
	San Diego Gas and Electric	Percent of calls answered within 60 seconds	80% on a 24 hour annual basis	Penalty
Colorado	Public Service Company of Colorado	Percent of calls answered within 45 seconds	At least 70%	Penalty/reward
District of Columbia	Pepco	Percent of calls answered within 30 seconds	70%	Explanation and plan for remediation
		Call abandonment rate	Below 10%	Explanation and plan for remediation
Indiana	Duke Energy (Cinergy)	Average speed of answer	60 seconds	Penalty
	Indiana-Michigan	Average speed of answer	NA	Monitoring
		Call blockage rate	NA	Monitoring
		Call abandonment rate	NA	Monitoring
Kansas	Aquila	Call blockage rate	3% first year, 2 % year 2+	Monitoring
		Call Abandoned Rate	year 1:7.5%, year 2:6%, year 3+:5%	Monitoring
		% of calls answered within 30 seconds	75%	Monitoring
		Average speed of Answer	year 1: 55 seconds, year 2: 50 seconds, years 3+: 45 seconds	Monitoring
Kentucky	AEP-Kentucky	Average speed of answer	NA	Monitoring
		Call blockage rate	NA	Monitoring
		Call abandonment rate	NA	Monitoring
Maine	Central Maine Power	Percent of customers surveyed reporting phone employees knowledgeable	82%	Penalty
		Percent of business calls answered within 30 seconds	80%	Penalty
	Bangor Hydro	Percent of outage calls answered (on the outage line) within 30 seconds	80%	Penalty
		Percent of business calls answered within 30 seconds	80%	Penalty
Massachusetts	Gas and electric companies	Percent of calls answered within 20 seconds	Average of most 10 recent years	Penalty
	National Grid - MA	Percent of calls answered within 20 seconds	Minimum of 68.5%	Penalty
Michigan	All utilities	Average speed of answer	Maximum of 90 seconds	Explanation and plan for remediation
		Abandoned call rate	Maximum of 5%	Explanation and plan for remediation
	Indiana-Michigan	Call blockage rate	NA	Monitoring
Minnesota	Northern States Power (New Century Energies)	Percent of calls answered within 20 seconds	78%	Penalty
Missouri	Utilicorp (St. Joseph Light & Power)	Abandoned call rate	NA	Monitoring
		Speed of Answer	NA	Monitoring
New Jersey	PEPCO (Conectiv)	Percent of calls answered within 30 seconds	70% of all calls by end of year 1	Target
		Percent of calls answered within 30 seconds	75% of all calls by end of year 2	Target

Table 6

State	Company	Indicators	Benchmarks	Consequences
New York	Rochester Gas & Electric	Percent of calls answered within 30 seconds	73%	Penalty
	Consolidated Edison	Abandoned call rate	Maximum 5.1%	Penalty
		Percent of calls answered within 30 seconds	94.90%	Penalty
	National Grid- NY	Percent of calls answered within 30 seconds	Minimum of 77%	Penalty
Ohio	All	Average Answer Time	60 seconds	Monitoring
Oklahoma	Public Service of Oklahoma	Average call answer time	NA	Monitoring
Pennsylvania	FirstEnergy (GPU)	Call center performance	Comparison to previous performance	Targets and possible penalty
	Exelon (Unicom)	Percent of calls answered within 30 seconds	70% through 2005	Targets and possible penalty
		Average call abandonment rate	NA	Monitoring
Rhode Island	National Grid (NEES)	Percent of calls answered within 20 seconds	Less than 68.6%	Penalty
		Percent of calls answered within 20 seconds	68.6-72.3%	Penalty
		Percent of calls answered within 20 seconds	72.4-80.0%	Target
		Percent of calls answered within 20 seconds	80.1-83.8%	Rewards
		Percent of calls answered within 20 seconds	More than 83.8%	Rewards
		Number of telephone calls that are designated Trouble, Non-outage	NA	Monitoring
Texas	ST Acquisition (Texas-New Mexico Power)	Average speed of answer	60 seconds 90% of the time	Penalty
	Northern States Power (New Century Energies)	Speed of answer	45 seconds for 70% of non-major event time calls	Penalty
		Abandoned call rate	3.4% hang-ups	Penalty
	AEP Texas	Average speed of answer	60 seconds	Penalty
Vermont	Green Mountain Power	Abandoned Call Rate	6% year 1, 5% thereafter	Penalty/Reward
		Outage Calls not answered	15%	Penalty/Reward
	Green Mountain Power, Central Vermont Public Service Corp.	Percent of customers not reaching company representative within 20 seconds	25%	Penalty/Reward
	Green Mountain Power, Central Vermont Public Service Corp.	Blocked Calls	3%	Penalty/Reward
	Central Vermont Public Service Corporation	Abandoned Call Rate, normal business hours	5%	Penalty/Reward
		Abandoned Call Rate, outside business hours	NA	Monitoring
Washington	Puget Sound Power & Light (Washington Energy)	Percent of calls answered within 30 seconds	75% answered by a service representative	Penalty
		Customer satisfaction with telephone center transactions	91% rating of 5 or higher on a 7-point scale	Penalty
Washington, Utah, Idaho, Oregon	Scottish Power (PacifiCorp)	Percent of calls answered within 30 seconds	80% in the first year after merger	Target
		Percent of calls answered within 20 seconds	80% in the second year after merger	Target
		Percent of calls answered within 10 seconds	80% in the third year after merger	Target
Wisconsin	WPL Holdings (IES Industries)	Average daily call wait time	NA	Monitoring

Table 7

Metering/Billing

State	Company	Indicators	Benchmarks	Consequences
Delaware	PEPCO (Conectiv)	Bill accuracy	NA	Penalty if customer finds error
Kansas	Aquila	Estimated bills per 1,000 customers	167	Monitoring
Massachusetts	Gas and electric companies	Bills adjusted	Average of most 10 recent years	Penalty
		On-cycle meter reads	Average of most 10 recent years	Penalty
	National Grid - MA	Percent meters read	Minimum of 88.5 (benchmark updates annually based on 5 year rolling average)	Penalty
Maine	Bangor Hydro	Bill error rate	0.40%	Penalty
Michigan	All utilities	Percent of meters read	85%	Explanation and plan for remediation
New York	Consolidated Edison	On-cycle meter reads	86.9% of meters read on schedule	Penalty
		Billing accuracy	97.2% of bills not adjusted due to company error	Penalty
	Rochester Gas & Electric	Bills adjusted	2.7% of bills adjusted	Penalty
		Estimated bills	13.7% of bills estimated	Penalty
	National Grid - NY	Percent meters read	Minimum of 88.5 (benchmark updates annually based on 5 year rolling average)	Penalty
Oklahoma	Public Service Company of Oklahoma	Billing errors per 1,000 bills	No more than 10	Monitoring
Pennsylvania	Exelon (Unicom)	Average number and % of residential bills not rendered once every billing period	NA	Monitoring
		Average number and % of small commercial bills not rendered once every billing period	NA	Monitoring
		Number and % of residential meters not read as required	NA	Monitoring
		Number and % of residential meters not read as required	NA	Monitoring
Rhode Island	National Grid (NEES)	Average of monthly % meters read	NA	Monitoring
Vermont	Central Vermont Public Service Corporation, Green Mountain Power	Percent of bills not rendered monthly	0.10%	Penalty
		Percent of bills found to be inaccurate	0.10%	Penalty
		Complaint Rate for payment postings	0.005%	Penalty
		Percent of meters not read per month	10%	Penalty
Washington, Utah, Idaho, Oregon	Scottish Power (PacifiCorp)	Response to bill inquiry	Within 15 days	Penalty
		Meter problems response	Within 15 days	Penalty

roughly equal numbers of metering and billing accuracy indicators, and several plans contain both billing and metering indicators.

Table Eight presents information on on-site service indicators. These indicators include timely installations for new customer service, which is included in Michigan's service standards. There are 18 States that regulate such indicators, including several that include customer installation measures.

Table Nine gives information on customer satisfaction and complaints indicators. There are approximately two dozen plans that feature these indicators. Both customer satisfaction and complaints indicators are represented about evenly in our survey. However, most complaints measures are based on the magnitude of complaints relative to the customer base rather than the utility's responsiveness to complaints, as in Michigan.

As a general matter, we find that the focus in target and penalty/reward plans is typically on service quality *trends* rather than inter-utility comparisons of benchmark *levels*. To the extent that benchmarks are used in such cases they pertain to a company's *historical* performance. This is commonly calculated by taking a simple average of the company's recent historical performance on the indicator. One good example of this approach has been in Massachusetts, where an initial statewide, generic review of service quality issues in 2000 established benchmarks for each gas and electric power distributor based entirely on the company's past performance on a service quality indicator. For all electricity indicators except SAIFI and SAIDI, benchmarks were based on 10 years' worth of data. Benchmarks for SAIFI and SAIDI were originally based on five years' worth of data.[31] However, Massachusetts' service quality standards were reviewed in 2006, and this update revised the calculation of SAIFI and SAIDI benchmarks in the State so that they were based on ten years' worth of data.

Within the approved penalty/reward plans, we find that penalty–only plans are somewhat more common, but prominent examples of plans where the utility might have rewarded include Southern California Edison, San Diego Gas and Electric, Northern States Power, Otter Tail Power, Mississippi Power, and National Grid–Massachusetts.

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[31] If a company did not have ten years of data on an indicator, new data would be used to update benchmarks until 10 years of data were available.

Table 8

Non-Emergency On-Site Services

Jurisdiction	Company	Indicators	Benchmarks	Consequences
Delaware	PEPCO (Conectiv)	Appointments met	NA	Penalty if face-to-face appointment is missed
		New connections/Re-energizing deadlines	3 business days after customer is ready	Target
		New connections/Re-energizing deadlines	10 business days after customer is ready	Penalty
District of Columbia	Pepco	Installations of new residential service requests	Within 10 business days	Monitoring
Kansas	Aquila	Percent of orders completed on time	95%	Monitoring
Maine	Central Maine Power Company	Percent of new service installed by date promised to customer	93%	Penalty
		Market responsiveness	100% of enrollments with competitive electricity providers processed within the timeframe provided by the Commission	Penalty
	Bangor Hydro	Service order timeliness	89% of all orders fulfilled by goal dates	Penalty
		Market responsiveness	100% of enrollments with competitive electricity providers processed within the timeframe provided by the Commission	Penalty
Massachusetts	Gas and electric companies	Percent of service appointments met as scheduled	Average of most 10 recent years	Penalty
Michigan	All utilities	Percent of new installations completed	Minimum of 90% within 15 days	Explanation and plan for remediation
New Jersey	PEPCO (Conectiv)	New customer installations/ Re-energizing existing services	3 business days	Target
		New customer installations/ Re-energizing existing services	10 business days	Penalty
New York	Consolidated Edison	Work orders, initial phase	Average 7.5 days between receipt of customer request and issuance of service layout for initial phase completion	Penalty
		Work orders, final phase	Average 10 days between receipt of customer request and completion of final inspection	Penalty
	Rochester Gas & Electric	Appointments kept	95% - 97% of appointments kept	Penalty
Ohio	All utilities	Percent of new installations completed if additional construction needed	99% in 10 business days	Monitoring
		Percent of new installations completed if no additional construction needed	99% in 3 business days	Monitoring
Oklahoma	Public Service of Oklahoma	Percent of new installation completed within 1 business day of customer readiness for service	95%	Monitoring

Table 8

Jurisdiction	Company	Indicators	Benchmarks	Consequences
Pennsylvania	FirstEnergy (GPU)	On-time appointments	Comparison to previous performance	Monitoring
	Exelon (Unicom)	Percent of appointments met	NA	Monitoring
Texas	PNM Resources (TNP Enterprises)	Service installations requiring no construction of electric facilities	95% completed within 24 hours of requested date or when customer's location is ready for service	Penalty
		Service installations requiring construction of electric facilities	90% completed within 10 business days of requested date or when customer's location is ready for service	Penalty
		Light replacements	90% of streetlight outages corrected in 2 business days, except during major events	Target
	Northern States Power (New Century Energies)	New service installations requiring no construction of electric facilities	95% completed within 24 hours after customer is ready for service or by requested date	Penalty
		New service installations requiring construction of electric facilities	75% completed within 10 business days after customer is ready for service	Penalty
		New service installations requiring construction of electric facilities	90% completed within 20 business days after customer is ready for service	Penalty
		New service installations requiring construction of electric facilities	100% completed within 90 business days after customer is ready for service or requested date	Penalty
		Light replacements	90% corrected in 2 business days	Target
		Light replacements	100% corrected in 5 business days	Target
	AEP Texas	New service installation requiring no electrical construction	95% completed within 24 hours after customer is ready for service or by requested date	Penalty
		New service installation requiring electrical construction	90% completed within 10 business days after customer is ready for service	Penalty
		Light replacements	95% of outages to be repaired within 72 hours of report	Target
Vermont	Green Mountain Power, Central Vermont Public Service Corp.	Average number of days late for customer requested work	5 days	Penalty
		Appointments met	Within 2 hour window	Penalty
		Meter Work	Within 2 business days of promised date	Penalty
		Percent of customer requested work not completed on time	5%	Penalty
Washington, Utah, Idaho, Oregon	Scottish Power (PacifiCorp)	Appointments	Offer and meet appointments from 8am-1pm or 12pm-5pm	Penalty for failure to keep appointment
		Switching on power	Within 24 hours of request	Penalty

Table 9

Customer Satisfaction/Complaints

Jurisdiction	Company	Indicators	Benchmarks	Consequences
California	San Diego Gas & Electric	Customer satisfaction survey	92.5% "very satisfied" responses on annual survey	Penalty
Colorado	Public Service Company of Colorado	Complaints per 1,000 customers	0.8	Penalty
Indiana	Vectren Holding (Southern Indiana G&E)	Number of customer complaints	NA	Monitoring
Maine	Central Maine Power Company	MPUC Complaint Ratio	1.17 complaints per 1,000 customers per year	Penalty
		MPUC Complaint Ratio	1.52 complaints per 1,000 customers per year	Penalty
		Call center service quality survey	84% favorable answers to questions in two categories	Penalty
	Emera (Bangor Hydro)	Office operations index	0.67	Target
Massachusetts	Gas and electric companies	Commission complaint rate	Average of most 10 recent years	Penalty
	National Grid - MA	Customer satisfaction survey	Minimum of 90% satisfied (benchmark updates annually based on 5 year rolling average)	Penalty
		Customer contact satisfaction	Minimum of 74.9% satisfied (benchmark updates annually based on 5 year rolling average)	Penalty
		Commission complaint rate	Maximum of 0.87 cases per 1000 customer	Penalty
Michigan	All utilities	Percent of customer complaints	Minimum of 90% answered within 3 business days	Explanation and plan for remediation
Minnesota	Northern States Power (New Century Energies)	Customer complaints received by the Minnesota Public Utilities Commission	No more than 450 per year	Penalty
		Number of Minnesota customer complaints received and handled by NSP Customer Advocacy Unit	NA	Monitoring
Mississippi	Mississippi Power	Customer Satisfaction index	No set benchmark, though a score based on reliability, prices, and customer satisfaction are used to compute Mississippi Power's penalties/rewards	Penalty/Reward
New Jersey	PEPCO (Conectiv)	Customer complaints per year to New Jersey Board of Public Utilities	1500 per year	Target

Table 9

Jurisdiction	Company	Indicators	Benchmarks	Consequences
New York	Consolidated Edison	PSC complaints threshold	8.0 divided by total customers multiplied by 100,000	Penalty
		PSC complaints performance	8.0 divided by total customers multiplied by 100,000, with rewards earned under stricter standards each year.	Penalty
		Visitor satisfaction	84.2% satisfaction on annual survey	Penalty
		Caller satisfaction	83.5% satisfaction on annual survey	Penalty
		Emergency center satisfaction	80.5% satisfaction on annual survey	Penalty
	Consolidated Edison (Orange & Rockland)	Public Service complaint rate	10.6	Target
		Customer Assessment Scores	2.73 for Residential Customers	Penalty
			2.65 Commercial & Industrial Customers	Penalty
	Rochester Gas & Electric	Customer satisfaction survey	Initial customer satisfaction survey in first plan year	Monitoring
		PSC complaints	9 per 100,000 customers	Penalty
	New York State Electric & Gas	PSC complaints	4 per 100,000 customers	Penalty
		Customer expectation survey	Complete study and report	Monitoring
		Customer satisfaction index	71% satisfaction on annual survey	Penalty
		Contact satisfaction index	83% satisfaction on follow-up survey of customers who contact the utility.	Penalty
	Niagara Mohawk	PSC complaint rate	10 per 100,000 customers	Penalty
		Customer satisfaction index	Minimum index value of 80	Penalty
	National Grid- NY	PSC complaint rate	Maximum of 4 complaints per 100,000 customers	Penalty
		Residential transaction satisfaction index	Year 1 Maximum of 79	Penalty
		Residential transaction satisfaction index	Year 2 Maximum of 80	Penalty
		Residential transaction satisfaction index	Year 3 and beyond Maximum of 81	Penalty
		Small/Medium commercial and industrial transaction satisfaction index	Year 1 Maximum of 74	Penalty
		Small/Medium commercial and industrial transaction satisfaction index	Year 2 Maximum of 76	Penalty
		Small/Medium commercial and industrial transaction satisfaction index	Year 3 and beyond Maximum of 78	Penalty
Pennsylvania	FirstEnergy (GPU)	Customer complaint handling	Comparison to previous performance	Target
	Exelon (Unicom)	Number of residential customer disputes not issued company report within 30 days	2001 levels	Target
		Justified consumer complaint rate	NA	Monitoring
		Percent satisfied with recent contact	NA	Monitoring

Table 9

Jurisdiction	Company	Indicators	Benchmarks	Consequences
Oregon	PacifiCorp	At-Fault customer complaints	NA	Monitoring
	Enron (Portland General Electric)	C1: frequency of PGE at-fault customer complaint to the Commission	0.07 at-fault/1000	Goal
		C1: frequency of PGE at-fault customer complaint to the Commission	0.10 at-fault/1000	Penalty
		C1: frequency of PGE at-fault customer complaint to the Commission	0.13 at-fault/1000	Penalty
Rhode Island	National Grid (NEES)	Percent of customers satisfied with service center contact	Less than 76.2%	Penalty
		Percent of customers satisfied with service center contact	76.2-77.9%	Penalty
		Percent of customers satisfied with service center contact	78.0-81.6%	Target
		Percent of customers satisfied with service center contact	81.7-83.4%	Rewards
		Percent of customers satisfied with service center contact	More than 83.4%	Rewards
Texas	ST Acquisition (Texas-New Mexico Power)	Customer service staff levels	Maintain at least 85% of residential and commercial customers served out of local Texas office until the next True-up date	Target
Vermont	Green Mountain Power, Central Vermont Public Service Corp.	Transactional customer satisfaction	80%	Penalty
		Overall customer satisfaction	80%	Penalty
		Rate of complaints to Commission	0.07%	Penalty
		Response to customer complaints	14 calendar days	Penalty
Washington	Puget Sound Power & Light (Washington Energy)	Customer satisfaction survey	90% of surveyed customers rated company a 5 on a 7 point scale	Target
		Commission complaint ratio	0.5/1000 customers	Penalty
		Field service operations transactions customer satisfaction	85% rating of 5 or higher on a 7-point scale	Penalty
	All other utilities	Number of Commission complaints	NA	Monitoring
Washington, Utah, Idaho	Scottish Power (PacifiCorp)	Disconnection complaints	Response within 4 business hours	Target
		Non-disconnection service complaints	Response within 3 business days	Target
		Commission complaints	90% of complaints referred by Commission resolved within 30 days by first year after merger and 95% by second year after merger	Target
		Power quality complaints	Investigate & report with 12 days	Penalty
Wisconsin	WPL Holdings (IES Industries)	Number of complaints	NA	Monitoring

One reason that penalty-only plans are more common is that a number of SQIs were implemented as part of merger agreements. In these cases, the motivation for the SQI was almost always to maintain existing quality levels while the consolidated utilities attempted to find cost efficiencies. In other words, SQIs in merger agreements are typically seen as countervailing incentives against cost–cutting that can imperil quality rather than mechanisms to induce optimal service quality *per* se, and penalty–only mechanisms are usually seen as sufficient to achieve this goal.

Regarding award/penalty rates, some regulators have recognized that customer value is important for designing appropriate SQI regimes, but regulators have rarely considered evidence on customer value. Instead, these penalty/reward rates have been set either through negotiation between parties or through judgment. This likely reflects the cost and complexity of undertaking original research on the valuation of quality to a company's own customers.

6.2 Applications of Service Quality Benchmarking in Regulation

Service quality benchmarking involves direct comparisons between a utility's level of performance on a designated indicator and the same level of performance for an external benchmark. Such comparisons can be to a "peer" utility or a "peer group," or can determined through benchmarking techniques such as econometric modeling. There have been very few cases where benchmarking of performance indicators has actually been implemented in US regulation. The only examples that we are aware of involve employee safety indicators. For example, the initial PBR plan approved for Boston Gas in 1997 included a lost time accident indicator for which it could be subject to penalties. Under the plan, Boston Gas had to keep a three-year moving average of its lost time accident rate below the three-year average of the industry's lost time accident rate, as reported in the National Safety Council report *Work Injury and Illness Rates*. However, this approach to regulating employee safety was superseded by a generic service quality proceeding in Massachusetts in 1999-2000. The outcome of this proceeding was to retain the lost time accident rate reported to OSHA as an employee safety indicator, but the benchmark would be set at each company's *historical* performance on that indicator over the most recent 10 years.

Benchmarking of employee safety indicators was also part of alternative regulation plans approved for two electric utilities in North Dakota. The plans for both Northern States Power Company (later Xcel Energy) and Otter Tail Power used the OSHA total incidence rate as an employee safety indicator. The OSHA total incidence rate is equal to the company's total number of employment-related illnesses and accidents per 200,000 hours worked. For Northern States Power, this indicator was benchmarked against the comparable value for large utilities (more than 7000 employees) participating in the 1997 safety survey by the Edison Electric Institute (EEI). The average value of the OSHA total incidence rates for these companies was computed for the 1994-97 period, and this average was the benchmark target included in the plan. For Otter Tail Power, the benchmark was computed comparably using data from the 1997 EEI Safety Survey, but Otter Tail's benchmark was calculated using data for "Group 5" participating utilities that had fewer than 1000 employees.

One factor that facilitates employee safety benchmarking is the data are generally high quality and consistent across companies. All utilities are required to report employee accident data to OSHA on standardized forms. Thus, the collection and reporting of employee safety data is much more centralized and standardized than for any other non-cost indicators of electric utility performance.

For other service quality indicators, we are not aware of any approved regulatory plans in North America that benchmark companies' performance directly against the performance of other electric utilities or against benchmarks developed through econometric or other methods. Some States have considered this issue but have not adopted service quality benchmarking. Perhaps the most detailed examination of service quality benchmarking took place in Massachusetts. In the generic service quality proceeding in Massachusetts discussed above, the Department of Telecommunications and Energy (the Department) wrote that it "remains committed to examining the potential (regulatory) use of nationwide, regionwide, or statewide (service quality) data. Use of such data may allow the Department and other parties the ability to gauge service quality on a cross-company, comparative basis. Such a comparison may allow the Department to ascertain if service levels being provided in the Commonwealth are comparable to those found in other areas of New England and other regions of the country."[32] Accordingly, the Department directed all gas and electric utilities in the State to provide a written report within 18 months of the generic service quality Order which: 1) details its efforts to collect service quality data other than the company's own performance; 2) identifies what nationwide, regionwide, and statewide performance data is potentially available for a comprehensive service quality database; and 3) assess the feasibility of establishing a cooperative approach to comparative benchmarking, under which all gas and electric companies would jointly develop a data gathering/sharing consortium that compiles comparative data.

The Massachusetts companies collectively filed the required report in December 2002. The report noted that service quality data, including reliability data, is generally not available from publicly available sources. Some of these data are collected by industry associations such as EEI and the American Gas Association ("AGA"), but these data are confidential. EEI and AGA members provide service quality data voluntarily to these organizations, but in almost all cases they will not do so unless they are assured that the data will not be released publicly, including for use in regulatory proceedings. Some other organizations (such as the Electric Utility Benchmarking Association) collect and share information among participating companies. However, companies participate in these collectives in order to identify best practices and use benchmarking for internal management purposes, not to use assembled data in the regulatory arena. The information developed through these processes cannot be shared with non-participating companies.

The report by the Massachusetts companies also concluded that comparative benchmarking was generally not feasible. With respect to reliability benchmarking in particular, problems included differences in how reliability data were defined (*e.g.* criteria for excluding major evens, whether or not planned outages were included in statistics) and measured (*e.g.* the degree of automation through Outage Management System or similar systems). The report also noted that a utility's measured reliability data can be affected by a variety of external business conditions that differ among companies and are largely beyond management control. Such conditions include

[32] Massachusetts Department of Telecommunications and Energy, D.T.E. 99-84, p.4.

lightening strikes, type and concentration of vegetation, topology of the service territory, the severity of summer and winter weather, the extent to which a territory is urbanized, salt corrosion (for companies with extensive seashore assets), and the extent of undergrounding. Reliability comparisons across companies would require controls for these differences in business conditions.

The Massachusetts DTE has not acted on the companies' report. Indeed, in December 2006 the Department updated the service quality regulatory approach that it created in 2000, but service quality benchmarking did not play any role in the new service quality framework it established. There has, accordingly, been essentially no practical movement towards implementing reliability or other service quality indicators, benchmarked against peer companies, in the State.

Outside of North America, there are a few examples where regulators have used service quality benchmarks in regulation. We are aware of two recent examples. In the Netherlands, the energy network regulator recently announced its intention to adjust distribution prices to reflect differences between the reliability of a given company and the average reliability level of the power distribution industry. Under this plan, eligibility will be measured using SAIDI only. For the 2007-10 period, the "CPI-X" price cap regime will include a "Q-factor" where each company's SAIDI performance is compared to a SAIFI benchmark equal to the average SAIDI value for *all* Dutch distributors for the 2004-05 period. The SAIDI benchmark was set using 2004-05 data since 2003 reliability data were not available for all distributors. After 2010, however, the SAIDI benchmark will be set using three-year averages (*i.e.* 2006-08) of SAIDI for the Netherlands' entire power distribution industry.

The Q factor adjustment will take place at the end of the three-year regulatory period based on each company's SAIDI performance over the entire 2007-2010 period. This is being done because SAIDI values can fluctuate from year to year because of factors beyond company control. Force majuere events are to be eliminated from each distributor's measured SAIDI in each year. The actual value of the Q factor will be determined by first calculating the difference between the company's average SAIDI performance and the SAIDI benchmark (*i.e.* the industry's average SAIDI value in the preceding regulatory period), and multiplying this difference by an estimate of the value of service reliability to customers.

Norway has also implemented an innovative approach to benchmarking power distribution reliability. Beginning in 2001, prices for each distributor were adjusted to include an allowance for “energy not supplied” (ENS). The ENS measure is analogous to SAIDI, and an *expected* value for this indicator was determined for each distributor. The expected ENS was generated using an econometric model in which ENS is a function of a variety of business condition variables, including weather and the length of the network. Model parameters were estimated using historical data from the Norwegian power distribution industry. Each company’s expected ENS was then determined by multiplying the parameter estimates by the average values of the business condition variables expected for a given company. This is an example of the econometric benchmarking approach discussed in Chapter Five.

Each year, the distributor’s annual ENS is compared to the benchmark, expected value. This difference is then multiplied by the value of reliability. This valuation of reliability is also tailored to each distributor to reflect its customer mix. If the difference is positive (i.e. reliability has been better than expected), it is added to the company’s capped revenue for the following year. If the difference is negative (i.e. reliability has been worse than expected), it is subtracted from the company’s capped revenue for the following year. This is a type of “Q factor” adjustment to allowed revenues, although it is not based explicitly on a comparison between company and industry reliability measures (as in the Netherlands). Rather, the target is determined using industry data and regression methods that establish a benchmark level of reliability that is expected if an average firm in the industry operated under the specific business conditions of the company in question.

6.3 Evaluation

This chapter has presented some information on service quality regulation practices in the US and, to a lesser extent, overseas. We have attempted to focus on the issues that received the most attention in the 2006 Settlement agreement in DTE’s Show Cause Order which prompted the current report. Our survey shows the service quality indicators established in Michigan are unique in several respects. No other State has placed as much emphasis on establishing service standards that apply to the reliability experience of individual and relatively small groups of customers (*e.g.* customers on a circuit) without also considering more system-wide reliability measures. The inclusion of two public safety measures for electric service appears to be unprecedented. The telephone, complaints, meter reading and customer installations indicators are generally within the mainstream of US service quality regulation. However, most approved plans measure telephone responsiveness as the percent of calls answered within a given time threshold rather than as the average speed of answer. Most complaints measures also establish benchmarks based on the number of complaints per customer, rather than the days it takes the company to respond to the complaint. Many plans that include metering indicators also include billing indicators, such as the percent of customer bills that are adjusted.

The regulatory process in Michigan is also somewhat unique. The State has adopted a penalty regime, although the penalties are based on customer-specific rather than system-wide measures. There are some precedents for this, particularly in the service quality plans implemented in Utah and Idaho as part of the Pacificorp-Scottish Power merger. However, most penalty plans have applied more widely and have been more balanced across all aspects of service quality.

Our review also shows that service quality benchmarking has been very rare in regulation. This issue has been considered most often for reliability comparisons but has not, to our knowledge, been accepted by any US jurisdiction that has examined the issue. One clear challenge in service quality benchmarking is obtaining data that are uniformly defined and measured across companies. This task is complicated by the fact that there are no requirements to report these data according to standardized formats and definitions in different States. This is especially true for reliability data. There are also challenges in attempting to control for the impact of external business condition variables on a utility's measured service quality performance. This can in principle be done through econometric methods, and there are examples of such methods being used in regulatory applications overseas. However, to our knowledge, no such studies have been used to set service quality benchmarks in US regulation.

7. Evaluation of Service Quality Regulation for Detroit Edison

This report was prompted by the 2006 settlement agreement between DTE, the MPSC Staff and other interested parties. Some parties were concerned that DTE's "Performance Excellence Process" (PEP) could lead to the unintended consequence of service quality degradation. The settlement agreement therefore required DTE

> "…to initiate an independent study performed by an outside consultant to monitor any impact of the PEP on service quality. The study will be submitted by the Company in the 2007 rate case and will address the following:
>
> - Disclosure of which indicators are currently established to measure customer service quality
> - Providing recommendations for a formal process of monitoring a possible expanded set of indicators
> - Present a proposal for inter-company service quality benchmarking"

The Settlement agreement does not discuss the prospect of monitoring the PEP program *per se*, and in our opinion this is not necessary. Companies should obviously be encouraged to pursue efficiency-enhancing programs, and this goal will generally be encouraged if regulators do not "micro manage" the utilities under their jurisdiction. It is better for regulatory policy to focus on service quality outcomes and put in place a regulatory process that is likely to ensure that quality levels are at least being maintained.

7.1 Evaluation of Service Quality Indicators

The first requirement for this report is to examine the indicators that are currently used to measure customer service quality in Michigan and to propose a possible expanded list of indicators that are appropriate for DTE given its PEP program. Recall that the current indicators used to regulate service quality in Michigan are the following:

1. Electric utilities should restore service to at least 90% of interrupted customers within 36 hours or less.
2. During catastrophic events, electric utilities should restore service to at least 90% of interrupted customers within 60 hours or less.
3. Under normal conditions, electric utilities should restore service to at least 90% of interrupted customers within 8 hours or less.
4. No more than 5% of utility circuits should experience 5 or more outages in a 12 month period.
5. In Metropolitan Statistical Areas (MSAs), at least 90% of downed wires in police and fire situations should be guarded by utility personnel within 4 hours.
6. In non-MSAs, at least 90% of downed wires in police and fire situations should be guarded by utility personnel within 6 hours.
7. The average speed of answer for customer calls to utility phone centers should not exceed 90 seconds.
8. A utility's call blockage factor (*i.e.* the percentage of calls to the phone center not answered by company personnel) should not exceed 5%.
9. A utility should respond to at least 90% of customer complaints within three business days.
10. A utility should read 85% of customer meters each billing period.
11. At least 90% of new service installations should be completed within 15 days.

Many of these indicators are somewhat unique in US service quality regulation. For example, few States or companies monitor indicators comparable to the downed wire indicators. Michigan's service quality standards also include three restoration indicators, which essentially focus on preventing very long outages when interruptions occur.

Several other States include outage restoration standards, but these indicators have received more emphasis in Michigan than perhaps any other jurisdiction. There are precedents for the State's two telephone indicators, although it is more common to monitor telephone response as the percentage of calls answered within 30 seconds than to target the average speed of answer. The metering, customer installation and complaints indicators are all within the US regulatory mainstream, although most plans have focused on the magnitude of customer complaints rather than the timeliness of utility responses to complaints.

The service quality plans that are most similar to that approved in Michigan are probably the provisions that were approved in Scottish Power's takeover of Pacificorp. Table Ten presents a side-by-side comparison of service quality regulation in Michigan with the Scottish Power-Pacificorp service quality regulatory provisions that were approved in Utah, Idaho and Washington.

Table Ten reveals three broad differences between the Michigan and Pacificorp plans. One is that Pacificorp includes more service quality indicators than in Michigan. In particular, the Pacificorp merger included SAIFI, SAIDI, MAIFI, and more on-site service indicators than Michigan's statewide standards. Second, the benchmarks that apply to Pacificorp are generally more demanding than those that were set in Michigan. Third, the Pacificorp plan features penalties for a broader range of indicators, and a relatively greater share of the indicators in the plan are subject to penalties, compared with Michigan.

As discussed, compared with other service quality plans in the industry, one of the unique aspects of Michigan's standards is that they are focused to an unusual extent on "extreme" rather than average reliability metrics. This is due, at least in part, to the statewide focus of the proceeding and the apparent desire to choose indicators where a single standard could be applied uniformly to all companies in the State. It is not always possible to adopt such uniform standards for metrics such as SAIDI or SAIFI because of the differences how these indicators are measured, as well as differences in business conditions, across utilities that affect average reliability performance.

The objective of developing uniform standards is not relevant for this report. This study is motivated by the PEP programs that are specific to DTE. Our work is to analyze

Table 10

Comparison of Service Quality Regulation: Michigan and Scottish Power-Pacificorp

		Michigan		Scottish Power-Pacificorp (WA, UT, ID)	
	Indicators	**Benchmarks**	**Consequences**	**Benchmarks**	**Consequences**
Reliability	SAIDI	NA	NA	10% reduction of underlying base line performance on the 5th year following merger	$1 per customer
	SAIFI	NA	NA		
	MAIFI	NA	NA	5% reduction of underlying base line performance on the 5th year following merger	
	Worst performing circuits	5% of all circuits experience 5 or more interruptions in a year	$25/per customer (at 8 interruptions)	20% reduction of underlying base line performance of 3 year average of 5 worst performing circuits	$1 per customer
Restoration	Supply restoration	90% of interrupted customers in average of 36 hours for all conditions	$25/per customer	80% restoration of supply outage within 3 hours if company is at fault	$1 per customer
		90% of interrupted customers in 8 hours in normal conditions	$25/per customer		
		90% of interrupted customers in 60 hours during catastrophic events	$25/per customer		
	Customer supply interruption	NA	NA	Restored within 24 hours if company is at fault	$50 for residential customers + $25 for each additional 12 hours
					$100 for commercial customers + $25 for each additional 12 hours
Public Safety	Downed wire response time	90% of downed wires in MSAs guarded by utility personnel within 4 hours	No penalty	NA	NA
		90% of downed wires in non-MSAs guarded by utility personnel within 6 hours			
Telephone	Responsiveness	Average speed of answer at most 90 seconds	No penalty	80% of calls answered within 30 seconds in the first year after merger	No penalty
				80% of calls answered within 20 seconds in the second year	
				80% of calls answered within 10 seconds in the third year	
	Blocked Calls	Maximum of 5%	No penalty	NA	NA
Metering/Billing	Response to bill inquiry	NA	NA	Within 15 days	$50 per customer
	Meter problems response	NA	NA	Within 15 days	$50 per customer
	Meters Read	85% of customers within billing period	No penalty	NA	NA
Onsite work	Appointments	NA	NA	Offer and meet appointments from 8am-1pm or 12pm-5pm	$50 for failure to keep appointment
	Switching on power	NA	NA	Within 24 hours of request	$50 + $25 for each additional 12 hours
	Estimates for providing new supply	90% of new service installations completed within 15 business days of start date	NA	Within 15 days of discussion if company needs to change its network	$50 per customer
				Within 5 days of discussion if no network changes are needed	
	Planned interruptions	NA	NA	At least 2 days notice	$50 for residential customers
					$100 for commercial customers
Complaints	Disconnection complaints	NA	NA	Response within 4 business hours	No penalty
	Non-disconnection service complaints	NA	NA	Response within 3 business days	No penalty
	Commission referred complaints	90% of complaints responded to within 3 business days	No penalty	90% of complaints resolved within 30 days	No penalty
				95% of complaints resolved within 30 days by second year after merger	
	Power quality complaints	NA	NA	Investigate & report with 12 days	$50 per customer

whether it is appropriate to modify the service quality indicators for DTE only, in light of the company's cost-cutting initiatives.

We believe that adding indicators to DTE's service quality plan is warranted. The main rationale for including new indicators is to create a more balanced set of incentives. The plan currently encourages DTE and other companies to prevent extremely long power outages and to reduce the number of outages to customers on certain circuits. However, service quality regulation for DTE does not explicitly target the level of power reliability currently experienced by an average customer on the system. The level of reliability provided to customers, on average, is clearly an important and relevant component of DTE's quality of service. We therefore make the following two recommendations regarding the reliability quality indicators for DTE.

Recommendation One: Add SAIFI as an indicator
Recommendation Two: Add SAIDI as an indicator

In both cases, we recommend that the indicators be measured to exclude outage events that lead to interruptions for at least 10% of customers on the system, as is currently the case in Michigan.

Compared to the current regime, we believe that adding SAIFI to the list of indicators will give DTE more incentives to help outages from occurring in the first place. We also believe that adding SAIDI to the list of indicators will give DTE more balanced incentives to reduce the durations of outages experienced by all customers on the system. Both indicators represent important service attributes that are not currently reflected in the service quality regime.

There are also compelling reasons for adding MAIFI as an indicator. Because of the increasing use of personal computers and digital equipment, even momentary outages can impose significant hardships on industrial, commercial and even some residential customers who rely on continuous power supplies. An increasing number of regulatory plans also include MAIFI as an indicator. However, DTE does not currently measure MAIFI, and it is not clear how costly it would be to collect reliable MAIFI data. We discuss this point further in the following section.

Our survey of US service quality regulation also revealed that the telephone indicators in Michigan's service quality standards differ from the metrics that are most commonly used in US service quality regulation. However, DTE does not currently measure telephone response using measures such as the percent of calls that are answered within 30 seconds, and it is not clear how costly it would be to collect these data. The telephone indicators used in Michigan are also broadly within the mainstream of US regulation and are valid measures of the quality of telephone services that DTE provides. For this reason, we do not recommend any changes to the telephone quality indicators used in regulation.

Michigan's current service quality standards include a meter reading but not a billing indicator. As discussed, there are an approximately equal number of meter reading and billing indicators in US service quality regulation plans, and several plans contain both measures. We believe that billing indicators are generally preferred to metering indicators since the former reflects the quality of something that customers experience directly – the bill – rather than an aspect of utility operations necessary to produce a bill. Billing indicators are therefore more akin to service quality "outputs" delivered to customers rather than the service quality "inputs" that firms utilize to provide service. Adding a billing indicator could therefore enhance balance and make Michigan's regulatory framework more directly focused on customer welfare. We therefore make the following recommendation:

Recommendation Three: Add the percent of bills that are adjusted as an indicator

We believe that the quality of billing services can be measured as the percent of customer bills that the utility is forced to adjust because of billing errors. This indicator reflects the "bottom line" service quality concern of billing accuracy, which incorporates errors that can occur at the meter reading (including an estimated rather than an actual meter read) and bill preparation level. This indicator is also superior to the dollar value of billing adjustments (*e.g.* relative to total billings) since the latter is more sensitive to billing problems that may occur for a few, larger customers and are therefore less representative of the quality of billing services provided to the entire customer base.

DTE also collects data on this indicator, so adding it to the list of service quality indicators is feasible. It should be noted, however, that other Michigan utilities may define and measure this metric differently than DTE, so the measured percent of bills adjusted indicators may not be comparable across companies.

While the downed wire indicators are unusual, they are certainly relevant to the safety and well-being of DTE customers. The complaints indicator is somewhat unusual but we have concerns about using the more standard complaint indicator, the complaint rate, in regulation. Not all customer complaints are necessarily appropriate or reflect poor service by a utility. Complaints may also be variable from year to year; for example, complaints could rise when there are a greater than normal number of service interruptions because of unfavorable weather. The current complaint indicator reflects the company's responsiveness in acting on a complaint, which is a valid reflection of the quality of service rendered and is less susceptible to these concerns. Finally, we believe that changes are not warranted for DTE's customer installations indicator since it is well within the mainstream of US regulation and amply supported by precedent.

7.2 Evaluation of Service Quality Regulatory Process

The second requirement for this project was to provide recommendations for a formal process of monitoring a possible expanded set of indicators. We are recommending that three indicators be added to the service quality regime for DTE. To accommodate these new indicators and advance the goal of establishing a more balanced service quality approach, especially in light of the PEP initiatives, we recommend the following modifications of the regulatory process for DTE:

- First, benchmarks need to be established for each of the new indicators. We would recommend that the benchmark be set at the 10 year average value on the respective service quality indicator. If ten years of consistently measured data (*e.g*. no discrete break in the observed data series due to the introduction of an OMS) are not available, then a moving average of the benchmark would be computed by rolling in data as they become available. This process would continue until ten years worth of data are available.

- SAIFI and SAIDI can fluctuate considerably from year to year because of factors beyond DTE's control, so to control volatility we recommend that both of these indicators be measured as the two-year average of the respective metrics.

- In addition, we recommend that deadbands be established around the benchmarks. The recommended deadbands will be set equal to one standard deviation, measured using the same data used to set the benchmarks. If less than ten years' worth of data are available and moving average benchmarks must be calculated in the interim, the recommended deadbands will also be updated annually.

- Michigan's current service quality framework allows for penalties only on the restoration and circuits indicators. Given the PEP initiatives, we believe that parties should consider extending the scope of potential penalties. Many of PEP's cost savings will evidently take place in operational areas that provide customer and retailing services. Thus, this report has been largely prompted by DTE's plans to cut spending in areas that may, unintentionally, lead to declines on the service quality attributes that are not currently subject to penalties in Michigan. Making all of DTE's service quality indicators (other than the downed wire indicators, for reasons mentioned below) subject to penalties will help to alleviate these concerns. Doing so will also eliminate the current asymmetry in the penalty regime, where reliability performance can be subject to penalties but non-reliability performance cannot. Extending the scope for potential penalties therefore creates more balanced incentives for DTE to maintain service for both reliability and non-reliability quality indicators. The latter may be particularly influenced by the cost reductions taking place through the PEP initiatives.

- As discussed, penalties and rewards in service quality regulation plans should ideally be linked to estimates of customers' valuation of service quality, but these estimates are difficult and costly to develop. Therefore, to develop feasible but well grounded estimates for penalties for the other indicators, the recommended approach is to use the average penalty amount for each of the relevant indicator tables presented in Chapter Six, scaled so that they are proportionate to DTE operations. Although for reasons of space these penalty rates are not listed in the relevant tables, this information is available to PEG. Thus:

- o the penalty rates for SAIFI and SAIDI would be based on the average penalties for SAIFI and SAIDI, respectively, for the plans listed in Table Three
- o the penalty rates for the telephone indicators would be based on the average penalty rates for the average speed of answer and the abandoned call rate for the plans listed in Table Six
- o the penalty rates for the metering and billing indicators would be based on the average penalty rates for the metering and billing indicators for the plans listed in Table Seven
- o the penalty rate for the customer installations indicator would be based on the average penalty rates for installations for the plans listed in Table Eight
- o the penalty rate for the customer complaint indicator would be based on the average penalty rates for complaints for the plans listed in Table Nine

This approach is feasible for all but the downed wire indicators, for which we are not aware of any relevant precedents. We therefore propose to exclude these indicators from the extended penalty regime. This is both practical and reasonable since these indicators are unique.

- DTE is allowed to propose service quality rewards in either a general rate case or single issue proceeding provided that it complies with certain conditions that are established by the MPSC.[33] For the reasons discussed in Chapters Three and Four, we believe that allowing rewards for service quality performance is generally good public policy, and it is typically appropriate to have balanced penalty-reward mechanisms in service quality regulation. We therefore recommend that DTE present a proposal to turn the penalty-only regime into a balanced penalty-reward approach at the earliest possible date (and provided that DTE has complied with all of the Commission's necessary requirements). The Company would be free to propose alternate estimates of penalties and rewards at this time.

- It is critical that all interested parties in Michigan have confidence in the data that are used in service quality regulation. This becomes even more important as service quality performance becomes more strongly linked to DTE's financial performance. We therefore recommend that the Company, MPSC Staff and perhaps other interested parties convene a technical conference and series of follow up discussions that educate Staff about precisely how the various service quality data are collected and what protocols can be established to ensure that the data provided to the MPSC are accurate. These discussions naturally do not reflect any suspicions that DTE will choose to provide inaccurate data to the Commission but, in light of the concerns with service quality data manipulation that have recently arisen in California and Minnesota, it is prudent to take steps to ensure that all parties know and understand the service quality data that are presented to regulators.

- Finally, it was noted that DTE does not currently collect certain indicators, such as MAIFI and the percent of calls to the telephone center answered within 30 seconds, which are either increasingly important or becoming the standard in service quality regulation. As part of the technical conference

[33] These conditions are specified in Part 4 of the Department of Labor and Economic Growth Public Service Commission *Service Quality and Reliability Standards for Electric Distribution Systems*, November 25, 2002.

related to data issues, we recommend that parties examine the costs and potential benefits to DTE and its customers of collecting MAIFI and enhanced telephone responsiveness metrics. It may be valuable for this examination to consider what other US utilities have collected MAIFI data, the different ways in which these companies have defined and measured MAIFI, how these differences in data compilation have impacted MAIFI measures, and the costs associated with different data collection systems.

7.3 Proposal for Service Quality Benchmarking

The third requirement for this project was to present a proposal for inter-company service quality benchmarking. As discussed in Chapter Five, service quality benchmarking is challenging. Rigorous and robust benchmarking would require a significant effort in standardizing measured service quality data, particularly for reliability indicators. This standardization would be required almost certainly within the State of Michigan, and ideally such efforts would be in conjunction with other States to provide as wide and rich a dataset as possible. Service quality benchmarking also involves technical econometric challenges, but we believe these are far more readily soluble than the efforts that would be required to standardize data.

If there is interest in pursuing service quality benchmarking in Michigan, we would propose the following process and approach:

- More data exists throughout the industry on reliability than for other service quality metrics; we therefore recommend a research project that begins by exploring service reliability benchmarking. The results of this project could then provide the foundation for the benchmarking of other service quality attributes.
- Data would be gathered from publicly available sources on SAIFI and SAIDI; PEG has in the past collected such publicly available data for as many as 70 US utilities operating under a wide range of business conditions

- Data would also be developed on business condition variables that can affect measured SAIFI and SAIDI, and these data would be mapped to specific electric utilities. In the past, PEG has gathered data on the following external business condition variables and mapped it to the companies in our SAIFI and SAIDI database:
    - Precipitation
    - Heating degree days
    - Cooling degree days
    - Electric utility customers per square mile of territory
    - Electric utility customers per circuit mile of distribution line
    - Percent of circuits that are underground
    - Percent of kWh deliveries to industrial customers
- Using the publicly available data developed above (including perhaps other business condition variables), the researcher would estimate econometric models that relate SAIFI and SAIDI to various business condition variables beyond management control. The econometric research would develop estimates of the quantitative impact of each of the external "quality drivers" on average SAIFI and SAIDI performance, respectively. Even if the SAIFI and SAIDI data are not measured uniformly across companies, the parameter estimates will not necessarily be biased provided that measurement error is random. This research can therefore be useful in better understanding the quantitative impact of various external factors on SAIFI and SAIDI performance.
- The reliability driver models can then be used to develop preliminary benchmarking evaluations of different utilities' reliability performance. This can be done by inserting values for the external business conditions into the estimated reliability driver econometric models. The results will be econometric benchmark predictions for SAIFI and SAIDI. Each company's actual SAIFI and SAIDI performance can then be compared to the predictions. However, these results must be interpreted with caution; in particular, this approach will not yield robust inferences on a utility's

SAIFI and SAIDI performance whenever a utility measures SAIFI and SAIDI in a way that differs from the way these indicators are measured, on average, by the firms in the sample that is used to estimate the econometric models.

- To develop more robust inferences on reliability performance, the researcher must apply the econometric approach in the step above to a set of SAIFI and SAIDI data that are measured comparably. Therefore, at the same time the econometric research outlined here is being pursued, the MPSC should commence a process to standardize SAIFI and SAIDI measures across the State's utilities. The resulting data can then be used to develop more robust benchmarking inferences.

7.4 Possible Further Research

Finally, it should be noted that service quality "value for the money" depends on both the utilities' efficiency in supplying quality and the customers' willingness to pay for quality improvements. Service quality benchmarking can address the efficiency of service quality provision, but research on consumers' demand and price-quality tradeoffs is necessary to evaluate willingness to pay. This topic did not arise in the settlement that prompted this report, so this topic goes well beyond our study.

Nevertheless, policymakers should not lose sight of the importance of customers' quality valuations for effective service quality regulation. Understanding customers' price-quality tradeoffs is critical if service quality regulation is to be structured so that it encourages utilities to provide the levels of service quality that customers actually demand.[34] A considerable amount of research also currently exists on the value of

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[34] Although a complete discussion of the topic is beyond the scope of this report, three basic methods are used to estimate the value of service quality. One method uses proxy data related to the service attribute. For example, the value of having to wait for a field service representative to arrive can be approximated as the customer's lost wages (*i.e.*, the opportunity cost of the customer's time). Proxy prices have the advantage of simplicity, but they can be imprecise and bear a tenuous link to actual service valuations.

A second method of estimating customer valuation uses market-based measures for the value of service. The difference between firm and interruptible rates is one example of market-based data that reflects some customers' valuations of reliability. Another example of market-based measures is the use of reliability to different customer groups, and there are rigorous methods for translating this research into penalty/reward rates for SAIFI and SAIDI indicators.[35] [36] At a

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hedonic price indexes, which are developed by regressing market prices on identifiable quality attributes. Hedonic price indexes reflect the notion that price differences are due to implicit markets for individual product characteristics. Some official statistics utilize hedonic methods; for example, the Bureau of Labor Statistics adjusts for quality changes of some products when computing the Consumer Price Index. While market-based methods are often conceptually sound, they can be controversial, are often not well-understood, and can produce divergent estimates of underlying quality valuations. In addition, hedonic methods are less likely to capture the underlying quality valuations in utility markets since prices often reflect regulatory decisions rather than market forces.

Finally, quality valuations can also be obtained through customer surveys. An advantage of this approach is that surveys can focus on specific aspects of utility services that might be included in an incentive plan. However, survey results reflect subjective perceptions rather than actual consumer behavior, and hypothetical valuations may not be a good guide to how consumers would actually act in markets. However, some survey approaches (such as conjoint analysis) better approximate actual consumer behavior and are likely to yield superior results.

[35] For further information on estimating the value of service reliability *per se*, see Caves, Herriges and Windle (1989) and Horowitz and McConnell (2002)

[36] The outage cost literature suggests that outages impose both fixed and variable costs on customers. Fixed costs are those that occur immediately when, for example, service interruptions disrupt an industrial customer's production plans. Variable costs are related to the duration of an outage. The relative proportions of these costs vary among customer groups. Industrial customers typically have a higher proportion of fixed costs, while residential customers usually have a lower proportion of fixed costs.

Let the system–wide cost for each outage, *i*, be given by

$$C_i = a + bh_i \qquad [1]$$

Here, C_i is the cost of the outage and h_i is the total duration of the outage experienced by customers on the system. This simple, linear expression says that outage costs can be decomposed into two components. The fixed costs, *a*, are incurred immediately as power interruptions disrupt production plans. The variable costs, bh_i, are related to the length of the outage. Total annual outage costs are obtained by summing the costs per outage in [1] over the number of outages in each year. Total outage costs in each year, *t*, are therefore equal to

$$TC_t = \sum_i (a + bhi) = N_t a + b\sum h_{i,t} \qquad [2]$$

Here, N_t stands for the number of interruptions experienced in year, *t*. The average outage costs experienced by customers on the system can be obtained by dividing [2] by the average number of customers served in year *t*, or C_t. Therefore

$$\frac{TC_t}{C_t} = a\frac{N_t}{C_t} + b\frac{\sum h_{i,t}}{C_t} \qquad [3]$$

In equation [3], $\frac{N_t}{C_t}$ corresponds to the average number of interruptions experienced by a customer on the system in year *t*. This is equivalent to the value of SAIFI in that year. Similarly, $\frac{\sum h_{i,t}}{C_t}$ stands for the total duration of outages experienced by an average customer on the system in year *t*. This is equivalent to the value of SAIDI in that year. Equation [3] therefore implies that the annual outage costs experienced by an average customer is a linear function of values for SAIFI and SAIDI. SAIFI is multiplied by the average fixed costs associated with an outage. SAIDI is multiplied by the average variable costs associated with a typical outage.

minimum, a better understanding of this research could be helpful for informing the choices for SAIFI and SAIDI penalty and reward rates. This understanding could also prove to be beneficially more generally for regulatory policy in the State.

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