Predictive Analysis of Power Generation Loss for Performance Improvement

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Abstract— These For predictive analysis of Power Generation loss the most important task is Preventive maintenance scheduling of generating units in a power plant. Also it plays major role in operation and planning of the system. The systems Engineers, controllers, grid operators and many other plant personnel take advantage of the Predictive analytic solutions to make real time decisions that have a significantly positive impact on performance and reliability. Advanced predictive analysis software helps power generation employees to work more effectively by providing early warning notification and give more lead time to plan necessary maintenance, it will ultimately avoiding potential equipment failure and improving performance. Predictive analytics software can allow power utilities to monitor critical issues for the purpose of identifying, diagnosing and prioritizing equipment problems in real time. Power generation and delivery utilities can transform their maintenance Strategies by power related data and predictive analytics solutions to spend less time.

1 INTRODUCTION

IN power sector industry Electricity demand is slowing, capital expenditures are rising and competition is growing with new market entrants. There are ongoing pressure from regulations and consumers, electric utilities are operating with the highest levels of efficiency, reliability as top priorities. The power utility industry is in the center point of a major financial restructuring. The growth of distributed power generation and diversification of power sources bring operational and maintenance system challenges, including loading issues, less switching flexibility and the potential for reverse power flow. There will be need for asset renewal prioritization and knowledge capture.

For automating energy monitoring processes, better efficiency in operations and for more informed decision making, the Power industry utilities are increasingly making use of IT. With a growing need for real-time data, communication technologies are becoming more important. To overcome these industry challenges and remain relevant in the changing energy marketplace power utilities are continually employing new and old strategies . There are few opportunity for transforming challenges into opportunities these are adapting to new rules, innovating new offerings and investing in cost saving technologies. The amount of data available is providing utilities with the information needed to operate more efficiently, effectively and safely. Using predictive analysis and asset-monitoring software, power utilities can improve equipment reliability and performance while avoiding potential failures. Predictive analysis solutions provide the information needed to prioritize maintenance and reduce operational and maintenance expenditures and thus reduce the power generation loss.

1.1 Objectives

Implement an integrated ERP system that brings IT culture, automates & Implement an integrated ERP system that brings IT culture, automates & integrates business processes, embeds transaction processing controls and provides appropriate reports to facilitate decision making and smooth functioning of MSPGCL operations. Independent, low maturity legacy; Transformation needed for Processes, Data, Infrastructure and People Power Project Challenges – Managing Schedule, Scope and Stakeholder Satisfaction, Working with Multiple Partners [12] Need to improve Operational efficiency, Delivery performance & Analytics, Health & Safety, Green IT, along with opportunity for high Learning & Growth getting ready for competition. Strategic Goals that are to be achieve by Predictive Analysis of Power Generation Losses are

- Better Decision Support and Strategic Reporting Capability
- Strong Business and IT Integration
- Opportunity to fine-tune current Business Processes
- Improved day to day Operational and Maintenance Reporting
- Cost Reduction
- Efforts Reduction
- Process Improvement
- Process Standardization
- Data Driven Management Information System
- Availability of Breakdown preventive and corrective maintenance cost with Mean Time Between Failure and mean Time To Repairs
- Online Inventory Report and Automatic Reports.
- Ease of reporting for fuel procurement and consumption
- Availability of data and analysis on plant performance Parameters
- Effective vendor selection based on Quality Performance
- Online Availability of data employee personal information
- Linkage of asset accounting with plant maintenance for capital purchases and Complete traceability of individual machine Location
- Tracking of all types of waste Disposals
- Improve Operational Efficiencies
- Reduce Working Capital, Better Cash Flow
- Optimize Inventory of Fuel, Spares, Consumables
- Streamline Accounts & Human Resource functionalities

- Reduce throughput time, improve reliability
- Centralized Salary for all Employee of MAHAGENCO
- Ensure IT System Readiness for future competition

2 LITERATURE REVIEW/SURVEY

Detailed For predictive analysis of Power Generation loss we must need Preventive maintenance scheduling of generating units. Preventive maintenance scheduling is an important task in a power plant and plays major role in operation and maintenance planning of the system. The economic operation of an power generation system requires the simultaneous solution of all aspects of the operation scheduling problem in the power plant which include overhaul, different external factors involved, different operation and maintenance factors and uncertainties of different order.[1]. Today power preserving and/or enhancing system reliability and reducing Operations and maintenance (O & M) costs are top priorities in power plant. As system equipment continue to age and gradually deteriorate their may be probability of power generation loss due to component failure increases. An effective predictive maintenance strategy is essential in delivering reliable and safe electric power to customers economically [2]. All power utilities perform maintenance of system equipment in order to supply electricity with a high reliability level. The efficiency of system operation and production cost in an electric power system is highly affected by the maintenance outage of generating facilities. Optimized maintenance schedule could save millions of dollars which may be use to allow critical maintenance work to be performed and for the implementation of new plants. Therefore, maintenance scheduling for electric power generation system is a significant part of the overall operations scheduling problems. By regular preventive maintenance Power plants components are able to remain in operating condition. The purpose of maintenance scheduling is to find the sequence of scheduled outages of generating units over a given period of time such that the reserve energy level is maintained [3]. To sustain in an increasingly competitive power delivery environment, power generation companies are forced to apply more predictive analysis methods of power utility asset management. Capital budgeting and O & M of existing facilities is one of the main components of electric power delivery asset management. O & M expenditure is the primary candidate for cost cutting and potential savings as in many cases the cost of construction and equipment purchases are fixed. As power plant system equipment continuously used may get damaged and their may be probability of power generation loss due to component failure increases. Electric utilities are confronted with many challenges in this new era of competition: growing demand on system, rising O & M costs, maintaining power reliability and power quality, and managing equipment aging. Revenues are affected by the condition of equipment therefore the health of equipment is of utmost importance to the industry . When demand is high and equipment is in working order, substantial revenues can be realized. A predictive maintenance strategy is essential to reduce the generation loss, to delivering safe and reliable electric power to customers economically because unhealthy equipment can result in service interruption, customer dissatisfaction, loss of good will, and customers loss also. [2].

In power plant keeping large enterprise inventory, keeping asset availability and reliability and reducing costs related to equipment maintenance, repair and ultimate replacement are at the top of management concerns [4]. In response to these concerns, Stanley Nowlan and Howard Heap developed the Reliability Centered Maintenance (RCM) in 1978 [5]. RCM has been defined formally by Moubray [6] as 'a process used to determine what must be done to ensure that any physical asset continues to give better performance'. For complex systems such as steam turbines, the unexpected occurrence of component failures drastically increases maintenance costs associated with corrective tasks which include direct corrective costs (spare parts, labour hours) but also for the system unavailability cost. The predictive or preventive maintenance tasks for critical components are used to reduce the system unavailability in power generation. This policy allows the reduction of unexpected failure occurrences that cause the system unavailability and are usually very expensive to repair. Failures in electric power stations result in downtime, production losses and economic losses as well. And to achieve the global maintenance objective of realizing high machinery availability at minimum cost, we must have to given adequate cognizance to the element that make up the cost, i.e. the cost of machine unavailability and the cost of maintenance resources. The objective of a good maintenance plan is to make a balance between these two costs to achieve the minimum total cost creates an ideal maintenance situation. [7]. Power loss analysis of grid connection system based on the loss factors of double line-frequency voltage ripple, fast irradiance variation, non uniform solar cell characteristic, fast dc load variation, and limited operating voltage range. These loss factors will result in power variation from the maximum power points (MPP). Both single stage and two stage grid connection PV systems are considered in the power loss predictive analysis. Due to an additional maximum power point tracker (MPPT) the effects of these loss factors effects on two stage grid connection PV systems are insignificant , but it will reduce the system efficiency. The power loss caused by these loss factors in single stage grid connection PV systems that is, a single stage grid connection PV system has the merits of saving components and reducing cost, it will not break up overall system efficiency. Simulation results with a MATLAB software package are presented to confirm the analysis.[8] Generation, transmission and distribution are the components of electric power systems.. As there is no limit for the demand for electricity grows., it is expected that a number of restriction, such as environmental, regulatory and economic, turn aside the construction of new power plants and transmission lines. Engineers, equipment manufacturers, and regulatory agencies are now facing a new problem of finding improved ways to utilize the capacity supplied by existing power transmission infrastructure and power generation facilities . This paper introduces an linear programming (LP) and predictive analysis optimization method using Dynamical Thermal Rating (DTR) to minimize generation costs or transmission losses.

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DTR values are derived from a spatially resolved thermal model of the transmission system based on actual weather conditions along the line. The temperature dependent conductor resistance along the line are use to count power losses more accurately. The model is used in a case study involving a simplified power transmission system with two types of generators and a single load center. The simulation results show that thermal generation are more expensive and polluting than the energy from hydro power plant transmitted to the load center.[9] In application module of SIS system, the online monitor and analysis system for energy saving is widely applied to power plants. There is still lack of sufficient research in the corresponding guide system which applied effectual guidance to realize optimal operation is . The main purpose of the guide system is to find out the various reasons for power generation loss. Then the effective operating adjustment or timely maintenance must be implemented to reduce power losses. The symptoms of power generation losses shows that the operating parameters always depart from their target values. Analysis of historical data are use to obtained operating target values there must be some logical relations with certain reason which leads to energy loss. . The method of symbolic logic logical established the relations between symptoms and reasons. The research of the paper provides the predictive analysis methods for energy saving in power plant.[13] Most of the utility generation planning models makes the assumption that power outages are independent events. The reason behind this assumption is twofold, the utilities have not generally collected data on the effect of outages on system forced outage rates and independence allows the calculations to be made using fairly simple algorithms. Independence of outages are assumed by the Calabrese method of calculating loss of load probability (LOLP). In the popular Baleriaux Booth algorithm and in the method of cumulants, the assumption of independence is fundamental to the calculation of production costs and reliability indices.[14]

A. Types of Power Generation Losses:
- Overhauls
- External Factors Details of External Factors
  a) Low System Demand
  b) Water Shortage
  c) Coal Shortage
  d) Poor Coal Quality
  e) Wet Coal Problem
  f) System Problem
- Operation & Maintenance FACTORS Details of O &M Factors
  a) Boiler Tube Leakage
  b) PR Parts Leakage
  c) Coal Cycle Problem
  d) ID/FD/PA Fan
  e) Flame Failure
  f) Drum Level
  g) Governing Problem
  h) HP Heaters
  i) BFP Problem
  j) Condenser Vacuum
  k) Hydrogen Leakage
  l) Electrical Problem
  m) T&IC Problem
  n) CHP Problem
  o) Start Up/Withdrawal
  p) Any Other Problem

B. Problems In Existing System
- Every power station has separate source code, different report format.
- Every power station have different Item code for same Item in different plant
- Difficult to find out Item in E-tender process
- Not possible to count per Human work cost
- Every time we have to send the data that Head office needed from time to time
- Not possible to share Item from one plant to another plant
- Store Inventory not properly maintain

3 Proposed System Analysis/Design

Optimization of Preventive Maintenance can improve Outage performance of power plant. It is good practice to keep power plant maintenance as efficient and short as possible because shutting down a power plant for any reason is a costly process. Loss of power production revenues from one unit can exceed millions of dollars per day. It is therefore necessary to adopt best practices to keep outages as short and efficient as possible. Preventive Maintenance (PM) is a major component of planned outages. Preventive Maintenance (PM) be applied only where needed. Unnecessary PM is costly, not only in terms of material and labor costs, but in additional lost time and production. In some cases where Preventive Maintenance PM is contraindicated by the components with decreasing failure rates. The problems in preventive maintenance can introduce incurring additional repair costs, failures, and production loss. The risk management group at the South Texas Project Electric Generating Station (STPEGS) has successfully developed software to optimize Preventive Maintenance schedules by minimizing total costs and risks associated with corrective maintenance and Preventive Maintenance. The optimum PM interval is determined as a multiple of outage cycles. Assets are evaluated based on risk ranking, maintenance type, cost of performing CM at power, and regulatory or internal commitments. [11] Implement an integrated ERP system that brings IT culture, automates & integrates business processes, embeds transaction processing controls and provides appropriate reports to facilitate decision making and smooth functioning of MSPGCL (Maharashtra State Power Generation Co. Ltd.) operations.[12] Enable a company to measure and monitor its performance on a operational and strategic level. The KPIs indicate what will be happenings in advance so we can say that it will act as the "lead indicators" as they indicate what will be happenings in advance. Target values for KPIs are set as per the requirement of the strategic goals of a company. Comparing actual KPI values to these targets identifies shortcomings immediately and shows poten-

tials improvement for business processes at the same time. This is the strength of every company. [12]

- Mean Time Between Repair (MTBR)
- Mean Time To Repair (MTTR)
- Actual Hours / Planned Hours for a Work Order
- Planning Efficiency
- Equipment Availability

4 Proposed System Architecture/Design

4.1 Maintenance Practices

Organizations first should ensure that a solid maintenance foundation exists while When considering new investments in predictive monitoring software

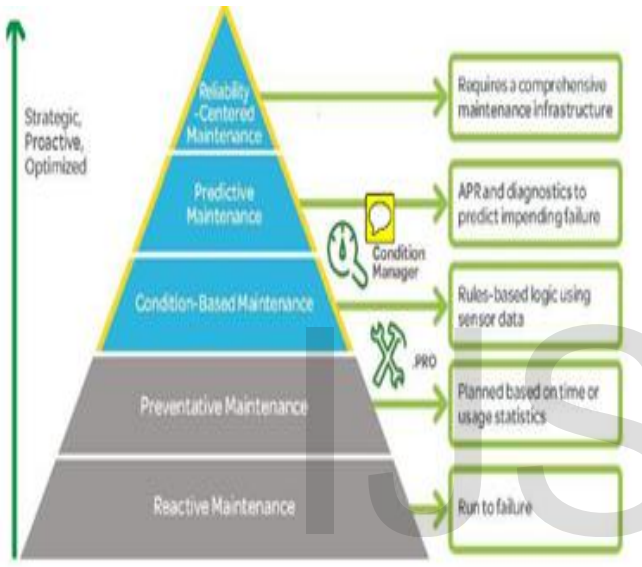

Fig. 1. Maintenance.

Reactive maintenance are also known as "breakdown maintenance". In this type maintenance are done when equipment has already broken down. It basically focuses on restoring the equipment to its normal operating condition. It involves letting an asset run until failure. Reactive maintenance are appropriate only for noncritical assets which have no immediate impact on safety or the reliable generation of electricity. Also their repair or replacement costs is very low so that investment in advanced technology need not be required. Preventive maintenance is maintenance that is regularly performed on equipment without failing. Though the equipment is still working preventative maintenance is regularly done, so that the equipment does not break down unexpectedly. preventive measures are taken in such a way that its asset will not reach to failure. The Preventive maintenance work to be conducted on a fixed time schedule and based on operational statistics. The best practices of different manufacturer/industry recommendations are accepted. Condition based maintenance (CBM) is a maintenance strategy that monitors the physical condition of the equipment to decide what maintenance needs to be done. Condition based maintenance should only be performed when certain indicators show that equipment is going to fail or that equipment performance is deteriorating.

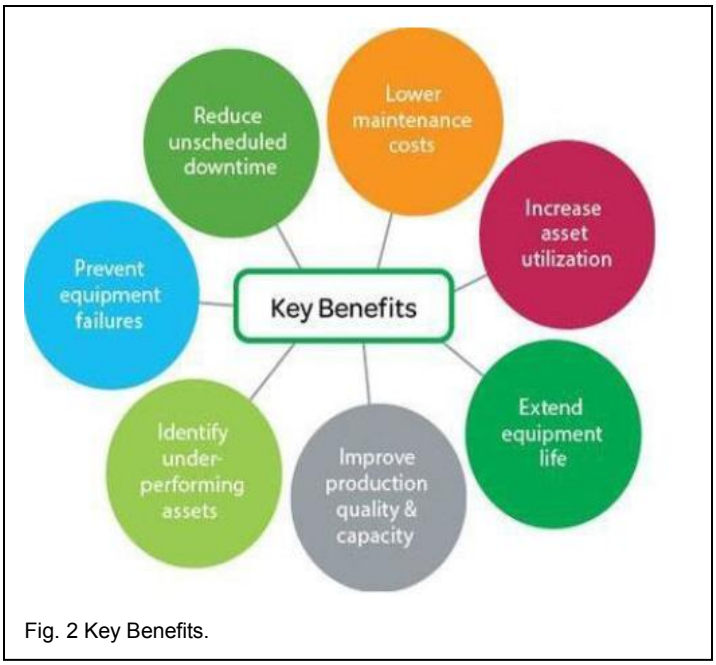

Fig. 2 Key Benefits.

For implementing the corporate level maintenance strategy to optimize the maintenance program of a company Reliability Centered Maintenance (RCM) is used. The final result of an RCM program is the implementation of a specific maintenance strategy on each of the assets of the company. RCM is a complex strategy focused on outcomes and is a process for determining what should be done to ensure that an asset perform at high level. RCM is the fully integrated maintenance program which includes predictive analytics solution in support of predictive maintenance

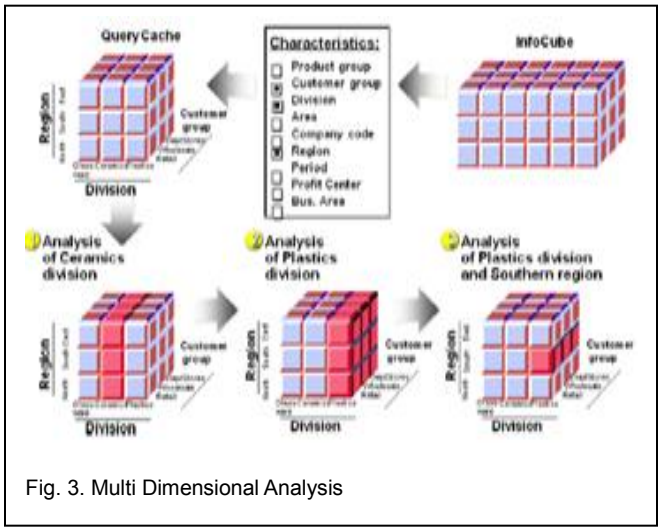

Fig. 3. Multi Dimensional Analysis

5 Feasibility Study

Bacterial Foraging Optimization (BFO) algorithm is an evolu-

tionary computation algorithm has been widely implemented in power engineering. It is proposed based on the foraging behavior of the Escherichia coli (E. coli) bacteria living in the human intestine and has ability in finding nutrients in the human body. The status of the generation system describe by the positions of each bacterium and its probability is the resulting fitness value . The generation system states were visited included a failure state. If the high probability failure states are obtained, the reliability indices are calculated as Loss of Load Expectation (LOLE), Loss of Load Probability (LOLP), and Expected Energy Not Supplied (EENS). BFA success measured from its ability to find the dominant failure state because the more we found dominant failure state, the reliability index is expected to be closer to the actual values. It is required to check whether the new investment or improvement needed or not for determining the lowest long term cost of ownership with low risk of power generation investment. Reliability indices based on Equivalent Force Outage Rate (EFOR) and power system and Equivalent Availability Factor (EAF) and of power generation. The new approach or model is proposed as a tool to make decision for new investment and improvement. The new model is included Reliability & Maintainability (R&M) calculation, Life Cycle Cost Analysis (LCCA) and BFA. The results tell us that calculation of LCCA and BFA were applicable to predictive analyze the reliability of power system to get optimum performance, risk and minimum cost. At the scenario 2, even additional investment is decided but it got the lowest long-term cost of ownership with low risk. Researches in this field are still interesting.[10]

6 Requirements & Input Output Specifications

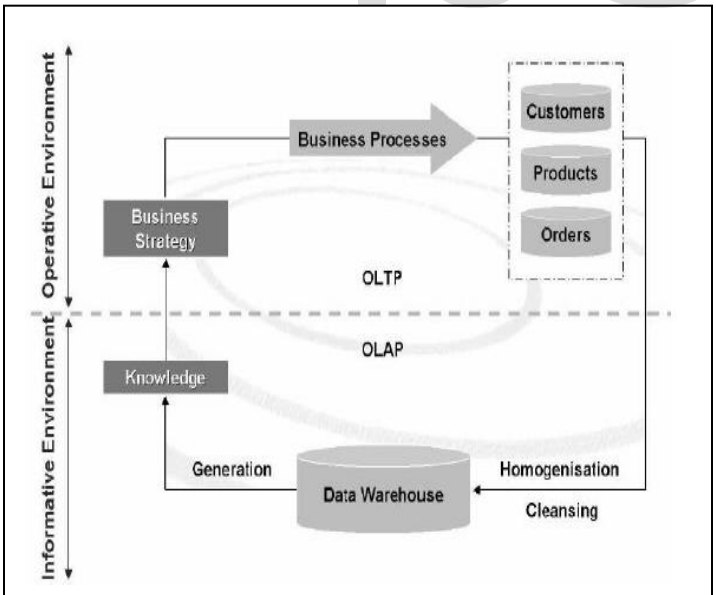

Fig 4 . Data Warehousing Overview.

6.1 BEx Query Designer

The key to making informed decisions is having the right data in the right place at the right time. Top management executives rely on business intelligence (BI). Reporting tools are very useful for deliver timely accurate and relevant data for both strategic and operational decisions. The Business Explorer (BEx) is a component of SAP BI that provides flexible reporting and analysis tools that we can use for strategic analysis and supporting the decision-making process in an organization. These tools include query, reporting, and analysis functions.

7 System Development Plan

7.1 Appendices

The systems Engineers, controllers, grid operators and many other plant personnel take advantage of the Predictive analysis solutions, and use it to make real time decisions that have a significantly positive impact on performance and reliability. Advanced predictive analysis software helps power generation employees to work more effectively by providing early warning notification and give more lead time to plan necessary maintenance, it will ultimately avoiding potential equipment failure and improving performance. Predictive analytics software can allow power utilities to monitor critical issues for the purpose of identifying, diagnosing and prioritizing equipment problems in real time. Power generation can transform their maintenance Strategies by power related data and predictive analysis solutions to spend less time. power utilities can monitor critical assets to identify, diagnose and prioritize impending equipment problems continuously and in real time. Cost analysis with respect to spares & consumables, special services, works, internal labor is possible. Availability of Breakdown maintenance. preventive maintenance. and corrective maintenance. Cost once the linkage of asset & equipment master is established, plant maintenance will allow knowing book value of Equipment. For Decision making and analysis we have to know information about MTBF (Mean Time between Failures) and MTTR (Mean Time to Repairs). With deployment of the historian and predictive analysis software, this utility has:

- Developed a robust data architecture for reliable access to real-time and historical data .
- Created interactive display screens for improved visibility into operations.
- Developed standardized and accurate reports, reducing the time to produce them.
- Identified early indications of asset failure. These results are not uncommon. By leveraging predictive analytics and fault diagnostic technology, customers have reported a 25% reduction in asset equipment downtime, 25% reduction in operations and maintenance costs.

8 Conclusion And Future Scope

Predictive analysis solutions use massive amounts of data for analysis and use it to make real time decisions that have a significantly positive impact on performance and reliability of power generation. It will be very needful for grid operators, systems Engineers, controllers, and many other plant personnel to take real time decision. Advanced predictive analysis software helps power generation employees to work more effectively by providing early warning notification and give

more lead time to plan necessary maintenance, it will ultimately avoiding potential equipment failure and improving performance. Power generation can transform their maintenance Strategies by power related data and predictive analysis solutions to spend less time for potential issues and more time taking actions to gain the greatest return on every single asset. New predictive asset analysis software tools can allow power utilities to monitor critical assets for the purpose of diagnosing, identifying, and prioritizing impending equipment problems continuously and in real time.

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