# USE OF KEY PERFORMANCE INDICATORS BY REGULATORS

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# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| BTU | British Thermal Unit |
| CA | Central Asia |
| CAIDI | Customer Average Interruption Duration Index |
| CAIFI | Customer Average Interruption Frequency Index |
| CEER | Council Of European Energy Regulators |
| CoS | Continuity of Supply |
| CTAIDI | Customer Total Average Interruption Duration Index |
| DER | Distributed Energy Resources |
| ECRB | Energy Community Regulatory Board |
| EE | Energy Efficiency |
| FAC | Fuel Adjustment Clause |
| HEA | Hungarian Energy and Public Utility Regulatory Authority |
| HV | High Voltage |
| KPI | Key Performance Indicator |
| kWh | Kilowatt hour |
| MV | Medium Voltage |
| MW | Megawatt |
| O&M | Operations and Maintenance |
| PCA | Power Central Asia |
| PSC | Public Service Commission |
| RERA | Regional Energy Regulators Association of Southern Africa |
| SAIDI | System Average Interruption Duration Index |
| SAIFI | System Average Interruption Frequency Index |
| T&D | Transmission and Distribution |
| USAID | United States Agency for International Development |

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# INTRODUCTION

Over the last two years, regulators and utilities in Central Asia (CA) have requested information from the United States Agency for International Development (USAID) Power Central Asia (PCA) program about using Key Performance Indicators (KPIs) for improving the performance of power utilities. This paper aims to respond to these requests and answer many of their questions.

KPIs are performance metrics used by regulators to measure and monitor the performance of a utility. Regulators use KPIs as a tool to align the interests of utility owners and management with those of customers. KPIs can focus on measuring progress towards achieving specific goals related to standard operational metrics such as customer service, reliability of service, or line losses, or for recent goals associated with combating climate change. They can also be used to advance progress towards meeting broader goals such as motivating utilities to become more efficient and productive.

KPIs are also beneficial for helping utilities to proactively plan for changes that may impact their operations such as amendments to state laws or, more recently, COVID- related changes in demand. They can be used to monitor how externalities such as new technologies impact short- and long-term utility operations and targets.

Regulators can use KPIs to improve utility performance and benefit customers through lower prices and improved service. For example, KPIs and rewards/penalties mechanisms can be used to improve utility plant (asset) utilization, reduce O&M expenses, improve system reliability and customer service, advance public policy initiatives such as Demand Side Management and combating climate change, and simulate competition where competition is not possible.

These performance mechanisms can motivate utility management by providing an additional return on their investment for superior performance or by penalizing poor performance. The mechanisms can also enunciate regulatory rules up front to communicate to the utilities as to what the regulatory priorities are so that utilities have a road map for what to focus on. The KPIs and targets chosen for KPI metrics affect utility investment decisions. There can be rewards or penalties or a combination of both attached to the performance of a utility. For example, rewards can be tied to the utility achieving a reduction in Transmission and Distribution (T&D) losses or penalties can be associated with a deterioration in service quality.

To assess utility performance, regulators can use time series analysis (i.e., monitoring changes in utility performance from period to period) and/or cross-sectional analysis (i.e., monitoring utility performance relative to its peers). The design of the regulatory mechanism for monitoring performance is important for achieving intended results and avoiding perverse incentives. For example, it's important to select performance targets that add value to the system and meet customer needs, are cost-effective, and are achievable for the utility.

In designing KPIs, it is important to consider regional perspectives and objectives. A set of regionally agreed KPIs in Central Asia would harmonize monitoring of utility performance and advance regional cooperation in the power sector.

The section below describes potential KPIs. Utilities can use KPIs, selected by a utility's Board or senior management, to assess their own performance. Typically, the number of metrics chosen for internal monitoring by utilities would be significantly greater than what regulators use. The following section discusses regulatory approaches for using KPIs. The report also contains two annexes, one describing illustrative performance mechanisms using KPIs for generation, and the other providing a survey of use of KPIs by regulators around the world.

## LIST OF POTENTIAL KPIS

KPIs can be grouped into several performance areas as follows:

- Financial;
- Operational Efficiency;
- Reliability;
- Customer Service;
- Public Policy.

Within each area, there are several metrics that can be measured and evaluated. Examples of these include:

FINANCIAL

Coverage: Can the utility cover its debt service obligations?
- ✓ Times interest earned ratio = earnings before interest and taxes divided by interest expense
- ✓ Debt service coverage ratio = net income divided by debt service (interest, principal, and lease payments)

Solvency or Leverage: How much is the utility leveraged?
- ✓ Total debt ratio = total liabilities divided by total assets
- ✓ Debt-to-equity ratio = total liabilities divided by (total assets minus total liabilities)

Profitability: How profitable is the utility?
- ✓ Net profit margin = net income divided by sales revenues
- ✓ Return on total assets = net income divided by assets
- ✓ Return on equity = net income divided by common equity

Tariff Coverage: What elements of utility costs does the tariff cover?
- ✓ Operational revenue/Operating costs
- ✓ Operational revenue /Operating costs plus capital costs

Collections: How effective is the utility at collecting payments from customers?
- ✓ Bill collection rate
- ✓ Average debt collection period
- ✓ Bad debt percentage of revenues

OPERATIONAL EFFICIENCY

Losses: What are the levels of various losses?
- ✓ Transmission losses
- ✓ Distribution technical energy losses
- ✓ Distribution non-technical (commercial) energy losses

Productivity: How productively are operations being conducted?
- ✓ T&D Operations and Maintenance (O&M) costs
    - T&D O&M cost per connection
    - T&D O&M cost per kilowatt hour (kWh) sold

- ✓ Staff/Labour Productivity
  - Staff/Labour cost to total cost
  - Energy Sold per employee
  - # of residential connections per employee

RELIABILITY

Outage/interruptions: What is the frequency and duration of outages to customers?

- ✓ System Average Interruption Frequency Index (SAIFI)
- ✓ Customer Average Interruption Duration Index (CAIDI)
- ✓ System Average Interruption Duration Index (SAIDI)

CUSTOMER SERVICE

Utility Service to Customers: How well is the utility serving its customers in its various interactions with customers? How satisfied are customers with their utility?

- ✓ Billing Accuracy
- ✓ Meter reading on time
- ✓ Appointments kept
- ✓ New connections provided on time
- ✓ Call answer rate
- ✓ Customer satisfaction with utility
- ✓ Customer complaints to the regulatory commission

PUBLIC POLICY

Utility performance on achieving public policy goals: How well is the utility progressing towards meeting public policy goals set out by the regulators and government policy makers?

- ✓ Energy Efficiency (EE): Cost effective EE achieved (Megawatt Hour, Megawatt (MW))
- ✓ Peak Load Reduction: Load (MW) reduced during system peak hours (permanent, as needed) through Demand Response
- ✓ Distributed Energy Resources (DER): New clean DER added in the system (MW)
- ✓ Electrification of transportation and other sectors in the economy
- ✓ Overall emission reductions

The following section describes how regulators can use KPIs to motivate utilities to improve their performance.

## REGULATORY USE OF KPIS

As described below, regulators can use several approaches to motivate utilities to improve their performance. The following section describes illustrative indicators, which are not mutually exclusive.

### USE OF STANDARDS

The regulator sets standard(s) for the performance indicators of interest and the utility is required to report on their performance relative to this standard. If there is a significant deviation in actual performance compared to the target, the regulator may take follow up action to explore the reasons for the deviation and any corrective actions needed.

For example, New York state regulators adopted service reliability standards in 1991, which were updated in 2004[1]. These encompass measures for frequency of interruptions (SAIFI) and duration of interruptions (CAIDI). The calculations exclude "Major Storms" (10%+ customers out for >24 hours) to normalize data for year-to-year comparisons. The targets are based primarily on historic performance and trends, geographic and technology conditions, demographics, and customer expectations. They allow room for yearly variability in smaller regions. The following table shows the standards for SAIFI and CAIDI for each of the six electric utilities in New York. The standards differ for each region served by each of the utilities. For the largest utility, Con Edison, they vary for network versus radial service areas.

**TABLE 1. SERVICE STANDARDS FOR RELIABILITY (2004)**

| ELECTRIC SERVICE STANDARDS LEVELS | | | |
|---|---|---|---|
| Duration Hours | | Interruption Frequency | Interruption |
| Company | Operating Division | (SAIFI) | (CAIDI) |
| CHGE | Catskill | 1.00 | 2.00 |
| | Fishkill | 1.20 | 2.00 |
| | Kingston | 1.00 | 2.25 |
| | Newburgh | 1.20 | 2.00 |
| | Poughkeepsie | 1.20 | 2.25 |
| NMPC | Capital | 0.90 | 2.00 |
| | Central | 1.00 | 2.00 |
| | Frontier | 0.60 | 1.75 |
| | Genesee | 1.00 | 2.00 |

[1] See New York Public Service Commission Order on Reliability Standards: https://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7BD9001691-1895-462A-A827-1BC09245548F%7D

## TABLE 1. SERVICE STANDARDS FOR RELIABILITY (2004)

| ELECTRIC SERVICE STANDARDS LEVELS | | | |
|---|---|---|---|
| Duration Hours | | Interruption Frequency | Interruption |
| Company | Operating Division | (SAIFI) | (CAIDI) |
| | Mohawk | 1.20 | 2.50 |
| | Northeast | 1.20 | 2.50 |
| | Northern | 1.00 | 2.25 |
| | Southwest | 1.00 | 1.75 |
| NYSEG | Auburn | 1.00 | 1.75 |
| | Berkshire | 1.40 | 2.00 |
| | Binghamton | 1.00 | 2.00 |
| | Brewster | 1.70 | 2.25 |
| | Elmira | 1.00 | 2.50 |
| | Geneva | 1.20 | 2.00 |
| | Hornell | 1.00 | 2.00 |
| | Ithaca | 1.20 | 2.25 |
| | Lancaster | 1.20 | 1.75 |
| | Liberty | 1.70 | 2.50 |
| | Oneonta | 1.00 | 2.50 |
| | Plattsburgh | 1.70 | 1.75 |
| ORU | Central | 1.40 | 1.75 |
| | Eastern | 1.20 | 1.50 |
| | Western | 1.70 | 2.00 |
| RGE | Canandaigua | 1.40 | 1.50 |
| | Genesee/Pavilion | 1.40 | 1.75 |
| | Lakeshore | 1.40 | 1.50 |
| | Rochester | 0.80 | 2.00 |
| CONED (Radial) | Queens | 0.35 | 1.50 |
| | Brooklyn | 0.45 | 1.50 |

| TABLE 1. SERVICE STANDARDS FOR RELIABILITY (2004) | | | |
|---|---|---|---|
| ELECTRIC SERVICE STANDARDS LEVELS | | | |
| Duration Hours | | Interruption Frequency | Interruption |
| Company | Operating Division | (SAIFI) | (CAIDI) |
| | Bronx | 0.45 | 1.50 |
| | Staten Island | 0.55 | 1.50 |
| | Westchester | 0.55 | 2.00 |
| CONED | Manhattan | 0.015 | 3.75 |
| (Network) | Brooklyn | 0.015 | 3.25 |
| | Bronx | 0.015 | 3.25 |
| | Queens | 0.008 | 3.25 |
| | Westchester | 0.008 | 3.25 |

## ROUTINE MONITORING AND ANALYSIS

On a routine and/or an as-needed basis, regulatory staff can monitor and audit utility activities to assess utility performance. For example, each year, the New York state regulator publishes the performance of utilities with respect to service metrics. As shown in Table 2, the 2020 report shows the utilities' performance over time with respect to service reliability for seven electric utilities in New York[2].

**TABLE 2. PERFORMANCE OF UTILITIES ON RELIABILITY INDICES**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 5 YR AVG |
|---|---|---|---|---|---|---|
| **CHGE** | | | | | | |
| FREOUENCV | 1.34 | 1.18 | 1.50 | 1.26 | 1.30 | 1.32 |
| DURATION | 2.33 | 2.20 | 2.04 | 2.38 | 2.37 | 2.26 |
| **CONED** | | | | | | |

[2] See New York Public Service Commission Electric Reliability Performance Report 2020: https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/d82a200687d96d3985257687006f39ca/$FILE/2020%20Electric%20Reliability%20Report.pdf

## TABLE 2. PERFORMANCE OF UTILITIES ON RELIABILITY INDICES

| | 2016 | 2017 | 2018 | 2019 | 2020 | 5 YR AVG |
|---|---|---|---|---|---|---|
| FREOUENCV | 0.13 | 0.11 | 0.12 | 0.18 | 0.19 | 0.15 |
| DURATION | 2.49 | 2.77 | 2.75 | 3.33 | 2.75 | 2.82 |
| **PSEG-LI *** | | | | | | |
| FREOUENCV | 1.11 | 0.95 | 0.86 | 0.68 | 0.80 | 0.88 |
| DURATION | 1.14 | 1.16 | 1.27 | 1.27 | 1.38 | 1.24 |
| **NAT GRID** | | | | | | |
| FREOUENCV | 1.05 | 1.03 | 1.02 | 1.03 | 1.05 | 1.03 |
| DURATION | 2.02 | 1.99 | 2.04 | 2.02 | 2.03 | 2.02 |
| **NYSEG** | | | | | | |
| FREOUENCV | 1.19 | 1.18 | 1.20 | 1.36 | 1.37 | 1.26 |
| DURATION | 2.02 | 2.06 | 2.17 | 1.93 | 1.98 | 2.03 |
| **O&R** | | | | | | |
| FREOUENCV | 1.06 | 0.92 | 1.14- | 1.09 | 0.97 | 1.04 |
| DURATION | 1.70 | 1.68 | 1.82 | 1.71 | 1.67 | 1.71 |
| **RG&E** | | | | | | |
| FREOUENCV | 0.58 | 0.59 | 0.75 | 0.73 | 0.89 | 0.71 |
| DURATION | 1.79 | 1.77 | 1.79 | 1.84 | 1.78 | 1.79 |

These metrics are published each year with an analysis of the reasons for changes from one period to the next. Further, the report presents an analysis of the reasons for outages and corrective actions taken. For example, Figure 1 below shows the root causes for outages for one New York state utility, National Grid.

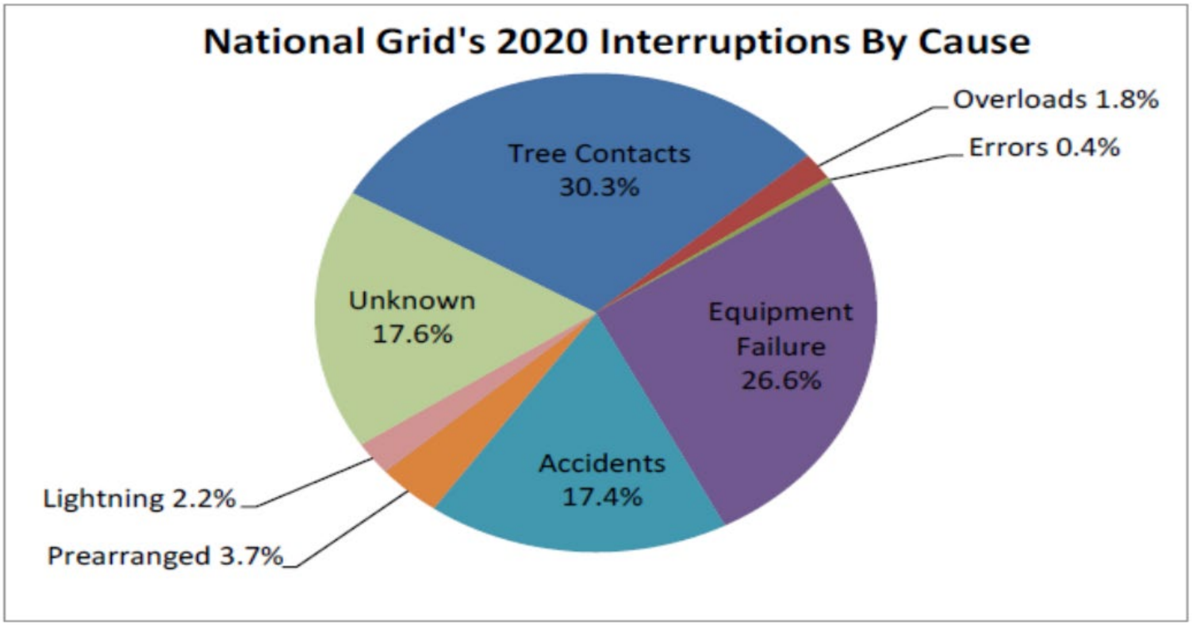


Figure 1: National Grid`s Interruptions By Cause (2020)

## SPECIAL INVESTIGATIONS

Regulators can conduct specific investigations following any major emergency events that affects service to customers to evaluate utility preparedness for the emergency event, execution of its emergency preparedness plan, and its overall performance in responding to the event. The utility develops emergency preparedness plans for major events and, each year, updates and files them with the regulators for their approval.[3] The plans describe how the utility will assess damage to the utility system, how it will fix the damages, roles and responsibilities of various units in the utility, how it will mobilize utility crews, how it will communicate with customers and the public, how it will address the needs of special customers who need continuous power supply for medical devices at homes, and several other aspects associated with dealing with emergency events. The annual updates consider the lessons learned from previous events. The regulator's evaluation of utility performance after an event is based on how well the utility followed its plan and executed it. There are built-in KPIs in the plans on time frames for various activities that utilities must follow in responding to such events and other process related metrics.

The next section goes into more detail on the use of rewards and penalties as a regulatory tool to motivate utilities.

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[3] For illustration, see the Commission Order approving utility emergency preparedness filings: https://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={CAD46EBE-AE43-4F06-A263-F8A6B82AC689}

## INCENTIVE AND PENALTY MECHANISMS

In addition to setting performance standards, monitoring performance against these standards, and conducting special investigations, regulators can establish incentives and penalties to further motivate utilities to achieve performance targets. Regulators can set targets for selected indicators and tie rewards or penalties to utilities' progress towards achieving these.

CAUTIONARY NOTE:

As a cautionary note upfront, it should be mentioned that despite the benefits that KPIs and reward/penalty mechanisms can offer, they can lead to unwanted or unintended consequences if not properly designed. For example, if the KPIs provide a strong incentive for utilities to reduce O&M costs, the utilities would do so and reduce O&M costs. But it is possible that utilities can reduce O&M expenditures, not through efficiency or productivity improvements but by simply cutting corners to increase profits. For example, they may not maintain the utility equipment as needed or do vegetation management as required. If the utility assets are not adequately maintained, reliability of service to customers may suffer. Typically, the drop in service quality to customers lags the utility investments, so cuts in costs now will show up as a drop in service quality in a few years. Such an outcome of cutting costs indiscriminately that would lead to service quality drop should be guarded against. Incentives to cut costs must be coupled with those aimed at maintaining or improving reliability to ensure reductions in O&M expenses occur only through increasing efficiency and productivity. Selecting appropriate KPIs is paramount so that utility management can focus on priority areas without putting other areas at risk. If improperly designed, performance benchmarks or targets may benefit the utility or customer to the disadvantage of the other party. Finally, if the consequences to the utility relate to external factors that are beyond the utility's control, they could increase a utility's business risk and concomitant cost of capital.

### PRINCIPLES FOR REGULATORY PERFORMANCE MECHANISM

Regulators should identify the goals to achieve in designing the performance mechanism. Typical goals include improving the efficiency and productivity of the utility, enhancing incentives and removing disincentives for reducing utility costs, and maintaining and improving service quality. Regulators must determine what to encourage and what to discourage as this focus affects utility motivation. For example, if the regulator focuses on tariff per unit prices, this sends a particular signal. If the focus, however, is on the customer's total bill, then the quantity used also becomes important as the bill is a product of per unit price and quantity used. The focus on quantity used will affect the deployment of energy efficiency activities. Regulators' design of the mechanism essentially allocates risks between customers and utilities, and this must be done in a manner that yields fair and efficient outcomes.

### KPI ATTRIBUTES

For performance mechanisms to be effective, the KPIs must be measurable, quantifiable, and auditable. This is extremely important to ensure that the KPIs are measuring what they are intended to measure and are being represented accurately by the utility. If not, the results may not be meaningful, and the regulator may not accomplish what was intended. The robustness of data depends on how well it is collected, stored, and tabulated, and the internal controls used to ensure its accuracy. This attribute is even more important in emerging economies where the robustness of data is not yet fully established. For example, it is likely that data for certain KPIs such as reliability indicators may be well established, but it is less likely for other KPIs discussed earlier in this report. Furthermore, as regulators are in the position of understanding customer preferences and values, KPIs should be designed to reflect these. As performance improvements typically require additional capital and/or O&M expenditures, it is essential that cost effectiveness be considered in setting performance targets. While motivating utilities to improve performance, the performance mechanisms must allow for adequate flexibility by utility management in deciding how it can best achieve them. Finally, the mechanisms must be simple, fair, and acceptable to stakeholders.

## DESIGN OF THE PERFORMANCE MECHANISM

In designing performance mechanisms, the regulator must define several parameters. An example parameter is the number of years the performance mechanism is valid for. Longer periods provide the utility with more flexibility to execute their plans and achieve the performance goals. This provides "regulatory lag," where the utility can keep some of the productivity-related savings for a longer period. Another parameter is the time period over which performance is measured – e.g., on a monthly, seasonal, or annual basis. Evaluation of performance on an annual basis would typically address seasonality and other monthly aberrations. Furthermore, it is important to define the specific products or service baskets to which the performance mechanism applies. The KPIs could relate to the performance of the overall utility or to just a business segment (generation, transmission, or distribution) or for a given customer class (residential, commercial, or industrial).

Establishing clear guidelines for determining rewards or penalties is extremely important. The targets and associated rewards/penalties could be symmetric or asymmetric for some or all the metrics. For example, there may only be penalties for not achieving reliability metrics as the utility is expected to provide a given level of service. On the other hand, the utility may earn rewards for achieving energy efficiency targets as otherwise it may not be interested in doing so. They can be expressed in absolute dollar terms, as a % of revenues, or in basis points return on equity to utility investors, e.g., 100 basis points (1%) return on equity.

Regulators must decide whether retaining the status-quo performance level is sufficient or whether they seek performance improvements for a given metric. For example, the current reliability level may be adequate and so there may be no need to provide incentives for improving reliability. As discussed before, performance improvements generally incur incremental costs and the utility would spend more in capital and/or O&M, which would in turn increase customer costs. Regulators must weigh the incremental costs against the value of the associated incremental improvements in service. Factors to consider include whether the reward/penalty and the targets address specific needs of the system and customers, provide sufficient motivation to the utility, provide adequate value to customers, are cost effective, and are acceptable to stakeholders.

## ILLUSTRATION OF A PERFORMANCE MECHANISM

An illustration of how regulators design performance mechanisms used is provided here. The following performance incentive mechanism for National Grid is an example of how penalties are used to incentivize National Grid to meet reliability, customer service and satisfaction standards. The regulator set performance targets for six KPIs: utility customer complaints to the Public Service Commission (PSC); residential customer satisfaction with the utility; small and medium commercial and industrial customer satisfaction with the utility; utility customer service responsiveness to customers; and reliability metrics SAIFI and CAIDI.[4] In this example, penalties are imposed on the utility for failing to meet the targets and they are graduated based on performance level. For example, if the complaints from customers to the regulator exceeds a target of 1.4 per 100,000 customers in 2022, then the company will face a penalty of 10 basis points (100 basis points = 1%) on its Return on Equity (profits to shareholders). The financial penalty paid by the utility if it fails to meet the targets would inure to the benefit of all customers and will be returned to customers in a fashion approved by the regulator.

**TABLE 3. EXAMPLES OF PERFORMANCE INCENTIVE MECHANISMS**

| PSC Complaint Rate per 100,000 Customers | Basis Points at Risk CY 2022 | Basis Points at Risk CY 2023 and 2024 |
|---|---|---|
| ≤1.0 | 0 BP | O BP |
| > 1.0 | 2 BP | 3 BP |
| ≥ 1.2 | 5 BP | 6 BP |
| ≥ 21.4 | 10 BP | 12 BP |
| Residential Customer Satisfaction Survey Interval | Basis Points at Risk CY 2022 | Basis Points at Risk CY 2023 and 2024 |
| ≥ 82.0% | 0 BP | 0 BP |
| < 82.0% | 2 BP | 3 BP |
| ≤ 81.0% | 5 BP | 6 BP |
| ≤ 79.9% | 10 BP | 12 BP |
| Small / Medium C&I Customer Satisfaction Survey Interval | Basis Points at Risk CY 2022 | Basis Points at Risk CY 2023 and 2024 |
| ≥ 78.0% | O BP | O BP |
| ≤ 78.0% | 2 BP | 3 BP |

[4] There are several other KPIs in the performance mechanisms but only a few are mentioned here for illustration. The appendix in the National Grid document also spells out significantly more details on each of the KPIs. See, Appendix 15 in the National Grid document at https://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={5468B0C8-519D-48AE-8703-3ECA4CEA50BA}

| TABLE 3. EXAMPLES OF PERFORMANCE INCENTIVE MECHANISMS | | |
|---|---|---|
| ≤ 75.5% | 5 BP | 6 BP |
| ≤ 73.0% | 10 BP | 12 BP |
| % Calls answered by a representative within 30 seconds | Basis Points at Risk CY 2022 | Basis Points at Risk CY 2023 and 2024 |
| ≥ 79.2% | 0 BP | 0 BP |
| < 79.2% | 2BP | 3 BP |
| ≤ 77.0% | 5 BP | 6 BP |
| <74.9% | 10 BP | 12 BP |

System Average Interruption Frequency Index ("SAIFI"): If the Company's SAIFI performance for the calendar year exceeds 1.08, the Company will incur a $4 million negative revenue adjustment.

Customer Average Interruption Duration Index ("CAIDI"): If the Company's CAIDI performance for the calendar year exceeds 2.10, the Company will incur a $4 million negative revenue adjustment.

# CONCLUSION

Utilities have long used KPIs to measure and monitor their own performance. They can monitor their performance over time for each of the KPIs selected and can benchmark their performance against peer utilities. Regulators have also been using KPIs as a tool to measure and monitor utility performance and align customers' interests and utility owners/managers' interests. The number of KPIs typically used by regulators are fewer and more macro in nature and often focus on areas such as operational efficiency and service quality.

Utilities must pay attention to the KPIs that regulators choose to monitor. In turn, regulators must ensure that the KPIs they select reflect customer and system needs and do not lead to unintended consequences. Regulators can simply set standards and evaluate utility performance against the standards. They can also continuously monitor performance on the KPIs and conduct root cause analysis for variances and take corrective actions where necessary. Many regulators use KPIs in performance-based mechanisms that reward or penalize a utility according to the extent to which they meet targets, lately with special emphasis on accomplishing public policy goals. These performance mechanisms must be well designed to ensure they serve the intended purpose.

Annex 1 to this report provides an illustration for a performance mechanism for addressing generation related costs. A recent PCA assessment shows that most Central Asian countries do not have a full set of technical and quality of service standards nor regulations for monitoring utility performance. Furthermore, related regulatory frameworks need to be assessed for their completeness. Annex 2 presents examples from Europe, Southern African and the USA on how regulatory procedures and outcomes can be streamlined and harmonized. These can be instructive for the development of harmonized regulatory frameworks for monitoring utility performance in CA countries.

Greater integration of CA energy infrastructure and markets could benefit CA countries by enabling increased access to more reliable, affordable, and environmentally friendly power services. Regional integration could be enhanced by developing and harmonizing regulatory frameworks for monitoring utility performance. Regulators could coordinate to harmonize performance mechanisms such as KPIs, procedures for collecting performance data, methodologies for data analysis, and schemes for setting incentives/ penalties. Establishing a set of regional KPIs for CA would be a significant step forward towards regional integration. PCA could support this effort through establishing a regional coordination platform for exchanging knowledge and best practices on KPI development and harmonization, among other activities.

# ANNEX 1: USING KPIS TO MONITOR GENERATION PERFORMANCE

Generation costs constitute a major portion of a utility's cost structure and a large part of the customer bill in many electric systems. Supply costs include cost of fuel, variable O&M costs, return on and of capital, and other fixed costs. In this example, only the fuel costs are addressed. However, there can be performance mechanisms and rewards/penalties for capital costs as well.

In many systems, there are fuel adjustment clauses (FAC) in place (primarily for thermal power plants) that allow the utility's total fuel costs to be passed through to customers with the assumption that fuel costs are beyond the utility's control. If there is a straight pass-through of fuel costs through an FAC, there is no incentive for increasing generation efficiency and this can skew the tradeoff between capital and operating costs as operating costs will be fully recovered via the FAC.

Regulators can tie rewards/penalties to maximize fuel efficiency and minimize fuel costs. For example, a KPI could be tied to heat rate performance. A target heat rate can be set in a tariff case. If the utility improves its heat rate compared to the target, it keeps fully or partially the associated benefits of lower fuel costs. Conversely, if the utility's heat rate is worse than the target level, only a part of the higher resulting fuel costs can be passed through to customers through the FAC.

To illustrate, say the target heat rate for a given period is 9,000 British thermal unit (Btu)/kWh. Based on this target, the fuel costs in the period are expected to be $5 million. If the actual heat rate during the period is 8,550 BTU/kWh, then the fuel costs would be $4.75 million, all else equal. The regulator can allow the utility to keep all the savings ($0.25 million) or pass on some percentage of the savings to customers. The higher the percentage the utility keeps, the higher its incentive to improve efficiency. If the actual heat rate is 9,450 Btu/kWh, then the fuel costs would be $5.25M, all else equal. The regulator can allow the utility to pass on none of the incremental cost to customers or pass on only some of it to customers. The less the utility passes on to customers, the more incentive the utility must keep costs down. This mechanism is intended to motivate the utility to improve its plant heat rate and thus efficiency and lower overall fuel costs to customers. Of course, the penalty levels and magnitudes must be balanced against other financial considerations (e.g., credit rating of the utility).

Regulators can also consider other metrics such as fuel procurement costs, plant capacity factor, plant availability, etc. Alternatively, regulators can set incentives for total supply costs. Here the reward/penalty mechanism could be based on "level of rate" or "rate of change." For example, under the level of rate (price per unit), one could compare a utility supply price to a target price based on a peer group cost (top 10 percentile) and expect the utility to bring the price toward the target. The peer group should have a similar generation resource mix and customer load profile. If a utility's price per unit is 4 c/kWh, while the peer-based target is 3c/kWh, regulators could set up a performance mechanism to motivate the utility to bring price down to 3c/kWh over a period. Under the "rate of change" approach, the utility would be rewarded or penalized for changes in its costs relative to the peer group cost. If a utility's price is 4c/kWh, while the peer group price is 3c/kWh, then if both go up/down by 10% next period, there would be no reward or penalty. But if the peer group price stays the same but the utility's price goes down by 10%, then there would be a reward; if the peer group price stays the same but the utility's price goes up by 10%, then there would be a penalty. These mechanisms are not easy to construct. Comprehensive and accurate data is needed for normalization to make sure the comparison between the utility and the peer group is "apples to apples."

# ANNEX 2: INTERNATIONAL EXAMPLES OF HOW KPIs ARE USED BY REGULATORS

This annex presents the current use of KPIs by regulators in CA countries and how KPIs are being or could be used by regulators in Europe, Southern Africa, and the state of New York, USA.

## CENTRAL ASIA: CURRENT STATUS OF QUALITY-OF-SERVICE STANDARDS REGULATORY FRAMEWORKS

In 2021 and 2022, PCA undertook Legal and Regulatory Gap assessments of the power sectors of the Central Asian countries of Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan, and Turkmenistan. PCA finalized five Gap Assessment reports which identified key regulatory areas that are not or only partially addressed in each of the country's legal and regulatory frameworks. Table 4 presents the key findings from this assessment including those related to monitoring and technical and quality-of-service standards.

**TABLE 4. SCORECARD FOR ENERGY REGULATORY FRAMEWORKS IN CA COUNTRIES**

| | KAZAKHSTAN | THE KYRGYZ REPUBLIC | TAJIKISTAN | TURKMENISTAN | UZBEKISTAN |
|---|---|---|---|---|---|
| Regulatory Authority Established | Yes | Yes | Yes | No | No |
| Status of Regulator, if Established | | | | | |
| Autonomous | No | Yes | Yes | N/A | N/A |
| Independent | No | No | No | N/A | N/A |
| Status of Specific Regulatory Frameworks | | | | | |
| Licensing Process | Yes | Yes | Yes | Yes | Yes |
| Monitoring Regulation | Yes | No | No | No | No |
| Dispute Resolution Procedure | Partially developed | No | No | No | No |
| Technical and Quality of Service standards Regulation | Partially developed | Partially developed | No | Partially developed | Yes |
| Tariff-Setting Framework | | | | | |
| Tariff Methodologies are Available | Yes | Yes | No | No | No |
| Tariff Regulation with Methodological and Procedural Guidance is in Use | Yes[5] | Yes | Yes | No | No |
| Special Treatment of RES | Yes | Yes | No | No | No |
| Degree of Sector Structural Unbundling | | | | | |
| Vertically Integrated | No | No | No | Yes | No |
| Accounting Unbundling | Yes | Yes | In progress | No | In progress |

[5] Tariff regulation and methodologies are available and in use. However, they require amendments given recent challenges and issues in the power sector.

| TABLE 4. SCORECARD FOR ENERGY REGULATORY FRAMEWORKS IN CA COUNTRIES | | | | | |
|---|---|---|---|---|---|
| | KAZAKHSTAN | THE KYRGYZ REPUBLIC | TAJIKISTAN | TURKMENISTAN | UZBEKISTAN |
| Functional Unbundling | Yes[6] | Yes | In progress | No | In progress |
| Legal Unbundling | Yes | Yes | Yes | No | Yes |
| Marketplace Organization | | | | | |
| Market Rules Adopted | Partially developed | Yes | No | No | No |
| Grid Code in Place | Partially developed | Yes | Yes | No | No |

Table 4 above shows that only Uzbekistan has fully developed and implemented regulations for technical and quality of services standards. In Kazakhstan, Kyrgyzstan, and Turkmenistan, there is a regulatory framework (decree/ regulation) covering quality of service standards, but these regulations need to be assessed for completeness. Tajikistan has not developed any regulations related to technical and quality of services standards.

All CA countries monitor implementation of the quality-of-service standards, but Kazakhstan is the only country that has monitoring regulations in place. The other four countries use old regulations and legal acts from the Soviet period or have a patchwork of relevant regulations but no regulations covering the full scope of monitoring procedures.

### COUNCIL OF EUROPEAN ENERGY REGULATORS (CEER) REPORT ON CONTINUITY OF SUPPLY KPIS

The Council of European Energy Regulators (CEER) publishes periodic reports on its findings and recommendations on the Continuity of Supply (CoS) in various European countries.

The overall findings and recommendations from the 2016, 6thCEER benchmarking report are presented below[7].

<u>OVERALL FINDINGS:</u>

1. CoS is monitored in all responding countries.
2. CoS indicators and procedures for data collection and analysis vary across countries.
3. Calculation of CoS indicators varies across countries.
4. There is a different approach to exceptional events across countries.
5. Incentive schemes are used to regulate CoS in distribution and transmission networks.
6. Incentive schemes for individual continuity levels are used in many countries and have different formulations.

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[6] Given that several electricity generating companies, transmission, and supply organizations are controlled by one state owned company, it is possible that certain management functions of these companies are not unbundled.

[7] 6th CEER Benchmarking Report On The Quality Of Electricity And Gas Supply https://www.ceer.eu/documents/104400/-/-/d064733a-9614-e320-a068-2086ed27be7f

OVERALL RECOMMENDATIONS:

1. Expand the monitoring of CoS.
2. Harmonize CoS indicators and data collecting procedures.
3. Harmonize calculation of CoS indicators.
4. Establish and harmonize definition of exceptional events.
5. Implement an incentive scheme for maintaining or improving general continuity levels.
6. Implement compensation payments for network users affected by very long interruptions.

6th CEER Benchmark Report Findings On The Use Of Rewards And Penalties By Regulators

As shown in Table 5 below, most countries employ rewards or penalties, or a combination of these for performance on CoS related KPIs.

TABLE 5. CONTINUITY OF SUPPLY REGULATION AT SYSTEM LEVEL

| System | Rewards | Penalties | Combination | Continuity indicators used |
|---|---|---|---|---|
| **Distribution** | | DK, HU | BG, CZ, DE, ES, FI, FR, GB, IE, IT, NL, NO, PT, SI, SE | BG (SAIDI, SAIFI), CZ (SAIFI, SAIDI), FI (outage costs based on planned and unplanned long interruptions), FR (SAIDI), DE (SAIDI for LV, ASIDI for MV), GB (customer interruptions and customer minutes lost), HU (SAIDI, SAIFI, outage rate), IE (customer minutes lost, customer interruptions), IT (SAIDI and SAIFI+MAIFI), NO (interrupted power at a specific time, duration, time of occurrence, planned, unplanned), PT (END), SI (SAIDI, SAIFI), ES (TIEPI, NIEPI), SE (ENS, PNS, SAIDI, SAIFI, CEMI4) |
| **Transmission** | BE, ES | HU | DE, FI, FR, IE, IT, NO, PT, SE | BE (AIT), FI (outage costs based on planned and unplanned long and short interruptions), FR (AIT and SAIFI+MAIFI), DE (SAIDI for LV, ASIDI for MV), HU (outage rate, AIT), IE (system minutes lost), IT (ENS), NO (interrupted power at a specific time, duration, time of occurrence, planned, unplanned), PT (TCD: Combined average availability rate in %), ES (availability of facilities), SE (ENS, PNS) |
| **No existing CoS scheme** | AT, CH, CY, EE, EL, LT, LU, MT, PL, SK | | | |
| **Intentions/plans for implementation** | AT (details under consideration), EL (penalty and reward scheme on basis of SAIFI and SAIDI indicators), LU (Q factor currently under discussion), RO (implementation under consideration) | | | |

6th CEER Benchmarking Report findings related to individual customer compensation

Table 6 below shows the countries where individual customers are compensated for the utility failing to meet standards for CoS related KPIs.

## TABLE 6. STANDARDS APPLICABLE TO ECONOMIC COMPENSATION

| Type of standard | Country adopting the standard | Standard value | Automatic compensation |
|---|---|---|---|
| **Individual duration of long unplanned interruption** | CZ, EE, EL (1), FI, FR, GB, HU, IE, LT, NL, NO, RO, SE | 8h for the capital – Prague, 12h elsewhere (CZ) (2), >12h (EL), >6h (FR), >12h (FI), >12h (GB) (7), >24h (IE), >8 urban, >12 suburban and rural (IT), >12h, >1h (NL) (5), >12h (NO), >12h (SE) | EE, EL, FI, FR, GB (only customers on the priority service register), HU, NL, SE |
| **Individual duration of long planned interruptions** | RO, EE | | EE |
| **Total duration of long interruptions (planned or unplanned or both) in a year** | ES, PL (3), PT (8), SI | 45min<T<17h (PT) (6), >9h (SI) (4) | ES, PT |
| **Total number of interruptions (long or short or both) in a year** | ES, HU (short), IT (1) (long and short), PT (8), SI | 6-9-10 long+short, according to territorial density (IT), 3<n<20 (PT) | ES, IT (1), PT |
| **Single-user advance notice for planned interruptions** | IE | 2 days | |

(1) Applies to MV customers only.
(2) Applies to LV.
(3) Poland differentiates between planned and unplanned interruptions.
(4) Individual customers (LV and MV).
(5) Depends on voltage level and capacity of the connected customer.
(6) EHV starts at 45 minutes.
(7) If a customer is without supply for 12 continuous hours under normal weather conditions, then they are eligible for a payment. If there is "severe weather" (determined by there being at least 8 times the daily average number of faults at HV (1 kV+) and above in a 24 hour period), then a customer must be without supply for at least 24 continuous hours.
(8) For comparison with standards, only long unplanned interruptions are considered.

The 7th Benchmarking CEER and Energy Community Regulatory Board (ECRB) Report shows that CAIDI, SAIDI, and SAIFI are the main indices used in most European countries.[8] CEER claims that a "reduction in SAIDI and SAIFI indicates improvement in CoS, but their reduction could still result in an increased value of CAIDI," and, for this reason, an indicator like CAIDI is not suitable for comparisons or trend analysis[9].

An indicator can also have different names in different countries, which makes their benchmarking difficult. For example, Customer Minutes Lost is used in Great Britain as a synonym for SAIDI. Customer Interruptions is used instead of SAIFI. Portugal, for example, uses Energy Not Distributed and Ireland has an indicator called Worst-Served Customers.

The report states that "the indicators such as Customer Average Interruption Frequency Index (CAIFI) and Customer Total Average Interruption Duration Index (CTAIDI) give a good impression of the CoS as experienced by those network users that are affected by at least one interruption. CTAIDI is currently only used by Norway, while CAIFI is used by Norway and Slovenia. Customer Experiencing Multiple Interruptions, a similar indicator that measures percentage of customers experiencing more than one interruption, is used by Sweden."

[8] The Energy Community Regulatory Board is the independent regional body of energy regulators of the Energy Community in Europe.

[9] See 7th CEER-ECRB Benchmarking Report on the Quality of Electricity and Gas Supply 2022 https://www.ceer.eu/documents/104400/7324389/7th+Benchmarking+Report/15277cb7-3ffe-8498-99bb-6f083e3ceecb

With respect to transmission operation, there are some indicators that are often used and are specific to transmission. For example, Average Interruption Time and Average Interruption Frequency are commonly used. Portugal uses the System Average Restoration Index for quantifying the average duration of interruptions. In some cases, indicators have different names in different countries. Spain uses an indicator Tiempo de Interrupción Medio which translates to Average Interruption Time.[10]

**HUNGARY: USE OF PERFORMANCE STANDARDS[11]**

During 1998 and 1999, Hungary suffered from very poor electricity distribution services, characterized by frequent outages, high losses, and dissatisfied consumers and industries. In response, the Hungarian government moved to regulate the quality of supply and set and monitor performance standards. A new Act on Electric Energy was adopted in 2003 which mandated that the Hungarian Energy and Public Utility Regulatory Authority (HEA) enact regulation on the quality of supply and establish service quality indicators with minimum quality requirements and expected quality levels, and incorporate these in license conditions. The Act authorized HEA to evaluate implementation of quality indicators, including the level of customer satisfaction and the level of quality of electricity supply that the licensees are expected to deliver.

HEA identified key service quality indicators and requested utilities to submit reliable information on their actual performance. After a few years of observation and data collection from licensees, HEA created a database of the current levels of service quality that utilities were capable of providing to customers and developed minimum quality requirements (expected quality levels) for monitoring.

In 2005, HEA issued a resolution on supply security and continuity of supply. HEA and the utilities agreed to the methodologies for calculating the following associated indicators:

- Continuity of supply;
- System reliability;
- Consumer contacts;
- Measurable and verifiable characteristics of voltage quality/gas quality;
- Service quality of other activities related to the core activity of the licensee.

The utilities in Hungary use SAIDI, SAIFI, and CAIDI for measuring planned and unplanned interruptions on low voltage, medium voltage (MV), and high voltage (HV). The outage rate (the ratio of Energy Not supplied and Energy Supplied) is used for MV and HV. The following additional indicators are used for distribution:[12]

- Proportion of customers to whom the supply was restored within three hours following a long unplanned interruption;
- Proportion of customers to whom the supply was restored within 18 hours following a long unplanned interruption;

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[10] Examples of different naming indicators are based on 7th CERR and ECRB Benchmarking Report on the Quality of Electricity and Gas Supply, 2022

[11] Source: Hungarian case study on supply quality regulation, ERRA February 2014.

[12] 7th CEER-ECRB Benchmarking Report on the Quality of Electricity and Gas Supply 2022.

- Proportion of customers to whom the supply was restored within six hours following a long planned interruption;
- Proportion of customers to whom the supply was restored within 12 hours following a long planned interruption;
- Number and proportion of customers affected by a long unplanned interruption lasting less than 0.5 hours; and
- Number and proportion of customers affected by a long unplanned interruption lasting between 0.5 and three hours.

HEA subsequently developed financial incentives and applied them, together with key quality indicators, to motivate the companies to exceed requirements related to customer service. This is in line with CEER recommendations in its 6th CEER Benchmarking Report on quality of electricity supply which recommends a "combination of overall standards with economic sanctions and guaranteed standards," to improve average utility performance and protect customers from inferior service conditions.[13]

As a final step, HEA modified electricity and gas sector licenses to include requirements related to service quality standards and reporting to the regulator in accordance with the reporting schedule. HEA monitors and publishes reports on implementation of the key performance indicators.

**SOUTHERN AFRICA: USE OF KPIS**

The Regional Energy Regulators Association of Southern Africa (RERA) is an association of national regulators from the Southern Africa Development Community region. It serves as a platform for effective cooperation among energy regulators and facilitates the harmonization of regulatory policies, regulations, and practices. In 2018, RERA, with USAID assistance, conducted a study on the use of KPIs by utilities and regulators.[14] The authors worked with all the utility regulators, utilities, and stakeholders in the region to develop a set of 30 KPIs out of 55 KPIs considered. Some of the culling was based on the availability of data and importance of the KPIs. Detailed definitions and quantification methodologies were developed for each of the 30 KPIs, listed in Table 7 below.

Developing a set of regional KPIs to monitor utility performance across the region is highly relevant for advancing regional cooperation. National regulators are responsible for protecting customers and setting service quality standards but their KPIs are primarily based on national objectives and priorities. From a regional standpoint, harmonization of national KPIs would serve to enhance regional cooperation and facilitate trade of electricity between countries.

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[13] https://www.ceer.eu/documents/104400/-/-/d064733a-9614-e320-a068-2086ed27be7f

[14] Development of Regional Key Performance Indicators (KPIs) For RERA
https://pdf.usaid.gov/pdf_docs/PA00XH9X.pdf

TABLE 7. PERFORMANCE AREA AND SELECTED KPIS

| SUMMARY OF PERFORMANCE AREAS AND SELECTED KPIS | | |
|---|---|---|
| **Dimension** | **Performance Areas Considered** | **KPI Selected** |
| Financial | Liquidity, Profitability, Solvency, Sustainability | Gearing, Profit/Loss Margin, Return on Capital Employed, Staff Cost to Total Cost, Debt Service Cover Ratio, Operational Revenue to Total Cost, Total Operating and Maintenance Cost to Revenue |
| Customer Service | Billing, Collections, Connections, Quality of service, Responsiveness | Collection Rate, Collection Period, Connection Time Targets, Outages Due to Short Supply, Field Staff Response Time |
| Technical | Distribution, Generation, Transmission | SAIDI, SAIFI, CAIDI, EAF, BCLF, UCLF, System Minutes Lost >1 |
| Safety | Prevention | Fatalities, Lost Time Injury Rate |
| Socio-Economic and Environmental | Electrification, Generation Capacity Adequacy, Public Health, Resource Utilization | Access to Electricity, Generation Capacity to Demand |
| Efficiency and Sustainability | Cost Management, Asset Reliability, Capital Expansion, Energy Loss Reduction, Sustainability | Operating Cost per MWh, Operating Cost per MW, Operating Cost of Electricity per MWh |

The report recommended the following steps for developing and implementing regional KPIs:

- Agree on a set of regional KPIs that are accepted by the majority of stakeholders.
- Agree on a regional regulatory framework for monitoring.
- Build trust amongst stakeholders and obtain alignment around the quantified KPIs.
- Ensure that the KPIs reflect a balanced view of the key sustainability areas for the region.
- Build regulatory capacity to monitor and enforce rules.

### NEW YORK, USA: USE OF KPIS

The state of New York recently enhanced its regulatory mechanisms for setting rewards and penalties for selected KPIs. In its recent Order in 2020, the regulatory Commission established the following KPIs for one of the state utilities, Con Edison.[15]

- Efficiency Incentives: Implicit in Tariff Determination Process
  - Revenue Decoupling Mechanism, Various Reconciliation Mechanisms, Labor Productivity, Earnings Sharing Mechanism
- Service Quality Incentives: Explicit KPIs

[15] Con Edison Utility Proposal; Appendix 23; filed with the NYPSC in Case 19-E-0065: http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={8DFF975D-C514-41C8-8E31-82C33318D898}

- SAIFI/CAIDI, Customer Complaints, Satisfaction, and others

- Public Policy Incentives: Explicit KPIs
  - Deeper Energy Efficiency Lifetime Savings Earning Adjustment Mechanism
  - Share-the-Savings
  - Beneficial Electrification
  - Demand Energy Response Utilization
  - Electric Peak Reduction
  - Locational System Relief Value Load Factor

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12. USAID/PCA Legal, Institutional and Regulatory (LIR) Energy Sector Gap Assessments.