**SMART BUSINESS PROCESS OPTIMIZATIONS MAKE UTILITIES SUSTAINABLE: NSPCL EXPERIENCE A CASE STUDY**

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**ABSTRACT**

To accommodate high quantum of renewable energy into the grid, thermal plants are likely to run at low plant load factor in future. Technologies borrowed from gaming (Augmented reality), finance (block chains), and nature will offer unique solutions to complex challenges that will reshape how the power generation sector thinks about plant operation. This paper attempts to discuss smart strategies at two levels- technological and process optimization for making utilities sustainable.

Alongwith state-of-the art technology, utilities need to deploy smart process optimizations, which ensure enhanced capacity utilization for them to become sustainable in the longer run. With an increasing renewable energy mix, the coal based stations in the country may well have to perform both base load as well as peak load function. This paper discusses mechanisms that will enable utilities to become smart, swift, flexible and agile in all areas of operation, particularly start-up, shutdown, low load operations etc. The paper also attempts to explore the recent policy interventions by Government of India, other related Regulatory Institutions and their impact on making the sector responsive to market dynamics ensuring their sustainability.

Further, the paper endeavors to share NSPCL experience as a case study for coping with these challenges and ensuring sustainable performance through several process innovations viz. inter-beneficiary Un-requisitioned Power Surplus (URS) tie-up, trading of URS power at exchanges, rendering Reserves Regulation Ancillary Services (RRAS), bundling- reverse bundling of power, reduction in Energy Charge Rate, Energy Saving Certificates etc.

*Key Words:* Process Optimizations, Policy Interventions, NSPCL, case study, URS, RRAS

1. **INTRODUCTION**

The existing stations in the country are facing unprecedented headwinds from stringent environmental norms on the one hand and technological obsolescence on the other. There are strong policies undercurrents reflecting phasing out of old stations (25 years plus) by new supercritical technology based units. The sustainability of these stations is in serious jeopardy and necessitate immediate policy and process optimizations.

Today the power sector in India is at crossroads with renewable energy being increasingly seen as the messiah. But, the increasing renewable energy mix also poses several challenges on sustainability of our existing stations as renewable energy sources particularly solar and wind recently achieved grid parity. Besides pricing concerns, utilities need to remodel their operations inconsonance with the vagaries of renewable generation.

The coal based stations essentially designed for base load, may well have to perform both base load as well as peak load function. Utilities may well need to undergo a paradigm shift in their orientation from being hitherto available and reliable to a more responsive and flexible one which necessitate the operations to become smart in technology and innovative sizing of units. Plant automation need to be enhanced significantly for higher degree of responsiveness of the system. Swift, subtle and agile operation of units which can be start-up and shutdown in less time alongwith sustained low load operations are some of the process optimizations that may be warranted in this milieu. These technologies represent the power plant of the future where the most cutting-edge technologies are effectively leveraged to provide clean and efficient power for us all.

NTPC-SAIL Power Supply Company (P) Ltd. (NSPCL), a 50:50 Joint venture of NTPC Ltd. and SAIL, owns and operates captive power plants of SAIL at Bhilai (74 MW), Durgapur (120 MW) and Rourkela (120 MW). NSPCL has installed 2 X 250 MW Bhilai Expansion Power plant and supplies power to the state of Chhattisgarh, UT Daman & Diu, UT Dadra & Nagar Haveli and SAIL. Besides its existing capacity of 814 MW, NSPCL has undertaken capacity addition at Rourkela (250 MW), Durgapur (40 MW), Salem Solar (50 MWp), Durgapur Solar (20 MWp) and Kulti Solar (25 MWp).

Making use of several policy interventions by Government and related Regulatory Institutions, an attempt has been made to discuss several policy and process optimizations in the sector which go a long way in making utilities sustainable. While discussing these mechanisms, the experience of NSPCL in implementing some of these has been cited as a case study.

Capacity utilization has now been widely regarded as a measure of performance of operating stations. Accordingly, the results have been quantified in terms of improved capacity utilization (Plant Load Factor-PLF) for each of these process optimizations individually and on a whole.

Based on the results it can be concluded that while technology automation is a pre-requisite for flexibility and responsiveness in the system, timely implementation of policy and process optimizations go a long way in making utilities sustainable.

**2. PROCESS OPTIMIZATION**

Process optimization refers to adjusting a process so as to optimize some specified set of parameters without violating some constraint. The most common goals are minimizing cost, maximizing throughput, and/or efficiency. Process orientation and optimization is now an indispensable part of any modern business unit, technical, administrative or managerial to survive in the national and international competitive environment.

The ongoing process optimization with continuous evaluation, are aimed at sustainable improvement of the given processes. Well-documented approaches in this context are Business Process Reengineering (BPR), Kaizen and Six Sigma etc. While BPR deals with fundamental radical rethinking of business design rather than iterative improvements, Kaizen advocates continuous improvements through small modifications and Sig Sigma is a quality improvement strategy focused on removing variability from processes.

1. **CUSTOMIZED TECHNOLOGICAL OPTIMIZATIONS FOR UTILITIES**

Emerging technologies in the field of instrumentation and controls are poised to have a big impact on power production. While some technologies are still in the basic stages of research and development (R&D) and on the cusp of widespread adoption, others are now entering operating rooms to change our industry for the better. Some of the technologies represent major advances on conventional approaches. Others are adaptations from outside industries, and even nature, that are providing game-changing innovations for tomorrow's power generation. Together, these technologies represent the power plant of the future where the most cutting-edge technologies are effectively leveraged to provide clean and efficient power for us all.

*Big data for utilities: Leveraging data generation and collection*

Power companies need to work on customized sector specific optimizations by leveraging technological innovations to achieve the next level of operational efficiency using existing data generation and collection tools for notification of potential equipment problems much before failure.

*Environmental Concerns*

The lack of real-time information is disadvantageous for power plants seeking to comply with growing stringent regulations for water, ambient air and effluent quality guidelines. Sensors that enable real-time feedback information regarding critical water treatment processes, such as flue gas desulphurization, will allow for optimized performance and cost savings in the form of more efficient metering and use of relevant chemicals.

*Automation of processes*

In today’s digital world, an optimally run power plant relies on valuable and accurate data in order to ensure assets are running reliably and with minimal downtime. Streaming in from control systems, Supervisory Control and Data Acquisition (SCADA) systems, distribution management systems, energy management systems, equipment sensors etc, this data may be organized and available to many resources if optimization is to be effective. With an ever-increasing trend toward big data and large systems of information, synthesizing this data in a meaningful way that provides actionable information is a significant undertaking.

1. **SUGGESTED PROCESS OPTIMIZATIONS FOR UTILITIES**

The paper has made an extensive study of some recent process optimizations deployed by utilities.

1. ***Inter-beneficiary tie-up of Un-requisitioned surplus (URS)***

With the entry of private players in the sector and implementation of merit order for scheduling of power from Stations, substantial capacity remained idle leading to a drop in national PLF over the years. Initially, stations used to tie up with their existing beneficiaries for utilising the Un-requisitioned Power Surplus (URS) of one beneficiary by the others.

Before the Revised Tariff Policy dated 28.01.2016 of Ministry of Power, Govt. of India, the URS of one beneficiary was requisitioned and utilised among the other beneficiaries of the Bhilai Station (2 X 250 MW).

The tariff1 for URS power being availed entails the following:

* Fixed charges for the quantum are to be paid by the beneficiary availing URS.
* Energy Charges are billed to the beneficiary utilizing the URS.

Bhilai Expansion Power Plant (2 X 250 MW) of NSPCL supplies power to four beneficiaries namely, the state of Chhattisgarh, UT Daman & Diu, UT Dadra & Nagar Haveli and Steel Authority of India Ltd. (SAIL). NSPCL had tied up with its beneficiaries namely UT Daman & Diu and Steel Authority of India Ltd. (SAIL) for utilizing the URS power from its Bhilai Expansion Power Plant (2 x 250 MW) left unscheduled by other beneficiaries namely UT Dadra & Nagar Haveli and Chhattisgarh. The results for Inter-beneficiary URS tie up by NSPCL with its beneficiaries from Bhilai Expansion Power Plant (2 x 250 MW) for 2016-17 have been very encouraging leading to enhanced capacity utilisation by approx. **1.65%**.

This mechanism is strongly recommended for higher capacity stations, which has a large number of beneficiaries so that the surplus power can be scheduled amongst each other in real time.

1. ***Trading of URS of Beneficiaries at Power Exchange***

In January 2016, Government of India notified amendments in the National Tariff Policy enabling trading of URS power at exchange with the consent of the beneficiaries concerned. NSPCL is one of the few power players which successfully implemented trading of URS of 100 MW of one of its beneficiaries namely Dadra & Nagar Haveli (DNHPDCL) at power exchange. It would be pertinent to mention that consent from other beneficiaries would have ensured higher quantum of capacity utilization.

High level consultations at the ministerial level are underway to allow generators to now trade URS without obtaining the mandatory explicit consent of the beneficiaries concerned which is expected to give a greater fillip to utilising the capacity remaining unscheduled for many of the stations in the country including NSPCL, ensuring their long term sustainability.

*Fig-1 : Different Players and their roles in Trading of URS at Exchange*

The tariff for URS power being traded in the market entails the following:

* Fixed charges for the quantum shall be borne by the principal beneficiary.
* Sharing of gains arising out of the same shall be in the ratio of 50:50.
* Such gain to be calculated as the difference between selling price of power and fuel charge

The results for trading URS at Power Exchange by NSPCL from Bhilai Expansion Power Plant (2 x 250 MW) for 2016-17 indicate profitability for both the generator and the original beneficiary and also higher capacity utilization for stations on a whole.

This mechanism is now being used in a large measure by several Utilities on a day ahead basis which have competitive prices (Energy charges).

1. ***Implementation of Reserves Regulation Ancillary Services (RRAS)***

Central Electricity Regulatory Commission (CERC) in March 2016 notified a procedure for Ancillary Services Operation which made obligatory for stations to provide the Reserves Regulation Ancillary Services (RRAS). Although the objective of RRAS Regulations is to help in restoring the frequency level to nominal level, it has also led to enhanced capacity utilization by mandating stations to attune their capacity as and when requisitioned by the system operator by ramping up (RRAS Up) and down (RRAS Down) as per the regional grid requirement.

NSPCL has also been fulfilling its obligation of implementing RRAS and in the process during the FY 2016-17 resulting in enhanced capacity utilization by a PLF of approx..1.25% besides getting compensated adequately for the Ancillary Services (AS) rendered.

The tariff (compensation for AS) for power being delivered by RRAS provider under RRAS up /RRAS down entails the following:

* Incentive @50 paise/Kwh for RRAS up
* 25% Energy Charges for RRAS down

The results for Fulfilling RRAS Obligation by NSPCL during the FY 2016-17 indicate improvement in capacity utilization and are considered to be favorable for operational efficiency and regional grid stability.

1. ***Reduction in Energy Charges (ECR)***

NSPCL has carried out Substitution of imported coal from domestic sources resulting in a secular decline in Cost of Energy in general and Energy Charges in particular. This reduction in Energy charges is critical for obtaining favourable merit allocation from DICOMS, which ensures sustained operation at higher loads.



*Fig-2: ECR Reduction for Bhilai (2 X250 MW) of NSPCL from 2012-13 to 2016-17 (upto Jan’17)*

1. **Bundling-Reverse Bundling of Power**

The bundling of power was a good scheme when tariffs for solar power were much higher but they have seen a steady decline and solar power is no longer being seen as a subsidized entity. However, some states no longer want thermal and solar power bundled.

The day has come when solar/wind have started subsidizing thermal generation as solar and wind based energy sources achieve grid parity with coal. This may well be described as *“Reverse Bundling of power”* in the sense that now thermal power can be bundled to ensure their marketability in the power market for improved capacity utilization.

1. **Real-time pricing (RTP) of Electricity**

Driven by concerns involving capacity (investment) constraints, environment issues and the need to balance intermittent renewable generation, there has been a renewed policy interest around the world in the efficient pricing of electricity. Given the specificities of the electricity market, the whole sale price of electricity varies substantially over the day, nonetheless consumers have been long charged a fixed retail price. RTP leads to substantial efficiency gains due to more efficient allocation of consumption leading to a reduction in the need for costly peak capacity.

Real time pricing (RTP) of electricity is theoretically more economically efficient than flat rate pricing. However, a switch to RTP means that many consumers will lose the cross subsidy they are receiving under the flat rates. However, RTP has the potential to bring a net welfare increase to the consumers if they shift or curtail usage during peak hours. Many consumers in the short run especially having smaller loads would find it less beneficial due to less elastic demand although with a potential for improvement in the long run.

Peak hours- 6-10 Hrs and 18 to 24 hrs

The major barrier against RTP is that the policy makers need to communicate the long term savings to consumers. Examples of few European Countries namely Germany and Austria can be of comparative learning to the policymakers.

1. **POLICY INTERVENTIONS AND INNOVATIONS**
2. **UDAY2- Ujjwal Discom Assurance Yojana-** The low utilization is primarily due to the inability of financially stressed DISCOMS to purchase electricity, underscoring the importance of addressing the financial health of the distribution companies. Ujwal Discom Assurance Yojna (UDAY), will allow the states to take over 75% of the debt of DISCOMS shall make them financially healthier.
3. **Revised National Electricity Policy3-** In January 2016, the Government of India notified amendments in the National Tariff Policy enabling trading of URS power at exchanges with the consent of the beneficiary(s).
4. **Amendments under Discussion-** High level consultations at the ministerial level are underway to allow generators to now trade URS without obtaining the mandatory explicit consent of the beneficiaries concerned which is expected to give a greater fillip to utilising the capacity remaining unscheduled for many of the stations in the country including NSPCL, ensuring their long term sustainability.
5. **Ancillary Services Operation- CERC4** in March 2016 notified a procedure for Ancillary Services Operation which made obligatory for stations whose tariff is determined by CERC including NSPCL to provide the Reserves Regulation Ancillary Services (RRAS).
6. **Coal Rationalization for power plants-** Govt. has ensured that all coal based stations in the country have sufficient stocks of domestic coal and there is little need to import coal which increases price of power and adversely affects the marketability of power from thermal power stations.
7. **RESULTS AND DISCUSSIONS**

***Inter-beneficiary tie-up of URS***

Bhilai Expansion Power Plant (2 X 250 MW) of NSPCL supplies power to four beneficiaries namely, the state of Chhattisgarh, UT Daman & Diu, UT Dadra & Nagar Haveli and Steel Authority of India Ltd. (SAIL). NSPCL had tied up with its beneficiaries namely UT Daman & Diu and Steel Authority of India Ltd. (SAIL) for utilizing the URS power from its Bhilai Expansion Power Plant (2 x 250 MW) left unscheduled by other beneficiaries namely UT Dadra & Nagar Haveli and Chhattisgarh.

The results for Inter-beneficiary URS tie up by NSPCL with its beneficiaries from Bhilai Expansion Power Plant (2 x 250 MW) for 2016-17 have been shown in the table underneath which indicates that approx.. 55 Million Units (MUs) have been utilized due to this arrangement, resulting in enhanced capacity utilisation by approx. **1.65%**.

*Table-1: Inter-beneficiary tie-up of URS for Bhilai (2 X250 MW) of NSPCL for 2016-17*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Beneficiary** | **DC (MU)** | **SG (MU)** | **URS (MU)** | **URS**  **availed (MU)** |
| **Chhattisgarh** | 359.96 | 185.78 | 174.18 | 36.89 |
| **UT DD** | 503.94 | 435.62 | 68.32 | 0.00 |
| **DNHPDCL** | 719.92 | 155.15 | 564.76 | 0.14 |
| **SAIL** | 2078.23 | 2050.85 | 27.38 | 18.39 |
| **TOTAL** | 3662.04 | 2827.40 | 834.64 | **55.42** |

***Trading of URS of Beneficiaries at Power Exchange***

NSPCL is one of the few power players which successfully implemented trading of URS of 100 MW of one of its beneficiaries namely Dadra & Nagar Haveli (DNHPDCL) at power exchange.

The results for trading URS at Power Exchange by NSPCL from Bhilai Expansion Power Plant (2 x 250 MW) for 2016-17 indicate that NSPCL has implemented trading of URS of 100 MW of DNHPDCL by delivering approx. **115 MUs** during the FY 2016-17 resulting in enhanced capacity utilisation by a PLF of approx.. **3%**. This improvement in capacity utilization is considered to be favorable for operational efficiency also.

*Table-2: Trading of URS at Power Exchange for Bhilai (2 X250 MW) of NSPCL for 2016-17*

|  |  |  |
| --- | --- | --- |
| **Beneficiary** | **URS (MU)** | **Profit accrued after sharing (Rs. Cr.)** |
| **DNHPDCL** | 115 | 2.89 |

***Implementation of RRAS***

**N**SPCL has also been fulfilling its obligation of implementing RRAS and in the process during the FY 2016-17 resulting in enhanced capacity utilization by a PLF of approx..1.25% besides getting compensated adequately for the Ancillary Services (AS) rendered.

The results for Fulfilling RRAS Obligation by NSPCL during the FY 2016-17 resulted in enhanced capacity utilisation by approx. **45 MU**, a PLF of approx..**1.25%** besides getting compensated adequately for the AS rendered. This improvement in capacity utilization is considered to be favorable for operational efficiency and regional grid stability.

*Table-3: Implementation of RRAS details for Bhilai (2 X250 MW) of NSPCL for 2016-17*

|  |  |
| --- | --- |
| RRAS Up Generation (till Feb’17) | 45.12 Mus |
| RRAS Down Generation (till Feb’17) | 7.79 MUs |



***Reduction in Energy Charges (ECR)***

NSPCL has carried out Substitution of imported coal from domestic sources resulting in a secular decline in Cost of Energy in general and Energy Charges in particular. This reduction in Energy charges is critical for obtaining favourable merit allocation from DICOMS, which ensures sustained operation at higher loads

*Fig-1: ECR Reduction for Bhilai (2 X250*

*MW) of NSPCL from 2012-13 to 2016-17 (upto Jan’17)*

1. **CONCLUSIONS**

The power plant of the future will continue to provide reliable, affordable, abundant energy to the country, but it will do so in a totally new way. Instrumentation and measurements will include "smart" components that feature embedded intelligence (AI), advanced 3D imaging, and immersive data visualization enabled by new technologies such as augmented reality. This newly acquired information can be leveraged to develop novel controls strategies based on rapid feedback that will enable robust, flexible power generation systems able to function with unprecedented efficiency. Technologies borrowed from gaming, finance, and nature will offer unique solutions to complex challenges that will reshape how the power generation sector thinks about plant operation. Together, these technologies will render our utilities smart and sustainable.

Besides automation, utilities need to deploy innovative and customized Business Process Optimizations, which not only give them a Sustainable Competitive Advantage (SCA) over their competitors but also usher in a new and better way of doing business in the power plant industry.

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