UPES Centre for Continuing Education

CASE STUDY ON GAS TURBINE CO-GENERATION PROJECT IN CERAMIC INDUSTRIES & IMPACTS OF GOVERNMENT POLICIES ON THE PROJECT IN GULF REGION.

By

KASTURI RAJU INDUKURI

SAP ID: 500065866

Guided By

Mr. Murali Krishna Patnala

Maintenance Manager - Head of the Department
GVK Industries Limited, Rajahmundry

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Kasturi Raju Indukuri
Flat No. 303, Manager Building-2, RAK Ceramics
Al Hamra Al Jazeera
PO Box 4714
Mobile: +971553179827 / +919652061146
E-mail: ikraju@rediff.com

Date: 22nd October 2019
Place: Ras Al Khaimah, U.A.E

GVK

DECLARATION BY THE GUIDE

This is to certify that the Mr. Kasturi Raju Indukuri, a student of MBA – Power Management, Roll No: 500065866 of UPES has successfully completed this dissertation report on "CASE STUDY ON GAS TURBINE CO-GENERATION PROJECT IN CERAMIC INDUSTRIES & IMPACTS OF GOVERNMENT POLICIES ON THE PROJECT IN GULF REGION" under my supervision.

Further, I certify that the work is based on his own experiences on role during his services in the Gulf region, he has analyzed data provided in the report with the support of project team and it has not been submitted in any other University or Institution for award of any degree. In my opinion, it is fully adequate, in scope and utility, as a dissertation towards partial fulfillment for the award of degree of MBA.

Signature

P. Murali Krishna

Mr. Murali Krishna Patnala
Maintenance Manager – Head of the Department
GVK Industries Limited, Jegurupadu, Kadiyam Mandalam,
East Godavari District-533126, Andhra Pradesh, India
Mobile No- +918498090343
Email- murali.patnala@gvk.com

Date: 24th October 2019
Place: Andhra Pradesh, India

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EXECUTIVE SUMMARY / ABSTRACT:

Planet Earth is an entity with vast amount of resources available in its nature, this is used for the better living of humankind. There are many other requirements by humans, which are not directly available in the nature and has to be converted or produced from the available natural resources. Electric Power is one such energy, which is very important for the survival and betterment of humankind and has to be produced with the available or synthesized natural resources.

It is the basic principle of Human beings to use the provided resources wisely and to minimize the exploitation of natural resources considering the better living of future generations. In search of wise/Optimum utilization of energy during power generation, Cogeneration or combined heat and power (CHP) came into existence. This system of power generation induces heat engine or power station to generate electricity and useful heat at the same time.

The paper insights self-experience in executing a Gas turbine Co-Generation project in one of the largest ceramics tiles manufacturing industry located in the gulf region. The project was successfully completed but the estimation of returns on the project was very much affected due to new policies framed by the local government which was out of prediction till the project was completed.

The paper provides the actual scenario of calculations and effects on Pay back/ROI due to the new policies in the power supplied through the Grid.

1. Introduction

1.1 Overview

Due to the current trend of increasing power demand and prices, there has been a huge impact on companies associated with larger power demands. For Ceramic Tiles manufacturing companies austere economic forecast has challenged the balance sheets and stakeholder dividends, leading to cuts in project spending and increased focus on productivity and cost control. Further companies are reducing their project budget costs and production costs in order to survive in the competitive market; the need for optimization of available energy and resources plays a vital role in such competitive scenarios.

In ceramic tiles manufacturing industry, Power cost accounts to around 10-15% of the total manufacturing cost and hence is further much attractive option for optimization if the manufacturing facilities are of huge volume. Captive power generation becomes necessary when the in-house power demands are very high and the power costs from the local government bodies are much higher comparatively.

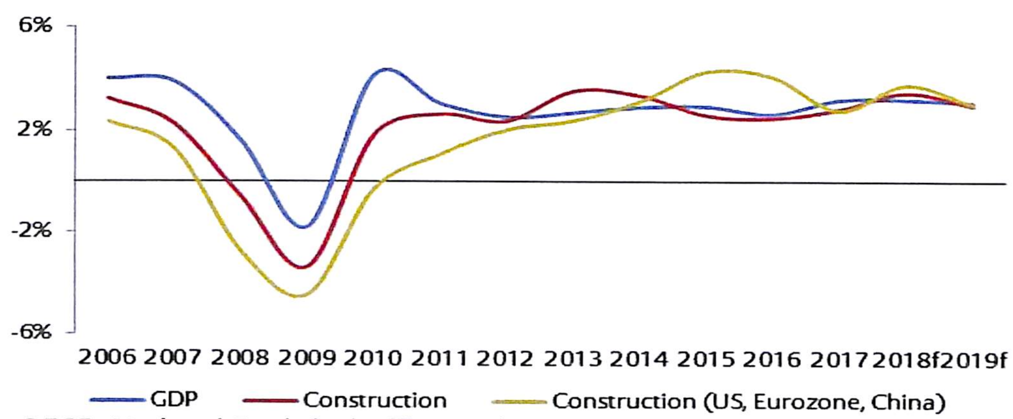
One such tiles manufacturing facility with a total power demand of 200 Million Kwh/year, operating in the gulf region where the power cost for manufacturing industries by the local government is around 9.0 INR/Unit. This amount to around 1800 Million INR on power expenses for the facility per year. Captive power generation with proper optimization and considerable reduction in power costs compared to the local power supply is an attractive option in this case.

Project planning with the support of consultants was started with the above inputs. The idea was clear to tap the available potential for reduction of energy costs by having a captive power generation plant. Co-generation systems was one of the finite option suggested due to the scheme of tiles manufacturing which involves requirement of Heat in many stages throughout the process. In addition, lot of literatures were available for such proven installations across the world, which made it more clearly for stepping up.

1.2 Background

Economic slowdown and hold of many Global construction projects resulted in low turnovers for construction and associated companies. Ceramic tiles manufacturing companies were also a victim for the same. Growth of construction companies are much dependent on the Global GDP, below provided graphical representation shows the trend of construction industry vs. the Global GDP. Fig-1.0 – Global GDP vs. Construction Industry.

Chart 1: Global construction industry vs. global GDP (real USD, %change y/y)



Sources: OECD, National Statistical Offices, Euler Hermes

As shown in Fig. 2.0, during the current global construction cycle, the infrastructure sector has been chronically underperforming due to the underinvestment from the governments that decided to spend their money elsewhere. Although the emerging markets are keen on developing the infrastructures, still the growth trend is not much compromising as expected.

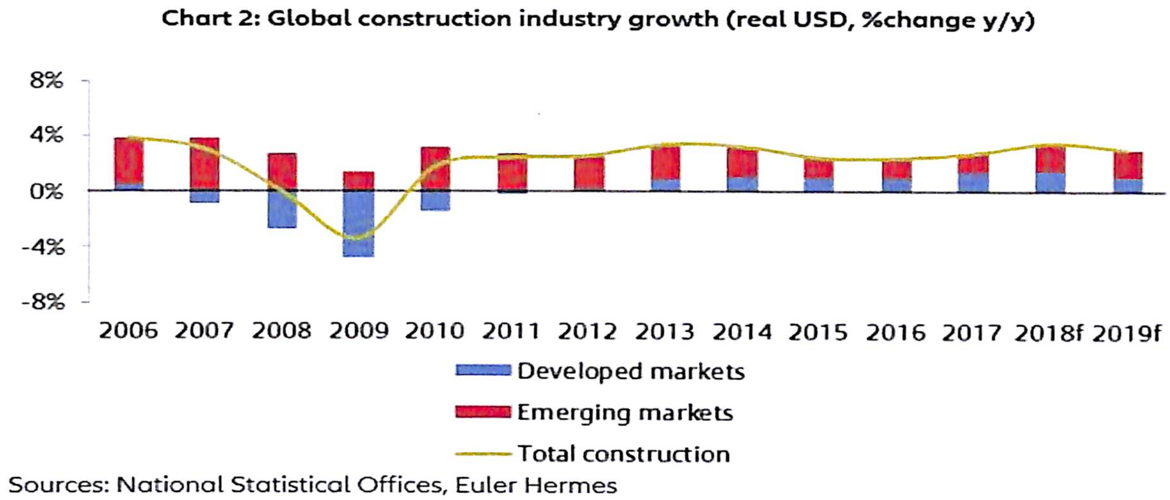
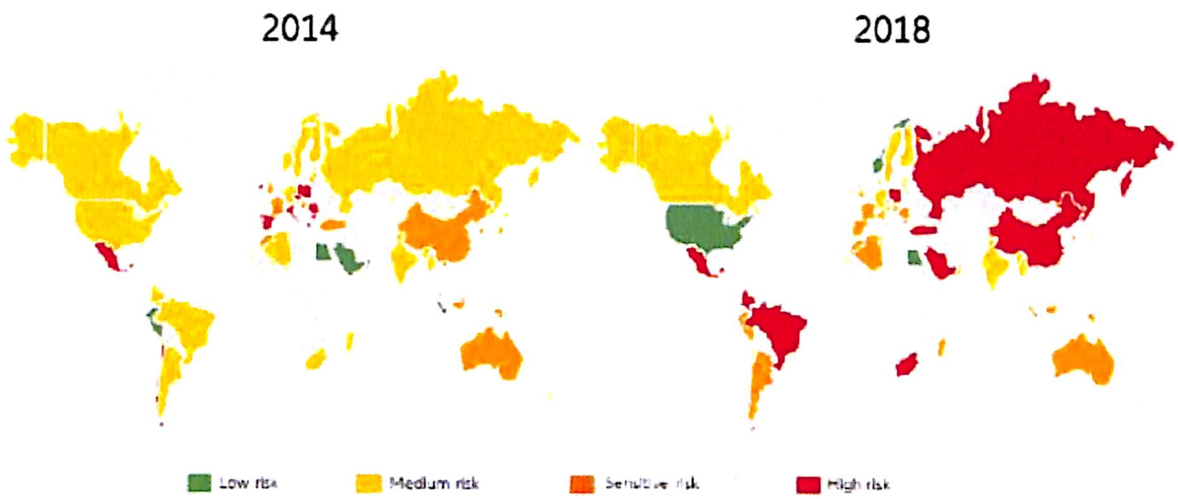


Figure 2.0 Global construction industry growth, real USD, % change y/y

With all the above Global scenarios, the fact that investments in future on infrastructure might be more degrading in the construction industries as the data precisely suggests that while the global economy has shown considerable improvement, at the same time the construction sector has seen its average risk grade deteriorate.

That is a worrying finding because it means that the construction industry is approaching the end of cycle unprepared. Currently, construction is the second riskiest sector in our portfolio, second only to metals. As of Q3 2018, more than two-thirds of the construction markets around the world have been graded "sensitive risk" or "high risk" compared to only half of these markets at the end of 2014.

Chart 8: Sector Risk in construction 2014 vs. 2018



Source: Euler Hermes

Figure 3.0 Construction Sector Geographical Risk profile – 2014 vs. 2018

Sector risk in construction industries increased across different geographies as shown in the above image, which is surprising as the performance of the construction industry is reliant mostly on the internal factors of each country, such as consumer spending, availability and cost of credit, state of consumer and government finances etc., which have been far from synchronized in all the countries in question.

As evident, the market for construction related products is globally challenging and hence the need for cost reduction projects were very important. Installation of co-generation captive power was considered and started in the year 2018 considering reduction of power costs for the firm.

1.3 Purpose of the Study / Project

Project revolves around installation of captive power generation plant with Co-generation to use the exhaust heat in the spray drying of milled ceramic powder, which is the processed raw material for manufacturing of Tiles. Provided below is a schematic diagram for understanding the conventional ceramic tile manufacturing process and the new generation system with Gas turbine co-generation system, which is in discussion.

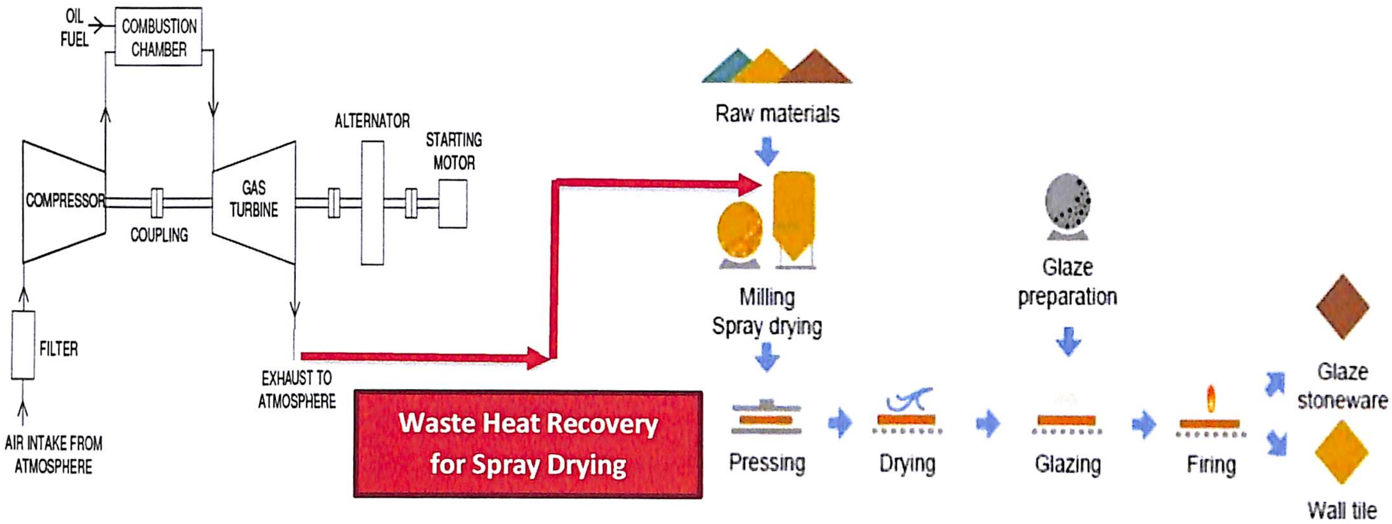


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Fig – 4.0 Schematic representation of modern age ceramic manufacturing process with Co-generation system

"Measurements are the key; If you cannot measure it, you cannot control it; If you cannot control it, you cannot manage it; If you cannot manage it, you cannot improve it." (James H. Harrington)

The present study will describe the better use of optimization of energy, project management, Programs management, etc. Also, this study will describe the better usage of the tools and techniques to compute Schedule Variance (SV), ROI forecasts, Cost Variance (CV), Schedule Performance Index (SPI), Cost Performance Index (CPI), better coordination and integration of project groups and to ensure and enable the contractor firm to have a clear vision of the project status within a stipulated time frame to avoid cost and schedule overrun if any. The study also gives insight on un expected post project impacts due to government regulations.

2. Literature Review

The major literature review carried out for the project was through the technical consultants involved in the EPC of the Gas turbine Co-generation project and the cost savings that would benefit the company due to reduced power costs.

The systematic conditions followed during the project phase through the EPC contractor and self-learning with the PMBOK® GUIDE Fifth Edition paid way for extensive learning of project management principles and tools, which will be shared in the report.

2.1 Project and Project Life Cycle:

In this section, we will discuss about project and different stages of project and how every stage plays an important role for the timely completion of the project.

2.1.1 Project:

A project is a temporary sequence and series of logically linked activities, with defined scope, time and quality. A project is unique and has a definite beginning and end.

2.1.2 Project Life Cycle:

A project life cycle is the series of phases that a project passes through from its initiation to its closure. The phases are generally sequential, and the management and control needs of the organizations involved in the project, the nature of the project itself, and its area of application determine their names and numbers. The phases can be broken down by functional or partial objectives, intermediate results or deliverables, specific milestone within the overall scope of work, or financial availability. Phases are generally time bounded with a start and ending or control point.

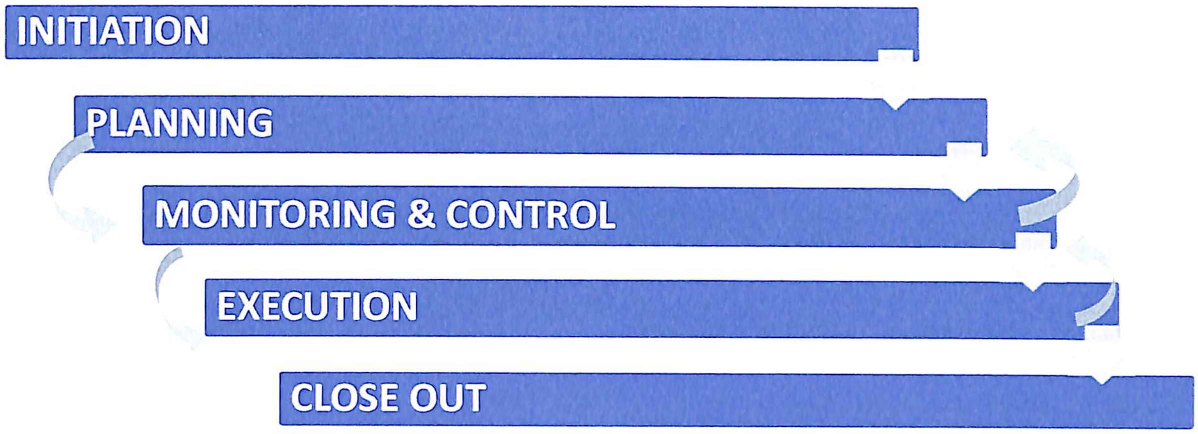

Fig: 5.0 Project Life cycle - Reference – PMBOK® GUIDE Fifth Edition

a. Initiation:

During the Initiation phase, a project is defined and initial financial resources are committed. All the information is captured in the project charter; ROI's are calculated and submitted for approval. When the project charter is approved, the project becomes officially authorized.

b. Planning:

The planning team identifies and documents the specific action to be performed to produce the project deliverables. Planning team then defines the activities, estimates resource requirement and estimates durations. Once all the inputs are in place, planning team develops a schedule by sequence of activities logically linked with each other with a relationship. However, a single activity can be linked with multiple activities. Once the schedule is ready, a critical path is formed that defines the overall duration of the project.

c. Monitoring and Control:

Once the project is started, progress for activities are updated, variance is calculated on the basis of planned versus actual. It provides the means to recognize deviation from the plan, take corrective and preventive actions, and thus minimize risk. It also helps to optimize resource usage and identify changes that may affect the target completion date of project.

In case of any deviation, the planning team revisits the schedule to capture the impact and revise the schedule to suit the requirement.

d. Execution:

Execution is a phase where all departments work together to achieve the target completion date and as per the scope requirement.

In case of deviation during the execution phase, which is captured during monitoring, it goes to planning team to revisit and revise the schedule, Hence, Planning, monitoring and control and execution phase is cyclic in nature.

e. Close Out:

After successful completion of works as defined in the scope, close out team prepares the final report, as built report and project close out report. These reports are submitted for approval and once approved final and formal closure of contract is performed.

Knowledge Areas	Project Management Process Groups				
	Initiating Process Group	**Planning Process Group**	**Executing Process Group**	**Monitoring and Controlling Process Group**	**Closing Process Group**
Project Integration Management	1.1 Develop Project Charter	1.2 Develop Project Management Plan	1.3 Direct and Manage Project Work	1.4 Monitor and Control Project Work 1.5 Perform Integrated Change Control	1.6 Close Project or Phase
Project Scope Management		2.1Plan Scope Management 2.2 Collect Requirements 2.3 Define Scope 2.4 Create WBS		2.5 Validate Scope 2.6 Control Scope	
Project Time Management		3.1 Plan Schedule Management 3.2 Define Activities 3.3 Sequence Activities 3.4 Estimate Activity Resources 3.5 Estimate Activity Durations 3.6 Develop Schedule		3.7 Control Schedule	
Project Cost Management		4.1 Plan Cost Management 4.2 Estimate Costs 4.3 Determine Budget		4.4 Control Costs	
Project Quality Management		6.1 Plan Quality Management	5.2 Perform Quality Assurance	5.3 Control Quality	
Project Human Resource Management		6.1 Plan Human Resource Management	6.2 Acquire Project Team 6.3 Develop Project Team 6.4 Manage Project Team		
Project Communications Management		7.1 Plan Communications Management	7.2 Manage Communications	7.3 Control Communications	
Project Risk Management		8.1 Plan Risk Management 8.2 Identify Risks 8.3 Perform Qualitative Risk Analysis 8.4 Perform Quantitative Risk Analysis 8.5 Plan Risk Responses		8.6 Control Risks	
Project Procurement Management		9.1 Plan Procurement Management	9.2 Conduct Procurements	9.3 Control Procurements	9.4 Close Procurements

Table 1 - Project Management Process Group and Knowledge Area Mapping

2.2 Project Control

The traditional view of Project Controls as defined by PMBOK has been cost & schedule during the project execution phase. Although this view is persuasive in industry, a more effective Project Controls process can influence and benefit the whole project life cycle including the following:

- Project strategy;
- Project objectives;
- Project control systems;
- Scope management;
- Work breakdown / cost breakdown structures;
- Schedule management;
- Cost management;
- Engineering deliverables;
- Procurement and material control;
- Construction management;
- Control administration;
- Change order control;
- Estimating;
- Risk management;
- Progress measurement / reporting;
- Cost control;
- Earned value reporting;
- Cost forecasting;

Project Controls systems and processes indicate the direction of change from the baseline costs and schedule, to the actual performance.

2.3 Project Control Department Process

The Project Services Department process consists of the following major constituents.

a. Preparation and Obtaining Approval of Project Budget(s) and Cost control activity of the Project
b. Project Planning, Scheduling, Control and Reporting

2.3.1 Preparation and Obtaining Approval of Project Budget(s) and Cost control activity of the Project:

At award of the project, estimated costs are available with Estimation Department. These documents, however, are in most cases not adequate for effective cost control. Therefore, this procedure requires that in an early stage of the project a control budget is prepared, based on the available information and within the boundaries of the project estimates.

Cost control within Company generally consists of the following categories:

- Company Services Cost reporting (reimbursable Engineering, Procurement, Construction Management and outside services).
- The investment cost reporting which includes all costs within the scope of the project (e.g. direct supplied materials, subcontracts, services including Company's services etc.).
- Company internal cost report, which is limited to Company's services, including non-reimbursable costs.

The requirement for the first two categories largely depends on the scope of work for the project and the contract type. Regardless of the scope of work and the contract type, internal cost reporting will always be required.

Costs are reported in following categories, representing the sum of all the various cost accounts associated with each category:

a) Budgeted Cost: The budgeted cost is derived from the detailed cost estimate prepared at the start of the project.
b) Change Order Cost: The Category wise Cost estimate for approved change Orders.
c) Current Budgeted Cost: The Current Budgeted Cost is sum of Original Budgeted Cost and Change order Cost.
d) Cost at completion (Estimated Total Cost): The estimated or forecast total cost in each category is the current best estimate of costs based on progress and any changes since the budget was formed. Estimated total costs are the sum of cost to date, commitments and Variance.
e) Cost Committed: Committed cost is the firm commitments. Commitments may represent material orders or subcontracts for which firm dollar amounts have been committed.
f) Cost to Date: The actual cost incurred to date is recorded as Cost to Date and can be derived from the financial record keeping accounts.
g) Variance (Over or Under): This indicates the amount over or under the budget for each category. This is an indicator of the extent of variance from the project budget; items with unusually large overruns would represent a particular managerial concern. Variance is used in the terminology of project control to indicate a difference between budgeted and actual expenditures.

For project control, Managers would focus particular attention on items indicating substantial deviation (variance) from budgeted amounts.

2.3.2 Develop Control Budget for a Project

The project cost engineer with the support of the estimating department converts the detailed estimate into a control budget. The cost details are consolidated and amended as required at a control level. The control level shall be at sufficient detail to allow for meaningful control and shall allow for timely and cost effective trending, progress measurement, allocation of commitments and assessment of estimates to complete and collection of actual costs. A consensus with all parties involved about the work breakdown structure should exist prior to issuing the control budget for review /approval cycle by Project Management.

2.3.3 Physical Progress at Control Budget Level

The cost engineer shall regularly update the commitments versus expenditure report with Purchase orders, Service orders and Subcontract details. Furthermore, the project cost engineer shall evaluate the forecast finals to reflect the effect of the commitments. All parties involved, in particular, the Project Manager, the Construction Manager and the Contract Manager shall inform the cost engineer about (potential) claims or other costs for which the cost engineer might have to make reservations.

Following the monthly cut off, the Control/Planning engineer provides the cost engineer with physical progress information (percentage complete) at control budget line item level for all Project activities. The progress information must have been reviewed with the disciplines (Project Engineer/Project Manager) involved prior to passing it on to the cost engineer.

2.3.4 Cost Forecasts

By analyzing the available information about budget, actuals and physical progress and using historical data, the cost engineer makes a forecast about the final project costs at budget line item level. When there are indications of major deviations from the current anticipated finals, a bottoms up detailed estimate to complete might be required to generate a reliable forecast. Towards the end of the project the forecast should be based on "punch list" items to be completed. The cost engineer shall review these forecasts with the disciplines involved.

Cost forecasts shall be made regularly through sampling, trend analysis and bottoms up estimates to complete. Deviations from plan shall be made where cost forecasts at cost report line item level deviate from the current anticipated final.

2.3.5 Project Cost Report and Cost Narratives

The cost engineer prepares following the period (monthly) cut off the Project Cost Report considering the latest information. Together with the Cost Report, Project Services Department will prepare and issue Monthly Project Management Book (PMB) including the physical progress, S-curve, Cash flow charts and narratives which describes the period highlights. Furthermore, the narratives should include major developments which have come to light during the last period, but for which time did not allow for the preparation of a deviation from Plan. These late developments are to be included in accordance with the procedure in the next cost report.

The Project Cost reports shall as a minimum contain the following information:

- Original budget.
- Approved Change Orders
- Current budget, being the sum of the original budget and the approved change orders.
- Variance from Current budget
- Estimated Cost at Completion
- Commitments to date.
- Actual Costs to date.
- Estimated Cost to Complete

Approved change notices which have not yet been converted into change orders are excluded from the anticipated final. They are reported in a change Order Register.

2.4 Project Planning, Scheduling, Control and Reporting

The Planning and Control are cross processes involving all the various stages (Engineering, Procurement, Fabrication, Transportation, Installation and Testing Commissioning) of the Project. The aim is to assure the best support to the Project Management, by use of professional techniques and procedures, and by the latest computer technology and software, for monitoring, analyzing, and taking, if necessary, the right corrective action, in order to achieve all Contractual objectives. The purpose of Reporting is to inform the Company on the status of the Project, on the scored Progress, to describe the activities in progress and forecasted, highlighting problems and areas of concern.

After the defining the WBS (Work Breakdown Structure) of the Project which is a hierarchical structure splitting up the Project, monitoring of the scope of work at the synthesis/detail rate required by the various involved parties is allowed. It is not a rigid structure. It is customized to a specific Project, considering the scope of work, the Company requirement and Contractor's standards.

Once the WBS is defined, the development of the Schedule starts, at this stage planning, interfacing with the Engineering, Procurement, Fabrication, Load out & Tie-Down, Mobilization, Transportation, Offshore Surveys, Offshore Installation & Tie-in, Testing, Pre-Commissioning & As Built Documentation is done to identify the activities, duration, links and sequences, allocations of resources are also evaluated.

When all the elements are available, a network analyses, an optimization of resources and successive simulations are carried out until a final configuration is reached. This is the Baseline Schedule (Control Schedule) that is preserved and represents the reference (benchmark) against which the actual values are compared in order to get the performance of the Project activities.

The Project Schedule shall be based upon and incorporate the Critical Milestone Dates and the Scheduled Completion Date, and shall be regularly updated or revised and resubmitted to Company for review so that it accurately reflects actual and forecasted Work progress, including the impact of Changes..

A Project Schedule shall be maintained throughout the duration of the project. The schedule shall be created and maintained by the Control/Planning Engineer using MS Project /Primavera software. The Control/Planning engineer shall identify schedule delays, inform Project Manager of any problems in meeting schedule dates, and assess the impact of these on the overall progress of the project.

2.5 Cost Control: Tools and Techniques

2.5.1 Earned Value Management

Earned value management (EVM) is a methodology that combines scope, schedule, and resource measurements to assess project performance and progress. It is a commonly used method of performance measurement for projects. It integrates the scope baseline with the cost baseline, along with the schedule baseline, to form the performance baseline, which helps the project management team assess and measure project performance and progress. It is a project management technique that requires the formation of an integrated baseline against which performance can be measured for the duration of the project. The principles of EVM can be applied to all projects in any industry. EVM develops and monitors three key dimensions for each work package and control account

- **Planned value**

Planned value (PV) is the authorized budget assigned to scheduled work. It is the authorized budget planned for the work to be accomplished for an activity or work breakdown structure component, not including management reserve. This budget is allocated by phase over the life of the project, but at a given moment, planned value defines the physical work that should have been accomplished. The total of the PV is sometimes referred to as the performance measurement baseline (PMB). The total planned value for the project is also known as budget at completion (BAC).

- **Earned value**

Earned value (EV) is a measure of work performed expressed in terms of the budget authorized for that work. It is the budget associated with the authorized work that has been completed. The EV being measured needs to be related to the PMB, and the EV measured cannot be greater than the authorized PV budget for a component. The EV is often used to calculate the percent complete of a project. Progress measurement criteria should be established for each WBS component to measure work in progress. Project managers monitor EV, both incrementally to determine current status and cumulatively to determine the long-term performance trends.

- **Actual cost**

Actual cost (AC) is the realized cost incurred for the work performed on an activity during a specific time period. It is the total cost incurred in accomplishing the work that the EV measured. The AC needs to correspond in definition to what was budgeted in the PV and measured in the EV (e.g., direct hours only, direct costs only, or all costs including indirect costs). The AC will have no upper limit; whatever is spent to achieve the EV will be measured.

- **Schedule variance**

Schedule variance (SV) is a measure of schedule performance expressed as the difference between the earned value and the planned value. It is the amount by which the project is ahead or behind the planned delivery date, at a given point in time. It is a measure of schedule performance on a project. It is equal to the earned value (EV) minus the planned value (PV). The EVM schedule variance is a useful metric in that it can indicate when a project is falling behind or is ahead of its baseline schedule. The EVM schedule variance will ultimately equal zero when the project is completed because all of the planned values will have been earned. Schedule variance is best used in conjunction with critical path methodology (CPM) scheduling and risk management.
Equation: $SV = EV - PV$

- **Cost variance**

Cost variance (CV) is the amount of budget deficit or surplus at a given point in time, expressed as the difference between earned value and the actual cost. It is a measure of cost performance on a project. It is equal to the earned value (EV) minus the actual cost (AC). The cost variance at the end of the project will be the difference between the budget at completion (BAC) and the actual amount spent. The CV is particularly critical because it indicates the relationship of physical performance to the costs spent. Negative CV is often difficult for the project to recover. Equation: CV= EV – AC.

The SV and CV values can be converted to efficiency indicators to reflect the cost and schedule performance of any project for comparison against all other projects or within a portfolio of projects. The variances are useful for determining project status.

- **Schedule performance index**

The schedule performance index (SPI) is a measure of schedule efficiency expressed as the ratio of earned value to planned value. It measures how efficiently the project team is using its time. It is sometimes used in conjunction with the cost performance index (CPI) to forecast the final project completion estimates. An SPI value less than 1.0 indicates less work was completed than was planned. An SPI greater than 1.0 indicates that more work was completed than was planned. Since the SPI measures all project work, the performance on the critical path also needs to be analyzed to determine whether the project will finish ahead of or behind its planned finish date. The SPI is equal to the ratio of the EV to the PV. Equation: SPI = EV/PV

- **Cost performance index**

The cost performance index (CPI) is a measure of the cost efficiency of budgeted resources, expressed as a ratio of earned value to actual cost. It is considered the most critical EVM metric and measures the cost efficiency for the work completed. A CPI value of less than 1.0 indicates a cost overrun for work completed. A CPI value greater than 1.0 indicates a cost under run of performance to date. The CPI is equal to the ratio of the EV to the AC. The indices are useful for determining project status and providing a basis for estimating project cost and schedule outcome. Equation: CPI = EV/AC

The three parameters of planned value, earned value, and actual cost can be monitored and reported on both a period-by-period basis (typically weekly or monthly) and on a cumulative basis. Figure 3 uses S-curves to display EV data for a project that is performing over budget and behind the schedule.

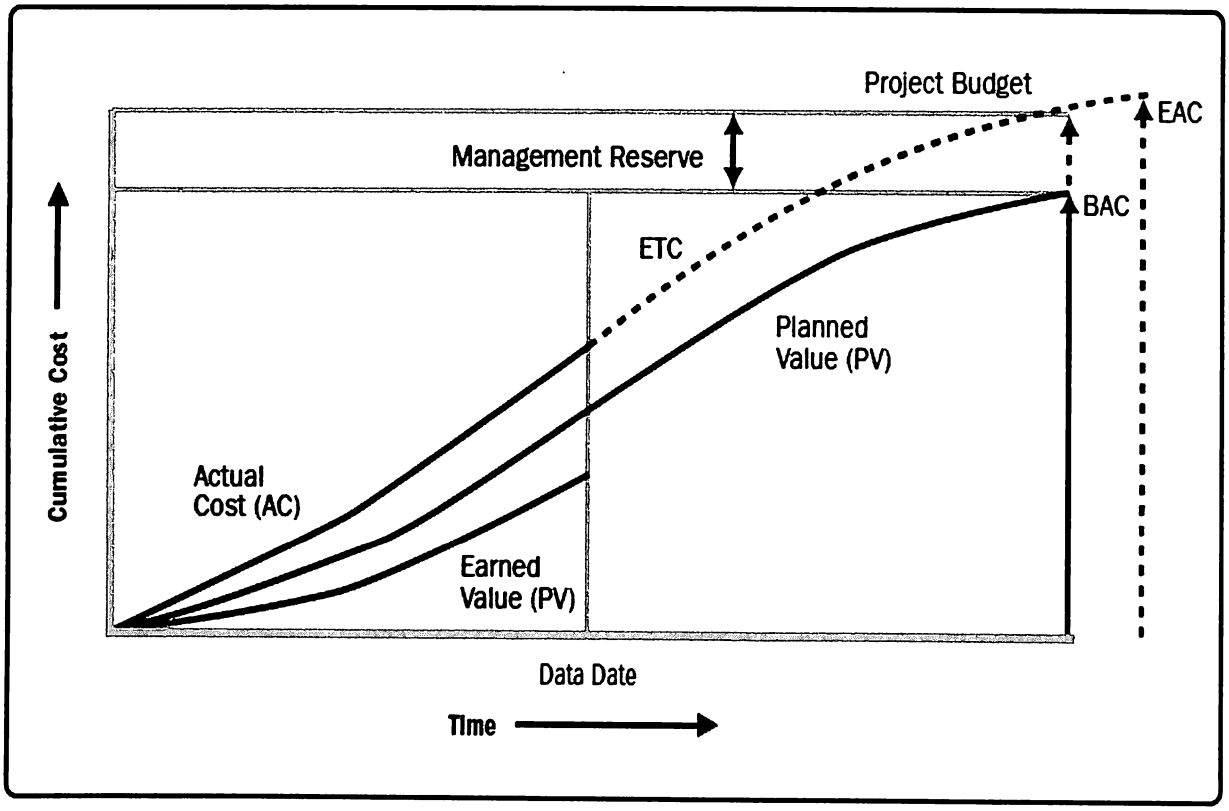

Fig: 6.0 - Project cost control tools and techniques

3.0 Project Plan

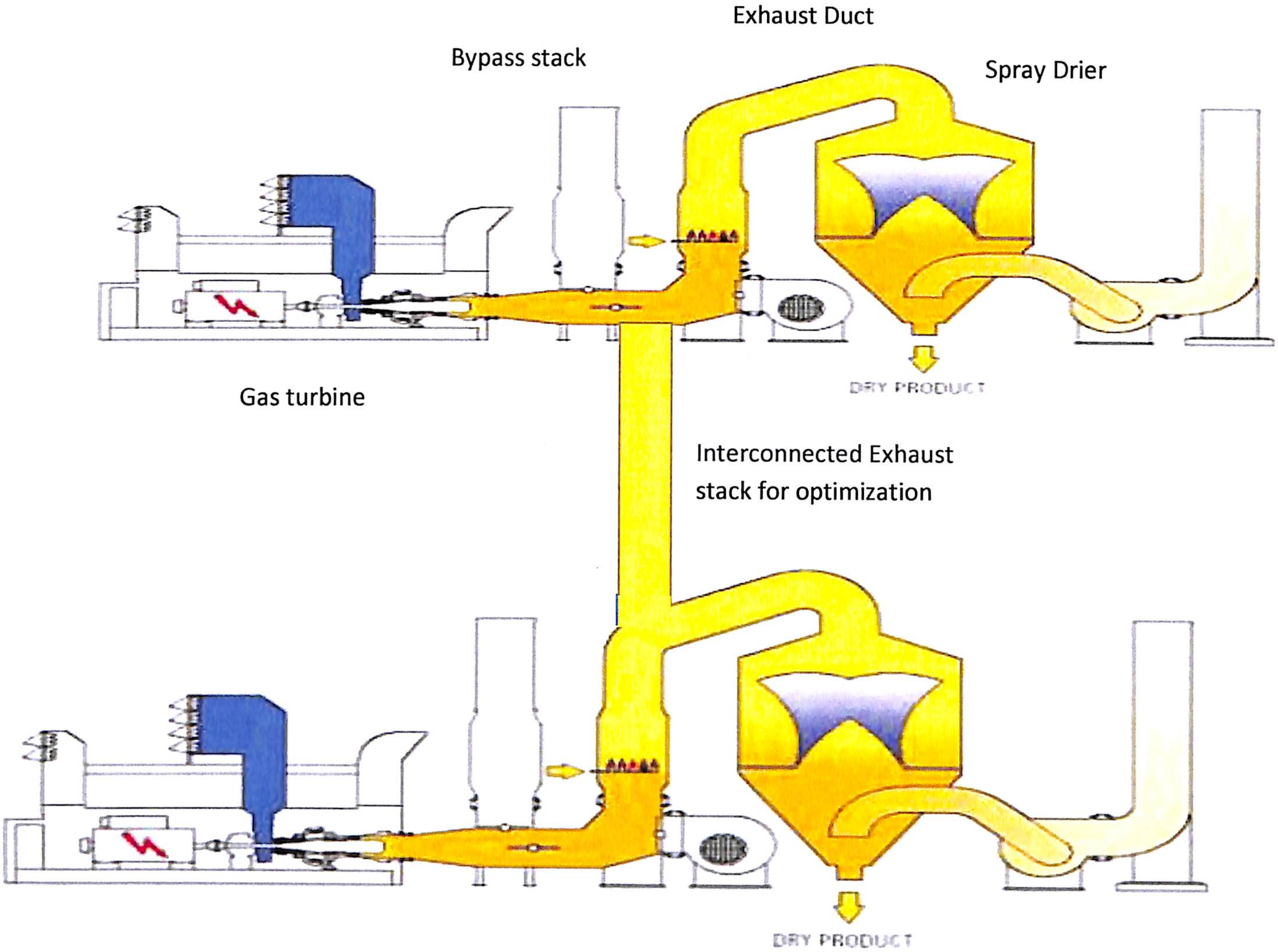

Fig 7.0 - Schematic representation of Co-generation project

Ceramic production process involves wet milling of raw materials with around 30-35% water, later spray drying at 500+ Deg. C in order to bring back the processed raw materials to a powdered form with a moisture content of less than 2% as needed by manufacturing process.

Waste heat from the exhaust gases of a Gas turbine power generator forms a very good medium for providing the latent heat required for vaporization of the water from the milled raw material. Find the below table mentioning key deliverables and ROI consideration for the project. This forms the base for approvals during vibrant scenarios.

3.2 Key Deliverables and ROI Calculations for the Project:

Sl.No	SAVINGS CALCULATIONS WITH TAURUS 60 AND 2 x ATM 110 SPRAY DRYER		
	Description	**Unit**	**TurboMach-T60 x 2Nos**
1	Gross power output (Nominal) - GT	KW	9,400.00
2	Nett power generated (excluding Gas booster)	KW	9,350.00
3	Annual GT operating hours	hrs	8,400.00
4	Unit rate of purchased electricity	INR/kwh	9.00
5	**Cost of electricity purchased from the Grid.**	**INR/year**	**706,860,000.00**
6	Energy input to spray dryer (SD) without cogeneration (Data sheet by RAKC for 1 ATM 110) - **A**	MMBTU/hr	60.00
7	Annual operating hrs of ATM 110 @18hrs/day	Hrs	6,570.00
8	Annual Energy Consumption of ATM 110 - **B**	MMBTU	394,200.00
9	**Current Annual Cost of Purchased Gas for Spray Dryer @ US$ 10 / MMBTU**	**INR**	**289,342,800.00**
	Energy cost calculation with GT cogen		
1	Net Energy input to GT to produce Gross power of 9400 kWe	MMBTU/hr	111.86
2	Annual gas consumption in GT @ 8400 hours / year	MMBTU	939,624.00
3	Net Exhaust Gas Flow rate from GT at 30 Deg C ambient	kg/hr	146,880.00
4	Temperature of GT Exhaust Gas at Dryer Inlet	Deg C	510.00
5	Net Heat input to spray dryer from Gas Turbine in MMBTU/hr - **C**	MMBTU/Hr	65.20
6	Additional Fuel Energy input required to operate the Dryers at full capacity **(A-C)**	MMBTU/hr	-
7	Total annual cost of GT cogen considering Fuel cost is 90% of total cost	INR/year	**689,684,016.00**
8	Total annual savings from Spray dryer gas consumption	INR/year	**289,342,800.00**
9	Total expenses on power generation after savings	INR/year	**400,341,216.00**
10	Cost/Unit of power produced by Co-generation with savings	INR/Kwh	**5.10**
11	Total annual savings due to Cogeneration	INR/year	**306,518,784.00**
	PAYBACK & ROI on the project	**Months**	**44.47**
	Note : The calculations are at 30 deg C with lower heat rates of Gas turbine. The Gas turbine heat rate will see an improvement of approx. 3 - 5 % at lower temperatures . This heat rate would be applicable for approx. 4-6 months of the year .		

Table-2 Key deliverables of the project –ROI

With all the above key project planning and execution, Installation of 2Nos of Cogeneration Gas turbines with 4.5 MW generation capacity each was completed successfully in the year 2018. Exhaust gases of around 150,000 Kg/Hr. Flow rate and 550 Deg. C temperature was being fed to the Spray drier from the ceramic manufacturing process.

As planned, Power cost reduced by 43% with in-house generation through Co-generation Gas turbines when compared to the Grid import. Power import was being made at 9.00 INR/Kwh and in-house captive generation was around 5.2 INR/Kwh.

3.3 Analysis of outcomes

Following was the project outcomes in terms of project performance assessments. The ROI calculated on the project was expected to be 45 months which was already high but was a need of the hour in consideration of long runs in the business during these challenging times.

Description of predicted Expenses	Amount in INR
EPC Co-generation Project Cost	867000000
SACMI scope	16800000
Gas piping & station cost	128000000
Civil & Construction cost	44000000
Electrical cable and related costs	77400000
Firefighting, Furnitures, Tools etc.	2600000
PROJECT PERFORMANCE COST INDICATORS	
Authorized Budget of the project (PV)	**1135800000**
Earned Value (EV)	**1135800000**
Actual Cost/Total Spent (AC)	**1128300000**
Scheduled Variance (SV) = EV-PV	**0**
Cost Variance (CV) = EV-AC	**7500000**
Scheduled Performance Index (SPI) = EV/PV	**1**
Cost Perfomance Indez (CPI) = EV/AC	**1.006647168**

Table-3 Project Budget and Cost indicators

4.0 Impacts due to Tariff cut-off from local Government:

The project got completed in the month of August-2018 and there was a night mare of announcement by the local government on Industrial tariff cut-off by 30% which would let the Returns on investment of the project with a huge question mark. The change of tariff came into effect from the month of November-2019 with around 23% reduction from the initial power cost from the Grid.

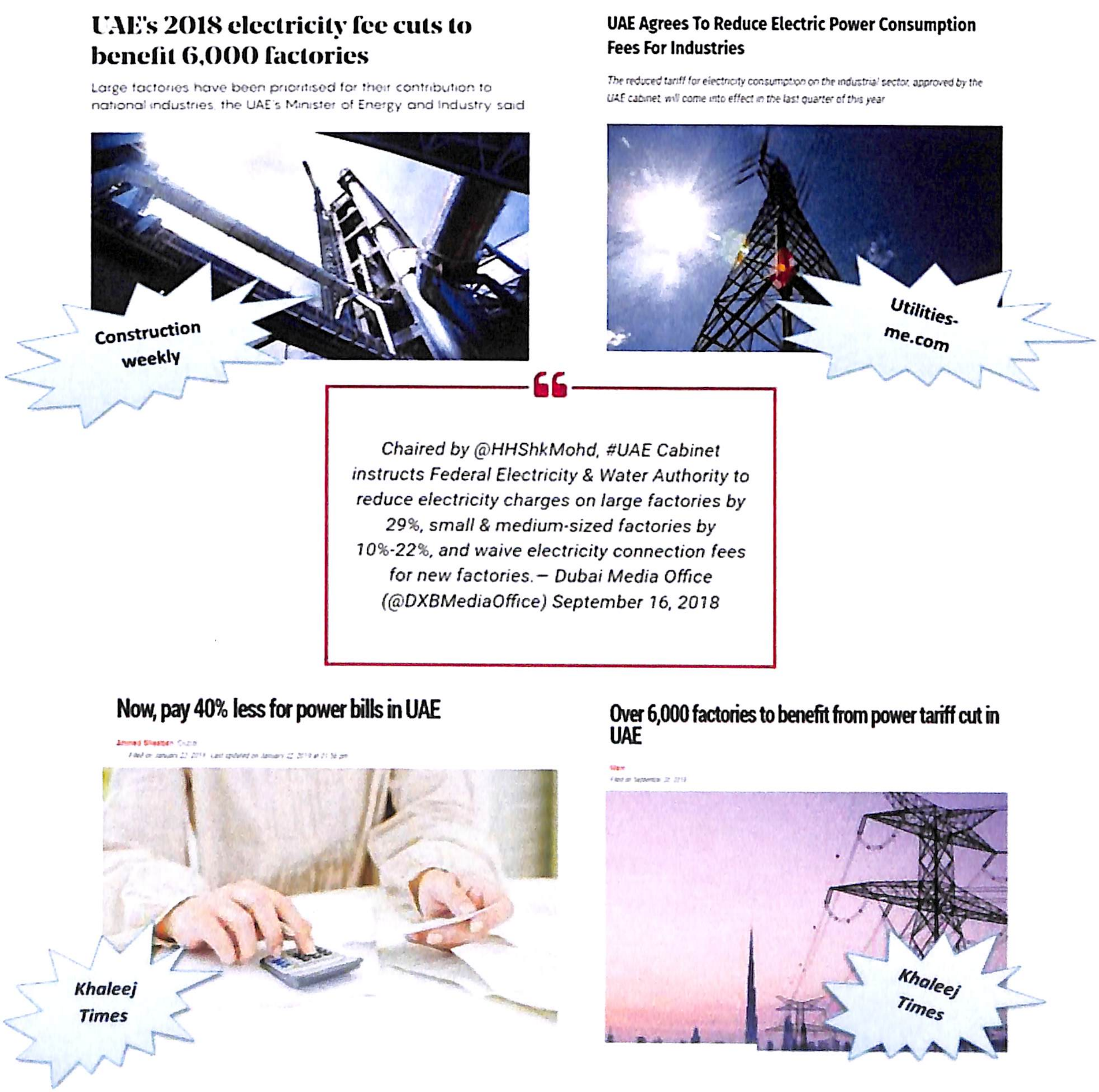

Fig: 7 – Paper cut-outs on new power policy.

4.1 Re-analysis of Outcomes

The project team was re-organized for assessing the impact of this move by the local government on our Co-generation project to understand things better, Pay back calculations were made again with the new Power cost from the Grid and following was the comparative calculations made by us to highlight the management on the impacts.

Sl.No	SAVINGS CALCULATIONS WITH TAURUS 60 AND 2 x ATM 110 SPRAY DRYER			
	Description	Unit	Previous PayBack TurboMach-T60 x 2Nos	Revised Tariff Payback TurboMach-T60 x 2Nos
1	Gross power output (Nominal) - GT	KW	9,400.00	9,400.00
2	Nett power generated (excluding Gas booster)	KW	9,350.00	9,350.00
3	Annual GT operating hours	hrs	8,400.00	8,400.00
4	Unit rate of purchased electricity	INR/kwh	9.00	7.00
5	**Cost of electricity purchased from the Grid.**	**INR/year**	**706,860,000.00**	**549,780,000.00**
6	Energy input to spray dryer (SD) without cogeneration (Data sheet by RAKC for 1 ATM 110) - **A**	MMBTU/hr	60.00	60.00
7	Annual operating hrs of ATM 110 @18hrs/day	Hrs	6,570.00	6,570.00
8	Annual Energy Consumption of ATM 110 - **B**	MMBTU	394,200.00	394,200.00
9	**Current Annual Cost of Purchased Gas for Spray Dryer @ US$ 10 / MMBTU**	**INR**	**289,342,800.00**	**289,342,800.00**
	Energy cost calculation with GT cogen			
1	Net Energy input to GT to produce Gross power of 9400 kWe	MMBTU/hr	111.86	111.86
2	Annual gas consumption in GT @ 8400 hours / year	MMBTU	939,624.00	939,624.00
3	Net Exhaust Gas Flow rate from GT at 30 Deg C ambient	kg/hr	146,880.00	146,880.00
4	Temperature of GT Exhaust Gas at Dryer Inlet	Deg C	510.00	510.00
5	Net Heat input to spray dryer from Gas Turbine in MMBTU/hr - **C**	MMBTU/Hr	65.20	65.20
6	Additional Fuel Energy input required to operate the Dryers at full capacity **(A-C)**	MMBTU/hr	-	-
7	Total annual cost of GT cogen considering Fuel cost is 90% of total cost	INR/year	**689,684,016.00**	**689,684,016.00**
8	Total annual savings from Spray dryer gas consumption	INR/year	**289,342,800.00**	**289,342,800.00**
9	Total expenses on power generation after savings	INR/year	**400,341,216.00**	**400,341,216.00**
10	Cost/Unit of power produced by Co-generation with savings	INR/Kwh	**5.10**	**5.10**
11	Total annual savings due to Cogeneration	INR/year	**306,518,784.00**	**149,438,784.00**
	PAYBACK & ROI on the project	**Months**	**44.47**	**91.21**

Table-4 Re-analysis with new tariffs

Pay Back months was doubled due to the revised power tariffs from the government, this ended up the project to have a very small monetary benefit to the firm in terms of profitability. The firm has to typically wait for 8 Years for returns on its investment which is a very bad scenario in the current market trends.

5.0 Conclusions

1. Project management is a Key subject of interest which requires all possible forecasts. Even with vibrant forecasts, some unpredicted moves may result in down trend of incomes.
2. Projects are failing by spectacular numbers and they have been doing so for as long as we can remember. Despite all the efforts that have been put into further professionalizing the project management discipline an average of 40% of projects do not deliver according to the conditions given (McKenna, Wilczynski & Vanderschee, 2006; Bakker, 2008).
3. Co-generation scheme of operating Gas turbines with spray dryers in Ceramic tiles manufacturing process is a very attractive option in countries with higher power costs.
4. Project control, cost control tools, scheduling, reporting all plays an important role in execution of project and the learnings by me in this project will be carried forward.
5. ROI calculations made during the planning stage of the project was greatly affected due to the new Power cost policies framed by the local government.
6. Many captive power generation industries proved to be ineffective with the reduction in power tariffs from the Grid. Whereas this was a boon to many large and small scale industries to improve on their profit margins during the tough economic conditions.
7. The power tariff reduction by the local government was in-line with their future prediction of getting higher FDI's in the region which would in turn boost their economy.
8. The management has to now take a wise decision to tap the opportunity provided by the government and also manage to keep the new system in operation. Optimization of scheme of power import would be made accordingly.
9. On a whole, the learnings from the project was vast and would be always thriving for betterment of my skills and knowledge. This experience would be utilized in all of my future assignments.

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