# Key Performance Indicators in Electricity Distribution Business

**M.K. Bansal AGM , NTPC Ltd, Noida**
**Dr. Pratibha Garg, Asstt Professor, Faculty of Management Studies, Noida**

***Abstract: Power distribution sector in India is not in good shape. The Generator, Transmitter and distribution are different companies. Some of them are controlled by Central Govt while others in control of various State electricity corporations. The electricity distribution require huge infrastructure for supply of reliable and quality power to consumers unlike LPG or water supply to consumers as it cannot be stored. It is either to be distributed or not to be generated. More over this business require skilled work force as it involves high voltage, which is prone to shock, or accidents if not dealt with properly. Presently, the power reaching to consumer is not reliable and having very poor quality with many interruptions and load shedding and many a times suffers from low voltage fluctuations. In such situation, key performance indicators are to be defined and implemented to assess the quality of power being supplied. The present paper deals with defining KPI and suggests various methods through KPI to improve power distribution system.***

***Key Words: KPI, DISCOM, KV, O&M***

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**Introduction:**

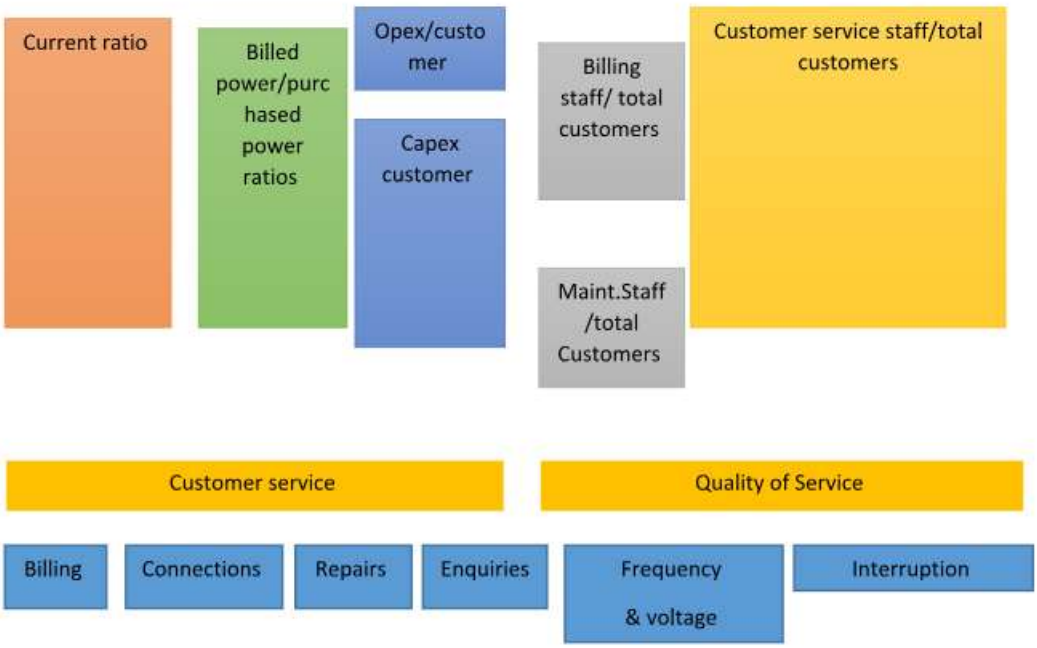
For electricity sector, a variety of measurable KPIs should be identified and defined with a vision of transforming the distribution segment so that the wholesome objective of electricity sector reform is achieved. The customer interaction starts from the time when an applicant wants to have an electrical connection. Upon the energisation of connection, consumer requires uninterrupted pure sine wave electricity and quick restoration of supply upon occurrence of a fault and to pay his bill without standing in queue. From the DISCOM's perspective, to serve its customer and to keep its promises, it is a mammoth task and it requires adequate infrastructure, resources, availability of quality & reliable power, customer friendly employees, finance, monitoring and control system, a mechanism to address varying degree of issues etc. Most of the factors are controllable by the utility but few factors are beyond its control e.g. availability of reliable and quality power etc. therefore, it becomes even more important to determine, devise and define the KPIs keeping in view the practical aspects and measure only those attributes which are controllable by the utility. The entire KPI exercise is presented keeping the above-mentioned philosophy in helm of affairs.

**Classification and selection of basic KPIs**

All the KPIs should be determined keeping in mind the consumer in the centre. For a business to remain successful and profitable, it is essential to earn a reasonable profit. However, it is bound to come if the customer is satisfied and delighted.

KPIs are a critical tool used in measuring and monitoring operational performance. KPIs are both used to inform those with oversight as well as to help run day- to- day operations of the utility. They allow a utility to track progress of improvement programs and serve as a flag for areas where service might be deteriorating and is in need of extra attention. They also allow the utility to set targets for improvement within a given year or over the course of an improvement programs. In many jurisdictions, utility performance against KPIs is key evaluation criteria used by regulators in setting tariffs. KPIs can be defined per an internal operating standard, by international standards or a mix, as is appropriate and realistic for the utility. While there is an endless array of potential KPIs that can be established, it is best to focus at first on a small, high level, high impact set of measures. This philosophy matches the approach we take with operational reforms focusing on those areas that have the highest potential for improvement, generating the highest value over the shortest period. In general, there are three main categories of KPIs against which performance is measured that is kilowatt-hours, people, and time. Examples of KPIs that are useful in Initiation and sustaining operational improvements are shown in Figure1. It provides an indication of the type of measures that can be used to keep track of performance improvement progress.

Figure 1: Sample Key Performance Indicators




It is up to the utility to select the appropriate KPIs and add further KPIs as it gains experience and progress. There are certain basic KPIs and other advanced KPIs. Accordingly, it is proposed to select and implement the KPIs in two stages.

**KPI for first stage implementation**

The KPIs which are to be selected for first stage implementation should be simple, easily measurable and easy to implement. At the same time they should address the qualitative aspects, customer needs and requirements, business needs and requirements and human resources. It would help to develop an enabling atmosphere to adopt the changes and involvement of all the concern stakeholders. Accordingly the KPIs are selected in four categories viz. Supply availability & reliability, Cost & Profitability, consumer service and Capacity building.

Supply Availability and Reliability

Reliability is one of the core KPI factor that Shape customer satisfaction. Customers' perceptions of reliability are actually shaped by a combination of factors, including voltage characteristics. However, the most visible of these are the continuity of supply factors that manifest themselves in outages, be they momentary or extended. Thus, they may be the most important of the customer service KPIs under the control of the management of distribution companies.

The main features related to measuring and regulating continuity of power supply are:

- The kind of breakdown: Scheduled and unscheduled Breakdown. Breakdown that is not notified may be recorded as unscheduled break down.
- The duration of each interruption: Short or Long interruptions. Any interruption that lasts more than ten minutes is a long interruption.
- The voltage levels of faults and other causes of breakdown: Low/medium/high voltage. The breakdown of supply to customers can start at any voltage level in the system. Customers connected to low voltage networks (i.e., 1 kV) are affected by interruption due to faults in low voltage, medium voltage (MV) and high voltage (HV) networks and transmission networks, while users connected to MV networks are not affected by interruptions due all faults in the LV networks.
- The type of continuity indicators i.e., number or duration of outages. The cumulative yearly duration of breakdown per customer, generally referred to as System Average interruption Duration Index (SAIDI) indicates how long during the year energy is not supplied (average per customer). The number of outages per customer in a year, termed System Average Interruption Frequency Index (SAIFI), indicates how many times in a year energy is not supplied. Some customers are more sensitive to the cumulative duration whereas others are more sensitive to the frequency of outages.

Supply Availability and Reliability – Proposed KPIs (Figure 2 )

| KPI | UOM | Measures | Representative Standards |
|---|---|---|---|
| SAIDI- System Average interruption Duration Index | Hours | (Duration of Outage) X (Number of Customers affected) / (Total Number of Customers) | 2 Hours |
| Distribution Transformer (DTR) failure | % | (Number Of DTR failure during a year) X 100 / (Average Number of DTRs during the year) | 0.5% |

| | | | |
|---|---|---|---|
| CAIDI – Customer Average Interruption Duration Index | Minutes per Occasion | (Customer Interruption Duration) / (Total Number of Customer Interruptions) = SAIDI/SAIFI | 90 Minutes |
| OH/Cable failure rate | Faults Per 100 ckt-km of 11kv line | Number of faulits during a year X 100 / (Total 11kV circuit kilometre) | 2 Number |
| SAIFI- System Average Interruption Duration Index | Number | (Number of interruptions ) X (Number of Customers affected) / (Total Number of Customers) | 1.3 Instances |

Supply Availability and Reliability – Proposed KPIs (Figure 3)

| KPIs for Utility Distribution | | |
|---|---|---|
| **Key Performance Indicator (KPI)** | **Category** | **Measures / Metrics** |
| Operational Performance | Quality & Reliability of power delivery | SAIFI (customers interrupted in a year/total customers) |
| | | SAIDI (sum of customer interruption duration/total customers) |
| | | CAIDI (SAIDI/SAIFI) |
| | | ASAI (Avg amount of time electricity is available to customers) |
| | | Interruptions per 100km of distribution line |
| | | Frequency of voltage fluctuation events |
| | Distribution Operating Efficiency | ATC Losses |
| | | Total operating expense/energy delivered |
| | | Controllable expenses/energy delivered |
| | | Substation metered & having annual energy audit |
| | | Net fixed assets/energy delivered |
| | | Total energy related expense/energy delivered |
| | | Efficiency & technology transfer |
| | Dispatch Efficiency | Demand side management (Kw reductions in Peak system demand & B/C ratio) |
| | | Demand response (kW of demand under contracts ) |
| | Repair & Maintenance | Total Outages |
| | | Service Restoration time |
| | | Emergency Response |
| | | Annual transformers replaced / serviced |
| Operational Cost & Management | Distribution cost/min | --------- |
| | Total labour cost/consumer | |
| | Customer service cost | |
| | O&M expenses per unit of energy | |
| | Non labour maintenance expense | |
| Financial Performance | Return on Equity | --------- |
| | Cost Recovery Index | Operation recovery/cost excluding capital expenses |
| | Accounts receivable as a percentage of Revenue from Energy Sales | --------- |
| | Capital Structure (% common equity) | |
| | Average Tariff level | |
| | Return on Assets | |
| | Debt service ratio | |
| | Cost of capital | |
| | Net pofit as percantage of Energy Costs | As energy costs increases the percentage of profit will decrease |
| | Debt Interest Coverage | --------- |
| | Return on Average Rate Base (%) | --------- |
| Customer Service Quality | Performance Connection Service | Lead time to provide new connection |
| | | Lead time to restore connection upon payment following disconnection |
| | | Lead time to replace meters in case of complaint |
| | | Connection completed within 5 days |
| | Performance in Complaint handling | Response time from fault complaint to service time |
| | | Scheduled appointment missed |
| | | Average complaint from per week/month |
| | Call center performance | Service Level (percent of call answered within 30 sec) |
| | | Percent of calls abandoned |
| | | First call resolution (% remaining unresolved after first call) |
| | | Average speed to answer (seconds) |
| Energy Efficiency & Demand side management | kWh annual reduction in total energy use | --------- |
| | kWh annual reduction in annual peak system demand | |
| Workforce (Including Health & Safety) | All injury/illness frequency | Physical exertion while lifting, pulling, pushing,etc |
| | Disabling injury/illness frequency | Over exertion, pushing their limits, etc |
| | Severity Rate | --------- |
| Sustainability | Lost time work incidents | Employee accidents results in missed work |
| | Non-accident related cost | Days absent, sickness, etc |
| | Employee Training & Development | # of employee, days, course |
| | Environmental Responsibility | Any measures for GHG reduction, |
| | Employee Sickness | Workdays loss due to sickness - only observation not KPI |

Cost and Profitability

The cost of per unit of energy is a very vital ingredient to determine the customer satisfaction. Though the consumer is ready to pay little higher tariff but he sees the value for every penny spent. Moreover, Regulator does not allow any untoward cost and it eats the profit. The cost and profitability are actually shaped by a combination of factors, including O&M expenses, Technical and Commercial losses, and collection efficiency. The main features related to measuring and regulating cost and profitability are:

- The present loss level and trajectory to reduce the loss: The per unit of cost delivered to the consumer is delivered by the quantum of prevalent loss level and the losses allowed by the regulators for that year. It is very important to constantly monitor the loss and take corrective action immediately by technological and/or administrative mechanism.

- Unaccounted Energy: The health of the metering system to be monitored constantly. Any meter out of circuit meaning not recording the correct energy should be replaced/ rectified immediately or within the stipulated turn around time. The meters are not available across many utilities particularly for Rural, Domestic, Agriculture and Street Light connections.It becomes more necessary to define a path to achieve the 100% metering status and till such time access the quantum of energy consumed in terms of the per unit connected load through sample study.

- Collection Efficiency: In the era of Information revolution, consumer wants better avenues for payment and their billing related complaint redressal. The efforts should be directed towards facilitation to the consumer so that they are motivation to make the payment and not harassed by standing in long queues. The collection efficiency ultimately decides both – the cost and profitability.

- Operating Expenses: i.e., the cost incurred by the utility toward Operation and Maintenance to supply the energy. It generally expressed in per unit. The cost should be benchmarked against the international standards and efforts to be put to reduce it.

Cost and Profitability – Proposed KPIs (Figure 4)

| KPI | UOM | Measures | Representative Standards |
|---|---|---|---|
| Aggregate Technical & Commercial Losses | % | Energy Realized / Energy Import | 8% |
| End to end Money Flow Efficiency | % | Collection Deposited In Bank / Energy Delivered to the Division (Monetised) | 92% |
| ROCE – Return on capital employed | % | (Profit Before Interest & Tax ) / (Long term loan +Equity) | 16% |
| O&M Expenses per unit of energy Input | Paisa per Unit | Total O &M expenses / Total energy imported | 10 Paisa per Unit |

Consumer Service

The consumers are becoming more and more demanding on each passing day. The Regulators have started imposing the minimum service standard levels with penalty. For the business to be successful and to remain successful, the satisfaction through better consumer service is of paramount importance. The satisfied and delighted consumer is great asset for any company and has direct bearing on the bottom line of the company's balance sheet. The list of consumer services is endless particularly for a DISCOM, however to begin with it is shaped by a combination of factors viz. Response time, Staff Attitude, Willingness of the staff, Customer satisfaction Index etc. The main features related to measuring and regulation consumer service are:

- Response Time: The consumer wants that the intended service should be provided by their service provider within the stipulated time. For a consumer or a prospective consumer, he wants that the new service connection to be provided at a minimum possible time, if there is any supply outage complaint, it should be resolved as early as possible. Similarly he wants that the bill delivered to him should be error free and in case of any error/dispute it should be resolved amicably and as fast as possible. It becomes imperative for DISCOM to define the minimum stipulated time frame for each kind of service, monitor the outcome on daily basis, generate exception reports and take corrective actions. If necessitates, bring he changes in the processes and adopt new technologies.

- Customer Satisfaction: The periodic satisfaction survey should be a part and parcel of every DISCOM. It provides a valuable insight about the present capabilities and the consumer expectations. A roadmap can be formulated to address the issues which are in control of the management.

- Staff Attitude: It plays a very vital role in any service industry. A proper training plan and calendar can be prepared to address this vital aspect. Human resource is very important gradient for any business and it determines the success or failure of the business. It is invaluable asset. The attitudinal training should be provided for each employee irrespective of his/her hierarchical position.

Consumer Service – Proposed KPIs (Figure 5)

| KPI | UOM | Measures | Representative Standards |
|---|---|---|---|
| Customer satisfaction index | % of customers, somewhat or | (Number of customers expressed satisfaction) / (Sample Size of Customer | 100% |

| | | | |
|---|---|---|---|
| | very satisfied | Interviewed) | |
| Number of voltage complaints | NO | Number of complaints received in a month | Nill |
| % billing complaints resolved within regulatory time limits | & | (Number of complaints resolved within regulatory time limits) X 100/ (Total Number of complaints) | 100% |
| % of new services provided within three days | % | (Number of new service connections provided within 3 days ) X 100/ (Total Number of Applications received) | 100% |

Capacity Building

DISCOMs have to not only manage the day to day operations but also manage the explosive growth, so it is dual task. At the top of it, consumers are becoming more and more demanding, resulting which DISCOMs require additional capabilities. The capacity building may be creation of assets, Performance improvement or human resources skill upgradation. In this section, we are concentrating only on Human resources skill upgradation aspects. The main features related to measuring and regulation consumer service are:

- Business Function: The consumer is the fulcrum for today's business; every strategy needs to be built keeping in view this fulcrum. Consumer does not know about the departments, roles and responsibilities of any individual, internal processes impediments etc. within the company, he wants a superior qualitative product/service at a low cost within the shortest possible time frame. It creates the need for the organization to work in a cross functional team rising above the cage of traditional thinking and produce versatile managers conversant with different functions and ready to take extra burden on their shoulder to meet the customer requirement. It does not obviously come through as a God gift, neither as learning provided in academics nor by virtue of simply doing the job with full honesty and versatility. It has be created and developed by imparting the training.

- Training Plan and Calendar: Nothing can be achieved if not properly planned and executed. Every organization should prepare a training plan, allocate resources as per the plan and maintain a calendar for its implementation and monitoring.

Capacity Building – Proposed KPIs (Figure 6)

| KPI | UOM | Measures | Representative Standards |
|---|---|---|---|
| Percentage of Employees having attended Electricity Distribution Business – Operation/Engineering Aspect Related Training | % | Planned versus Actual | 100% (For that segment of employees) |
| Percentage of Employees having attended Electricity Distribution Business – Commercial/Finance aspects Related Training | % | Planned versus Actual | 100% (For that segment of employees) |
| Percentage of Employees having attended Electricity Distribution Business – Management Aspect Related Training | % | Planned versus Actual | 100% (For that segment of employees) |

**KPIs for second stage implementation**

The KPIs which are to be selected for second stage are selected in five categories viz. Commercial quality standards, Consumer Interaction and Service Standards, Voltage Quality Standard, Finance and Accounting and Human Resources.

Commercial Quality Standards

These KPIs deal with the quality of the relationship between a supplier and a user (customer). They are important to potential customers when they request information or ask to be connected to the network. Commercial quality standards may be classified as follows:

- Connection to the network – time frame;
- Price associated with the supply – tariff schedule;
- Customer query response – turn around time to pick up the phone call;
- Meter reading;
- Accuracy of estimated bills;
- Accuracy and timeliness of actual bills;
- Meter Testing;
- Billing anomaly reduction and rectification; and
- Payment arrangement.

Commercial Quality Standards – Proposed KPIs (Figure 7)

| KPI | UOM | Measures | Representative Standards |
|---|---|---|---|
| Number or actual meter readings within a year | % | Planned versus Actual | Say 99% of meters will be read at least six |

| | | | |
|---|---|---|---|
| | | | times each years on bi-monthly billing cycle |
| Cutoff at customer's request | % | Number of Cut – offs executed within 10 working days/Total cut- off requested received | Say 99% compliance within 10 working days |
| Voltage complaints | % | Number of Complaints Attended to within 10 working days/Total voltage complaints received | Say 99% compliance within 10 working days |
| Outage Response Time | % | Number of Complaints Attended to within 8 hours in rural area/Total complaints received in that segment | Say 99% compliant attended to within 8 hours in rural areas |
| Estimating Charges | % | Number of estimates provided subsequent to inspection within 7 working days / Total Estimates request received | Say 99% compliant within 7 days from the date of survey for simple requests |
| Meter Problem response Time | % | Number of meter Complaints Attended to within 15 working days/Total meter complaints received | Say 99% complaint within 15 working days |

Consumer Interaction and Service Standards

These KPIs deal with the customer, internal business processes and change management. These are important to provide the desired services at predefined standards and to monitor the quality. These indicators also give insignt about the consumer satisfaction level.

Consumer Interaction and Service Standards – Proposed KPIs (Figure 8)

| KPI | UOM | Measures | Representative Standards |
|---|---|---|---|
| Queries on Charges and Payments | % | Number of occurrences | Say Reply within 10 working days |
| Reconnection after disconnection for non-payment | % | No. of reconnections effected by 5 p.m. the day following payment / N. of reconnections request received | Say 100% compliance by 5 p.m. the day following payment |
| Maximum waiting time in a Customer service Center | % | No. of customers served within 30 minutes / Total number of customer served | Say 90% of customers served within 30 minutes |
| Time to Answer Customer Service Telephone | | No. of times customer telephone calls attended to within 60 seconds/ Total no. of customers call received | Say 75% within 60 seconds |
| Notice of Supply Interruption | % | Planned versus Actual | Minimum 24 hours before planned interruption |
| Response to Customer Letters | % | Planned versus Actual | 100% within 10 days |

Voltage Quality Standards

The term voltage (or power quality) is an umbrella concept for a variety of disturbances in a power system. The quality of delivered electricity is difficult to define and quantify. The quality is mainly determined by the quality of the voltage waveform as it is impossible to control the currents drawn by customer loads. Voltage quality is not only the responsibility of the network operator but also, in certain respects, depends on producers and customer. Generally, voltage quality covers a range of factors including interruption.

There are several technical standards for voltage quality criteria, but in the end the quality is directly and indirectly determined by the ability of customer equipment to perform properly. However customer awareness about power quality is highly subjective. A good definition of voltage quality including the technical parameters like frequency, voltage level or harmonics are used to indicate the voltage quality. Although definitions are not fully consistent in standards, the most relevant quality phenomena are the same. For power systems the main phenomena are indicated as below:

- Frequency variation;
- Fluctuation of voltage magnitude;
- Short-duration voltage variation (dips, swells and short interruption);
- Long-duration voltage variations (over- or under – voltage);
- Transients ( temporarily transient over voltage);
- Unbalance; and
- Interruption.

Importance of voltage Quality

The voltage quality has a growing economic impact on the customer and the network operator. The costs associated with "lack of quality" can be large, especially for industrial customer. Usually voltage quality is considered at the customer's connection point. However the reasons for the growing importance of voltage quality lie not within the power system itself but are closely related to the developments in customers' equipment. Some important examples are:

- Customer equipment contains more microprocessor controls and power electronic devices which can be sensitive to variations in voltage quality;
- The growing importance of higher energy efficiency has led to an increase in the number of adjustable motor drives and shunt capacitors which generate harmonics on the power system;
- Processes and equipment have become more interconnected and interrelated which can make them more vulnerable to failure of one component;
- Customers are becoming more aware about the issue of voltage quality and becoming more demanding in that respect.

Utilities want to meet customer demands and expectations. With the introduction of competition between them it is important for a utility to maintain its customers' confidence. Where the financial consequences of solving voltage quality problems affect the economic position of the network operator, voltage quality becomes an issue for the regulator.

Voltage Quality Standards – Proposed KPIs (Figure 9)

| KPI | Representative Standard for Low Voltage | Representative Standard for medium Voltage |
|---|---|---|
| Frequency | 49.5-50.5 Hz (99.5% of the year) or 47-52 Hz (all year). | 49.5-50.5 Hz (99.5% of the year) or 47-52 Hz (all year). |
| Magnitude | Un +/- 10% (95% of the week, 10min. RMS)<br><br>Un+10% to – 15% (100% of the week, 10min. RMS). | Un +/- 10% (95% of the week, 10min. RMS) |
| Fluctuations of Voltage Magnitude | + 5% up to + 10% some times per day Flicker: Plt ≤n1 (95% of the week). | + 4% up to + 6% some times per day Flicker: Plt ≤ 1 (95% of the week). |
| Voltage Unbalance | U- ≤ 2% (95% of the week. 10 RMS); 3% in some area. | U- ≤ 2% (95% of the week. 10 RMS); 3% in some area. |
| Voltage dips | Indicative: up to a few tens to up to one thousand. | Indicative: up to a few tens to up to one thousand. |
| Short Interruptions | Indicative: up to a few tens to up to a few hundred. | Indicative: up to a few tens. |
| Long Interruptions | Indicative : (interruptions > 3 min ) annual frequency 10 up to 50, depending on area | Indicative : (interruptions > 3 min ) annual frequency 10 up to 50, depending on area |

Finance and Accounting

Every business is done to earn some profit and it is the underline concept. The major tasks are to maintain the finances effectively to meet the future requirement, to earn profit and to incur the cost prudently. It also provides a trigger where any expense goes out of gear. These are expressed in ratios, expenses per unit of output etc.

Finance and Accounting – Proposed KPIs (Figure 10)

| KPI | UOM | Measures | Representative Standards |
|---|---|---|---|
| Debt/Equity Ratio | % | Ratio | Say 2:1 |
| Collection/Billing Ratio | % | Total Collection Amount/ Total Billed Amount | Say 98% |
| Days Outstanding | Day | Time | Say 55 days for monthly billing cycle |
| Operating Expenses / Energy (kWh) | Paisa per unit | Planned versus Actual | Say 10 paisa per unit |

Human Resources

It is the responsibility of management to have the lean, efficient, customer friendly organization which strives for catering to diversified need of all the stakeholders. The productivity should be measured with respect to each employee and it should be benchmarked with respect to past performance and with the industry best.

Human Resources – Proposed KPIs (Figure 11)

| KPI | UOM | Measures | Representative Standards |
|---|---|---|---|
| Total Staff / Total Customer | % | Planned versus Actual | 99% |
| Billing Staff / Total Customer | % | Planned versus Actual | 99% |
| Maintenance Staff / Total Customer | % | Planned versus Actual | 99% |
| Customer services Staff / Total Customer | % | Planned versus Actual | 99% |

Conclusion:

The paper endeavours to define various parameters for key performance indicators in the areas of distribution sector but many electricity distribution companies are yet to set indicators to assess the quality of power. This may be because they do not have enough funds, resources and infrastructure to deal and define such parameters and monitor them on continuous basis. The paper also suggest regulators to make it mandatory for DISCOM to include in their plan as part of evaluation of efficiency of DISCOM and not meeting the minimum required parameter shall be penalised . It is also proposed to include KPI in the Indian Electricity Act to make mandatory for all DISCOM to become part of this exercise.

It is also to be emphasised that Utility Performance Monitoring is one of major gaps in Indian distribution utility or DISCOMs. The major reason is missing measurements and analytics to drive decisions and implementation and the MIS that gets created is not effectively used to control distribution system optimally. One abstraction is to look utility as a complex distributed network with multiple stakeholders/nodes (various end consumers, linked to DTCs, feeders and substations forming a network and one network interconnected with others). Each stakeholder has different metrics of performance and it is this mismatch of KPIs among various stakeholders that make the network run non-optimally.

A good set of KPIs together should also give a good causal analysis of any problem in the network. KPIs are broadly known but still Indian utilities are not running profitable. This is because just having KPI alone is not sufficient for growth, a follow up interventions have to be executed well. Since most of the mis-management of utilities get directly pass through to the end-consumers, there is missing incentive layer for efficient utility management

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