Table of Contents

1. Background 5
2. Observations from review of existing processes 6

2.1. Executive Summary 7
  2.1.1. As-Is situation 7
  2.1.2. To-be Process 8
  2.1.3. Capex prudence and approval of capital investment in other States 11
  2.1.4. Detailed Guidelines 11

3. Observations from review of existing processes 12
  3.1. Planning 13
  3.2. Execution 14
  3.3. Project Monitoring 14
  3.4. Ex-post Analysis 14

4. Capital Investment Planning Process 16
  4.1. Setting of Objectives 16
  4.2. Perspective Planning 18
    4.2.1. Key studies to be carried out periodically 20
  4.3. Identification and prioritization of schemes 21
  4.4. Annual Program of Works or Annual Capital Budgeting 23

5. Investment Analysis Process 25
  5.1. Need for the capital work 26
  5.2. Defining primary and secondary objectives 26
  5.3. Technical Justification 28
  5.4. Bill of Material and Project Costing 28
  5.5. Benefit Cost Analysis 29
  5.6. Evaluation of alternatives 35
  5.7. Execution timelines 35
  5.8. Risk analysis and mitigation strategies 36

6. Execution Process 38
  6.1. Avoidance of time over run 38
  6.2. Accurate resource estimation 38

7. Quality Control 39
8. Project Monitoring Process 40
  8.1. Project Monitoring System 40
  8.2. Single Data Repository for a Robust Documentation Mechanism 43
To,

The Secretary
Karnataka Electricity Regulatory Commission
6th & 7th floor, Mahalaxmi Chambers,
No 9/2, MG Road, Bangalore 560001

Dear Sir

Subject: Regarding work order no KERC/M/13/14/791 dated 8th July 2014, submission of report

In accordance with your instructions as confirmed in work orders dated 8th July 2014, we enclose our reports Capital Expenditure Guidelines for Utilities.

The report is mainly based on information and data gathered from the utilities corporate offices and KERC. Additionally, we bring in the insights gained from our experiences in working on similar assignments where we believe it to be useful in achieving the scope of this report. It may be noted that in our work we have relied on the integrity of the information made available by the utility. We make no representation regarding the sufficiency of our work either for purposes for which this report has been requested or for any other purpose.

This report is one of the two parts of the whole report and covers the – ‘Capital Expenditure Guidelines for ESCOMs’

Yours Sincerely,

Kameswara Rao, Partner

PricewaterhouseCoopers Private Limited
Telephone: +91 (40) 44246688
Mobile: +91 98480 41352
Email: kameswara.rao@in.pwc.com
1. Background

The Karnataka Electricity Regulatory Commission (KERC) by its letter dated 8th July 2014, ref: KERC/M/13/14/791 has engaged PwC in Developing Capital Expenditure Guidelines for Utilities. The broad objective of this engagement was to examine the existing systems, procedures and practices being followed by Utilities for incurring capital expenditure and suggest improvement in processes at all stages of capital investment lifecycle.

We have carried out the study by reviewing system and processes followed for incurring capital expenditure at Karnataka Power Corporation Limited (KPTCL) and Chamundeshwari Electricity Supply Company (CESC). Additionally we have also referred to observations made in the Capex Prudence Check Report on ESCOMs.

The report is prepared based on the information provided by KERC, documents from utilities and inputs obtained from the staff of KPTCL.

We have broadly classified our report into five sections:

1. Executive Summary
2. Introduction
3. Review of As-Is Process
4. Recommendations and Way forward on Capex Guidelines
5. Guidelines on Capital Expenditure
A: Executive Summary
2.1. **Executive Summary**

The capital expenditure procedures for Chamundeshwari Electricity Supply Company (CESC) were studied in this study.

The existing As-Is situation in various stages of the capex implementation such as planning, execution, monitoring and ex-post analysis were reviewed and recommendations on the To-be process are provided.

2.1.1. **As-Is situation**

**Planning**

In CESC, schemes such as NJY, RAPDRP etc., are being spearheaded by a dedicated projects team whereas the Extension and Improvement works are undertaken by the individual division offices. RGGVY scheme is being supervised by the Chief Engineer's office.

The works identified in various divisions are approved by competent officers based on the value of the work and the approval powers of the respective authority.

It is observed that ESCOMs do not carry out studies such as load forecasting, demand supply analysis, transmission infrastructure (from KPTCL) availability planning for short/medium and long term for determining the capex requirements. Planning is mostly reactive and urgent in nature.

**Execution**

In CESC, the works of higher value like NJY, RAPDRP, RGGVY, UNIP schemes etc. are generally carried out through contractors awarded through competitive bidding process on total turnkey or partial turnkey basis. Works of small value are given out to contractors on rate contract basis only for the labor portion, while material is supplied by the utility.

Material procurement is being done as per the policies laid down in KTPP Act. The estimation for material requirement is done by Sub-Division and Division Officer, it is further scrutinized and consolidated by the Zone/Circle offices and forwarded to Tendering and Procurement wing of corporate office for procurement.

Delays in project execution have been observed due to material shortage situation arising because of diversion of material to works taken up on emergency basis or because of delay in supply of the materials.

**Project Monitoring**

For CESC, currently there is no monitoring of each and individual works for E&I projects. However the corporate office regularly monitors the funds drawn against the budget allocated towards expenditure to each division office. Schemes such as R-APDRP, NJY, RGGVY, UNIP etc. are tracked by either Projects Office or Chief Engineer’s Office or the Corporate Office.

There is no central repository or database for DPRs/Estimates/Work Awards of projects executed in the past. The documents are available only in respective section/sub-division offices which have implemented the project.

**Ex-Post Analysis**

Currently, there is no Ex-Post analysis being done for works executed by CESC. However, third party inspection is carried out for few schemes such as RAPDRP, NJY etc. wherein the emphasis is mainly on verifying the execution of project rather than if the objectives for which the work has been taken up has been achieved or not.
2.1.2. To-be Process

Transmission System Planning or Distribution System Planning works on specific planning objectives that the utilities are intended to achieve.

For ESCOMs, the objectives can be:

1. To meet load growth,
2. Operate within the permissible levels of voltage,
3. Minimize energy losses,
4. Improvement in reliability and quality of supply,
5. Improved customer service etc.

The utilities should clearly define objectives that they want to achieve in the short, medium and long term and set related goals to meet the objectives and achieve meaningful growth. This will only be possible when the utilities understand and analyze the existing system and its performance using measurable parameters. Thus to clearly identify what exactly should be the goals, utilities should carry out detailed studies to identify the system performance as on date, which will form the baseline and the studies will enable them to forecast future capital expenditure requirements.

Based on these objectives, utilities should work towards identifying the projects which require capital expenditure. These objectives should be revisited and reviewed periodically during the planning process. Scheme approval, prioritization, fund allocation etc., should be done in a manner that achieves the set objectives.

Capital expenditure planning is an important part of the entire network planning and design process as it entails identification of projects/schemes, evaluation of the investment need, expected outcome levels, optimality of the investment, etc. Thus, it is important that the utilities have a foresight on the long term objectives and future growth potential to identify the areas of investment.

Perspective planning

A perspective planning exercise would help ascertain and identify the future needs and problem areas, and zero in on the areas that require investment. The ESCOMs shall be required to carry out perspective planning studies for a time horizon of 5 years, every 3 years. The plan should include organizational objectives, system needs and capital outlay in detail. ESCOMs perspective plan shall help KPTCL in planning for upstream substations and lines.

Based on the Perspective plan, the ESCOMs are required to come up with 3 year Rolling Investment Plan detailing the projects/schemes to be executed, their primary and secondary objectives, benefits and proposed outcomes for each of the schemes. The rolling plan shall demonstrate achievements of the objectives of previous year against the plan and should also incorporate course correction requirements, if any.

It is recommended that utilities look to establish a dedicated unit or team for perspective planning and system planning. The same team can facilitate data consolidation as per Grid Code and Distribution Code and conduct planning exercises and come up with the Perspective Plan and periodic Rolling Plans.

In order to support Perspective Plan and periodic Rolling Plan, detailed load forecasting studies have to be carried by the ESCOMs on a regular basis based on robust demand forecasting models to determine the future load growth in their respective areas.

It is essential to note that Load Forecast studies are not just about quantum of growth but also about geographical locations as well. Knowing the specific locations within the network will help in siting of substations or routing of feeders or undertaking any augmentation to the network. In this context it is also
important for the ESCOMs to not just look at past trends and economic indicators but also make an effort to carry out spatial or small area load forecasts using the grid coordinate system or random area method i.e. divide the network into sufficiently large number of small areas and forecast for each small area.

These forecasts would form the basis of planning for expansion of Transmission network, which would be carried out by KPTCL.

**Capital budgeting**

Understanding the need for investments for each type of capital project is a prerequisite. Currently, ESCOMs are categorising capital expenses based on type of work (ex: Extension and improvement work etc) rather than the objectives the projects intend to achieve. We suggest that management should reclassify and categorise investments based on the objectives. Projects/schemes identified may be classified and categorized by the Organizational Objectives identified in the Perspective Plan. The projects and schemes are prioritized and phased in the rolling plan based on the criticality of the project to network and to the consumers, payback and payment profile, regulatory & policy requirement.

Scheme prioritization is critical to allow resource allocation and program trade-offs based on relative merit. All projects approved to be taken up during a particular year should be prioritized and ranked depending upon the analysis of costs and benefits to the system by using the Benefit Cost Ratio or Payback period or IRR or Net Present Value approaches.

Capital planning should usually be accomplished through an organization’s Capital Review Committee or a Planning Committee, which establish final criteria for prioritizing projects and for setting the capital budget. Utilities should look at setting up specific teams to undertake planning and prioritization. Management should keep in mind factors such as resource constraints (manpower, material and funds), effective resource allocation, and efficiency in delivery of services and minimization of costs, while finalizing the capital plan for year.

The budget or Annual Program of Works should cover all plan as well as non-plan or contingent works, so that the budget presents a consolidated picture of these operations and should be finalized accordingly. The annual capital budget for the next fiscal year should be prepared and submitted to the Commission along the revised and updated Rolling Plan by 30th November every year. The Commission shall scrutinize and review the same.

**Investment Analysis**

Investment analysis is critical for undertaking thorough evaluation of projects which tells us if the intended benefits are being achieved and if the project justifies the amount being invested. While load growth based investments and system improvement schemes must be assessed through investment analysis, the policy driven schemes need not be subject to the part where benefit to cost analysis is carried out due to their policy dependent nature and the broader welfare and social objectives.

Currently, ESCOMs are preparing estimates and DPRs for the capital works. However, there is no standard approach followed in the estimates or DPR preparation. These documents do not fully capture the extent of planning or investment evaluation carried out by the utility before going ahead with a capital work.

The ESCOMs shall follow following guidelines for all the works of value equal to or above Rupees 3 lakhs.

The estimates/DPRs should clearly articulate the as-is situation, the need for taking up of the work & fitment with long term objectives, alternatives possible/considered, primary objective, technical design (as required) among other aspects. As much as possible, the primary objective should be defined in quantifiable terms so that it can be compared against the actual outcome after completion of project.
The estimates/DPR should have a mathematical approach to calculate Benefit to Cost analysis to quantify the benefits received out of a capital investment made, so that financial feasibility of the project could be determined. ESCOMs have to justify the capital expenditure with a formal business case analysis, including different methods such as NPV, IRR, payback period and other financial criteria. This will help the utilities to maximize the value for the consumer with the limited resources available. Also, different alternatives are to be analyzed in terms of their respective costs and benefits, to finalize the least cost plan with maximum benefits.

Also, though utilities currently do not go for project based or scheme based capex funding, however, going forward it is important to have a more formal approach to the fund raising process. This will help utilities manage budgets in better manner and bring in more accountability.

The DPR/estimates should also capture the risks involved in the project/work and mitigation strategy. A risk management plan/ matrix/ strategy should address these risks in all phases of the project- viz, design, approvals, financing, procurement, construction, completion and have mitigation strategies for various risks. Risk assessment during early stages of project planning helps in understanding the key risks for a project and likewise formulate appropriate risk response strategies.

**Execution Process**

In order to streamline the execution process, utilities should accurately estimate the time and resource requirement. Execution schedules for each type of capital works should be defined and time limits should be specified. Though the time limits would broadly indicate the activity wise duration, yet while preparing the detailed activity chart for particular project, care should be taken to minimize instances of time over runs and also provide realistic execution schedules. Also, pro-active care can be taken to minimize RoW issues wherever possible by way of relying on recent route surveys and deploy recent technical/design interventions.

**Project monitoring**

Project monitoring is a key aspect related to capital investment process. The ability to control spending and implement programs successfully within timelines is hugely dependent on the review and monitoring mechanisms set up by utilities.

Utilities can deploy a simple IT tool similar to that of PMS (Project Monitoring System) being followed by KPTCL. The tool can however be strengthened by expanding its capabilities to track projects from the day they are conceptualized till the Ex-Post analysis stage. Similarly the system could be used to capture information to bring in efficiencies by tracking individual elements of construction and capturing risks and mitigation measures in detail. It could also capture all project related documentation and photographs that capture physical progress of the projects.

ESCOMs should have a project management and monitoring team with a composition of technical and finance personnel to effectively track monitor and review the progress of projects undertaken by ESCOMs.

**Ex-Post analysis**

Currently there is no Ex-post analysis framework in place in ESCOMs. An Ex-post analysis is only being undertaken as a regulatory mandate at this point. KERC has come up with Guidelines for Carrying out Prudence Check of Capital Expenditure undertaken by the utilities. It is recommended that the guidelines continue to be used to establish prudence until the utilities in the state come up with a dynamic and transparent system of planning and executing capital projects as outlined in this report.

Utilities henceforth shall endeavor to voluntarily carry out Ex-Post analysis. Till such time an IT tool to document the Ex-Post analysis is established, Ex-post analysis reports should be submitted to the Commission yearly for all the projects capitalized and commissioned 12 months before. After completion of each project, a
project is automatically subject to prudence check. Utility shall measure the benefits achieved every 3 months and fill the capex prudence formats, self-evaluate the project and submit the report along with findings.

Commission can review the prudence reports and call for details for sample projects from among the completed projects on a random basis. Commission may ask for supporting documents or ask for explanation in case of any particular project.

Utilities can use IT based tool for integration of processes at all stages (starting from the DPR stage till Ex-Post analysis stage). Once it is achieved, Utility can upload/document the performance on the primary and secondary objective every quarter from the date of commissioning of the project for a period of two years.

The Commission shall rate and rank the projects based on the achievement of stated objectives at the time of planning and Key Performance Indicators (KPIs). In case recorded benefits do not matchup to the envisaged benefits, Utilities shall be asked to provide justification to the Commission. In case the utility cannot provide explanation/proof to the satisfaction of the Commission that the reasons for failure to meet the objectives as envisaged is due to factors beyond the control of the utility, the Commission may consider the said Capex as imprudent and disallow the related costs.

### 2.1.3. Capex prudence and approval of capital investment in other States

States such as Maharashtra, Delhi, Madhya Pradesh and Rajasthan have capital investment guidelines defined for the utilities in the respective states. The regulations broadly ask for rolling investment plan for either major schemes or for comprehensive capital investment plan. The utilities are required to also submit supporting information such as demand projections, network reliability and design criteria.

The utilities in these states are also required to submit the achievement related to capital investment vis-à-vis approved plan. Also the utilities (both transmission and distribution) are required to take in-principle approval from the respective SERC for taking up high value works. Supporting information such as DPR with techno economic analysis, justification of investment, Benefit cost analysis etc. is to be submitted to SERCs. The same is reviewed in detail by the SERC before approving the investment.

### 2.1.4. Detailed Guidelines

In line with the target To-be process mentioned above, detailed guidelines have been chalked out for ESCOMs in the ‘Guidelines’ Section.
B: Review of As-Is Process
3.1. Planning

The capex planning procedures for Chamundeshwari Electricity Supply Company (CESC) were studied in detail in order to understand the procedures in place.

In CESC, currently the schemes such as NJY, RAPDRP etc., are spearheaded by a dedicated Projects Team whereas the Extension and Improvement (E&I) works are undertaken by the individual division offices, while RGGVY scheme is being supervised by the Chief Engineer’s office.

CESC does not carry out a perspective planning exercise. The approach towards capital expenditure planning is mostly short term in nature. The Capital Expenditure Budget is prepared on an annual basis. The planning is a bottom up approach, where the field officers identify the requirements and the budget requirements is prepared. Government driven schemes such as NJY, RAPDRP, Ganga Kalyana etc. are reviewed and driven by the corporate office.

Approval Process

In CESC, the capital works are approved by Executive Engineer or Superintending Engineer or the Chief Engineer based on the value of the work and the financial powers specified in the order no. KPTCL/B25/475/98 dated 4.1.2001.

All the works approved at different levels are grossed up and discussed at corporate office for finalization of the Capital expenditure budget for the year.

Capital Budgeting

The budget requirement is scrutinized for completeness, relevance and importance by the EE/SE/CE/DT at different levels. The plan or budget requirement is consolidated at the corporate office after taking into consideration the requirement of each division. The management prioritizes the same based on the necessity of the works, availability of funds, material and resources at hand and approves the Annual Budget for a particular financial year.

Budget provision in utilities is made for commissioned works, on-going works and works that have been proposed to be taken up during the ensuing fiscal year.

Following are the major observations related to capex planning:

- The distribution utilities do not carry out studies such as load forecasting, demand supply gap analysis, generation planning and transmission planning for short/medium and long term to arrive at the investment requirements.

- Planning is mostly reactive in nature. Reactive planning here means that the capital expenditure requirement is more immediate and urgent in nature and will have to be undertaken in the next 6-12 months to ensure quality of supply or reliability.

- Estimates and DPRs are not standardized and majorly in case of E&I estimates, certain critical information such as Need and Technical justification, cost benefit analysis and standard formats are missing.

- There is a need for comprehensive risk analysis and response strategies to be in place particularly for high value projects.
3.2. Execution

The Utilities are executing projects either on partial turnkey or total turnkey basis. The works are awarded to contractors through competitive bidding process carried out by the Tendering and Procurement Wing. At the time of work award, the work execution schedule is agreed upon between the contractor and utility and payments are made against the set milestones.

The works of higher value like NJY, RAPDRP, RGGVY, UNIP schemes etc. are generally carried out through contractors awarded through competitive bidding process on total turnkey and partial turnkey basis. Works of small value are given out to contractors on rate contract basis only for the labor portion and material is supplied by the utility.

It was observed in the capex prudence exercise that works of smaller value are mostly completed without any time and cost over runs. However, higher value works such as NJY, RGGVY etc. have experienced time and cost over runs. Right of Way issue is one of the most important reasons for the time over runs.

Material Procurement is done by the Tendering and Procurement wing at the corporate office and distributed among the 15 stores at division level. The requirement of materials is given by Zonal offices and the procurement is done through e-procurement as per the guidelines of KTPP Act. The weekly stock position of essential line materials of each zone is submitted to the corporate office for inventory analysis. In case of additional requirement by any zone, first the scope for re-appropriation of materials within division stores is looked at before going for additional procurement.

The major materials procured are Poles, Pole clamps, transformers, TC Sets, conductors, line equipment, line materials, insulators, transformers oil, etc. It has been observed that there are situations where works are delayed due to shortage of material. This happens when the material procured as per initial plan is diverted to unplanned works or works taken up on emergency basis.

3.3. Project Monitoring

Project monitoring is a critical function in the capex lifecycle in order to ensure that the works are being carried out as per the estimated timelines and within budget. The key issues identified during monitoring can also act as a feedback for further planning exercises.

Following are the major observations related to project monitoring process:

- For CESC, currently there is no monitoring of each and individual works for E&I projects. However the corporate office regularly monitors the funds drawn against the budget allocated towards expenditure to each division office. Schemes such as R-APDRP, NJY, RGGVY, UNIP etc. are tracked by either Projects Office or Chief Engineer’s Office or the Corporate Office.

- There is no central repository or database for DPRs/Estimates/Work Awards of projects executed in the past. The documents are available only in respective section/sub-division offices which have implemented the project.

3.4. Ex-post Analysis

Currently, there is no Ex-Post analysis being done on voluntary basis for works executed CESC. However, third party inspection is carried out for few schemes such as RAPDRP, NJY etc. wherein the emphasis not mainly on verifying if the objective for which the work has been taken up has been achieved or not.
C: Recommendations on To-Be Process
4. Capital Investment Planning

Transmission System Planning or Distribution System Planning both work on specific planning objectives that the utilities are intended to achieve.

For the ESCOMs the objectives can be

1. *Meet load growth*
2. *Operate within the permissible levels of voltage*
3. *Minimize energy losses*
4. *Improvement in reliability and quality of supply*
5. *Improved customer service etc.*

ESCOMs should carry out detailed studies on a regular basis to identify the system performance as on date, which will form the baseline and these studies will enable them to forecast future requirements. This will help in identifying the specific needs of the system. The key studies that are pertinent for system planning are:

- ESCOMs
  - Load Forecast or Demand Forecast Studies
  - System Loss Reduction Studies
  - Feeder wise Load Flow Analysis
  - Reliability Analysis
  - Asset mapping and asset management

Based on studies, utilities should clearly define objectives that they want to achieve in the short, medium and long term. Once the objectives are clearly identified, it is important to set related goals to meet the objectives and achieve meaningful growth. This will be possible when the utilities understand and analyze the existing system and its performance using measurable parameters.

It is based on these objectives that utilities should work towards identifying the capital expenditure requirements. These objectives should be revisited and reviewed periodically during the planning process and scheme approval. Further, prioritization, fund allocation etc. should be done in a manner that achieves the set goals.

Capital expenditure planning is an important part of the entire network planning and design process as it entails identification of projects/schemes, evaluation of the investment need, expected outcome levels, optimality of the investment, etc. Thus, it is important that the utilities have a foresight on the long term objectives and future growth potential to identify the areas of investment.

4.1. Setting of Objectives

Understanding the need for investments for each type of capital project is a prerequisite. Currently utilities are categorising capital expenses based on type of work rather than the objectives the projects intend to achieve. While it is alright to classify them based on the type and category of works, it is important for the management and the employees to understand what ends the investment is going to achieve. Accordingly we believe the management should reclassify and categorise investments based on the objectives and to begin with investment requirements can be broadly categorised as below:
- **Policy and regulatory driven investment schemes**: Investments in this group are driven by policy or regulatory requirements with respect to social / economic / technical objectives to be achieved and the capital cost approved by the central/State Government and/or central regulator.

- **Load growth and system expansion based investments**: These schemes are primarily driven by projected load growth in an area or the need to serve new areas, and thus include network reinforcement and expansion to cater to such load growth. Load forecasting is the starting point in the preparation of these capital expenditure requirements. The forecast defines the need and determines the timing for network augmentation. A significant amount of data and information needs to be recorded for this process to be accomplished. The outcomes / benefits of these schemes are indicated by associating them with meeting increased demand, reduced congestion at different voltage levels, extension of equipment life, or rehabilitation of network, etc.

- **Efficiency or system strengthening based investments**: Schemes under this are aimed at improving performance of the existing system in terms of commercial and technical loss reduction, improving the quality of supply, enhancing reliability, strengthening grid networks, new investments in control centers and associated metering/communications/settlement systems. The benefits of such schemes are quantified by reduction in transmission / distribution losses, improvement in voltages and reliability of supply.

- **Addressing deteriorating assets and new technology investment**: These schemes are aimed at renovating and modernization of the old and deteriorating assets. New investments in control centers and associated metering/communications/settlement system such as implementation of new Information Technology systems, Smart Grid and Communication Equipment etc

The capital works undertaken by ESCOMS can be classified as per the objectives shown in the table below:

### Figure 1: Mapping of type of works to objectives

<table>
<thead>
<tr>
<th>Type of Works</th>
<th>Efficiency and system improvement</th>
<th>Meeting future load growth</th>
<th>R&amp;M and new technology investment</th>
<th>Policy and regulatory driven</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objectives</td>
<td>- Reconductoring of lines</td>
<td>- Service connection works</td>
<td>- Replacement works and investment in new technology</td>
<td>- Rural electrification (RGGVY)</td>
</tr>
<tr>
<td></td>
<td>- Replacement of deteriorated poles</td>
<td>- New feeder/link line</td>
<td>- New substation</td>
<td>- R-APDR</td>
</tr>
<tr>
<td></td>
<td>- Replacement of failed transformers</td>
<td></td>
<td></td>
<td>- Nirathara Jyothi Project(NJY)</td>
</tr>
<tr>
<td></td>
<td>- HVDS</td>
<td></td>
<td></td>
<td>- Ganga Kalyana</td>
</tr>
<tr>
<td></td>
<td>- DTC Metering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Reactive compensation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Express Feeders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Improvement in voltage regulation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Reduction in number of interruptions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Improve reliability of power supply</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Reduction in technical and commercial losses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Reduction in accidents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Ability to meet increased demand</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Improve reliability of power supply</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Improving system availability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Reduces un scheduled outages</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Improves the voltage profile in the proposed substation area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Provide Power for All</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Reduction in technical and commercial losses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Provide uninterrupted power supply to non-agricultural loads in rural areas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Achieve social benefits</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Accordingly based on the organizational objectives set, the management should identify and categorize projects/schemes that help achieve the set objectives identified in the perspective plan.

**4.2. Perspective Planning**

A perspective planning exercise would help ascertain and identify the future needs and problem areas, and finalize areas that require investment.

As a first step to capital expenditure planning, *ESCOMs should carry out perspective planning studies* for a time horizon of **5 years** once in every 3 years and notify a Perspective plan document with details of study outcomes, the system needs, steps to be taken to meet organizational objectives and capital outlay. ESCOMs perspective plan shall help KPTCL in planning for upstream substations and lines.

The broad level framework that should govern the Capex planning process is outlined below:

**Figure 2: Overview of Capex planning process**

**Medium Term Rolling Investment Plan**

The Perspective Plan document will be the guiding document based on which the ESCOMs will come up with a **3 year Rolling Investment Plan** respectively detailing the projects/schemes, their primary and secondary objectives, benefits and proposed outcomes for each of the schemes.

This plan shall be a rolling plan demonstrating the achievements of the previous year vis-à-vis the approved plan and the plan for the subsequent years. The rolling plan on a yearly basis should highlight any deviations
and spillovers detailing the reasons and corrective action taken. Additionally the system studies carried out by ESCOMs should be reviewed and compared against the actual growth achieved every year and any variations should be accounted for in the rolling plan subsequently, the same should be provided to KPTCL to make sure KPTCL can accordingly update/revise their plans accordingly.

The rolling plan should start with a period covering year 1 to year 3. The plan shall be updated next year to cover the period from year 2 to year 4 and then to cover year 3 to year 5 and so on. In the year 4, a new perspective plan shall be prepared and a new rolling plan shall be prepared taking cues from the perspective plan.

It is recommended that utilities look to establish a dedicated unit or team for perspective planning and system planning. The same team can facilitate data consolidation as per Grid Code and Distribution Code and conduct planning exercises and come up with the Perspective Plan and periodic Rolling Plans.

ESCOMs should mandatorily carry out perspective planning studies to identify areas of investment and assess capital investment required to meet the short-term, medium-term and long term organizational goals based on outcome of various studies concerning future load growth, reliability and quality of power supply etc. A medium to long term plan for a time horizon of 3-10 years would enable ESCOMs to identify the future needs and problem areas, and zero in on those areas that require investment.

Some of the key considerations in the perspective planning exercise for ESCOMs are outlined below:

- Demand Supply Analysis
- Feeder wise Load flow studies
- Feeder wise loss analysis
- Load growth forecasts
- Projected loss trajectory
- System strengthening requirements
- Rural Electrification Projects
- Social Schemes
- Asset mapping and asset management

**Table 1: Planning studies to be carried out**

<table>
<thead>
<tr>
<th>Consideration</th>
<th>Items to be covered</th>
<th>Importance</th>
</tr>
</thead>
</table>
| Load growth study & Demand Supply Analysis | a. Study of feeder wise detailed load growth historically  
b. Forecast future load growth for all feeders  
c. Historical Demand Supply analysis (energy and peak demand) for Discom and projection | The study will help in planning for system augmentation works such as new feeder, new substation, link lines, etc. |
| Feeder wise loss analysis               | a. Study of historical feeder wise losses  
b. Projection of the future loss trajectory at sub-division/division/circle and Discom level | This study will help in  
a. Identifying feeders where investment towards link lines, load relief, Reconductoring, DTC metering, etc.is required  
b. Designing strategy to meet the projected loss trajectory |
<table>
<thead>
<tr>
<th>Feeder wise Load flow studies</th>
<th>Analyze the system in normal steady state operation and identify the bottlenecks and problem areas</th>
<th>This study will help in identifying capital works required to reduce losses, determine the voltage, current and active &amp; reactive power flow in the network. Reveals the losses in the system network and help improve power factor and the quality of supply.</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Strengthening</td>
<td>Comparison of the Quality of Supply situation feeder wise with the set benchmarks by KERC</td>
<td>The study will help in identifying works such as ring main systems, Reconductoring, auto-reclosures, new DTC requirement, reconfiguration, reconducturing, reactive compensation, express feeder ad sub-stations etc.</td>
</tr>
<tr>
<td>Rural Electrification and Social schemes</td>
<td>Review of the requirement towards a. Rural electrification  b. Feeder segregation (NJY)  c. Water supply works (Ganga Kalyana)  d. State and Central Government sponsored schemes  e. Arranging power supply schemes, etc.</td>
<td>Strengthening of rural infrastructure. Improving access to consumers and providing uninterrupted supply.</td>
</tr>
<tr>
<td>Energy Accounting and Auditing</td>
<td>DTC Metering  Energy Audit and DSM schemes  SCADA implementation</td>
<td>Study will help in reducing losses in the system and improving reliability in supply. Managing and shifting loads and improving energy efficiency in the system.</td>
</tr>
</tbody>
</table>

ESCOMs may appoint reputed third party agency/consultants in carrying out the necessary studies and develop a detailed and comprehensive perspective plan on the lines of that developed by KPTCL.

Based on the organizational objectives to be achieved in the long term and short term, management should prepare Perspective Plan and medium term rolling plan. Following that, schemes/projects should be identified under particular organizational objectives and associated implementation plan drafted. The schemes should be further prioritized on a broader level to ascertain the areas that require attention in the short term, medium term and long term. This list will essentially form the 3 year Rolling Distribution Investment Plan.

All the ESCOMs shall prepare and submit a 5 year Perspective Plan based on the report submitted by consultants or on their own beginning **FY 2016**. The baseline studies should be undertaken in the FY 2015 and a 5 year Perspective Plan and a 3 year Rolling Plan should be submitted in **November 2015**. ESCOMs will have to make sure the report is prepared and published much in advance so as to serve as input to KPTCL for the Transmission System Planning.

### 4.2.1. Key studies to be carried out periodically

#### 4.2.1.1. Load Forecasting

It is envisaged in the State Grid Code and Distribution Code that the primary responsibility to carry out a detailed load forecast analysis within his area of supply is with the Distribution Licensee. However ESCOMs in the state currently are not providing any data on this front to KPTCL. PRDCL has carried out the forecast analysis in the perspective plan of KPTCL. Henceforth it should be mandated that ESCOMs will provide KPTCL with the necessary inputs on Load Forecasts to enable them in transmission system planning.
ESCOMs have to conduct annual load forecasting studies based on robust demand forecasting models to determine the future load growth in their respective areas. The utilities should create a database of loads for each consumer category and for each Distribution Substation connected to the Distribution System and update it on annual basis. The utilities should determine the peak load and energy forecasts for each category of loads, and compare it against the forecasted values in the perspective plan. Any major deviation should be flagged out and necessary corrective actions undertaken. Any new requirement from industrial consumers for EHV power supply, any change in distribution network configuration, digital maps of distribution system (33 kV, 11 kV and LT Lines) have to be updated regularly and summarily presented in the load forecasting report.

The ESCOMs should submit the peak load and energy forecasts of their areas, for each category of loads for the succeeding 5 to 10 years to KPTCL. These shall include the details of demand forecasts, data methodology and assumptions on which the forecasts are based. The load forecasts shall be made for each interconnection point with the Karnataka Power Grid and other Users and shall include the annual peak load and energy projections along with the daily load curves.

It is essential to note that Load Forecast studies are not just about quantum of growth but also about geographical locations as well. Knowing the specific locations within the network will help in siting of substations or routing of feeders or undertaking any augmentation to the network. In this context it is also important for the ESCOMs to not just look at past trends and economic indicators but also make an effort to carry out spatial or small area load forecasts using the grid coordinate system or random area method i.e. divide the network into sufficiently large number of small areas and forecast for each small area.

These forecasts would form the basis of planning for expansion of Transmission network, which would be carried out by KPTCL. KPTCL should receive the load forecasts from all the ESCOMs and consolidate it to arrive at the load projections for the entire state.

4.2.1.2. Annual System Studies

To assess the planned investments, the utility needs to carry out studies to show key issues, alternatives (or the proposed solution, if it has only one approach) that addresses the problem, including non-network alternatives and maintenance alternatives if possible, to achieve the desired objective.

Annual system studies such as Feeder wise Load Flow Analysis and other relevant studies should be undertaken to check the operation of the existing system under normal or outage conditions, to see if the existing system is capable of supplying planned additional loads, or to check and compare new alternatives for system additions to supply new load or improve system performance. As the load and network changes during different time periods/seasons, it is necessary to obtain load flow solutions representing different system conditions such as peak load, average load or light load on an annual basis.

Utilities shall perform Residual Life Assessment of all key equipment older than 15 years in usage. The asset replacement and maintenance requirement should be identified based on asset age and condition data. For e.g.: In order to reduce transformer failure rates, the asset condition analysis would act as an input for identification of transformers that are overloaded or operating beyond the asset life.

4.3. Identification and prioritization of schemes

Identification of projects should be a combination of bottom up and top down approach. The ways in which new capital investment initiatives are triggered currently among the utilities are:

a. The division/sub division offices identify works based on existing system conditions such as overloaded feeders, overloaded transformers, frequent interruptions, etc
b. Corporate office driving schemes such as NJY, regularization of unauthorized IP sets through the division/sub division offices.

c. Implementation of state and central Government schemes such as GK, RGGVY and R-APDRP through the division/sub division offices.

The approach doesn’t evaluate alignment of works with the organizational objectives

The beginning point for the capital expenditure planning should be the Perspective Plan. As already mentioned in the previous section the utilities should come up with a Rolling Plan based on the Perspective Plan document. The Rolling Plan is essentially definitive set of schemes identified and phased over the next 3 to 5 years to help utility achieve the defined set of organizational objectives. The following principles broad should be considered while arriving at the Rolling Plan.

- Projects/schemes identified may be classified and categorized by the Organizational Objectives identified in the Perspective Plan
- Each scheme/project will have its individual objectives defined that align with the overall objectives.
- Each project and scheme should be phased based on the following factors:
  - Criticality of the project to network safety and stability
  - Compliance to Grid Code and Distribution code requirements and other regulatory directives
  - Least cost alternative with the maximum benefit to the utility
  - Regulatory, Policy and Business requirements
- The projects should be listed based on priority for each of the years in the Rolling Plan. The following factors should be considered while establishing priority:
  - The criticality of the project to achieve the desired organizational objectives/targets
  - The amount of energy savings or improvement in targeted parameters that can be brought to the system by taking up the project
  - The payback profile or returns possible for the project
  - The potential risks and mitigation measures possible

A proactive approach for identification of projects would include continuous monitoring of asset conditions, review of critical planning parameters and synchronization with the Perspective Plan and 3 year Rolling Plan. This would to a large extent minimize undertaking network improvement works in a haphazard manner and avoid sub optimal investments.

The projects so identified should be classified and re-categorized into heads based on organizational objectives as illustrated in Figure 1 and based on the factors underlined at the beginning of this section. Further, projects under each objective should be evaluated using the investment analysis framework as explained in the subsequent section.

Scheme prioritization is critical to allow resource allocation and program trade-offs based on relative merit. All projects approved to be taken up during a particular year should be prioritized and ranked depending upon the analysis of costs and benefits to the system by using the Benefit Cost Ratio or Payback period or IRR or Net Present Value approaches. These are dealt with in detail in the next section. The Planning team at the corporate
office based on the investment framework analysis and inputs received from the concerned CE/SE/EE should arrive at an appropriate phasing and priority for individual projects.

The projects should be listed in the order of priority (High BCR, spill over projects, social causes, etc.) which will be implemented/supervised by corporate office, division offices, Chief Engineer’s office, project office etc. This will be easy for reviewing at a later date.

The new projects to be taken up should be prioritized and aggregated objective wise in the proposed format below:

**<Organizational Objective-1>**

**Table 2: Format for scheme prioritization**

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Organizational Objective</th>
<th>Total Investment Required</th>
<th>Plan Approved By</th>
<th>Nature of work (TK/PTK)</th>
<th>Critical components</th>
<th>Total estimated cost</th>
<th>Total estimated Benefit (savings/improvements)</th>
<th>Risks involved</th>
<th>Suggested contingency measures</th>
<th>Overall Rank assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>RoW.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>Supply of Tr</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**4.4. Annual Program of Works or Annual Capital Budgeting**

Annual Budget or the Annual Program of Works preparation is (or should be) at the heart of good expenditure management for any public utility. Capital planning should usually be accomplished through an organization’s Capital Review Committee or a Planning Committee, which establish final criteria for prioritizing projects and for setting the capital budget. Utilities should look at setting up specific teams to undertake planning and prioritization. To be fully effective, capital expenditure management require four forms of fiscal and financial discipline:

1. control of aggregate expenditure to ensure affordability; that is, consistency with the macroeconomic constraints;
2. effective means for achieving a resource allocation that reflects expenditure policy priorities;
3. efficient delivery of services (reliable supply); and
4. Minimization of the financial costs of budgetary management (i.e., efficient budget execution and cash and debt management practices).

It is important that ESCOMs considers revenue and expenditure (as well as borrowing constraints) together to determine annual budget targets. The budget or Annual Program of Works should cover all plan as well as non-plan or contingent works, so that the budget presents a consolidated picture of these operations and is finalized accordingly.

In addition, the utilities should look to develop the annual budget within a multiyear perspective, through the preparation of medium-term revenue and expenditure frameworks. Focusing on the current or next fiscal year’s capital expenditure alone can be misleading. Expenditure planning should be extended beyond one year so as to gain a full appreciation of the future spending implications of present policy decisions. Nowhere is this more
important than on the recurrent costs of capital spending. Now that the utilities are moving towards multi-year planning, such plans need to be reintegrated with recurrent expenditures and into a multiyear expenditure plan that provides the basis for establishing a realistic annual budget.

In principle, the basic steps in a standard budget preparation system comprise the following:

1. The first step in budget preparation should be the determination of a macroeconomic framework for the utility for the budget year (and ideally at least the next two years). The projections should be agreed upon at the time of finalizing the Rolling Plan. This allows for determination of the level of expenditure that can be afforded without adverse implications on the functioning of the utility, given expected revenues and the gap in capital expenditure that can be safely financed.

2. The second step should be the allocation of this total among priority projects, at the same time making provisions for reserves (a separate contingency reserve).

3. The next step should be for the Zonal/Circle/Divisional offices to prepare a budget circular to give instructions to officers, with the indicative aggregate spending ceiling for each of them, on what projects to execute within the budgets in a way that will be consistent with macro objectives.

Currently, the utilities do not prepare a macro framework capturing revenue and expenditure. In such cases, it is an administrative mechanism that initiates the budget-making process, usually providing a timetable for submissions from field offices below— that is estimates by line item and by category of works—but not giving them much guidance in the preparation of their estimates or overall by the organizational objectives or spending limits. With this mostly "bottom-up approach," field offices at times overstate their needs, exerting upward pressure on overall spending.

Some of the additional factors or questions that should be answered before the list of works to be undertaken in a specific year are finalised:

1. Are my estimates based on reasonable revenue projections? How are these made, and by whom?
2. Are the financing provisions realistic?
3. Is there a realistic costing of works and programs and hence expenditures (e.g., assumptions about inflation, average cost of power purchase, interest rates etc.)
4. How are future cost and revenue implications taken into account?
5. How far are spending priorities determined and agreed under the budget process?

Once the Annual Budget or Annual program of Works is determined based on the above analysis, the published document should clearly have the following:

1. List of projects classified into three categories;
   a. The Budgetary estimates required to settle the claims of the Contract for the commissioned works agency during the ensuing fiscal year
   b. The Budgetary estimates required for the capital works which will be under execution during the ensuing fiscal year
   c. The Budgetary estimates required for taking up new capital works during the ensuing fiscal year.

2. The projects should be listed in the order of priority (High BCR, spill over projects, social causes, etc.) which will be implemented /supervised by corporate office, zonal or chief engineer’s office, division offices, project office etc. This will be easy for reviewing at a later date.

The annual capital budget for the next fiscal year should be prepared and submitted to the Commission along the revised and updated Rolling Plan by 30th November every year. The Commission shall scrutinize and review the same.
5. Investment Analysis Process

Investment analysis is critical for undertaking thorough evaluation of projects. It is a vital step that tells us if the end being achieved justifies the amount being invested. Further, it will help avoid any slip ups, as because of slip ups, customers are burdened with costs of redundant investments.

While load growth based investments and system improvement schemes must be assessed through investment analysis, the policy driven schemes need not be subject to the part where benefit to cost analysis is carried out due to their policy dependent nature and the broader welfare and social objectives. However, the rest of the aspects of framework such as identifying the need, the objectives, evaluating alternatives, project costing etc. all should be applicable for even the social welfare schemes.

All capital works should have techno-economic analysis captured in the estimate or a DPR. In addition to covering the technical aspects related to the project, the investment analysis process should answer:

a. What is the as-is situation?

b. What is the forecast and what is the need for taking up the project, is it aligned with our overall objectives or planning philosophy or not?

c. Is the investment properly targeted at the right location / issue / asset, and is based on asset utilization and consumer demand or such other quantitative measure?

d. Is it optimal, i.e. is the investment happening at the right time? Optimality of the investment (i.e., Right Time) can be assessed by studying the expected load growth for the assets and phasing investments appropriately.

e. Have we reviewed all the possible alternatives and identified the most optimal one?

f. Is it efficient in terms of expected outcome levels being met by spending the right amount given the multiplicity of options? (for example, a demand-side management scheme may probably avoid an investment to upgrade the network)

Currently, distribution utilities are preparing estimates and DPRs for the capital works. However, there is no standard approach followed in the estimates or DPR preparation. These documents at times do not fully capture the extent of planning or investment evaluation carried out by the utility before going ahead with a capital work.

The estimate/DPR should capture aspects like the need for investment (with supporting readings), benefit cost analysis, technical design, implementation timeline, etc. An indicative DPR structure is given in Annexure-1. Also every estimate/DPR should have a validity period of not more than 1 year. If the capex work is not executed within that validity period, estimate/DPR should be revised for the techno-commercial aspects and should be re-submitted for approval.

The DPRs or project reports prepared for implementation for long term plans should clearly bring out the various preliminary investigation carried out including route survey, land acquisition, etc., The works proposed under project may be notified as per the statutory requirement. The bar/pert-chart for each activity/work involved for timely implementation of project may be furnished. The requirement/tie-up of funds for implementation of project may be captured in the DPR which can help the utility arrange for the funds and make timely payments to the vendors.

ESCOM shall have such detailed estimates/DPRs for all the works of value equal to or above Rupees 3 lakhs. The same can be followed for lower value works at the discretion of the ESCOM.
The following sections explain in detail the areas to be covered in the Detailed Project Report or Project Proposals.

### 5.1. Need for the capital work

This section of the estimate/DPR should capture why a particular work is being taken up. Status of the infrastructure before taking up of the project should be captured. If the work is related to improvement of the quality of supply or reduction in losses, the document should provide details of existing situation of HTVR or LTVR or losses or interruptions etc. The most important task for utilities is to document and record all parameters for each critical facility in the network infrastructure, so that the same can serve as a pointer for investment decisions at the same time the recorded parameters can be used to describe the current situation and justify the investments. Given below are few illustrative examples on the data to be collected against certain types of works:

<table>
<thead>
<tr>
<th>Reason for taking up of work</th>
<th>Supporting information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load bifurcation</td>
<td>Historical peak load (in Amps and kVA) recorded taken from MUSS for last 12 months</td>
</tr>
<tr>
<td>New feeder</td>
<td>If new feeder is drawn to connect new load, details of the proposed load should to be highlighted. If new feeder is created as part of load reconfiguration, details of loading on the affected feeders should be provided.</td>
</tr>
<tr>
<td>Improve Quality of Supply</td>
<td>Record of existing HTVR or LTVR (details of where and when such reading is taken should also be provided)</td>
</tr>
<tr>
<td>Reduce interruptions</td>
<td>Historical record of interruptions (in numbers and hours) for the last 12 months</td>
</tr>
<tr>
<td>Re-conductoring</td>
<td>Age of old conductor or history of line-snapping/accidents/interruptions etc should be captured.</td>
</tr>
<tr>
<td>Replacement of failed transformer</td>
<td>Reason for failure of the transformer and actions to be taken to avoid failure again</td>
</tr>
<tr>
<td>Addition of new substations</td>
<td>Number of pending customer applications, Estimated load growth in the area and loading of the existing substations</td>
</tr>
<tr>
<td>DTC Metering</td>
<td>Distribution losses on the feeder and/or losses for load connected to DTC.</td>
</tr>
</tbody>
</table>

This information not only helps in understanding the need for the capital work but also acts as baseline information for comparing and evaluating the success achieved after the execution of the capital work.

### 5.2. Defining primary and secondary objectives

The estimate/DPR should highlight what are the primary and secondary objectives which are expected to be achieved from the proposed capital works. As much as possible, the primary objective should be measurable and defined in quantifiable terms as well so that it can be compared against the actual outcome after completion of project.

Following are some examples of Primary Objectives for certain type of works:

<table>
<thead>
<tr>
<th>Type of Work</th>
<th>Primary Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>New feeder/link line</td>
<td>Load relief achieved in MWs, Reduction in losses in %, Decrease in number of</td>
</tr>
</tbody>
</table>

KERC - Capital Expenditure Guidelines for ESCOM

PwC
Along with Primary objective the utility should have identified Secondary objectives for each investment. The secondary objectives can indicate the other benefits envisaged in qualitative as well as quantitative terms. A sample illustration indicating primary and secondary objectives to be identified for certain type of works depending on the nature of investment and the system requirement is given below:

<table>
<thead>
<tr>
<th>Nature of work</th>
<th>If Primary Objective is</th>
<th>Secondary Objectives can be</th>
</tr>
</thead>
</table>
| Substation (New substation, Additional transformer) | • Load growth. Details in terms the expected future loads and loading on the existing feeder/transformer can be recorded.  
• No of new connections and increase in consumption estimated.  
• Distribution losses and Voltage regulation | Quality of Supply (HTVR)                                                             |
| New feeder/feeder bifurcation         | • Load relief/ New load.  
• Details in terms of the expected future loads and loading on the existing feeder/transformer can be recorded.  
• Envisaged load distribution between feeders can be specified | Energy savings in MUs,  
Improvement in tail end voltage                                                                 |
| Reconductoring – example 1            | Reduction in interruptions                                      | Reduction in losses, Quality of supply (HTVR)                                              |
| Reconductoring – example 2            | Energy Savings                                                  | Reduction in interruptions,  
Improvement in tail end voltage                                                               |
| Link Line                             | Voltage Regulation HTVR, Recorded tail-end voltage and expected improvement | Reduction in length of line,  
Reduction in interruptions                                                                |
| Intermediate Pole works – example 1  | Reduction in interruptions                                      | Reduction in duration of interruptions, Reducing no of accidents,  
Reducing span length                                                                      |
| Intermediate Pole works – example 2  | Improving safety. In case data on electrical accidents is not available details can be recorded in terms of inadequate ground clearance, reduction in span length and compliance to standard distribution planning requirements | Reduction in number of interruptions, Reduction in duration of interruptions |
The above list is merely an indication of primary and secondary objectives. The engineer preparing the DPR/Estimate shall define quantifiable primary and secondary objectives based on the understanding of the need for executing the work.

5.3. Technical Justification

Detailed Techno Feasibility analysis should be performed for all projects in order to ensure the following points:

- The design follows the existing norms and standards
- If equipment is replaced, it has to be proved whether the existing equipment has outlived its normal life span
- Average rate of technology obsolescence for the equipment to be replaced should be mentioned
- The capacity planned should be in tune with the demand growth
- Redundancy in the system to be built appropriately

5.4. Bill of Material and Project Costing

A bill of materials (BOM) is a formal and complete hierarchal documentation of the specific items that needs to be included in a finished product. This list can include specific components, assemblies, and subassemblies. Bills of materials should be drafted at the onset of a project as part of the estimation and budgeting process, and should also be used in the determination of material drawl schedule. Currently utilities are carrying out this process however it is not uniformly adopted across projects particularly in ESCOMs.

A master inventory list along with reference cost for each inventory item should be maintained. Also standard formats for bill of material (BOM) should be used. Few key essential element checks that are required during preparation of bill of material:

a. **Completeness:** Incomplete data is the most common BoM defect. Critical pieces of information, such as quantity, part description, item specifications are often omitted. Thus, a completeness check should be done after preparation of BoM.

b. **Consistency:** Information in the BoM sometimes conflicts with information provided in engineering drawings and design files. For example, quantities may not match — there may be a requirement of a particular component for works at 10 locations, but only a quantity of nine components is specified in the BoM. A standard format for BoM preparation should be used across utilities.

c. **Correctness:** Incorrect data is a serious problem. Common errors include obsolete data and incorrect part numbers. Therefore, BoM should be verified by competent authority.

After preparing bill of material, costing needs to be elaborated based on project requirements and timeline.

Project costing is a method that uses Standard Rates schedule to measure overall cost and plan productivity through the full life cycle of project. Project costing encompasses several specific functions of project management including estimating, job controls, field data collection, scheduling, accounting and design.

There are 3 key essential processes in this area including:

a. **Planning Cost Management:** Planning cost management deals with estimation of expected costs while the project is still in the planning period and is approved beforehand. During the project execution, all expenses are recorded and monitored to make sure they stay in line with the cost management plan. After the project is finished, the predicted costs and actual costs (including deviations in quantity of material used, unit cost variation, etc.) can be compared and analyzed, helping future cost management predictions and budgets.

b. **Estimating Costs:** Estimation of cost is an important element of project costing as any wrong selection of element cost may lead to sudden project cost overrun or it may also lead to over estimated
Design of Capex Guidelines

KERC - Capital Expenditure Guidelines for ESCOM

PwC

29

cost resulting in over budget burdens. For avoiding these situations three key steps levels should be followed in project cost estimation process:

(1) Planning preliminary estimate: a rough approximation of cost within a reasonable range of values, prepared for initial information purpose only.

(2) Budget estimate: an approximation based on well-defined (but preliminary) cost data (Schedule of Rates) and established ground rules. Here revised cost as per schedule of rates needs to be checked before firm estimate is prepared as it may lead to sudden cost overruns due to under cost project elements.

(3) Firm estimate: The cost estimate so arrived at should be used in the DPR. Any further revision should be updated as a part of project management control and all further estimated cost version should be properly saved with their revised version and details of reviser.

Assumptions made in making the estimates; for example, the labor rate and where this data came from should also be properly described. In a nutshell, the outcome of estimating costs will include a cost estimate for each project activity and the basis for that estimate, which can be used to determine the project budget.

c. ‘Determining Budget: Determining the project budget is the process of aggregating the cost estimates for all project activities and assigning a timeline to them. The timeline assigned to this cost will be important to reconcile the expenditure with the funding limits. Also the key risk elements need to be identified and factored in the cost estimate as contingency reserve. Contingency reserves are the funds that can be used to deal with the unplanned events that can potentially transpire in case one or more identified risks occur.

5.5. Benefit Cost Analysis

Benefit Cost analysis is a mathematical approach to quantify the benefits received out of a capital investment made and decide on the financial feasibility of the project.

When deciding which capital investments to make, companies usually use a combination of formal financial criteria, including

- Net present value (NPV),
- Internal rate of return (IRR),
- Return on investment
- Payback period
- Benefit to Cost Ratio

**Internal Rate of Return (IRR) or NPV:** IRR and NPV is a measure to evaluate the financial feasibility of investments giving importance to time value of money. This method calculates the returns earned by the company over the life of the asset.

IRR can also be defined as the discount rate at which the present value of all future cash flow is equal to the initial investment or in other words the rate at which an investment breaks even. Higher a project’s IRR the more desirable it is to undertake the project first. A project is economically feasible if IRR is greater than Weighted Average Cost of Capital of the company

Alternatively, Net Present Value (NPV) can be used to calculate the net benefit to the company after considering initial investment, yearly costs and yearly benefits after taking into consideration time value of money. The discounting of the cash flow shall be done using Weighted Average Cost of Capital (WACC) of the company. A project is economically feasible if the NPV is greater than zero.
Weighted Average Cost of Capital = (% of Equity in the capital structure) x (Pre-tax RoE) + (% of Debt in capital structure)x (marginal cost of borrowing) x (1- utility marginal tax rate)

Example: Illustration

<table>
<thead>
<tr>
<th>Weighted Average Cost of Capital calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Tax RoE</td>
</tr>
<tr>
<td>%</td>
</tr>
<tr>
<td>Cost of debt</td>
</tr>
<tr>
<td>%</td>
</tr>
<tr>
<td>Tax rate</td>
</tr>
<tr>
<td>%</td>
</tr>
<tr>
<td>Debt %</td>
</tr>
<tr>
<td>%</td>
</tr>
<tr>
<td>Equity %</td>
</tr>
<tr>
<td>%</td>
</tr>
<tr>
<td>WACC</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Payback period: It is the ratio of the investment to the monetary value of benefits expected due to the execution of project. This method does not consider the time value of money and the life of investment after the pay-back period but this measure is used as an indication of the amount of investment’s risk. Acceptable payback period for power utility projects ranges from 1 to 5 years.

Benefit cost Ratio: The method is based on life cycle (25-30 years period) cost benefits. The financial analysis is usually done for the lifetime of the project considering the year-wise costs including interest, depreciation, operation and maintenance charges, and the expenditure on additional sale of energy and the year-wise gross benefits including the revenue from additional energy, and cost saving due to saving in losses etc. The year-wise net present value of the net benefits is calculated and the cumulative net present value of the net benefits is evaluated.

Capital investments should also be evaluated with respect to strategic consistency and risk. And, because capital spending is planned to maximize value, as much as possible investments should be undertaken only when expected returns are equal to or greater than the average cost of capital and the risks have all been addressed to a larger extent. It is also important that utilities carry out sensitivity analysis to see the impact of variation in cost parameters or revenue assumptions to understand the investments better.

In order for a specific capital expenditure to be funded, its sponsors may have to justify it with a formal business case analysis, including estimates of NPV, IRR, payback period and other financial criteria. Though utilities currently do not go for project based or scheme based capex funding, going forward it is important to have a more formal approach to the fund raising process. This will help utilities manage budgets better and bring in more accountability. Additionally if the utility has limited capital funds, moreover, the potential capital expenditure may have to enter a competitive capital review process, where all requested expenditures are compared, and only the most favorable receive funding with the exception of social schemes. Those who propose or request funding for capital expenditure should be sure they understand:

- The organization’s criteria for prioritizing capital expenditure proposals.
- The timing of the current and next capital planning and spending cycles.

It has been observed that ESCOMs compute the energy savings expected to be achieved from the work. However, it has been observed that BCR or payback is not computed. The energy savings computation alone cannot tell if the work is financially feasible or not.
In few estimates/DPRs, ESCOMs are using Benefit to Cost Ratio to evaluate financial feasibility of the work/project being taken up. Leaving works taken up for achieving social benefits, as much as possible, ESCOMs should take up works which have BCR more than 1. We have observed that while computing BCR, time value of money concept has not been applied uniformly and certain necessary escalations (O&M cost per year and revenue realization from energy saved etc.) have not been considered. Also, all economic benefits and costs should be captured as much as possible while computing BCR. Proper BCR computation will help utility in prioritization of capital expenditure and also identify steps required to improve the financial feasibility of work/project. Alternatively, for high value works, ESCOMs can use IRR approach for capital budgeting (as IRR computation inherently applies time value of money concept to all benefits and costs. Also it is easy to apply any escalations i.e., for O&M, energy cost and other benefits)

Not all proposed distribution projects can (or should) be justified economically. Distribution projects can provide a wide range of benefits—economic, social, and reliability—to the consumers. While social and policy driven schemes need not be subject to investment analysis, all other projects should be. Narrow or conservative evaluation of distribution benefits risks rejection of valuable projects. If any work/project is executed despite it having BCR less than 1, a justification needs to be given in the estimate/DPR giving details of why the work/project is taken up.
Review of BCR calculation methodology currently being used by ESCOMs

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Estimate cost</td>
<td>Rs in lakhs</td>
</tr>
<tr>
<td>2</td>
<td>Annual energy savings (UPA)</td>
<td>Units</td>
</tr>
<tr>
<td>3</td>
<td>Cost of energy/unit</td>
<td>Rs</td>
</tr>
<tr>
<td>4</td>
<td>Cost of annual energy savings due to loss reduction(2*3)</td>
<td>Rs in lakhs</td>
</tr>
<tr>
<td>5</td>
<td>Life of the project</td>
<td>Years</td>
</tr>
<tr>
<td>6</td>
<td>Interest rate</td>
<td>%</td>
</tr>
<tr>
<td>7</td>
<td>Discount factor</td>
<td>K</td>
</tr>
<tr>
<td>8</td>
<td>Present value of annual savings(due to loss reduction over a project period of 30 years)=4*7</td>
<td>Rs in lakhs</td>
</tr>
<tr>
<td>9</td>
<td>Savings in generated power in KW</td>
<td>Units saved/(LLF<em>8760)= units saved/(0.132</em>8760)</td>
</tr>
<tr>
<td>10</td>
<td>Financial benefit due to savings in generated power at Rs. 50000/KW at 12% interest P.A.=(850.12<em>50000</em>12)/100</td>
<td>Rs in lakhs</td>
</tr>
<tr>
<td>11</td>
<td>Benefit due to energy saved and savings in generation(4+10)</td>
<td>Rs in lakhs</td>
</tr>
<tr>
<td>12</td>
<td>Annual O&amp;M charges @ 1% of the estimate cost</td>
<td>Rs in lakhs</td>
</tr>
<tr>
<td>13</td>
<td>Present value of annual O&amp;M expenses over a projected period of 30 years=7*12</td>
<td>Rs in lakhs</td>
</tr>
<tr>
<td>14</td>
<td>Total investment + present value of O&amp;M expenses = 1+13</td>
<td>Rs in lakhs</td>
</tr>
<tr>
<td>15</td>
<td>Payback period= estimated cost/total benefit(1/11)</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Benefit to cost ratio (8/14)</td>
<td></td>
</tr>
</tbody>
</table>

As an illustration for distribution project investment analysis, we have underlined below cost items and the estimated benefits that can be considered during the analysis for different type of projects.

1. **Cost Benefit Analysis for Feeder Bifurcation:**

   **Cost Items:**

   *Estimated Capital Cost:* The comprehensive capital cost along with Interest During Construction should be considered

   *Other Costs:* Operations and Maintenance Costs should be considered after accounting for the appropriate escalation rates.

   **Benefits:**

   *Benefit due to energy savings (Loss reduction):* Due to change in line length and size of conductor used in feeder bifurcation there will be reduction in the technical loss levels. This loss reduction calculations suggested in Annexure 7 can be used as reference.
Benefit due to increase in sales: If the new feeder results in catering to new load. The benefit from increase in energy sales in form of customer consumption and profit from such sales should be considered in the BCR computation.

2. Cost Benefit Analysis for DTC Augmentation:

Cost Items:

Estimated Capital Cost: The comprehensive capital cost along with Interest During Construction should be considered

Other Costs: Operations and Maintenance Costs should be considered after accounting for the appropriate escalation rates.

Benefits:

Benefit due to increase in sales: While using extra capacity margin more number of customer load can be catered through this margin capacity size (KVA). This increase in loading will result in increase in energy sales and profit from such sales is the benefit to the distribution utility.

However please note that the above is only an illustration and ESCOMs may look to document a number of quantifiable benefits as well as other benefits (not necessarily estimating their value) as tabulated below:

<table>
<thead>
<tr>
<th>Quantifiable Benefits</th>
<th>Other Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced Distribution Losses (energy savings)</td>
<td>Improving performance and stability during contingency events</td>
</tr>
<tr>
<td>Reliability benefits (interruptions, voltage profile)</td>
<td>Social benefits (increased supply hours, increased access)</td>
</tr>
<tr>
<td>Avoided cost of generation (short term power or marginal stations)</td>
<td>Facilitating development of grid connected renewable technologies</td>
</tr>
<tr>
<td>Increased availability of energy for sale (for future loads) (the revenue realization can be based on consumer mix instead of average rates)</td>
<td>Increased access to electricity</td>
</tr>
<tr>
<td>Capacity benefits due to reduced generation investment costs</td>
<td>Improved customer satisfaction</td>
</tr>
<tr>
<td>Reduced O&amp;M costs (replacement of ageing assets)</td>
<td></td>
</tr>
<tr>
<td>Expected unserved energy (energy at risk with a probability of a major outage of transformer or a feeder)</td>
<td></td>
</tr>
<tr>
<td>Computing indices such as SAIFI, SAIDI or CAIDI, CAIFI and show the improvement in the indices</td>
<td></td>
</tr>
</tbody>
</table>

ESCOMs may use any or a combination of these benefits to build a comprehensive business case for distribution projects. An important thing to note is that under the envisaged framework ESCOMs will take up projects organizational objective wise and in case a single project or a part work of a larger scheme or a project in a geographical area prove to have a BCR of lesser than one, the project can still be taken up provided a sound rationale is available and at an ESCOM level the project is contributing to achieving of objectives.
## Illustration - Cost benefit analysis for ESCOMs projects

<table>
<thead>
<tr>
<th>Year Index</th>
<th>Remarks</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>...</th>
<th>Year n</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COSTS in Rs Lakhs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O&amp;M Expenses (escalating Y-o-Y)</td>
<td>O&amp;M expense can be escalated Y-o-Y at CERC approved rate</td>
<td>a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital Investment</td>
<td>b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Costs</td>
<td>a+b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BENEFITS in Rs Lakhs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Energy savings (in Units)</td>
<td>Calculated from appropriate energy loss computation methodology</td>
<td>c</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of energy saved per unit (Rs/Unit)</td>
<td>Utility can consider average cost of energy escalated at 3%</td>
<td>d</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefit unit due to Loss Reduction (in Rs Lakhs)</td>
<td>e=cd</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional Power available with ESCOMs for sale (in MU)</td>
<td>Additional power available with ESCOMs for sale in case of augmentation works</td>
<td>f</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit from sale of power</td>
<td>Average revenue minus cost of energy</td>
<td>g</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefit to utility from additional sale of energy</td>
<td>h=fg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total benefits (in Rs Lakhs)</td>
<td>i = e+h</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BCR calculation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PV of Benefits (Rs Lakhs)</td>
<td>Discounting factor to be used is WACC.</td>
<td>j</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PV of Costs (Rs Lakhs)</td>
<td>k</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BCR</td>
<td>( L = \frac{j}{k} )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IRR Calculation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefits</td>
<td>i</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating costs</td>
<td>a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital cost</td>
<td>b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash flow to the company</td>
<td>( M = i-a-b )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRR</td>
<td>Compute IRR based on the cash flows</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Few factors that ESCOM should consider while carrying out Investment Analysis are:

- The cost items should be escalated taking appropriate escalation rates such as inflation and average interest rates of the utility into consideration. IDC should not be neglected.
- Utility can consider average cost of energy, escalating at a rate of 3% year on year for computing energy savings
- While estimating the revenue from sale of additional energy the average realization rate based on the consumer mix on the particular feeder can be considered instead on average.
- Cash flows should be discounted at the WACC
- Projects with IRR greater than the hurdle rate (WACC) are preferrable

The detail format for Cost Benefit Analysis for various types of E&I works and Transmission projects is attached in Annexure-2

5.6. Evaluation of alternatives

Different alternatives are to be analyzed in terms of their respective costs and benefits, to finalize the least cost plan with maximum benefits.

As an example for augmentation works the study of each alternative should be analyzed under normal condition as well as outage condition. It should be ensured that the network does not experience overloading and the voltage variation in all the alternatives is within permissible limit as indicated in the planning criteria. To evolve the least cost alternative, subject to their meeting the technical requirements, the total cost of the various alternatives should be estimated. The least cost optimal solution may be finalized considering the capital cost and net present value of losses over the life of the project.

The DPR should summarize the alternatives in the proposed format below:

Table 3: Format for Alternatives evaluation

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Particulars of the Alternatives</th>
<th>Total Investment Requirement [As per ......]</th>
<th>Benefit due to Loss Reduction</th>
<th>Benefit due to sale of additional power</th>
<th>Other quantified benefits</th>
<th>Total Benefit</th>
<th>IRR</th>
<th>NPV</th>
<th>Rank</th>
</tr>
</thead>
</table>

The DPR/estimate should give reasons why a particular alternative is finalized and also why other alternatives are less preferred.

5.7. Execution timelines

The timelines for capital projects undertaken by ESCOMs as part of government initiatives or social schemes should be as specified in the corresponding DPRs and for Extension and Improvement works, it shall be within 2 months from the date of 100% supply of material.
5.8. Risk analysis and mitigation strategies

Risk is an uncertain event or condition which, if occurs, has a negative effect on the envisaged project outputs and results in issues like time over run, cost over-run, poor quality execution resulting in increased O&M or poor system availability etc. The power transmission projects, like other infrastructure projects face various risks in different stages of the life cycle. A risk management plan/ matrix/ strategy should address these risks in all phases of the project- viz, design, approvals, financing, procurement, construction, completion and have mitigation strategies for various risks. Risk assessment during early stages of project planning helps in understanding the key risks for a project and likewise formulate appropriate risk response strategies.

Some of the risks that should be considered during project evaluation stage are outlined below.

<table>
<thead>
<tr>
<th>Political Risk</th>
<th>Environmental Risk</th>
<th>Technological Risk</th>
<th>Regulatory Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Right of Way</td>
<td>2. Environmental Impact of the project</td>
<td>2. Feasibility of design Cost and economic viability</td>
<td>2. Aviation clearances from Government</td>
</tr>
<tr>
<td>3. Political Stability in the area</td>
<td>3. Social Impact of the project</td>
<td>3. Availability of material and labour as per the Qualification Requirement</td>
<td></td>
</tr>
<tr>
<td>4. Opposition on environmental ground</td>
<td>3.</td>
<td>4.</td>
<td></td>
</tr>
</tbody>
</table>

The evaluation can be carried out at a scheme level or project level depending on the value, scale and criticality of the project. It is important that even for the minor works being undertaken it is important that the DPR/Estimate copies include a write-up on the possible issues/risks that the Officer foresees in implementation of the said project.

Each of the projects along with the alternatives should be analyzed for the risks identified. It is pertinent to understand the probability of occurrence and impact of such risks before approval of any project. A project risk matrix framework can be followed to quantify the expected impact of any risk on the project.

<table>
<thead>
<tr>
<th>Risk Description</th>
<th>Probability of Occurrence</th>
<th>Potential Impact</th>
<th>Risk borne by</th>
<th>Overall risk rating</th>
<th>Risk Response Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Survey Risks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tender and Contractual Risks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction Risks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financing Risks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational Risks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Expected Impact of any risk = Probability of the risk * Impact due to the risk.
The probability of any risk may be low, medium or high. This may be represented in a suitable scale. For example, in a 3 point scale, any risk with less probability may be represented with “1”, medium with “2”, and high with “3”. Similarly, if the financial impact of any risk is less it can be represented with “1”, medium with “2” and high with “3”.

After identification and impact assessment of risks, appropriate response strategy should be decided. The management can stick to any of the below mentioned four strategies to deal with the risks identified:

- **Avoidance:** In case the expected impact is high, and no appropriate mitigation plan can be put in place, then the project/alternative can be avoided and a different approach can be adopted. For example, if a laying of a particular distribution infrastructure is difficult owing to RoW issues or because of difficulty in obtaining clearances, then an alternative route can be adopted.

- **Transference:** The risk can be transferred to a third party in case the Utilities do not want to take the responsibility. But this involves payment of a risk premium to the party taking on the risk.

- **Mitigation:** Mitigation strategy can be adopted when the risk perceived is of lesser impact. In such a case the project risks should be closely monitored throughout the entire life cycle and mitigation plan adopted as and when required. For example, alternate source of material procurement should be identified well ahead of time to tackle the risk of unavailability of material.

- **Acceptance:** When the projects team is unable to identify any other suitable response strategy, it generally accepts the risk and develops a contingency plan to tackle the risk should it occur. A contingency allowance in terms of time, funds or resource can be done to account for such risks.
6. Execution Process

In order to streamline the execution process, utilities should accurately estimate the time and resource requirement. Execution schedules for each type of capital works should be defined and time limits specified. Though the time limits would broadly indicate the activity wise duration, yet while preparing the detailed activity chart for particular project, flexibility should be given to factor in any anticipatory delay arising out of issues such as RoW, land acquisition, statutory clearances, etc. This would minimize instances of time over runs and also provide realistic execution schedules.

The key recommendations pertaining to avoidance of time over run and accurate resource estimation is as follows:

6.1. Avoidance of time over run

The primary reason for time over run in Transmission and Distribution projects is Right of Way problem. In order to handle RoW issues and minimize their incidence, technological /design interventions like GIS sub-stations, underground cabling system, insulated lines (ABC) etc. can be used.

Identification of RoW issues at the survey phase, through proper route survey can help factor in the associated time delay to resolve it in the project Bar/PERT chart.

Utility shall apply for all the necessary approvals and clearances from host of stakeholders (for example: PTCC, forest department, railways, approvals for road/river crossing, defense, wild life sanctuary clearance, aviation, environment clearance etc) immediately after completing detailed survey without waiting till the work is awarded to a contractor. Wherever possible, the agency performing the detailed survey shall assist in filling and submitting required documents for obtaining necessary approvals and clearances. The approval process can be later taken care of by the contractor, to whom the work is awarded.

In the DPR, along with Bar Chart for activities to be carried out, the utility shall also highlight finance requirement for purchase of equipment/payment to contractor. This shall help the finance department plan for arranging funds in time and also making payments to utility without any delay. Prompt payments to contractors will result in lower cost of execution as the contractors reduce the overheads related to delay in payments

6.2. Accurate resource estimation

In case of partial turnkey projects and for augmentation works for which generally only labor contracts are awarded, material requirement should be correctly and accurately estimated and forwarded to the Tendering and Procurement Wing after due considerations for lead time of procurement. Monthly reporting of field teams to material procurement wing on use of actual materials vis-à-vis estimated should be done. Month wise material requirement projections can be submitted by all the circle offices for better synchronization between material and labor availability. Also Utilities should have quick and alternative sources of procuring material to handle contingencies which result in diversion of material from one scheme of works to other.

In order to check for inventory position, inventory audit should be done yearly once for physical inspection of division stores.
7. Quality Control

Strict quality assurance and quality management system has to be enforced to facilitate the quality of equipment and materials. The Quality Management System to be followed shall be built around a philosophy of "prevention" rather "detection and cure". The Various Steps involved in the Quality System Management are:

- Inclusion of Quality Requirement in the Contract & Selection of good quality vendors/sub vendors
- Approval of unambiguous Manufacturing Quality Plan (MQP)
- Finalization of Field Quality Plan (FQP) ensuring regular, timely and consistent inspection at various stages, viz. raw material, during in-process stage and final inspection and testing prior to dispatch.
- Analyze the equipment failures in association with Engineering and Operation services departments and use feedback for improvement of systems.
- Implementation of Quality Systems and Procedures as per ISO – 9001 for System of Vendor and Sub Vendor Approvals
- A standard format is to be developed for the approval of Manufacturing Quality Plan (MQP) which includes the quality requirements at the raw material stage, In process testing and final inspection and testing requirements as per Technical specifications of the contract and well known good engineering practices of the industry

Vendor Performance Rating

All utilities should consider a creation of a vendor rating database in which contractors and suppliers should be rated based on the following categories:

a. **Timeliness:** Degree to which the vendor supplied product or service within the time frames identified/specified in the contract/scope of work.
b. **Quality:** Degree to which the vendor’s product or service meets or exceeds standards set forth in the contract/scope of work.
c. **Technology:** The level to which the vendor utilizes current technologies to deliver and support products and services as specified in the contract/scope of work.
d. **Flexibility:** Adaptability of vendor to adjust to any change in plans based on situation on the ground
e. **Pricing:** The level to which the vendor adheres to the pricing structure outlined or specified in the contract/scope of work and provides clear and comprehensive invoices.

Rating Definitions are as follows:

1=**Below Standard:** Vendor performance regarding the terms and conditions of the contract/scope of work has been less than standard/satisfactory. Supporting documentation is required.

2=**Standard:** Vendor has met the specifications/requirements of the contract/scope of work.

3=**Above Standard:** Vendor performance regarding the terms and conditions of the contract/scope of work has been more than standard/satisfactory. Supporting documentation is required.

Based on the above parameters and rating methodology, vendors should be rated to identify the performers and non-performers accordingly.
8. Project Monitoring Process

Monitoring is as critical to the whole investment process as any of the above mentioned principles. The ability to control spending and implement programs successfully within timelines is hugely dependent on the review and monitoring mechanisms set up by utilities.

8.1. Project Monitoring System

ESCOMs should have a project management and monitoring team with a composition of technical and finance personnel to effectively track monitor and review the progress of projects undertaken by ESCOMs.

PMS Lite, project management tool used by KPTCL is an effective tool and can also be implemented by ESCOMs as well to begin with. The same can be enhanced to track the entire lifecycle of projects and be customized to distribution system requirements by a team of KPTCL employees who have developed and worked on the PMS system as a team identified by ESCOMs.

The PMS system can be strengthened to incorporate planning stage as well as Ex-Post Analysis stage. Once a project obtains administrative approval, a docket must be raised in the IT tool for the work/project. The same shall be maintained till the work/project is commissioning and ex-post analysis is completed for a period of 2 years post commissioning.

The system could be used to capture and modify information to bring in efficiencies by tracking individual elements of construction and capturing risks and mitigation measures in detail. It could also capture project related documentation and photographs that capture physical progress of the projects.

Since, ESCOMs have so far not implemented a project monitoring unit it is important to understand a few prerequisites given here. Preparation of detailed project plan for all projects is a key role of Project Monitoring Unit or Office (PMO). To start with, PMO officials can use MS Project or any such tool to prepare the plan which should incorporate all the activities and the time required for completion of each activity for different types of works in the distribution system. PMO officials can also use methods like Critical Part Method (CPM), Program Evaluation & Review Technique (PERT) for planning and scheduling. For example, steps in CPM method are
1. **Activity identification:** Identify activities in different phases of the project from inception to commissioning

2. **Activity precedence identification:** Identify the dependent activities i.e. activities that cannot start until the completion of another activity (say, Bill of quantities and costing of projects cannot start until the completion of survey activity or Notice inviting tender cannot be floated till approval of bid documents). Activities which can be taken simultaneously should be defined. Parallel execution of such activities can help in reducing the

3. **Network construction:** The detailed project plan can be prepared using MS project. Subsequently, time, cost and resource implications of a various activities in the plan are decided

4. **Critical Path:** Critical path determines the shortest possible time to complete the project. It is the sequence of activities that add up to the longest overall duration. PMO can prepare a detailed list of activities with help of concerned departments with their early and latest start and finish times. Dependencies between different activities are already identified. This will help in identification of critical path.

The contractor is also required to prepare a detailed schedule of activities for completion of work within time frame for approval of ESCOMs. The actual execution timelines of different activities will be regularly monitored against this schedule.

For effective monitoring, utilities can use Project Monitoring Tools such as MS Project, Primavera, etc. and subsequently migrate to an IT based system. The need and usefulness of proactive monitoring should be communicated well by the management across all administrative levels. Clear roles and responsibilities should be defined to increase accountability and bring in efficiency in the system.

The following table describes the responsibility matrix for maintaining and monitoring the project monitoring system:

**Table 4: Responsibility Matrix for Project Monitoring**

<table>
<thead>
<tr>
<th>Nodal Officer</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Engineers Office, Division</td>
<td>• Record the findings of field visits.</td>
</tr>
<tr>
<td></td>
<td>• Bring out in writing any instances of deviations from accepted quality of</td>
</tr>
<tr>
<td></td>
<td>materials, workmanship and general quality of execution. Include comments</td>
</tr>
<tr>
<td></td>
<td>on alignment of line, conductor sag, provision of insulators, and safety</td>
</tr>
<tr>
<td></td>
<td>guard at road crossings, provision of additional stay at tension points,</td>
</tr>
<tr>
<td></td>
<td>transformer rating and fittings. This is only an indicative list and based on</td>
</tr>
<tr>
<td></td>
<td>the type of work being reviewed, relevant aspects for each type of work</td>
</tr>
<tr>
<td></td>
<td>should be covered</td>
</tr>
<tr>
<td></td>
<td>• Carry out technical audits to ascertain and certify the standard of</td>
</tr>
<tr>
<td></td>
<td>implementation and adherence to guidelines issued by KERC or CEA.</td>
</tr>
<tr>
<td></td>
<td>• Upload photographs of the site taken in field visits</td>
</tr>
</tbody>
</table>

| Superintendent Engineer’s Office     | • The copies of documents listed below should be uploaded by the             |
|                                      |   Superintendent Engineer’s team of the respective circles/from respective    |
|                                      |   division office to the project specific docket.                            |
|                                      | ✓ Survey Reports                                                            |
|                                      | ✓ Detailed Work Award (DWA)/Letter of Award (LoA),                           |
|                                      | ✓ DPR/ Technical specifications/BoQ                                           |
|                                      | ✓ Drawings                                                                  |
|                                      | ✓ Any other labor and material contracts or any other related document       |
|                                      | • Monitor the actual progress of capital works vis-à-vis milestones specified |
|                                      |   in Bar/PERT Charts at the start of the project                           |
|                                      | • Monitor the actual expenditures incurred vis-à-vis the LoA Cost            |
• Record the reasons for time and cost overruns if any and if the delay is attributable to utility or the contractor
• Send out alerts in case of deviations (post and anticipatory) from Execution Schedules to the concerned entity (For e.g. delay in submission or approval of drawings should be flagged out at the appropriate time)
• Record key issues raised by vendors in the meetings and their resolution status
• Record actual project completion date

Chief Engineer’s Office

• Conduct Monthly Review Meetings to discuss the status of projects and take corrective actions as and when necessary.
• Initiate action for dispute resolution
• Review if necessary approvals and clearances as required have been taken for effective execution of the project.
• Review the costs incurred cumulatively and compare with the cost estimates and payment milestones agreed in the Detail Work Award or the Estimate/DPR copies.

Project Monitoring Unit, Corporate Office

• Conduct Monthly Review Meetings to discuss the status of projects and take corrective actions as and when necessary

PMOs will be monitoring weekly/ bi-weekly/ monthly progress of pre-award and post-award activities of projects, as decided at the inception of the project, based on criticality of project. Progress monitoring reports regarding status of projects will be shared as summary reports to top management.

Various status reports need to be generated by the PMO officials for the purpose of project status reporting to top management. The templates of such reports need to be developed and standardized by the PMO officials. Templates and reports with common interest parameters cost, budget, loading of resources that need to be monitored can be standardized for all the common packages like civil and electrical erection works of lines, supply of conductor, insulators, transformers etc. MS Project has capabilities to track scheduled and actual values of timelines of different activities, budget spent, loading of resources etc.

Till the time PMS tool is not developed or there are areas where software does not provide information, PMOs will interact directly with concerned departments and obtain information and compile using a simple excel based system. Standard templates for accessing information will be prepared by PMOs for gathering information from departments. Information can be accessed via e-mail from all the concerned officials. PMU officials can also visit project sites in case of necessity.

Project Completion Report

ESCOMs should ensure that after completion of any project, the completion certificate should be prepared and sent to accounts section within a period of 15 days. This shall avoid delay in asset capitalization. The project completion report should be comprehensive and organized to reflect all relevant project information. An indicative list of information to be captured is given below:

• Name of the project
• Date of Commissioning
• Estimated Date of Commissioning
• Material envisaged as per the DPR, Material drawn from the store and Material utilized
• Time Overrun
• Actual Cost
• Estimated Cost as per LoA
• Cost Overrun
• EPC Contractor Name
- Engineer In Charge
- Materials drawn and labor cost
- Key issues faced in execution
- Photographs of the completed work (GPS and time stamp for soft copies)

### 8.2. Single Data Repository for a Robust Documentation Mechanism

Currently, there is no centralized repository or database for DPRs/Estimate/Award copies and all relevant documents associated with a project. Also it has been observed that the frequent transfer of employees to other division offices makes it difficult to enforce ownership of the capital investments. To overcome these challenges, instead of a people oriented system, a strong process oriented framework needs to designed which would help the utility in assessing the benefits from capital investments.

A centralized data repository of information should be maintained at the corporate office and made accessible to all respective circles, division and sub division offices. It should have the following project specific documents:

- Survey Reports
- Detailed Work Award (DWA)/Letter of Award (LoA)
- DPR/ Technical specifications/BoQ
- Drawings
- Any other labor and material contracts or any other related document
- Minutes of all review meetings
- Photographs taken during field visits
- Project completion certificate

An IT based project management system can be used to facilitate project information gathering and making it available for reference by all administrative levels.

Also, the corporate office shall keep a quarterly record of all the works executed and categorized. The same shall be available for review for KERC at any point of time. The corporate office shall maintain the following information:

a. Date of completion of the work  
b. Estimated value of the work as per the estimate/DPR  
c. Amount Categorized  
d. Date of Categorization  
e. Delay in Categorization  
f. Reasons for any delay in categorization

It is expected that the amount categorized as per the above mentioned record shall match with the amount capitalized as per the books of accounts.
9. Ex-post Analysis

Currently there is no Ex-post analysis framework in place. An Ex-post analysis is only being undertaken as a regulatory mandate at this point. KERC has come up with Guidelines for Carrying out Prudence Check of Capital Expenditure undertaken by the utilities. The guidelines underline the principles and criterion based on which the projects executed by ESCOMs will be reviewed and graded to establish the prudence. It is recommended that the guidelines continue to be used to establish prudence until the utilities in the state come up with a dynamic and transparent system of planning and executing capital projects as outlined in this report.

For projects executed in past where the quantifiable objectives are not mentioned in the DPR, based on the prudence check guidelines we have highlighted below certain KPI’s to be monitored post project implementation, which will help utilities and regulator understand the prudence of projects. The key performance indicators would vary depending on the type of capex works. We have outlined the KPIs against each type of capital works to analyze the results of capital works.

Table 5: KPIs for Capital Works undertaken by ESCOMs

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Type of Work</th>
<th>Primary Objective</th>
<th>KPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Substation (New substation, Additional transformer)</td>
<td>Load growth</td>
<td>No. of new customer added/connected load (KW/KVA)addition, Capacity Margin (redundancy)</td>
</tr>
<tr>
<td>2</td>
<td>New feeder/feeder bifurcation</td>
<td>Load relief/ New load</td>
<td>System Loading Relaxation, Technical Loss reduction, Reduction in No. of customers complaints/Faults/trippings, Tail-end voltage improvement,</td>
</tr>
<tr>
<td>3</td>
<td>Reconductoring</td>
<td>Reduction in interruptions</td>
<td>Reduction in no. of forced outages, Reduction in fuse off calls, Improvement in Voltage Regulation, Loss reduction</td>
</tr>
<tr>
<td>4</td>
<td>Improvement works (Intermediate poles, Auto reclosures)</td>
<td>Reduction in interruptions</td>
<td>Reduction in no. of trippings/breakdowns, Reduction in no of accidents, Improvement in Reliability indices,</td>
</tr>
<tr>
<td>5</td>
<td>Replacement of Failed Transformers</td>
<td>Reliability &amp; Quality of Supply</td>
<td>Reduction in number and duration of interruptions, reduction in fuse-off calls,</td>
</tr>
<tr>
<td>6</td>
<td>DTC Metering</td>
<td>Reduction of commercial losses</td>
<td>Energy accounting purpose, Billing improvement, Identification of high loss area, Decrease in revenue leakage</td>
</tr>
<tr>
<td>7</td>
<td>Additional DTCs</td>
<td>Loss reduction</td>
<td>No. of new customer added/connected load (KW/KVA)addition, Capacity Margin, Technical Loss reduction</td>
</tr>
<tr>
<td>8</td>
<td>Regularizing unauthorized IP Sets</td>
<td>Reduction in losses</td>
<td>Increase in sales and revenue from that area/feeder, regularization of load</td>
</tr>
</tbody>
</table>

Going forward, once a project is completed, ex-post analysis is required to be carried out by the utilities voluntarily documenting the performance of the projects against the set objectives for a period of 24 months (performance should be captured every 3 months) from the date of completion of the work.
Till such time an IT tool to document the Ex-Post analysis is established, Ex-post analysis reports should be submitted to the Commission yearly for all the projects capitalized and commissioned 12 months before. Apart from the Ex-post analysis report, a report should be submitted to the Commission for all completed projects, ongoing projects along with its details with focus on time overruns, cost overruns and other related issues on a half yearly basis. After completion of each project, the project is automatically subject to prudence check.

Commission can review the prudence reports and call for details for sample projects from among the completed projects on a random basis in a specific month. Commission may ask for supporting documents or ask for explanation in case of any particular project.

As mentioned in earlier section, utilities can deploy an IT tool which can document all aspects related to capital investment starting from planning till ex-post analysis stage. Once such IT system is available, utilities can upload/document the performance on the primary and secondary objective every quarter from the date of commissioning of the project for a period of two years.

A view access can be given to KERC for the software, from which KERC will monitor data points such as what is the extent of projects taken up by the utility, projects initiated, completed, amount spent in a year and data provided by ex-post analysis etc. This would be the mechanism for prudence check from Commission’s end. The Commission shall rate and rank the projects based on the achievement of stated objectives at the time of planning and KPIs. In case recorded benefits do not matchup to the envisaged benefits, Utilities shall be asked to provide justification to the Commission. In case the utility cannot provide explanation/ proof to the satisfaction of the Commission that the reasons for failure to meet the objectives as envisaged is due to factors beyond the control of the utility, the Commission may consider the said Capex as imprudent and disallow the related costs.
D: Reference to other states
10. Regulations or Guidelines for Approval of Capital Investment Schemes

<table>
<thead>
<tr>
<th>Maharashtra Electricity Regulation Commission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulation/Guideline</td>
</tr>
<tr>
<td>Investment Plan</td>
</tr>
<tr>
<td>Approval required for</td>
</tr>
</tbody>
</table>

**Submission**

- The Licensee has to submit Feasibility Reports with a broad Cost-Benefit Analysis.
- These capital investment proposals should constitute a least cost plan.
- The FRs must clearly outline the scope and objectives of the proposed Scheme and explain how the Scheme meets the evaluation criteria mentioned herein.
- The FRs must be accompanied by such information:
  - Technical reports
  - Design criteria
  - Supplier/contractor quotations
  - Term sheets of financing agencies etc.
  - or as may be required to enable assessment of the nature involved in ex-ante, in-principle clearance.

**Approval Process**

- The Commission plans to adopt a 2-Stage Approval Process.
  - In-Principle Clearance
  - Final Approval during the Tariff Determination Process and/or ARR Review

During the Tariff Determination Process and/or ARR Review, the following will be borne in mind when granting final approval to the Scheme.

- To what extent the scope and objectives given at the time of In-Principle Clearance have been achieved.
- What is the actual expenditure incurred by the Licensee, as against the amount considered while granting In-Principle Clearance with justification for significant variations, particularly on the higher side.

**Scope of Investment**

1. Works of a similar or related nature
   - New Receiving Stations (proposed at different locations within the licensee area must be clubbed together and presented as a Scheme for New Receiving Stations), Schemes for modernization / augmentation, Information Technology Schemes, SCADA and Communication Equipment at the region/State level, Schemes for Major Replacement of Old Equipment etc.

2. Different types of Works within a geographical area, say in a District

3. An independent identifiable project as would be submitted to a financial institution like REC, PFC, etc. Or for funding under APDRP.
**Delhi Electricity Regulatory Commission**

<table>
<thead>
<tr>
<th>Regulation/ Guideline</th>
<th>Guidelines for Approval of Capital Investment Schemes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Investment Plan</strong></td>
<td>Capital Investment Business Plan for MYT Period outlining the major schemes proposed for each Financial Year along with other relevant proposals and supporting information such as demand projections, network reliability and design criteria.</td>
</tr>
<tr>
<td><strong>Approval required for</strong></td>
<td>If Project cost equals or exceeds Rs.2,00,00,000.00 (Rupees two crore only) or such other amount as may be notified by the Commission</td>
</tr>
<tr>
<td><strong>Submission</strong></td>
<td>The Licensee has to make an application to the Commission for obtaining prior approval. Detailed Project Report need to be submitted for In-Principle Approval containing technical reports, design criteria, bill of quantity, item-wise estimated cost and all such information, particulars and documents as necessary to support the details contained in DPR. The Licensee shall invite and finalize tenders for procurement of equipment, material and / or services relating to such major investment, in accordance with a transparent, competitive, fair and reasonable procedure</td>
</tr>
<tr>
<td><strong>Approval Process</strong></td>
<td>The Commission plans to adopt a 2-Stage Approval Process. In-Principle Approval and Final Approval. The initial approval of the Commission before implementation of capital works schemes is an &quot;in-principle&quot; approval mainly keeping in view the following: Necessity, Overall suitability and Payback period. In stage two, the final approval of capital outlay consequent to implementation of a scheme is granted at the time of capitalization, after a diligent and proper prudence check and verification of the actual cost, actual quantity of material used, proper implementation of the scheme and after verifying that all legal clearances have been obtained. At the time of final approval, if the actual expenditure is found to be inflated, whether by inflating the cost by making purchases from Group Companies at high rates or otherwise, then the same is corrected.</td>
</tr>
<tr>
<td><strong>Scope of Investment Scheme</strong></td>
<td>New Grid Sub Stations proposed at different locations within the license area, Schemes for modernization / augmentation of the Distribution Network, Loss reduction, Information Technology Schemes, SCADA and Communication Equipment at the region, Schemes for Major Replacement of Old Equipment etc.</td>
</tr>
</tbody>
</table>
### Madhya Pradesh Electricity Regulatory Commission

<table>
<thead>
<tr>
<th>Regulation/Guideline</th>
<th>Guidelines for Capital Expenditure by Licensee in Madhya Pradesh</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Investment Plan</strong></td>
<td>Comprehensive five years Capital Investment Plan by 31st July every year. This plan should contain the details of all the projects to be executed in the defined five year block. This plan shall be a rolling plan demonstrating the achievements of the previous year plan vis-à-vis the approved plan</td>
</tr>
<tr>
<td><strong>Approval required for</strong></td>
<td>If Project Cost is above:</td>
</tr>
<tr>
<td></td>
<td>• Rupees Five crores (or any other minimum threshold investment, as may be specified by the Commission from time to time) for Transmission licensee</td>
</tr>
<tr>
<td></td>
<td>• above Rupees One and half crores (or any other minimum threshold investment, as may be specified by the Commission from time to time) for the Distribution licensee</td>
</tr>
<tr>
<td><strong>Submission</strong></td>
<td>The Licensee has to submit following documents along with the petition for approval of investment:</td>
</tr>
<tr>
<td></td>
<td>a) Brief outline of the project, its salient features (including whether this is a new/augmentation/renovation and modernisation project) such as scope and objectives of this investment, technical reports, design criteria, project financing avenues, contractor/supplier quotations, etc.,</td>
</tr>
<tr>
<td></td>
<td>b) Details and cost estimates of components amenable to physical verification along with the provision of price escalation, if any.</td>
</tr>
<tr>
<td></td>
<td>c) Detailed justification of the investment in light of existing operating conditions such as the equipment is operating close to or above their rated capacity, to facilitate the backup system in conditions of exigency or during maintenance, to cater the normal load growth; the equipment has outlived its life, introduction of new and advance technology, etc.</td>
</tr>
<tr>
<td><strong>Approval Process</strong></td>
<td>The Commission would approve the scheme if it feels that</td>
</tr>
<tr>
<td></td>
<td>• there is need for the investment in the Transmission or Distribution System</td>
</tr>
<tr>
<td></td>
<td>• Licensee has examined the economic, technical, financial and environmental aspects of all available reasonable options. This should be supported by a comprehensive cost benefit analysis.</td>
</tr>
<tr>
<td><strong>Scope of Investment Scheme</strong></td>
<td>New/augmentation/renovation and modernisation project</td>
</tr>
<tr>
<td>Rajasthan Electricity Regulatory Commission</td>
<td>The Rajasthan Electricity Regulatory Commission (Investment Approval) Regulations, 2006</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Investment Plan</strong></td>
<td>Utilities to submit annual investment plan by 30th November every year capturing investment requirement for year (categorized into schemes) and capturing previous year performance. No investment is considered towards capital cost or additional capital cost for ARR and/or tariff determination unless it has been approved by the Commission under annual investment plan.</td>
</tr>
<tr>
<td><strong>Approval required for</strong></td>
<td>Capital expenditure exceeding Rs 10 Crores</td>
</tr>
</tbody>
</table>
| **Submission**                              | The project feasibility reports needs to be submitted which should include:  
  - objective,  
  - technical justification,  
  - capital cost,  
  - year wise phasing of expenditure and their financing plan etc.  
  
  The schemes for setting up of power station should incorporate estimated cost of generation, details in respect of dedicated transmission lines and/or substations the justification of the least cost of transmission satisfying the requirement of Grid Code.  
  
  Other schemes should indicate cost-benefit ratio or the least cost consideration. The cost benefit analysis should be based on tangible/intangible benefit except for those specially mentioned otherwise.  
  
  Capital expenditure on Institutional strengthening, consumer services and Preliminary works may not require cost benefit analysis. |
| **Approval Process**                        | The Approval would be given if:  
  Commission is satisfied with all aspects of the project and further:  
  - Schemes / works comply with the provisions of Grid Code, Power survey Electricity supply Code, Metering Code, Safety regulations under section 53 of the Electricity Act 2003, National Electricity Plan, Electricity Policy Survey and prudent utility practices, as applicable.  
  - Schemes are formulated with the design criteria & selection criterion as prescribed by the Commission |
| **Scope of Investment Scheme**              | Generation project; Power evacuation Project, Loss Reduction, System Augmentation and improvement schemes; Rural electrification; Capacitor Installation Schemes; Metering Schemes (transmission); Load Dispatch and Communication Schemes; Institutional Strengthening Scheme; Preliminary works |
E: Guidelines
1. **Preamble:**

1.1 Capital Expenditure planning is important for Licensees to determine the areas that need investment, and achieve the objectives as envisaged by them and those outlined by the Commission in the Karnataka State Grid Code and in form of directives issued from time to time.

1.2 Currently there is a need for adopting a more scientific approach to strengthen all the stages of capital investment process. Also from the Commission's point of view, current regulatory oversight through annual prudence check exercises is primarily focused at ascertaining if the results achieved through capital expenditure justify the amount invested.

1.3 Thus in order to streamline the capital expenditure process at all stages, Commission intends to have guidelines that would govern the entire capital investment lifecycle. The five key stages in capital investment procedure are as follows:
   a. Planning
   b. Investment Analysis
   c. Execution
   d. Monitoring
   e. Ex-post analysis

1.4 The following guidelines are suggested to ascertain an efficient method of incurring capital expenditure by ESCOMs.

2. **Proposed Guidelines:**

2.1 Planning:

   A. **Objective Setting**
      i. The Utilities shall adopt an objective driven approach for capex planning. They should set clear long term, medium term and short term objectives and categorize capital expenses based on the objectives that the schemes intend to achieve.
      
      ii. The broad objectives that shall govern capex planning of ESCOMs are:
          a. Load Reduction and system strengthening
          b. System expansion for meeting load growth
          c. Policy and regulatory driven schemes
          d. Addressing deteriorating assets and new technology investment

   B. **Perspective Planning Studies**
      iii. ESCOMs should plan and execute capital expenditure schemes that ensure an efficient, coordinated, safe, secure, reliable and economical Distribution System for the respective areas of distribution in order to satisfy the requirements of electricity demand in the State. ESCOMs shall make efforts to plan their capex with a foresight on the long term objectives and future growth potential of the state.
      
      iv. Based on the objectives identified, ESCOMs shall be responsible to prepare and submit a Perspective Plan for a period of 5 years, every 3 years to KERC duly identifying the future demand
in the state and the required Distribution System expansion to cater to the demand. ESCOMs may appoint reputed third party agency/consultants in carrying out the necessary studies and develop a detailed and comprehensive perspective plan on the lines of that developed by KPTCL.

v. Additionally ESCOMs shall carry out necessary studies to check the operation of the existing system under normal or outage conditions, to see if the existing system is capable of supplying planned additional loads, or to check and compare new alternatives for system additions to supply new load or improve system performance. The details of the studies should also be included in the Perspective Plan. The System Studies that ESCOMs may carry out are outlined below for identification of areas of investment in the distribution system:

- Load Forecast or Demand Forecast Studies
- System Loss Reduction Studies
- Feeder wise Load Flow Analysis,
- Reliability Analysis
- Asset Life Studies for Transformers, RMUs and 33Kv substation equipment

vi. ESCOMs have to conduct annual load forecasting studies based on robust demand forecasting models to determine the future load growth in their respective areas. The utilities should create a database of loads for each consumer category and for each Distribution Substation connected to the Distribution System and update it on annual basis.

vii. ESCOMs should determine the peak load and energy forecasts for each category of loads, and compare it against the forecasted values in the perspective plan. Any major deviation should be flagged out and necessary corrective actions undertaken. Any new requirement from industrial consumers for HV / EHV power supply, any change in distribution network configuration, have to be updated regularly and summarily presented in the feeder wise load flow study.

viii. Additionally ESCOMs shall submit to KPTCL details with regard to Load Forecasts and the Rolling Plan to KPTCL to aid in Transmission System Planning.

ix. While carrying out studies the performance of assets should be assessed in light of Karnataka State Distribution Code to identify any bottlenecks in the system. Based on this assessment, capital works should be planned to achieve system improvement.

Medium Term Rolling Investment Plan

- The Perspective Plan document shall be the guiding document based on which ESCOMs shall come up with a 3 year Rolling Investment Plan detailing the major schemes proposed for each Financial Year over the next 3 years along with other relevant proposals and supporting information such as demand projections, network reliability and design criteria.
- Based on the outcome of such studies ESCOMs may set targets for network parameters, to be achieved over a period of 3-5 years and identify schemes and projects that will assist attaining the set goals which essentially will form part of the 3 year Rolling Plan.
- The rolling plan should start with a period covering year 1 to year 3. The plan shall be updated next year to cover the period from year 2 to year 4 and then to cover year 3 to year 5 and so on. In the year 4, a new perspective plan shall be prepared and a new rolling plan shall be prepared taking cues from the perspective plan.
- The scope of investments included in each scheme may cover works of New Grid Sub Stations proposed at different locations within the license area, Schemes for modernization/augmentation of the Distribution Network, loss reduction, Information Technology Schemes, SCADA, Schemes for Major Replacement of Old Equipment etc.
- The following can be adopted to classify and categorize schemes:
Projects contributing to an objective can be clubbed together i.e. Schemes for link lines or intermediate poles of the distribution system that are contributing to improving reliability in the system can be clubbed as Scheme for improving Reliability.

- Projects of similar nature can be clubbed together i.e. New Receiving Stations proposed at different locations within the license area can be bundled together and presented as a Scheme for New Receiving Stations,
- Different Projects contributing to the improvement of a geographical area can be bundled together i.e. Rural Electrification schemes in a particular Circle
- Projects to be funded by external agencies can be bundled together i.e. R-APDRP, NJY etc.
- Projects that are not necessarily contributing to infrastructure but are essential to enable efficient operations in system i.e. Information Technology Schemes, SCADA, Distribution Automation and Communication Equipment can be presented together

C. Identification of schemes and Prioritization

x. Based on the perspective studies undertaken and objectives defined Utilities shall identify projects with a proactive approach.

xi. The works in case of ESCOMs must be executed with 6 months of estimate/DPR sanction. The DPR should be revised and submitted for re-approval, in case there is a delay in award beyond 12 months.

xii. All projects approved to be taken up during a particular year should have been prioritized and ranked giving due considerations to Investment Analysis and Risk analysis. Projects with higher IRR or BCR and low pay-back period and with less critical risks should have higher priority. Scheme prioritization is critical to allow resource allocation and program trade-offs based on relative merit.

The following principles should be considered while identifying and prioritizing schemes.

xiii. Projects/schemes identified may be classified and categorized by the Organizational Objectives identified in the Perspective Plan

xiv. Each scheme/project will have its individual objectives defined that align with the Organizational objectives.

xv. Each project and scheme should be phased across years based on the following factors:

a. Criticality of the project to Network safety and stability

b. Compliance to Grid Code and Distribution code requirements and other regulatory directives

c. Investments that offer maximum benefit to the utility

d. Regulatory, Policy and Business requirements
xvi. The projects should be listed based on priority for each of the years in the Rolling plan. The following factors should be considered while establishing priority:

a. The criticality of the project to achieve the desired organizational objectives/targets

b. The amount of energy savings or improvement in targeted parameters (energy savings, voltage regulation, system reliability etc.) that can be brought to the system by taking up the project

c. The payback profile or returns possible for the project

d. The potential risks and mitigation measures possible

xvii. All projects approved to be taken up during a particular year should be prioritized and ranked depending upon the analysis of costs and benefits to the system by using the Cost Benefit Ratio or Payback period or IRR or Net Present Value approaches.

D. Annual Capital Budget

xviii. The annual capital budget should have a list of projects classified into three categories;

a. The Budgetary estimates required for settling claims of contractors of commissioned works during the ensuing fiscal year

b. The Budgetary estimates required for the capital works which will be under execution during the ensuing fiscal year

c. The Budgetary estimates required for taking up new capital works during the ensuing fiscal year.

xix. ESCOMs should consider Revenue and expenditure as well as borrowing constraints together to determine Annual Capital Budget. The budget or Annual Program of Works should cover all plan as well as non-plan or contingent works.

xx. The projects should be listed in order of priority in the Capital Budget.

xxi. The annual capital budget for the ensuing fiscal year should be prepared and submitted to the Commission along with the revised and updated Rolling Plan by 30th November every year.

2.2 Investment Analysis:

All capital works should have techno-commercial analysis captured in the estimate or DPR. The estimate/DPRs should be standardized and must contain justification of need, primary and secondary objectives, evaluation of alternatives considered, technical reports, design criteria, bill of material, item-wise estimated cost, Cost-Benefit Analysis, execution timelines, cash flow requirement etc.

ESCOM shall have such detailed estimates/DPRs for all the works of value equal to or above Rupees 3 lakhs. The same can be followed by ESCOMs for lower value works at the discretion of the ESCOM.

Every estimate/DPR should have a validity period of not more than 1 year. If the capex work is not taken up within that validity period, estimate/DPR should be revised for the techno-commercial aspects and be re-submitted for approval.

An illustrative format for Detailed Project Report preparation is attached in Annexure-1.

Investment analysis should be done keeping in view the following:

a. Need for the capital work along with the data capturing the existing status of the infrastructure

b. Defining primary and secondary objectives

c. Alternatives evaluated
d. Benefit to Cost Analysis  

 e. Technical Justification  

 f. Bill of Material and Project Costing  

 g. Execution timelines  

 h. Risk analysis  

**A. Justification of Need**  

 i. The need for undertaking the capital work must be clearly established along with relevant supporting information. Status of the infrastructure before taking up of the project should be captured. ESCOMs shall document and record all parameters for each critical facility in the network infrastructure, so that the same can serve as a pointer for investment decisions. Following are some examples:  

   a. Load Bifurcation: Historical peak load (in Amps and KVA) recorded taken from MUSS for last 12 months  

   b. Improve Quality of Supply: Record of existing HTVR or LTVR (details of where and when such reading is taken should also be provided) or derived from feeder wise load flow studies  

   c. Reduce interruptions: Historical record of interruptions (in numbers and hours) for the last 12 months  

   d. Addition of new substations: The % Voltage regulation and percentage distribution loss in ESCOMs, Number of pending customer applications, Estimated load growth in the area and loading of the existing substations  

   e. New feeder works: Details of new load to be connected, load relief on other feeders etc  

   f. Replacement of failed transformer: Reason for failure of the transformer and actions to be taken to avoid failure again  

   g. DTC Metering: Distribution losses on the feeder and/or losses for load connected to DTC.  

**B. Defining Primary and Secondary Objectives**  

 ii. The primary and secondary objectives which are expected to be achieved from the proposed capital works must be clearly identified  

 iii. As much as possible, the primary objective should be measurable and defined in quantifiable terms so that it can be compared against the actual outcome after completion of project. Along with Primary objective the utility can also identify Secondary objectives for each investment. The secondary objectives can indicate the other benefits envisaged in qualitative as well as quantitative terms.  

**C. Technical Justification**  

 iv. Detailed Techno Feasibility analysis should be performed for all projects in order to ensure the following points:  

   a. Whether the scheme meets design criteria as per the existing norms and standards?  

   b. Whether the scheme conforms to the planning criteria of Central Electricity Authority and that of the state grid?
c. If equipment is replaced, it has to be proved whether the existing equipment has outlived its normal life span.

d. Average rate of technology obsolescence for the equipment to be replaced should be mentioned.

e. The capacity planned should be in tune with the demand growth

f. Whether redundancy in the system is being created appropriately.

D. **Bill of Material and Project Costing**

v. Bills of Material (BoM) should be a complete documentation of the specific components, assemblies and sub-assemblies to be prepared for a project.

vi. The Utilities shall ensure key element checks as outlined below in preparation of BoM:

   a. Completeness: BoM should be complete in all respect relating to quantity, part description, item specification, supplier information, etc.

   b. Consistency: Information in BoM should be consistent with that provided in engineering drawings and design files. A standardized format for BoM should be used across Utilities.

   c. Correctness: Correctness should be ensured by avoiding errors such as obsolete data and incorrect part numbers, quantity, etc.

vii. Cost estimation should be done using prevailing Schedule of Rates. The schedule of rates should be revised once every year based on market trends and impact of relevant indices.

viii. Any revision in costs as part of project management control should be properly saved with their revised version and details of revision.

E. **Benefit Cost Analysis**

ix. ESCOMs shall carry out Benefit to Cost Analysis for all projects being taken up irrespective of the value of works.

x. ESCOMs may use any or a combination of formal financial criteria, such as Net present value (NPV), Internal rate of return (IRR), Return on investment, Payback period, Benefit to Cost Ratio.

xi. Distribution projects can provide a wide range of benefits—economic, social, and reliability—to the consumers. Social and Government driven schemes need not be subject to investment analysis.

xii. ESCOMs shall develop standard formats and templates to carry out the Benefit to Cost Analysis using the relevant method for all capital investments, the template given in the guidelines here can be used as reference. The energy loss computation methodology described in Annexure 7 can be used as reference.

xiii. The analysis should capture in detail all the quantifiable benefits and additional benefits (including qualitative wherever quantifiable). ESCOMs should look to ensure all benefits are covered and captured appropriately to provide a more comprehensive analysis.

xiv. The cost items should be escalated taking appropriate escalation rates such as inflation and average interest rates of the utility into consideration. IDC should not be neglected.

xv. Utility can consider average cost of energy, escalating at a rate of 3% year on year for computing energy savings. Utility can compute annual energy savings using the appropriate methods (discussed in Annexure 7)
xvi. The cash flows considered in cost benefit analysis should be discounted at Weighted Average Cost of Capital (WACC).

xvii. If a project with BCR less than 1 or IRR less than hurdle rate is selected for implementation, the utility should documented the rationale with supporting information that justifies taking up such projects.

F. Execution timelines

xviii. ESCOMs shall develop standard timelines for execution of different types of capital works and shall include in the form of Bar/PERT charts in the DPR outlining the schedule of project pre-award activities, supply, erection and commissioning schedules etc.

xix. Any delay foreseen due to certain project risks, should be identified in the planning stage and appropriate duration should be factored in the standard timelines and incorporated in the agreements with contractors and vendors.

G. Evaluation of Alternatives

xx. ESCOMs shall elaborate on all the alternatives considered for arriving at a capital investment decision. The basis on which the proposed scheme has been selected out of several alternatives considered by the Utilities will have to be mentioned.

xxi. If the proposed investment includes repair and maintenance of substations then since the expenses of repairs are already provided for in the O&M expenses and, therefore, justification for claiming these expenses under capital investment must be clearly brought out.

xxii. To evolve the least cost alternative, subject to their meeting the technical requirements, the total cost of the various alternatives should be estimated. The least cost optimal solution may be finalized considering the capital cost and net present value of losses over the life of the project.

xxiii. The alternatives should be analyzed in terms of their respective cost and benefits, to finalize the least cost plan with maximum benefits.

xxiv. The format attached in Annexure-4 can be used for evaluation of alternatives.

H. Risk Analysis

xxv. The Utilities shall assess risk associated with a project and all its alternatives during planning phase.

xxvi. The distribution projects, like other infrastructure projects face various risks in different stages of the life cycle. A risk management plan/ matrix/ strategy should address these risks in all phases of the project- viz, design, approvals, financing, procurement, construction, completion and have mitigation strategies for various risks.

xxvii. A detailed risk evaluation matrix should be prepared at a scheme level or project level depending on the value, scale and criticality of the project.

xxviii. ESCOMs should ensure the evaluation of risks for the minor works as well. The DPR/Estimate copies should include a minimum of a write-up on the possible issues/risks that the Field Officer foresees in implementation of the said project.

xxix. After identification and impact assessment of risks, appropriate response strategy should be decided by the ESCOMs. The probable response strategies are outlined in Annexure-3.

2.3 Execution Process

A. Time and cost control

i. The contractor should be selected using a Competitive Bid process. And the bidding documents for all types of works should be standardized.
ii. Major schemes, which are dependent on survey schemes, survey reports prepared by Utilities shall have a validity of 12 months. In case the project is being taken up for execution at a period later than 12 months of survey report preparation, then adequate time and effort should be directed towards conducting new detailed surveys.

iii. The Utility shall ensure that the execution timelines as agreed upon during the time of work award is being adhered to and there are no delays in project completion or over runs in costs.

iv. The utility shall ensure quality execution of works as per the industry guidelines (Ex. Alignment of primary /secondary lines, erection of poles, stringing of conductors in terms of sag, providing guards at the road crossing, grounding of poles carrying 11kV lines etc.)

v. Utility shall apply for all the necessary approvals and clearances from host of stakeholders (for example: PTCC, forest department, railways, approvals for road/river crossing, defense, wild life sanctuary clearance, aviation, environment clearance etc) immediately after completing detailed survey without waiting till the work is awarded to a contractor. Wherever possible, the agency performing the detailed survey shall assist in filling and submitting required documents for obtaining necessary approvals and clearances

vi. Utilities shall take adequate measures to identify RoW issues at the survey phase and adopt means to minimize their incidence. Technological /design interventions like, underground cabling system, insulated lines (ABC) usage etc can be used to minimize RoW issues.

vii. For partial-turnkey projects or projects in which material is to be supplied by the utility, care should be taken to ensure that the required resources are procured in time and made available for timely execution.

viii. The material requirement should be correctly and accurately estimated and forwarded to Tendering and Procurement wing after allowing sufficient lead time for procurement.

ix. Monthly reporting of field teams to material procurement wing on use of actual materials vis-à-vis estimated should be done.

x. Utilities should have quick and alternative sources of procuring material to handle contingencies.

xi. Inventory audit shall be done annually, for physical inspection of division stores to check for the inventory position.

B. Quality control

i. Utilities shall take following steps towards effective Quality Management and Control

   a. Inclusion of Quality Requirement in the Contract & Selection of good quality vendors/sub vendors
   b. Approval of unambiguous Manufacturing Quality Plan (MQP)
   c. Finalization of Field Quality Plan (FQP) ensuring regular, timely and consistent inspection at various stages, viz. raw material, during in- process stage and final inspection and testing prior to installation.
   d. Analyze the equipment failures in association with Engineering and Operation services departments and use feedback for improvement of systems.
   e. Implementation of Quality Systems and Procedures as per ISO – 9001 for System of Vendor and Sub Vendor Approvals
   f. A standard format is to be developed for the approval of Manufacturing Quality Plan (MQP) which includes the quality requirements at the raw material stage, In process testing and final inspection and testing requirements as per Technical specifications of the contract and well known good engineering practices of the industry
ii. Vendor Rating Database should be maintained by utility in order to evaluate the performance and rate the contractors and suppliers with respect to parameters such as Timeliness, Quality, Technology, Flexibility and Pricing. The vendor rating framework is attached in Annexure-6.

2.4 Project Monitoring

i. The utilities shall have a project management and monitoring team with a composition of technical and finance personnel at the corporate level.

ii. Project Monitoring Tools such as MS Project, Primavera, etc. should be used or the ones similar to PMS developed by KPTCL Engineers.

A. Project Monitoring System

iii. ESCOMs should institute a project management and monitoring team (PMO) with a composition of technical and finance personnel to effectively track monitor and review the progress of projects undertaken.

iv. Monitoring should start right from the time a project is conceptualized either during perspective planning or annual planning exercise.

v. ESCOMs will ensure a PMS tool such as PMS Lite (KPTCL) shall be developed to track the entire lifecycle of projects till the Ex-Post analysis stage and customized to distribution system requirements. Once a project obtains administrative approval, a docket must be raised in the IT tool for the work/project. The same shall be maintained till the work/project is commissioned and ex-post analysis is completed for a period of 2 years post commissioning.

vi. Till the time PMS tool is not developed or there are areas where software does not provide information, PMOs will interact directly with concerned departments and obtain information and compile using a simple excel based system.

vii. Preparation of detailed project plan for all projects is a key role of Project Monitoring Unit or Office (PMO). To start with, PMO officials can use MS Project to prepare the plan which should incorporate all the activities involved and the time for completion of each activity for different types of works in the distribution system. PMO officials can use methods like Critical Part Method (CPM), Program Evaluation & Review Technique (PERT) for planning and scheduling.

viii. PMOs will be monitoring weekly/bi-weekly/monthly progress of pre-award and post-award activities of projects, as decided at the start based on criticality of project. Progress monitoring reports regarding status of projects will be shared as summary reports to top management.

ix. ESCOMs shall ensure that the project pre-construction activities as well as the activities post-award are being carried out as per the agreed timelines. Any cases of deviations should be flagged through Project Monitoring System and necessary corrective actions undertaken.

x. Alerts shall be sent in case of deviations (post and anticipatory) from Execution Schedules to the concerned entity (For e.g. delay in submission or approval of drawings should be flagged out at the appropriate time)

xi. The Utilities shall conduct Monthly Review Meetings at the zone/circle level to discuss the status of projects of their respective zones/circles.

xii. The Utilities shall conduct Quarterly Review Meetings at the corporate level to discuss the status of projects and take corrective actions as and when necessary.

xiii. The detailed Responsibility matrix for carrying out various project monitoring activities is attached in Annexure-5.
xiv. After completion of any project, the completion certificate should be prepared and sent to accounts section within a period of 15 days from completion.

xv. The project completion report should be comprehensive and organized to reflect all relevant project information. An indicative list of information to be captured is given below:

  a. Name of the project:
  b. Date of Commissioning:
  c. Material envisaged as per the DPR, Material drawn from the store and Material utilized
d. Estimated Date of Commissioning:
  e. Time Overrun:
  f. Actual Cost:
  g. Estimated Cost as per LoA:
  h. Cost Overrun:
  i. EPC Contractor Name:
  j. Engineer In Charge:
  k. Materials drawn and labor cost:
l. Key issues faced in execution:
  m. Photographs of the completed work (Time and location stamped using GPS for soft copies):

B. **Centralized Data Documentation**

xvi. The Utilities shall maintain a centralized data repository of information at the corporate office and made accessible to all respective circles, division and sub division offices.

xvii. An indicative list of project specific documents to be maintained is as follows:

  a. Survey Reports
  b. Detailed Work Award (DWA)/Letter of Award (LoA)
c. DPR/Technical specifications/BoQ
d. Manufacturer’s & pre-commissioning test results for comparison during regular maintenance
e. Drawings (SLD etc.), cable schedules, (all actual documents created and used for project implementation)
  f. Any other labor and material contracts or any other related document
g. Minutes of all review meetings
  h. Photographs taken during field visits
  i. Project completion certificate

xviii. The corporate office shall keep a quarterly record of all the works executed and categorized. The same shall be available for review for KERC at any point of time. The corporate office shall maintain the following information:

  a. Date of completion of the work
  b. Estimated value of the work as per the estimate/DPR
c. Amount Categorized
d. Date of Categorization  
e. Delay in Categorization  
f. Reasons for any delay in categorization  

It is expected that the amount categorized as per the above mentioned record shall match with the amount capitalized as per the books of accounts.

2.5 Ex-post Analysis

xix. The utility should periodically record the benefits achieved from the projects. The year on year details related to energy savings, reduction in interruptions, additional supply of power, additional capacity evacuated, etc. achieved should be compared with the estimated benefits in terms of:

a. Whether the primary and secondary objectives as listed out are met  
b. Benefit Cost analysis - estimated vs actual recorded  
c. Payback period is in line with the estimated number in the DPR

xx. Utility will have to document the performance on the primary and secondary objective every quarter from the date of commissioning of the project for a period of two years.

xxi. The performance and effectiveness of various types of projects shall be analyzed with respect to the achievement of objectives.

xxii. Till such time an IT tool to document the Ex-Post analysis is established, Ex-post analysis reports should be submitted to the Commission yearly for all the projects capitalized and commissioned 12 months before. The format for Ex-post analysis reports should be duly approved by the Commission.

xxiii. A summary report should be submitted to the Commission for all completed projects, ongoing projects along with its details with focus on time overruns, cost overruns and other related issues on a half-yearly basis.

xxiv. Commission can review the prudence reports and call for details for sample projects from among the completed projects on a random basis in a specific month. Commission may ask for supporting documents or ask for explanation in case of any particular project.

xxv. After completion of each project, the project is automatically subject to prudence check. Utility shall measure the benefits achieved for a period of 3 months and fill the capex prudence formats, self-evaluate the project and submit the report along with findings to the Commission.

xxvi. Utilities can deploy an IT tool which can document all aspects related to capital investment starting from planning till ex-post analysis stage. Once such IT system is available, utilities can upload/document the performance on the primary and secondary objective every quarter from the date of commissioning of the project for a period of two years..

xxvii. A view access can be given to KERC for the software, from which KERC will monitor data points such as what is the extent of projects taken up by the utility, projects initiated, completed, amount spent in a year and data provided by ex-post analysis etc. This would be the mechanism for prudence check from Commission’s end.

xxviii. The Commission will review the reports and in case recorded benefits do not matchup to the envisaged benefits, Utilities shall be asked to provide justification to the Commission.
xxix. In case the utility cannot provide explanation/ proof to the satisfaction of the Commission that the reasons for failure to meet the objectives as envisaged is due to factors beyond the control of the utility, the Commission may consider the said Capex as imprudent and disallow the related costs.

xxx. Until the necessary processes and procedures are put in place by ESCOMs for the above mentioned guidelines, the Guidelines for Carrying out Prudence Check of Capital Expenditure will remain in force and Prudence check will be carried out by the Commission for investments made by ESCOMs in a particular year.
11. Appendices

11.1. DPR Structure

An indicative structure for DPR preparation to be followed consistently across utilities is given below:

Structure of DPR

A. **Executive Summary:** - Introduction of the project in this section and summarize the key parameters being discussed in DPR such as need for the project, objectives to be achieved, key alternatives considered, cost involved, BCR/IRR, timelines involved, key risks and mitigation strategy.

B. **Introduction:** This section shall cover the need for the project and also capture existing status of the system which shall form the baseline information for the project. This section can also talk about how the project/work can help in meeting the utility's long term or short term objectives.

C. **Defining objective, perceived outcomes, strategy of implementation:** - Define measurable objectives, perceived outcomes (quantitative and qualitative), strategy of implementation and other strategic aspects of implementation of scheme(s).

D. **Field survey report:** - The findings and analysis of field survey shall be captured in this section of DPR. The field survey report shall be exhaustive in nature and shall provide complete details of network configuration and topology along with loss levels, DT wise loading and other related aspects as covered in the field survey.

Identification of key options and their evaluation

E. **Scheme identification and technical evaluation:** - Detail out the available alternatives for implementation of identified project/work/scheme, geographical area and based on the field survey, technical feasibility, load flow study, revised network configuration, revised loss levels etc. shall be captured in the technical feasibility report.

F. **Financial evaluation:** - Assess the broad level financial impact/implication for implementation of each option. The broad level cost estimates shall be prepared for each scheme for financial evaluation.

G. **Cost benefit analysis:** - Detail out cost benefit analysis including the IRR and other measures used to capture the techno-economic viability of each option and to select the most suitable approach to be taken to achieve the perceived objectives.

Detailed project design and implementation plan

H. **Technical designs and drawings:** - Detailed project designs, drawings, layouts, Bill of Quantity, technical specification etc. and related technical aspects.

I. **Preparation of Cost Estimates:** - Estimate the cost of implementation for the finalized option, based on the BoQ as per prevailing Schedule of Rates of the utility.

J. **Implementation plan:** - Develop the detailed implementation plan along with milestones, monitoring framework, MIS templates monitoring the progress of various activities during execution stage etc. The section should also cover the details of approvals and clearances required, and estimated timelines for obtaining the same.
K. **Means of finance and Project Budget:** This section should cover details related to the cost of the project, the means of finance and comment on provisions in the budget for the project. The section should also cover the cash flow requirement at each stage of the project development. This can help the management understand the cash flow requirements over the project’s construction period and make necessary arrangements for the same.

L. **Risks in Implementations and Mitigation strategy**-Identify key risks which can occur during execution of Capex work. The steps to mitigate risks should be highlighted in this section.
# 11.2. Cost Benefit Analysis Template

<table>
<thead>
<tr>
<th>Year Index</th>
<th>Remarks</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>...</th>
<th>Year n</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COSTS in Rs Lakhs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O&amp;M Expenses (escalating Y-o-Y)</td>
<td>O&amp;M expense can be escalated Y-o-Y at CERC approved rate</td>
<td>a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital Investment</td>
<td></td>
<td>b</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Costs</td>
<td>a+b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BENEFITS in Rs Lakhs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Energy savings (in Units)</td>
<td>Calculated from appropriate energy loss computation methodology</td>
<td>c</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of energy saved per unit (Rs/Unit)</td>
<td>Utility can consider average cost of energy escalated at 3%</td>
<td>d</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefit due to Loss Reduction (in Rs Lakhs)</td>
<td>e=cd</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional Power available with ESCOMs for sale (in MU)</td>
<td>Additional power available with ESCOMs for sale in case of augmentation works</td>
<td>f</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit from sale of power</td>
<td>Average revenue minus cost of energy</td>
<td>g</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefit to utility from additional sale of energy</td>
<td>h=fg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total benefits (in Rs Lakhs)</td>
<td>i=e+h</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BCR calculation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PV of Benefits (Rs Lakhs)</td>
<td>Discounting factor to be used is WACC.</td>
<td>j</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PV of Costs (Rs Lakhs)</td>
<td></td>
<td>k</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BCR</td>
<td>L=j/k</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IRR Calculation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefits</td>
<td>i</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating costs</td>
<td>a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital cost</td>
<td>b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash flow to the company</td>
<td>M=i-a-b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRR</td>
<td>Compute IRR based on the cash flows</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
11.3. Risk analysis and mitigation

For utilities, it is important that each project should carry a detailed risk evaluation matrix. Each of the projects along with the alternatives should be analyzed for the risks identified. It is pertinent to understand the probability of occurrence and impact of such risks before approval of any project. A project risk matrix framework can be followed to quantify the expected impact of any risk on the project.

<table>
<thead>
<tr>
<th>Risk Description</th>
<th>Probability of Occurrence</th>
<th>Potential Impact</th>
<th>Risk borne by</th>
<th>Overall risk rating</th>
<th>Risk Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Survey Risks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tender and Contractual Risks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction Risks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financing Risks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational Risks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Expected Impact of any risk = Probability of the risk * Impact due to the risk.

The probability of any risk may be low, medium or high. This may be represented in a suitable scale. For example, in 3 point scale, any risk with less probability may be represented with “1”, medium with “2”, and high with “3”. Similarly, if the financial impact of any risk is less it can be represented with “1”, medium with “2” and high with “3”.

After identification and impact assessment of risks, appropriate response strategy should be decided. The management can stick to any of the below mentioned four strategies to deal with the risks identified:

- **Avoidance:** In case the expected impact is high, and no appropriate mitigation plan can be put in place, then the project/alternative can be avoided and a different approach can be adopted. For example, if a laying of a particular distribution infrastructure is difficult owing to RoW issues or because of difficulty in obtaining clearances, then an alternative route can be adopted.

- **Transference:** The risk can be transferred to a third party in case the utility does not want to take the responsibility. Generally it is done certain terms and conditions of the contract. But this involves payment of a risk premium to the party taking on the risk.

- **Mitigation:** Mitigation strategy can be adopted when the risk perceived is of lesser impact. In such a case the project risks should be closely monitored throughout the entire life cycle and mitigation plan adopted as and when required. For example, alternate source of material procurement should be identified well ahead of time to tackle the risk of unavailability of material.

- **Acceptance:** When the projects team is unable to identify any other suitable response strategy, it generally accepts the risk and develops a contingency plan to tackle the risk should it occur. A contingency allowance in terms of time, funds or resource can be done to account for such risks.
11.4. Evaluation of alternatives

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Particulars of the Alternatives</th>
<th>Total Investment Requirement [As per ......]</th>
<th>Benefit due to Loss Reduction</th>
<th>Benefit due to sale of additional power</th>
<th>Other quantified benefits</th>
<th>Total Benefit</th>
<th>IRR</th>
<th>NPV</th>
<th>Rank</th>
</tr>
</thead>
</table>

11.5. Responsibility Matrix for project monitoring

**Nodal Officer**

**Executive Engineers, Division Office**
- Record the findings of field visits.
- Bring out in writing any instances of deviations from accepted quality of materials, workmanship and general quality of works. Include comments on alignment of line, conductor sag, provision of insulators, and safety guard at road crossings, provision of additional stay at tension points, transformer rating and fittings. This is only an indicative list and based on the type of work being reviewed, relevant aspects for each type of work should be covered
- Carry out technical audits to ascertain and certify the standard of implementation and adherence to guidelines issued by KERC or CEA.
- Upload photographs of the site taken in field visits

**Superintendent Engineer’s Office, Respective Circle**
- The copies of documents listed below should be uploaded by the Superintendent Engineer’s team of the respective circles/from respective division office to the project specific docket.
  - Survey Reports
  - Detailed Work Award (DWA)/Letter of Award (LoA),
  - DPR/ Technical specifications/BoQ
  - Drawings
  - Any other labor and material contracts or any other related document
- Monitor the actual progress of capital works vis-à-vis milestones specified in PERT/Bar Charts at the start of the project
- Monitor the actual expenditures incurred vis-à-vis the LoA Cost
- Record the reasons for time and cost overruns if any and if the delay is attributable to utility or the contractor
- Send out alerts in case of deviations (post and anticipatory) from Execution Schedules to the concerned entity (For e.g. delay in submission or approval of drawings should be flagged out at the appropriate time)
- Record key issues raised by vendors in the meetings and their resolution status
- Record actual project completion date
Chief Engineer’s Office

- Conduct Monthly Review Meetings to discuss the status of projects and take corrective actions as and when necessary.
- Initiate action for dispute resolution.
- Review if necessary approvals and clearances as required have been taken for effective execution of the project.
- Review the costs incurred cumulatively and compare with the cost estimates and payment milestones agreed in the Detail Work Award or the Estimate/DPR copies.

Project Monitoring Unit, Corporate Office

- Conduct Monthly Review Meetings to discuss the status of projects and take corrective actions as and when necessary.

11.6. Vendor Rating framework

Vendor Performance Rating

Utilities should consider a creation of a vendor rating database in which contractors and suppliers should be rated based on the following categories:

a. **Timeliness**: Degree to which the vendor supplied product or service within the time frames identified/specified in the contract/scope of work.
b. **Quality**: Degree to which the vendor’s product or service meets or exceeds standards set forth in the contract/scope of work.
c. **Technology**: The level to which the vendor utilizes current technologies to deliver and support products and services as specified in the contract/scope of work.
d. **Flexibility**: Adaptability of vendor to adjust to any change in plans based on situation on the ground.
e. **Pricing**: The level to which the vendor adheres to the pricing structure outlined or specified in the contract/scope of work and provides clear and comprehensive invoices.

Rating Definitions are as follows:

1=**Below Standard**: Vendor performance regarding the terms and conditions of the contract/scope of work has been less than standard/satisfactory. Supporting documentation is required.

2=**Standard**: Vendor has met the specifications/requirements of the contract/scope of work.

3=**Above Standard**: Vendor performance regarding the terms and conditions of the contract/scope of work has been more than standard/satisfactory. Supporting documentation is required.

Based on the above parameters and rating methodology, vendors should be rated to identify the performers and non-performers accordingly.

11.7. Energy loss computation

Methodology for conducting studies for 11 kV and L.T. system:

The assessment of Energy losses & voltage regulation are generally done by 3 following methods:

- Using Distribution system analysis software.
• KVA * KM Method.
• 3 * I² * R method.

The most accurate method is by Using Distribution system analysis software.

The KVA * KM method involves many assumptions and being an empirical formulae does not give accurate results. However for system expansion & system strengthening involving comparison of existing system and proposed system the errors are of compensative in nature and hence acceptable.

The 3 * I² * R method is most commonly used for Energy loss assessment of Distribution system which are fairly accurate.

a) Using Distribution system analysis software:

• Technical loss in the primary distribution system consists of losses in the 11kV lines and the losses in the 11kV/415V distribution transformers. The conductors used in the 11 kV lines are Coyote, Rabbit, Weasel and Squirrel ACSR. Positive sequence parameters of the 11 kV line is given in the following table with standard line configuration, generally practiced in India.

<table>
<thead>
<tr>
<th>Sl No</th>
<th>ACSR Conductor</th>
<th>R (ohm/km)</th>
<th>X (ohm/km)</th>
<th>Current rating (A)</th>
<th>MVA rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Squirrel</td>
<td>1.531</td>
<td>0.386</td>
<td>97</td>
<td>1.848</td>
</tr>
<tr>
<td>2</td>
<td>Weasel</td>
<td>1.014</td>
<td>0.374</td>
<td>123</td>
<td>2.343</td>
</tr>
<tr>
<td>3</td>
<td>Rabbit</td>
<td>0.64</td>
<td>0.369</td>
<td>190</td>
<td>3.62</td>
</tr>
<tr>
<td>4</td>
<td>Coyote</td>
<td>0.266</td>
<td>0.35</td>
<td>292</td>
<td>5.56</td>
</tr>
</tbody>
</table>

• Computation of Load factor (L.F.):

\[ \text{Load factor} = \frac{\text{Average load}}{\text{peak load}} \text{ OR Energy served} \div (\text{peak load} \times \text{Total Hrs}) \]

• Computation of Loss Load Factor (L.L.F)

\[ \text{L.L.F} = \frac{\text{Average power loss}}{\text{Power loss at peak load}} \]

An approximate empirical formula to relate the loss load Factor = \( A \times LF + (1-A) \times LF^2 \).

A is factor, which is either 0.2 or 0.3 depending on the system networks.

For Karnataka distribution system the generally adopted formulae is \( LLF = 0.3LF + 0.7LF^2 \)

• The 11 kV feeder wise Peak power losses in KW will be directly derived from the software output. The Annual energy losses to be computed by using the formulae

\[ \text{Annual Energy losses} = \text{Peak Power losses in KW} \times \text{L.L.F} \times T. \]

b) KVA * KM Method:
i. **Annual Energy losses in kWhrs** = \[ \frac{0.105 \times L \times R^2 \times P \times LLF^2}{2 \times LDF \times DF^2} \]

D.F. — Diversity Factor = Connected Load / Peak Load.
L.L.F — Loss Load Factor = 0.3 \times LF + 0.7 \times LF \times LF
L.D.F. — Load Distribution Factor = \[ \frac{P \times L}{\text{KVA} \times \text{KM}} \]
L.F. — Load Factor = Annual energy sent out / Peak Load \times \text{No of Hrs of supply}

\[ P \] = Connected Load in KVA.
\[ L \] = Length of the Line in K.M.
\[ R \] = Resistance of the conductor per KM in ohms.

ii. **The % Voltage Regulation as per empirical formulae** = \[ \frac{1.06 \times P \times L \times P.F \times L.D.F \times RC \times D.F.}{L.D.F. \times R.C. \times D.F.} \]

Where as:
- \[ P \] = Connected Load in KVA.
- \[ P.F. \] = Power Factor.
- \[ L.D.F \] = Load Distribution Factor.
- \[ D.F. \] = Diversity Factor = \[ \frac{\text{Connected Load}}{\text{Peak Load}} \]
- \[ RC \] = Regulation Constant for conductors.
  - Squirrel = 771.
  - Weasel = 1043.
  - Rabbit = 1524.

### c) 3 * I² * R method:

An illustration

![Typical 11 kV feeder](Typical 11 kV feeder)
### Peak load – 40 Amps, Annual Energy- 2.136 MU, P.F. = 0.8

**Peak Power Loss calculations by 3*I*I*R (Rabbit)**

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Capacity in KVA</th>
<th>Current per KVA in Amps</th>
<th>Current in each section in Amps</th>
<th>Length in Kms</th>
<th>Resistance in Ohms per KM of Rabbit ACSR</th>
<th>Resistance of the conductor per section</th>
<th>Peak power losses in kW (3<em>I²</em>R)</th>
<th>Voltage (I*R) Drop in Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>250</td>
<td>0.04</td>
<td>10</td>
<td>2.0</td>
<td>0.5524</td>
<td>1.10</td>
<td>0.33</td>
<td>5.52</td>
</tr>
<tr>
<td>2</td>
<td>250</td>
<td>0.04</td>
<td>10</td>
<td>0.20</td>
<td>0.5524</td>
<td>0.11</td>
<td>0.03</td>
<td>5.52</td>
</tr>
<tr>
<td>3</td>
<td>500</td>
<td>0.04</td>
<td>20</td>
<td>1.50</td>
<td>0.5524</td>
<td>0.83</td>
<td>0.99</td>
<td>11.05</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>0.04</td>
<td>4</td>
<td>1.00</td>
<td>0.5524</td>
<td>0.55</td>
<td>0.03</td>
<td>2.21</td>
</tr>
<tr>
<td>5</td>
<td>100</td>
<td>0.04</td>
<td>4</td>
<td>0.60</td>
<td>0.5524</td>
<td>0.33</td>
<td>0.02</td>
<td>2.21</td>
</tr>
<tr>
<td>6</td>
<td>200</td>
<td>0.04</td>
<td>8</td>
<td>1.50</td>
<td>0.5524</td>
<td>0.83</td>
<td>0.16</td>
<td>4.42</td>
</tr>
<tr>
<td>7</td>
<td>100</td>
<td>0.04</td>
<td>4</td>
<td>0.10</td>
<td>0.5524</td>
<td>0.06</td>
<td>0.00</td>
<td>2.21</td>
</tr>
<tr>
<td>8</td>
<td>300</td>
<td>0.04</td>
<td>12</td>
<td>0.50</td>
<td>0.5524</td>
<td>0.28</td>
<td>0.12</td>
<td>6.63</td>
</tr>
<tr>
<td>9</td>
<td>800</td>
<td>0.04</td>
<td>32</td>
<td>0.60</td>
<td>0.5524</td>
<td>0.33</td>
<td>1.02</td>
<td>17.68</td>
</tr>
<tr>
<td>10</td>
<td>100</td>
<td>0.04</td>
<td>4</td>
<td>0.10</td>
<td>0.5524</td>
<td>0.06</td>
<td>0.00</td>
<td>2.21</td>
</tr>
<tr>
<td>11</td>
<td>900</td>
<td>0.04</td>
<td>36</td>
<td>0.50</td>
<td>0.5524</td>
<td>0.28</td>
<td>1.07</td>
<td>19.89</td>
</tr>
<tr>
<td>12</td>
<td>100</td>
<td>0.04</td>
<td>4</td>
<td>0.50</td>
<td>0.5524</td>
<td>0.28</td>
<td>0.01</td>
<td>2.21</td>
</tr>
<tr>
<td>13</td>
<td>1000</td>
<td>0.04</td>
<td>40</td>
<td>1.00</td>
<td>0.5524</td>
<td>0.55</td>
<td>2.65</td>
<td>22.10</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6.442</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>103.85</td>
</tr>
</tbody>
</table>

Peak load in Amps | 40 | Peak load Amps per KVA | 0.04 |

**Peak Power Loss calculations by 3*I*I*R (Squirrel)**

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Capacity in KVA</th>
<th>Current per KVA in Amps</th>
<th>Current in each section in Amps</th>
<th>Length in Kms</th>
<th>Resistance in Ohms per KM of Squirrel ACSR</th>
<th>Resistance of the conductor per section</th>
<th>Peak power losses in kW(3<em>I²</em>R)</th>
<th>Voltage (I*R) Drop in Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>250</td>
<td>0.04</td>
<td>10</td>
<td>2.0</td>
<td>1.394</td>
<td>2.79</td>
<td>0.84</td>
<td>27.88</td>
</tr>
<tr>
<td>2</td>
<td>250</td>
<td>0.04</td>
<td>10</td>
<td>0.2</td>
<td>1.394</td>
<td>0.28</td>
<td>0.08</td>
<td>2.79</td>
</tr>
<tr>
<td>3</td>
<td>500</td>
<td>0.04</td>
<td>20</td>
<td>1.5</td>
<td>1.394</td>
<td>2.09</td>
<td>2.51</td>
<td>41.82</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>0.04</td>
<td>4</td>
<td>1.0</td>
<td>1.394</td>
<td>1.39</td>
<td>0.07</td>
<td>5.58</td>
</tr>
<tr>
<td>5</td>
<td>100</td>
<td>0.04</td>
<td>4</td>
<td>0.6</td>
<td>1.394</td>
<td>0.84</td>
<td>0.04</td>
<td>3.35</td>
</tr>
<tr>
<td>6</td>
<td>200</td>
<td>0.04</td>
<td>8</td>
<td>1.5</td>
<td>1.394</td>
<td>2.09</td>
<td>0.40</td>
<td>16.73</td>
</tr>
<tr>
<td>7</td>
<td>100</td>
<td>0.04</td>
<td>4</td>
<td>0.1</td>
<td>1.394</td>
<td>0.14</td>
<td>0.01</td>
<td>0.56</td>
</tr>
</tbody>
</table>
### Design of Capex Guidelines

#### KERC - Capital Expenditure Guidelines for ESCOM

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Particulars</th>
<th>Values / Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Number of hrs the Transformer is charged during the year</td>
<td>8760</td>
</tr>
<tr>
<td>2</td>
<td>Peak current in Amps</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>Power factor</td>
<td>0.8</td>
</tr>
<tr>
<td>4</td>
<td>Peak load in kW</td>
<td>610</td>
</tr>
<tr>
<td>5</td>
<td>Peak load in kVA</td>
<td>762</td>
</tr>
<tr>
<td>6</td>
<td>The energy input to feeder during year in kWh</td>
<td>2670328</td>
</tr>
<tr>
<td>7</td>
<td>Load factor</td>
<td>0.40</td>
</tr>
<tr>
<td>8</td>
<td>Loss Load factor</td>
<td>0.232</td>
</tr>
<tr>
<td>9</td>
<td>DTCs loading</td>
<td>0.76</td>
</tr>
</tbody>
</table>

### DTC Losses:

- **i.** \( L.F = \frac{(2.136\times1000000)}{(1.732\times11\times40\times8760\times0.8)} = 0.4 \)
- **ii.** \( LLF = 0.3 \times 0.4 + 0.7 \times 0.4 \times 0.4 = 0.232 \)
- **iii.** Peak Power losses – Rabbit ACSR = 6.442 KW.
- **iv.** Annual energy losses with Rabbit ACSR conductor = 6.442 * 0.232 * 8760 = **0.0131 MU.**
- **v.** % Annual energy losses with Rabbit ACSR = **0.61%**
- **vi.** Peak power losses with Squirrel ACSR conductor = 16.26 KW.
- **vii.** Annual energy losses with Squirrel ACSR conductor = 16.26 * 0.232 * 8760 = **0.033 MU.**
- **viii.** % Annual energy losses with Squirrel ACSR = **1.55%**
- **ix.** Voltage (I*R) drop with Rabbit ACSR conductor = 104 Volts.
- **x.** % V.R with Rabbit ACSR = 0.944 %.
- **xi.** Voltage (I*R) drop with Squirrel ACSR conductor = 218 Volts.
- **xii.** % V.R with Rabbit ACSR = 1.98 %.

#### Standard format for Energy loss assessment of DTCs

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Particulars</th>
<th>Values / Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Number of hrs the Transformer is charged during the year</td>
<td>8760</td>
</tr>
<tr>
<td>2</td>
<td>Peak current in Amps</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>Power factor</td>
<td>0.8</td>
</tr>
<tr>
<td>4</td>
<td>Peak load in kW</td>
<td>610</td>
</tr>
<tr>
<td>5</td>
<td>Peak load in kVA</td>
<td>762</td>
</tr>
<tr>
<td>6</td>
<td>The energy input to feeder during year in kWh</td>
<td>2670328</td>
</tr>
<tr>
<td>7</td>
<td>Load factor</td>
<td>0.40</td>
</tr>
<tr>
<td>8</td>
<td>Loss Load factor</td>
<td>0.232</td>
</tr>
<tr>
<td>9</td>
<td>DTCs loading</td>
<td>0.76</td>
</tr>
</tbody>
</table>
The energy losses in the L.T. lines can be assessed similar to 11 kV lines by any one of the 3 methods.

<table>
<thead>
<tr>
<th>10</th>
<th>Capacity wise DTCs in KVA</th>
<th>Numbers</th>
<th>Total kVA</th>
<th>Iron Losses</th>
<th>Copper losses</th>
<th>Total DTC losses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>kW</td>
<td>% Losses</td>
<td>kWh</td>
</tr>
<tr>
<td>a)</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>80</td>
<td>475</td>
<td>8760</td>
</tr>
<tr>
<td>b)</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>685</td>
<td>8760</td>
</tr>
<tr>
<td>c)</td>
<td>63</td>
<td>0</td>
<td>0</td>
<td>180</td>
<td>1235</td>
<td>8760</td>
</tr>
<tr>
<td>d)</td>
<td>100</td>
<td>5</td>
<td>500</td>
<td>260</td>
<td>1760</td>
<td>8760</td>
</tr>
<tr>
<td>e)</td>
<td>250</td>
<td>2</td>
<td>500</td>
<td>620</td>
<td>3700</td>
<td>8760</td>
</tr>
<tr>
<td>f)</td>
<td>315</td>
<td>0</td>
<td>0</td>
<td>740</td>
<td>4200</td>
<td>8760</td>
</tr>
<tr>
<td>g)</td>
<td>500</td>
<td>0</td>
<td>0</td>
<td>1100</td>
<td>6500</td>
<td>8760</td>
</tr>
<tr>
<td>h)</td>
<td>750</td>
<td>0</td>
<td>0</td>
<td>1500</td>
<td>10000</td>
<td>8760</td>
</tr>
<tr>
<td>i)</td>
<td>Total</td>
<td>100</td>
<td>0</td>
<td></td>
<td></td>
<td>8760</td>
</tr>
</tbody>
</table>

| 74 | KERC - Capital Expenditure Guidelines for ESCOM |